Regional Comparative Advantage in China's Main Grain Crops

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This paper explores the regional comparative advantage in grain production in China directly according to production and associated costs. Two groups of indicators are used in the study. The first group of indicators includes Net Social Profitability (NSP) and Domestic Resource Costs (DRC), both measuring the net social welfare gained from one production activity against its opportunity costs at border prices. The second group of indicators includes Efficiency Advantage Indices (EAI), Scale Advantage Indices (SAI) and Aggregated Advantage Indices (AAI), which measuring relative yield and scale advantages in a region. The study reveals that the comparative advantage in main grain crops varies significantly across China. It implies that there exists great potential to improve resource allocation and to increase grain production through restructuring of the grain sector. The study also indicates that China is able to compete in the world market even if it as a whole has comparative disadvantage in producing some crops, as some of its provinces may still have comparative advantage in those crops. This implies that detailed analyses at provincial level are needed in projecting China's grain trade flow in the future.

1 Introduction

With 9.6 million km^2 of total land area, China is a big country and exhibits significant regional differences in climate, topography, soil and so on. Partly due to such differences in natural resource endowments and partly due to those in the level of economic development, various cropping systems and production techniques have been developed in the grain sector across China during her long history. Those differences constitute the bases of regional comparative advantages in grain production, as well as in other sectors.

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In a market economy, regional comparative advantage may lead to diversified production and exchange of products among regions. Producers may benefit from higher returns on more efficient resource allocation, and consumers may benefit from more choices, better qualities, and lower prices. Comparative advantage is evident in the volumes in regional grain transactions. This measurement, and its evolution, can be used as a guide in policy making, and the later may contribute to better utilisation of comparative advantage and to realising higher economic growth.

However, that approach may not be possible in China. The control on grain production in central planning was the tightest among all agricultural products before the reform. Although the "unified procurement and marketing" scheme was replaced by the "contracted purchasing" at farm gate in 1985, and the ration coupon system was formally abolished in the urban areas in 1993, the control on grain production, as well as on grain marketing, has continued throughout the reform era. As a matter of fact, such control was tightened once again when the "governor responsibility system" (to insure grain supply in each province) was instituted in 1994. To most provincial leaders, ensuring grain supply simply means producing adequate grain under their direct control in order to meet the demand for local consumption and for outward shipment required by the central government. Furthermore, the under-developed marketing infrastructure is also partly responsible for China's inability to fully realise regional comparative advantage in grain production.

Therefore, it is reasonable to assume that regional comparative advantage in China's grain production is far from being fully realised, and there is significant potential in improving the resource allocation efficiency based on regional comparative advantage. It is also reasonable to assume that the volumes of regional grain shipments are not a good indication of regional comparative advantage, so any policy aiming at such improvement should seek alternative measurements. This study tries to measure regional comparative advantage in China's grain production with direct production indicators instead of the trade flow data. It is expected that the formers are able to reveal the underlying but not yet realised regional comparative advantage in the sector.

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As the grain market is to be reformed and developed further, the finding of this study may help the Chinese policy makers to understand how and to what extent they can adjust their policy in order to improve resource allocation. It may also help grain producers to foresee in what directions they will be able to change their production structure in order to increase their income when the market situations change. The finding of this study may also have important implications in international grain trade, as China is approaching to joining the WTO and to opening her grain market to a larger extent.

2 Analytical framework and data

This study uses two types of indicators to measure regional comparative advantage in China's grain production. The first type of indicators includes Net Social Profitability (NSP) and Domestic Resource Costs (DRC), both measuring the net social welfare gained from one production activity against its opportunity costs at border prices[2]. The second set of indicators includes Efficiency Advantage Indices (EAI), Scale Advantage Indices (SAI) and Aggregated Advantage Indices (AAI), which measure relative yield and scale advantages in a region[3].

The NSP measures the net social gain produced from an economic activity defined as the difference between values of the products and associated opportunity costs plus possible externality:

$$NSP_j = \sum_{i=1}^{n} a_{ij} P_i - \sum_{s=1}^{m} F_{sj} V_s + E_j \qquad (1)$$

where NSP_j = the net social profit generated from the jth activity;

a_{ij} = quantity of the ith product produced by the jth activity;

P_i = the border price of the ith product;

F_{sj} = the quantity of the sth input used in the jth activity;

[2] See Pearson, (1973).

V_s = the opportunity cost of the sth input; and

E_j = the externality of the jth activity.

The first term on the right hand of the equation is the sum of the gross values of all products produced by the jth activity measured at border prices, and the second term is the sum of the opportunity costs of all inputs required in the activity. So the difference between the two is a direct net gain (or loss) of the society resulted from carrying out that activity. The last term on the right hand of the equation is a measurement of any potential externality resulted from that activity. It is an indirect net social gain (or loss) which should be taken into account if not equal to zero. If the sum of the direct and indirect net social gains is positive, the jth activity is socially desirable as the total benefits exceed the total opportunity costs, and vice versa.

Measured at border prices, the value of the NSP indicates the potential net social gain from one activity based on an international comparison. As such, it can be taken as an indicator of the implied comparative advantage (or disadvantage) for that activity.

If the imported or tradeable inputs and foreign factors of production are distinguished from domestic resources, the above equation may be revised as

$$NSP_j = (U_j - M_j - R_j)*V - \sum_{s=1}^{m} F_{sj} V_s + E_j \qquad (2)$$

where U_j = the gross value of the jth activity measured at border prices and in foreign currency;

M_j = the total value of all imported and/or tradeable inputs measured at c.i.f. and in foreign currency;

R_j = the total opportunity costs of all foreign factors of production in foreign currency;

V = the shadow price of foreign exchange denoted by the quantity of local currency per unit of foreign currency.

[3] See Li, (1997).

All other notations are the same as before.

The difference between the two equations is that the latter emphasises the net social benefit generated from one activity based on international comparison. In that case, the social desirability of the jth activity is assessed under open-market assumptions.

The DRC measures the necessary total costs of domestic resources required in one activity in order to earn (or save) one unit of foreign currency:

$$DRC_j = \frac{\sum_{s=1}^{m} F_{sj}V_s - E_j}{U_j - M_j - R_j} \qquad (3)$$

where DRC_j = the domestic resource costs required in the jth activity, and all other notations are the same as before.

The numerator of the equation is the total costs of domestic resources used in the activity in local currency, and the denominator is the total foreign exchange earned (or saved) from the same activity. So the quotient is the implied exchange rate resulted from carrying out the jth activity.

Equation (3) is linked with Equation (2). If the NSP is set equal to zero, meaning that the jth activity is at the break-even point based on a social benefit-cost analysis, the shadow price of foreign exchange must be equal to the DRC, the implied (or actual) exchange rate. This can be easily verified mathematically. If the left hand of the Equation (2), NSP_j is set equal to zero, the first term of the right hand is moved to the left hand, and both sides are divided by the part in the brackets, then, it leaves V in the left hand of the equation and the remaining in the right hand exactly same as in the Equation (3).

Therefore, the following conclusions hold:

1. If $DRC_j = V$, then $NSP_j = 0$, the jth activity is at break-even point;
2. If $DRC_j < V$, then $NSP_j > 0$, the jth activity has a comparative advantage;
3. If $DRC_j > V$, then $NSP_j < 0$, the jth activity has a comparative disadvantage.

A Domestic Resource Costs Coefficient (DRCC) is defined as the DRC divided by the shadow price of foreign exchange, V:

$$DRCC_j = \frac{DRC_j}{V} \qquad (4)$$

The following conclusions also hold:

1. If $DRCC_j = 1$, then the ith activity is at break-even point;
2. If $DRCC_j < 1$, then the ith activity has a comparative advantage;
3. If $DRCC_j > 1$, then the ith activity has a comparative disadvantage.

Furthermore, the extent to which one activity has a comparative advantage or disadvantage could be measure by how much its value of DRCC is less or greater than one. Although the original usage of the DRCC is to measure the comparative advantage of one activity in a country against international standards, the relative comparative advantages among activities and/or across regions could also be compared with DRCCs.

The NSP, DRC and DRCC only use production and cost data, and many factors such as border and shadow prices are assumed to be the same for all regions, at least in practice. Therefore, social and cultural factors, which may have some impact on producers' decision and hence should be taken as a part of regional comparative advantage in broad sense, are not considered. Even the price variables may have some problems in measuring regional comparative advantage, since there is no difference in border and shadow prices across regions, and as transportation and marketing costs are not explicitly considered for various regions. For a small country, these factors are not important, as a certain degree of homogeneity is likely to exist. But this can not be assumed to hold for China.

For the above reasons, a set of comprehensive comparative advantage indices, such as the Efficiency Advantage Indices (EAI), the Scale Advantage Indices (SAI), and the Aggregated Advantage Indices (AAI), is also used in this study.

The EAI is an indicator of the relative yield of one crop in one region, in relation to the average yield of all crops in the region, and to the national average:

$$EAI_{ij} = \frac{AP_{ij} / AP_i}{AP_j / AP} \qquad (5)$$

where EAI_{ij} = the Efficiency Advantage Index of the jth crop in the ith region;

AP_{ij} = the yield of the jth crop in the ith region;

AP_i = the average yield of all crops in the ith region;

AP_j = the national average yield of the jth crop;

AP = the national average yield of all crops.

If $EAI_{ij} > 1$, then the yield of the jth crop, relative to all other crops, is higher than that at national average, and vice versa. Assuming no significant difference in techniques among regions, or, at least no significant barriers to technology diffusion and adoption, the EAI_{ij} can be taken as an indicator of relative efficiency due to natural resource endowments and other local economic, social and cultural factors. As such, it could be used as an indicator of comparative advantage as well.

The SAI shows the extent of concentration of one crop in a region, relative to that at national average:

$$SAI_{ij} = \frac{GS_{ij} / GS_i}{GS_j / GS} \qquad (6)$$

where SAI_{ij} = the Scale Advantage Index of the jth crop in the ith region;

GS_{ij} = the sown area of the jth crop in the ith region;

GS_i = the total sown area of all crops in the ith region;

GS_j = the total sown area of the jth crop in the country;

GS = the total sown area of all crops in the country.

If SAI_{ij} >1, then the degree of concentration of the jth crop in the ith region is higher than that in the all country, implying that farmers in the ith region prefer to grow more jth crop, in relative terms, and vice versa. If the concentration level is determined by economic factors, then the SAI could be taken as an indicator of comparative advantage. In this case, a low value of SAI means that producers do not want to increase the share of that production, either as less profitable or restricted by natural (or other) conditions. This implicitly assumes that producers are able to respond to market situation with adjustment in their crop mix, and that the degree of concentration of one crop reflects the relative profitability of that crop in a region. In a sense, it is also a kind of "revealed" comparative advantage, viewed from production structure instead of trade flow.

This assumption seems to contradict to the general assumption in this study, i.e., that the Chinese farmers are not able to fully realise their comparative advantage as the government intervention prevents them from fully adjusting their production. However, the general assumption does not rule out some degree of freedom enjoyed by farmers in their decision making, so the SAI can still be used as one of the regional comparative advantage indicators.

The AAI is simply the geometric average of the EAI and SAI:

$$AAI_{ij} = \sqrt{EAI_{ij} * SAI_{ij}} \qquad (7)$$

If AAI_{ij} >1, then the jth crop in the ith region is considered to have a comparative advantage over the national average, and vice versa. As EAI indicates yield differentials and SAI indicates relative production shares, their geometric average could be taken as a kind of aggregated indicator of comparative advantage.

The regional comparative advantages of main grain crops, such as rice (*Japonica* and

middle *Indica* varieties), wheat, corn, and soybeans are analysed in this study. Due to their small and declining shares in grain production, sorghum and millet are not analysed in this study. For the same reason, early and late *Indica* varieties of rice are also not included in the analysis.

The 1998 cost-benefit data for main farm products and other relevant data are used to calculate DRCC and NSP of the above main grain crops in each province. In order to reduce the impact of weather and other random disturbances, 3-year moving averages of yields and sown areas are used in calculating EAI, SAI and AAI.

3 Empirical analysis

3.1 Comparative advantage in *Japonica* rice

Table 1 is a summary of the calculation of comparative advantages for *Japonica* varieties of rice. There are 13 provinces, minority autonomous regions, and municipalities directly under the State Council[4] growing *Japonica* varieties of rice. Among them, there are 8 provinces where the sown areas exceeding 5% of the national total and hence referred to as major producing regions.

The values of DRCC indicate that most of the growing provinces, and China as a whole, have comparative advantages in growing *Japonica* varieties of rice with only Zhejiang as an exception. The same conclusion can be drawn from the NSP values, as all provinces except Zhejiang will earn net social profit from the production.

Among the 8 major producing provinces, 7 of them (except Zhejiang) have comparative advantages with DRCC values less than 0.85 and positive NSPs. In addition, Liaoning, Jilin and Yunnan have comparative advantages as their EAI, SAI and AAI values exceed one; Heilongjiang and Jiangsu also have comparative advantages as their SAI and AAI values are greater than one and EAI values are very close to one. Although Anhui has a little scale advantage, but it has no advantage in

[4] These three administrative regions are considered at the same level in the hierarchy, and will be

yield and the aggregate advantage index is also less than one. Similarly, Henan has a little advantage in yield but not in scale, and its AAI value is even lower.

Among the 5 minor producing provinces, all of them have comparative advantages in DRCC, but none of them have EAI, SAI and AAI all exceeding one. However, Tianjin, Shanghai and Ningxia might have some comparative advantages as their SAI and AAI greater than one and EAI relatively close to one.

Combining all factors considered, Liaoning, Jilin, Heilongjiang, Jiangsu, and Yunnan are likely to have strong comparative advantages in growing *Japonica* varieties of rice. Tianjin, Shanghai and Ningxia are likely to have comparative advantages in that production. Anhui might have a comparative advantage over other provinces in producing *Japonica* varieties of rice. However, its low values of EAI and AAI might be an indication that it may have stronger comparative advantage in growing other crops. Hebei, Shanxi and Henan might have comparative advantage in producing *Japonica* varieties of rice, but the low values of SAI showing that the expandability of rice production is questionable in the three provinces.

Table 1 Regional Comparative Advantage in *Japonica* Rice

Regions	Share in Sown Areas %	DRCC	NSP Yuan/*mu*	EAI	SAI	AAI
National	100.0	0.84	104.21	1.00	1.00	1.00
Tianjin	1.02	0.77	209.98	0.86	2.56	1.49
Hebei	2.46	0.74	237.49	1.35	0.39	0.73
Shanxi	0.11	0.57	366.41	1.13	0.04	0.21
Liaoning	8.40	0.75	183.10	1.13	3.04	1.85
Jilin	7.66	0.65	246.03	1.15	2.35	1.65
Heilongjiang	19.02	0.74	136.94	0.99	2.77	1.66
Shanghai	2.16	0.80	171.98	0.93	7.29	2.60
Jiangsu	27.28	0.83	126.87	0.99	5.26	2.28
Zhejiang	5.48	1.01	-7.99	0.82	2.13	1.32

referred to as province for simplicity hereafter.

Anhui	5.68	0.76	135.27	0.83	1.05	0.94
Henan	5.16	0.73	202.04	1.08	0.61	0.81
Yunnan	6.23	0.71	203.12	1.03	1.86	1.39
Ningxia	1.13	0.69	244.77	0.93	1.61	1.22

Note: The shadowed areas in the Share in Sown Areas indicate major growing regions with sown area shares greater than 5% of the national total in each province. The shadowed areas in DRCC indicate significant comparative advantage in each province with DRCC values less than 0.85. Those in EAI, SAI and AAI indicate comparative advantage in each province with corresponding values greater than one. One *mu* equals to 667 m^2 or 1/15 hectare.

Source: China's Agricultural Yearbook, 1996-98; National Compilation of Cost-Benefit Data for Farm Products (Quanguo Nongchanpin Chengben Shouyi Ziliao Huibian), 1996-99.

3.2 Comparative advantage in *Indica* rice

Same as in the case of *Japonica* varieties of rice, China has a comparative advantage in middle *Indica* rice production with DRCC equal to 0.8. Among the 7 major and 3 minor growing provinces, only Fujian has a DRCC just above one and NSP negative, and Hubei is at the margin (see Table 2 for details).

Taking all indicators into consideration, Sichuan and Guizhou have strong comparative advantage in middle *Indica* rice production in major producing regions. Their DRCCs are below 0.8 and 0.6, NSPs are above 135 and 283 yuan per mu, respectively, and EAIs, SAIs and AAIs are all above one (AAI close to two). Yunnan and Anhui may have more or less the same level of comparative advantages if measured by DRCC only. However, as they do not have yield advantages, and as their scale advantages are far below the levels in Sichuan and Guizhou, the two provinces might have higher comparative advantages in other crops, and/or they have some problems in expanding rice production. Therefore, the comparative advantages in middle *Indica* rice production are less strong in Yunnan and Anhui. The cases in Jiangsu and Hubei are similar, with the values of DRCC higher and close to one, so the comparative advantages are at the margin.

Table 2 Regional Comparative Advantage in Middle *Indica* Rice

Regions	Share in sown areas	DRCC	NSP	EAI	SAI	AAI

	%		Yuan/mu			
National	100.00	0.80	122.10	1.00	1.00	1.00
Jiangsu	5.69	0.89	77.89	0.90	1.09	0.99
Anhui	10.92	0.69	175.35	0.99	2.05	1.43
Fujian	4.27	1.01	-6.13	0.80	2.35	1.37
Henan	2.39	0.56	260.09	0.96	0.31	0.54
Hubei	10.81	0.98	9.98	1.07	2.48	1.63
Hunan	6.49	n.a.	n.a.	n.a.	1.41	n.a.
Sichuan	37.56	0.78	135.73	1.02	3.81	1.97
Guizhou	9.16	0.58	283.92	1.09	3.53	1.96
Yunnan	6.12	0.58	273.30	0.99	1.85	1.35
Shaanxi	1.89	0.69	182.21	1.28	0.54	0.84

Note: Ibid.
n.a. = not available.
Source: Ibid.

Among the minor production regions, Shaanxi and Henan have comparative advantages measured by DRCC. However, the low values of SAI and AAI indicate that they might have problems in expanding the production.

As the double-rice production is dominant in the province, Hunan has no available cost-benefit survey data on middle *Indica* rice production so the same comparison can not be made. The same situation exists in Jiangxi, Guangdong and Guangxi.

3.3 Comparative advantage in wheat

Wheat production is widely spread in China, where all provinces except Hainan grow wheat. In order to narrow down our focus without loosing important information, 13 provinces are included in the analysis. The 7 provinces with sown areas greater than 5% of the national total each are considered major producers, and the other 6, with sown areas between 3% to 5% of the national total, are considered minor producers in this case. In general, China has no advantage in wheat production as the overall DRCC is very close to one and the NSP is only about US$ 15 per hectare. However, there are still some provinces have some degree of comparative advantages (see Table 3 for details).

It is interesting to note that all minor producers, except Hubei, have a comparative advantage in wheat production measured by DRCC and NSP, and all those advantageous provinces are in the north. Looking at other indicators, Shanxi and Gansu have EAI, SAI and AAI values all greater than one, and hence have relatively strong comparative advantages in wheat production. Xinjiang, and Inner Mongolia have some comparative advantages in two of the three indicators. Heilongjiang does not have any advantages in three indicators, meaning it might have stronger comparative advantage in other crops.

Among the major production provinces, Hebei, Henan and Shaanxi all in the north, have advantages in all indicators, with the latter at the marginal levels measured by DRCC and NSP. Jiangsu, and Anhui, both in the south, have disadvantages in DRCC and NSP, but their EAI, SAI and AAI values all greater than one (or very close to one), which indicate that they may not have other better alternatives in the winter growing season. The situation of Shandong is likely similar to those in Jiangsu and Anhui, although it is located to the north of the two provinces. Sichuan has an obvious disadvantage in growing wheat.

Table 3 Regional Comparative Advantage in Wheat

Regions	Share in sown areas %	DRCC	NSP Yuan/mu	EAI	SAI	AAI
National	100.00	0.98	8.43	1.00	1.00	1.00
Hebei	8.82	0.74	132.69	1.52	1.41	1.46
Shanxi	3.17	0.77	85.88	1.11	1.12	1.12
Inner Mongolia	3.70	0.83	64.57	1.12	0.92	1.01
Heilongjiang	3.87	0.76	76.60	0.81	0.56	0.67
Jiangsu	7.58	1.64	-168.25	0.97	1.44	1.18
Anhui	7.00	1.15	-45.40	1.12	1.31	1.21
Shandong	13.65	1.00	0.74	1.39	1.87	1.61
Henan	16.50	0.87	49.58	1.28	2.08	1.63
Hubei	4.16	1.39	-112.49	0.72	0.96	0.83
Sichuan	8.00	1.15	-44.79	0.76	0.82	0.79
Shaanxi	5.42	0.94	19.18	1.27	1.56	1.40
Gansu	4.55	0.83	80.35	1.06	1.75	1.36
Xinjiang	3.34	0.73	146.97	0.93	2.26	1.45

Note: Ibid.
Source: Ibid.

In summary, the northern minor producers, such as Shanxi, Gansu, Inner Mongolia and Xinjiang, as well as some northern major producers such as Hebei, Henan, and Shaanxi, are likely to have a comparative advantage to some extent in producing wheat. The major producers in the wheat-rice region, such as Jiangsu and Anhui have disadvantages in growing wheat, but their other winter crops might be at even worse situations. This is also likely to be true for Shandong to some extent.

3.4 Comparative advantage in corn

Taking China as a whole, corn production is obviously at disadvantage as the overall DRCC is 1.14, and the NSP is negative 44.68 yuan per *mu*, implying a net social loss in its production. Among the 18 corn growing provinces listed in Table 4, Hebei is the only major producer having significant advantage in all indicators, and Tianjin is the only minor producer in such positions except without a yield advantage. One of the major producers, namely Heilongjiang, has advantages in EAI, SAI and AAI, but only

marginal advantage in DRCC and NSP. Another major producer, Henan, has also marginal advantage in DRCC and NSP, but not in other indicators.

Among the minor producers, Anhui has advantages in DRCC and NSP, but not in the others, implying that some other crops are likely to be better choices according to yield differentials, while Yunnan, Gansu and Xinjiang are at the margin.

Table 4 Regional Comparative Advantage in Corn

Regions	Share in sown areas %	DRCC	NSP Yuan/mu	EAI	SAI	AAI
National	100.00	1.14	-44.68	1.00	1.00	1.00
Tianjin	0.67	0.83	61.44	0.78	1.67	1.14
Hebei	10.19	0.79	71.64	1.08	1.62	1.33
Shanxi	3.42	1.11	-36.86	1.14	1.20	1.17
Liaoning	6.57	1.00	-1.35	1.13	2.41	1.65
Jilin	10.25	1.04	-12.18	1.24	3.18	1.99
Heilongjiang	10.72	0.96	9.75	1.21	1.55	1.37
Anhui	2.36	0.87	30.38	0.85	0.44	0.61
Shandong	11.47	1.09	-30.95	0.98	1.57	1.24
Henan	8.53	0.90	29.36	0.92	1.07	1.00
Hubei	1.69	1.83	-188.68	0.77	0.39	0.55
Guangxi	2.35	1.48	-177.08	0.73	0.71	0.72
Sichuan	7.44	1.43	-121.67	0.78	0.75	0.76
Guizhou	2.69	1.08	-23.31	0.93	1.04	0.98
Yunnan	4.17	0.99	4.61	0.88	1.26	1.05
Shaanxi	4.08	1.22	-53.58	1.02	1.18	1.10
Gansu	1.77	0.96	18.19	1.57	0.68	1.04
Xinjiang	1.90	0.95	21.41	1.04	1.29	1.16

Note: Ibid.
Source: Ibid.

3.5 Comparative advantage in soybeans

The comparative advantage in China's soybean production is rather significant, with the overall DRCC of 0.76 and NSP of 86 yuan per *mu*, while all provinces have DRCC less than one and positive NSP (see Table 5 for details). It is shown in the table that all

major growing provinces have significant advantages in both DRCC and NSP, as well as in all other indicators with a few exceptions. Among the minor producers, Liaoning and Jilin have significant advantages in all indicators, Hubei and Shaanxi have significant advantages in DRCC and NSP, but no advantage in other indicators.

Combining all factors, Liaoning, Jilin, Heilongjiang, Anhui and Inner Mongolia have strong comparative advantages in soybean production. Hebei, Shandong, Henan, Hubei and Shaanxi have also strong advantages in DRCC and NSP, but may have some problems in expanding their soybean production (Hubei does not have yield advantage as well).

Table 5 Regional Comparative Advantage in Soybeans

Regions	Share in sown area (%)	DRCC	NSP Yuan/mu	EAI	SAI	AAI
National	100.00	0.76	86.03	1.00	1.00	1.00
Hebei	5.92	0.58	192.89	1.21	0.94	1.07
Shanxi	2.82	0.99	1.89	0.67	0.99	0.82
Inner Mongolia	7.79	0.81	80.68	1.26	1.94	1.57
Liaoning	3.18	0.79	83.23	1.19	1.17	1.18
Jilin	4.11	0.66	140.38	1.27	1.28	1.27
Heilongjiang	29.47	0.77	64.91	1.19	4.25	2.25
Jiangsu	2.49	0.92	28.67	1.11	0.48	0.73
Anhui	5.65	0.69	86.74	1.01	1.06	1.04
Fujian	1.37	0.95	24.16	1.16	0.75	0.94
Shandong	6.29	0.62	177.79	1.18	0.86	1.01
Henan	6.96	0.63	105.89	1.05	0.88	0.96
Hubei	2.28	0.75	70.44	0.89	0.52	0.68
Shaanxi	3.25	0.64	106.99	1.03	0.93	0.98

Note: Ibid.
Source: Ibid.

4 Conclusions and implications

The above analysis clearly indicates that the comparative advantages in main grain crops vary significantly across China. It implies that there exists great potential to improve resource allocation and to increase grain production through restructuring of

the grain sector. Such restructuring is likely to reduce domestic resource costs in producing grain, and to bring higher returns to producers, as well as to the society.

The analysis also indicates that China is able to compete in the world market even if she as a whole has disadvantage in producing some crops, as some of her provinces may still have comparative advantage in those crops. This implies that detailed analyses at provincial level or below are needed in projecting China's grain trade flow in the future.

Any restructuring of the grain sector requires further market-oriented reform and less government intervention in the sector, as well as further improvement in infrastructure to facilitate large volumes of interregional grain shipment. In addition, more information of regional comparative advantages is essential for policy makers and producers to decide the direction and the pace of the restructuring. This study has provided some information of regional comparative advantages, measured crop by crop for some main crops and among provinces. Further studies are needed in order to cover more crops, and to break down provincial boundaries if possible. More importantly, further studies should reveal regional comparative advantages, province by province, or at lower levels, in growing various crops. The regional comparative advantage viewed from each region, combined with that viewed from each crop, will provide clearer picture of the desired directions of the restructuring.

Such restructuring, if realised, will certainly have major implications in China's grain trade. Not only is the total production likely to increase further and its mix is likely to change significantly, but also the overall DRCC and NSP are likely to be improved significantly. Even though China as a whole is at a disadvantage in some crops, such as wheat and corn, some provinces may still have a comparative advantage in growing them. The restructuring will improve China's position in the international grain market in terms of costs in general, but this does not prevent China from importing more grains in which she has a disadvantage. China can carry out a restructuring with reference to the world market situation, as the comparative advantages revealed in this study indicate.

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