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Trends in China's regional grain production and their implications

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Abstract

The paper examines the growth of China's regional grain production during the reform period. Impacts of regional trends on China's interregional grain transfers and international trade are tackled. It finds that there are significant variations between regions in terms of magnitudes and patterns of growth. Northern regions experienced a faster growth than southern regions. There is a tendency to shift grain production centres towards north, leading to a modification of crop composition in total national output, a reversal of the prevailing direction of interregional transfers and a change in contents of grain flows. The study argues that this shift is an inevitable result of the uneven progress of reforms and economic development and, consequently, the varying opportunity costs of grain production in different regions. The analysis suggests that for China as a whole, further growth of grain output has been impeded by the lack of new technologies and increasingly high opportunity costs of grain production. In the northeast region where the potential for increasing maize output is relatively high, production has been constrained by the shortage of transport and storage facilities as well as policy obstacles. The study concludes that there is a necessity for China to decentralize its grain international trade. In doing so, the imports of grain in the south will increase, and so will the exports of maize in the north.

1. Introduction

The issue of grain production and supply has always been a crucially important concern for the Chinese government and people. With China's increasing involvement in the world market, this issue has drawn more and more international attention. Following the pessimistic prediction of Brown (1994) of China's future grain production and the potential threat to the global grain supply, the issue has recently been subject to further scrutiny.[2]

Numerous studies have tackled China's grain production both before and since the reform. Most of them, however, have focused on the country as a whole. Studies concerning regional disparities in grain production have been relatively few in number. Even fewer studies have linked the impact of uneven regional growth on crop composition, interregional transfers, potential growth of total output and China's performance in international grain markets. Yet, China is a large country with great variations in natural and

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[2]According to Brown, by the year 2030, not only would China not be able to feed itself, but the surplus of the rest of the world would also not be enough to meet China's grain shortfalls.

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socio-economic conditions. These variations have brought about great disparities in regional grain production. Since the reform, begun in 1978, the decentralisation of production management and the uneven progress of reforms in different regions have further intensified the disparities. The south and southeast coastal areas have experienced a remarkable development in the rural economy. Accompanying this has been a swift rise in opportunity costs of grain production and a massive loss of arable land to the residential and industrial uses. In the northeast and northwest regions, however, reforms have progressed much slower and the development of the rural economy has also been lagging. Grain production remains the major activity in the rural economy. The uneven progress of reforms and rural economic development has exerted different impacts on grain production across regions. As respective crops tend to concentrate in certain geographical areas, varying trends in regional grain production have also led to an uneven growth among them. The presence of regional variations and associated disparities in respective crops underlines the necessity to study the grain sector from a regional perspective.

During the reform period, China's grain output has experienced a relatively rapid growth. Total output rose from 304.77 million tonnes in 1978 to 466.62 million tonnes in 1995, representing an increase of 53.1% (SSB, ZTN, 1996). Despite this achievement, the pace of growth has been uneven. The most rapid growth occurred in the early years of the reform. Since the mid 1980s, growth has been modest. For individual regions, both magnitudes and patterns of growth have varied significantly. Growth in some regions has been greater than that in some others. The time of the greatest momentum also differs. For some regions, growth in the early 1980s was remarkable but has been followed by stagnation ever since. Elsewhere, growth has been sustained over the whole period considered. These varying trends have changed the roles of individual regions in the national grain production at different stages of development, and consequently, have influenced the composition, quantity and direction of grain flows in interregional transfers. China's grain international trade has also been adjusted accordingly.

This paper aims to examine regional trends in grain production between 1978 and 1995. It investigates the impact of regional variations on national grain output and interregional grain transfers. Factors influencing regional output and potential growth of respective crops are tackled. The implications of regional trends for China's international trade and some policy suggestions are also addressed. The analysis attempts to provide insights into the mechanism of regional output growth in the past and the potential growth in the future. It also sheds lights on the policy arrangement for China in dealing with its diverse regional needs and national food security at large.

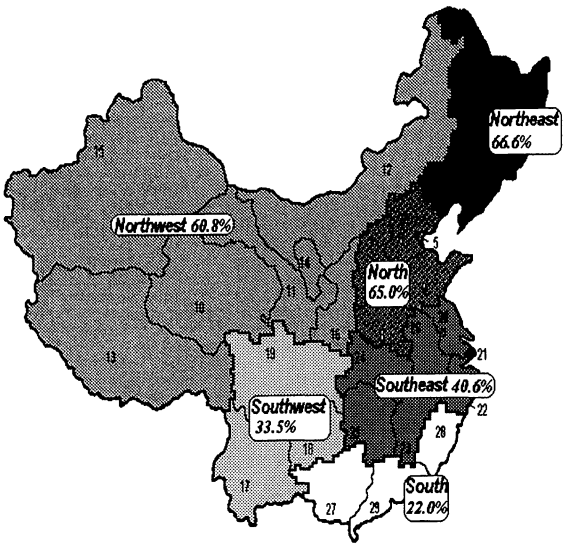
The study is organised as follows: Section 2 overviews changes in the role of regions in the national profile during the reform period. Section 3 examines trends in regional grain production and investigates their effects on the performance and composition of national grain output. Section 4 traces changes in grain-sown areas and yields in different regions and explores major factors responsible for uneven growth of regional production and the potential growth. Impacts of regional trends on interregional grain transfers and their implications for China's international trade are elaborated in Section 5. Some policy suggestions are also raised. Concluding remarks form the final section.

2. An overview of regional grain production during the reform period

China can be divided into six regions according to similarities in the natural and social-economic conditions.[3] Each comprises several provinces. These regions are: northeast (Heilongjiang, Jilin and Liaoning), north (Beijing, Tianjin, Hebei, Shandong, Henan and Shanxi), northwest (Xinjiang, Qinghai, Gansu, Neimenggu, Xizang, Ningxia and Shaanxi), southwest (Sichuan, Yunnan and Guizhou), southeast (Jiangsu, Anhui, Shanghai, Zhejiang, Jiangxi, Hubei and Hunan) and south (Guangdong,[4] Guangxi and Fujian).

[3]The definition of regions varies in different studies. The six-region division is the most comprehensive one and has been commonly used. During the reform period, the uneven economic development and varying trends in grain production across the regions have been distinct. For further discussion on the issue of regional divisions, see Yang (1994).

[4]Hainan is incorporated into Guangdong province for the data consistency.



1. Heilongjiang	2. Jilin	3. Liaoning	4. Beijing
5. Tianjin	6. Hebei	7. Shanxi	8. Henan
9. Shandong	10. Qinghai	11. Gansu	12. Neimenggu
13. Xizang	14. Ningxia	15. Xinjiang	16. Shaanxi
17. Yunnan	18. Guizhou	19. Sichuan	20. Jiangsu
21. Shanghai	22. Zhejiang	23. Jiangxi	24. Hubei
25. Hunan	26. Anhui	27. Guangxi	28. Fujian
29. Guangdong			

Source: SSB, *ZTN*, 1979-1996.

Map 1. Percentage changes in Grain Output by Region, 1978–1995

Map 1 illustrates the spatial location of regions and the percentage changes in grain output during the period studied. It can be seen that although growth was a nationwide trend the magnitude differed between regions. In the northern, northeastern and northwestern regions, the increase exceeded 60%. The growth in the southwestern and southeastern regions was below 40%. The southern region recorded only 22% of growth during this period.

The faster growth in north and the slower growth in south changed the relative weights of these two groups of regions in national grain production. Table 1 gives details of the changes. During the period studied the total national output increased by 135.6 million tonnes. Of this increment, the three northern regions accounted for 61.2%, leaving 38.8% to the three southern regions. As a result, the share of the three northern regions in the national output rose from 41% to 47%. Accordingly, the share of the three southern regions dropped from 59% to about 53%.

For respective regions, there are significant variations in terms of volumes of production and contributions to national increment. The volume of production in the southeast is large. More than 30% of national output is produced in this region. However, the slow growth of output led to a decline in its share in national

Table 1
Regional grain production in the national profile

	Nation	South	Southwest	Southeast	Northwest	Northeast	North
Regional share in total national output (percent)							
1978/79		11.0	14.7	33.3	7.6	10.9	22.5
1994/95		9.1	13.6	30.6	8.7	12.9	25.0
Output increase, 78/79–94/95 (million tonnes)							
	135.6	5.9	14.8	31.1	16.1	24.2	41.8
Regional share in national total increase (percent)							
		3.9	11.1	23.8	11.8	17.8	31.6

Source: SSB, ZTN, 1996.

production. Nevertheless, the region's contribution to total increment was substantial due to its large size of production.

The northern region is the second largest grain producing area in China. Its output accounts for approximately a quarter of total national output. During the period studied, output in this region experienced a relatively rapid growth. This, together with the large volume of production, contributed greatly to the growth of national output. The region's role in the national grain production is raised accordingly. In comparison to the above two regions, the volume of production in the other regions is relatively small. However, it is noted that the shares of the northeastern and northwestern regions in the total national increment are larger than their shares in total output, indicating their enhanced roles in the national profile. An opposite trend is evident in the southern and southwestern regions.

Uneven growth of regional output has modified individual regions' relative roles in national grain production. In terms of the spatial distribution, the faster growing north and the slower growing south indicate a tendency to shift national grain production centers towards the northern regions. Along with the shift, there has been a concurrent change in crop composition in the total national output. Determined primarily by natural conditions, wheat and maize are concentrated in the northern regions and rice in the southern regions. The shift of grain production centres increased the shares of wheat and maize by 4.2% and 5.6%, respectively, between 1978 and 1995. Conversely, the share of rice dropped by 4.6% during the same period (SSB, ZTN, 1996).

3. Growth patterns of regional grain production and their impact on national output

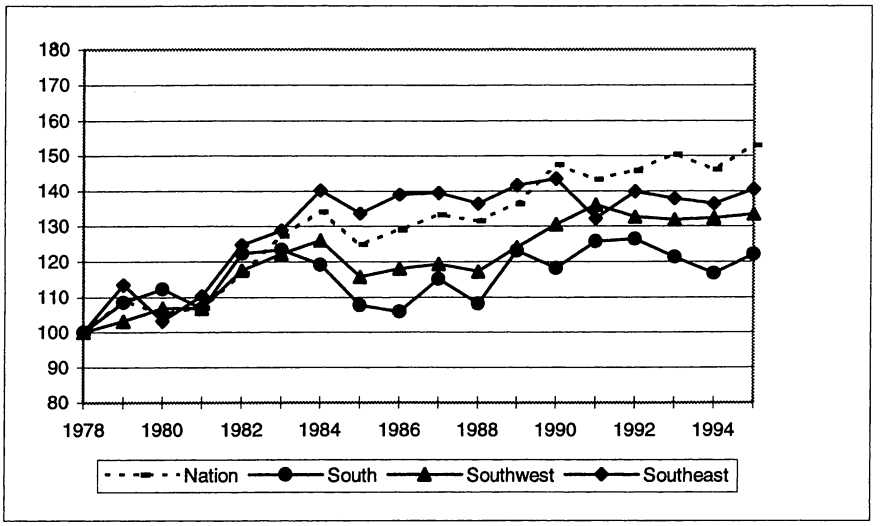
Over the years of the reform, the pace of output growth has been uneven both at the national and the region levels. Fig. 1 illustrates this unevenness.

For the nation as a whole, between 1978 and 1995 total output increased by more than 50%. This is, however, mainly attributable to the remarkable growth in the early 1980s. Between 1978 and 1984, total output increased by nearly 35%. Output plunged in 1985 and then stagnated for several years. In 1990, output had a big jump and since then has been relatively stable at that level.

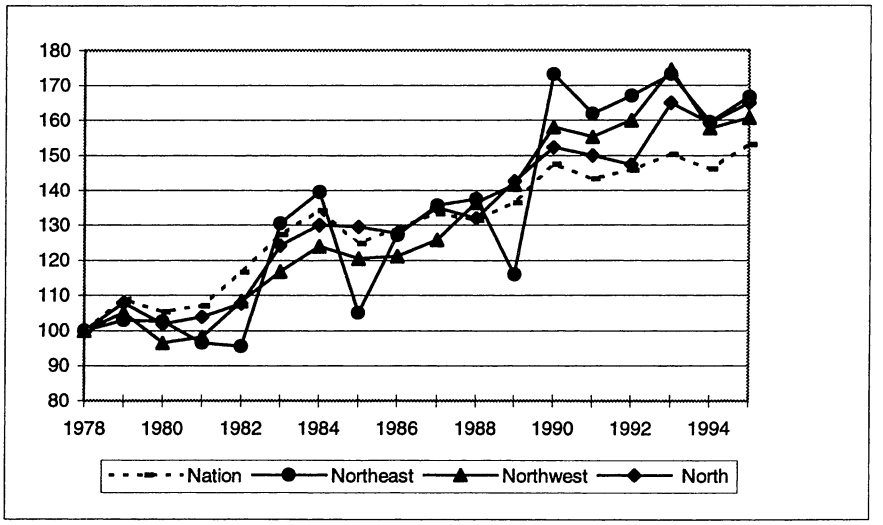
Trends in the three southern regions are depicted in Fig. 1(a). The patterns in the southern and southwestern regions were similar – both grew slowly but smoothly. In the southeast region, the growth in the early 1980s was remarkable, but this was followed by stagnation in the later years of that decade and a decrease in the 1990s. As a result, the growth for the period as a whole was modest. Taking the national trend as a reference, in the early 1980s the growth in the three southern regions was all above the national average. This rendered them the major contributors to the national growth during that period. Entering the 1990s, their growth has been invariably below the national average, and their contribution to the national growth has been only modest.

The trends in the three northern regions are shown in Fig. 1(b). Compared with the southern regions, the growth in these regions was relatively faster and sustainable. With reference to national production,

(a) Southern regions



(b) Northern regions



Source: SSB, *ZTN*, 1980-1996.

Fig. 1. Trends in grain output by regions, 1978–1995.

the growth in the three northern regions was slow in the early 1980s. In the late 1980s, their growth caught up with the national pace. In the 1990s, the growth has surpassed the national average, making them the major source of the national growth.

It is noted, however, that in the northeastern region, the rapid growth in output is accompanied by exceptionally sharp fluctuations. For example, output increased by more than 30% in 1983, whereas in 1985 the same percentage of plunge was recorded.

The jump in 1990 was dramatic, 50% above the previous year. However, in the succeeding year, output dropped by 15%. Since the northeastern region is the major maize producer and supplier in China, the sharp fluctuations may have strong effect on the stability of maize supply at the national level.

Sharp fluctuations in the northeastern region are partly attributable to the volatile weather conditions in the region. Using the figure for areas affected by natural disasters as a proxy for weather conditions, it can be seen that year-to-year proportions of such areas in the total crop-sown areas fluctuated quite substantially in the northeastern region compared with that in other regions.[5] Given the limitations of human ability to overcome the effect of severe natural disasters, sharp fluctuations in this region will remain. This may imply a long-term instability in national maize supply. International trade may be necessary for mitigating the intensity.

Another noteworthy feature in Fig. 1 is that in 1995, grain output in all regions registered a relatively significant increase. Officials and many scholars have attributed this to the Provincial Governors Responsibility System implemented in the early 1995 (Cui, 1995; Luo, 1996 and Wang, 1996). Under this system, provincial governors are required to take responsibility for the balance of grain supply in their jurisdiction areas. In order to increase output, some administrative means have been restored. It has been reported that in many provinces sown-area plans have been set up and disseminated to lower levels and eventually to farm households to fulfill (Cui, 1995). There has much debate on the efficiency and necessity of this system. It remains a question as to whether this system is a long-term strategy or a temporary measure to increase market grain supply. The analysis in the following section will help in the search for an answer.

[5]In Chinese statistics, natural disasters refer to floods, droughts, frosts, freezes, typhoons and hailstorms. Areas affected by natural disasters refer to the areas where the output is reduced by 30% or more compared to the level of normal year due to disasters. The excessive fluctuations in weather conditions in the northeastern region can be reflected by its high value of coefficient of variation for proportions of areas affected by natural disasters in total crop sown areas over the years. During the period 1980 to 1994, the values are 0.589, 0.234, 0.320, 0.341, 0.318 and 0.328 for the northeast, north, northwest, south, southeast and southwest, respectively.

4. Regional trends in yields and sown areas and potential growth of grain output

4.1. Regional trends in grain yields and sown areas

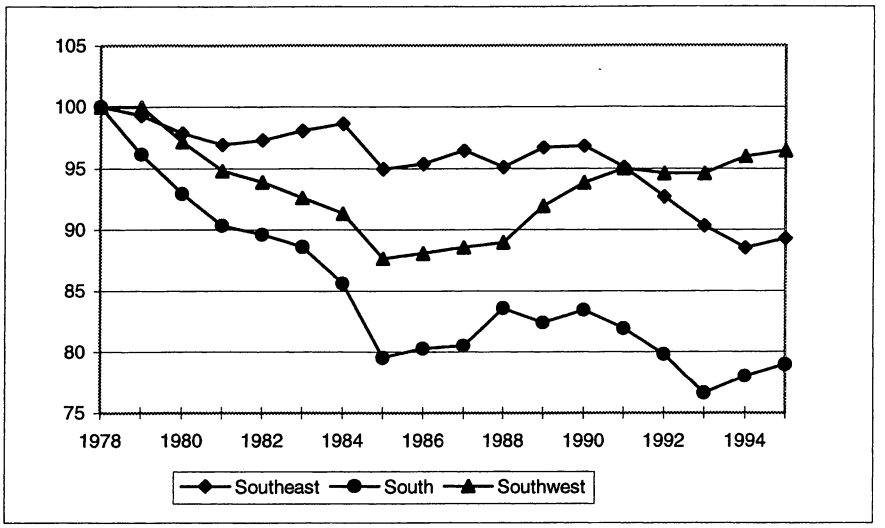
In China, the scarcity of arable land has determined that increasing the yield is the major means for increasing output. This is particularly the case during the reform period, when sown areas of grain have been decreasing constantly as the result of industrial encroachment and infrastructure construction. Again, there are regional variations in terms of changes in sown areas and yields.

Fig. 2 shows that the decrease in sown areas was the general trend in all the regions. However, the magnitude of the decrease varied. The southern region experienced a drastic decrease, whereas in the northeastern region, the decrease was only evident in some years in the mid 1980s. In the later years, the figures recovered. Other regions registered somewhat smaller decreases than that in the southern region. In 1995, corresponding to the implementation of the Provincial Governors Responsibility System, there was a significant recovery of sown areas in all regions.

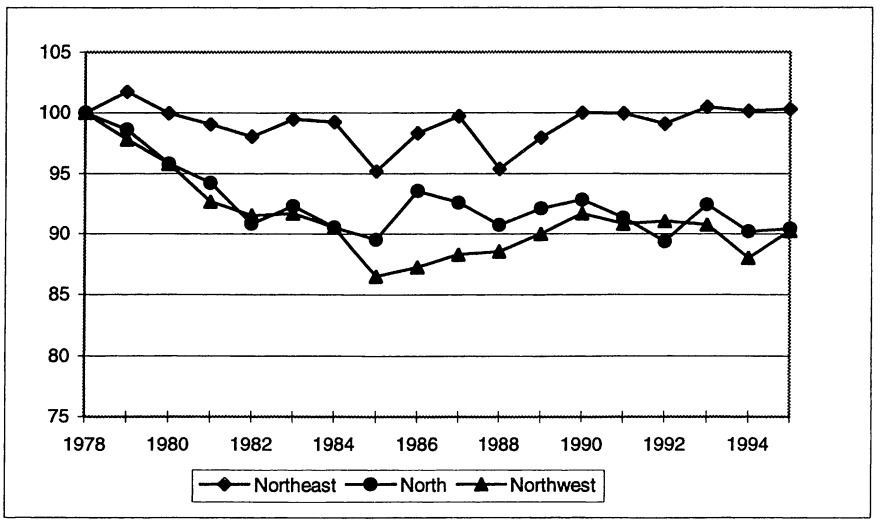
Regional trends in yields are illustrated in Fig. 3.[6] During the period studied, the magnitude of the increase tended to be greater in the northern regions than that in the southern regions. This is consistent with the performance of output in these two groups of regions, highlighting the crucial role of yields in supporting the growth of grain output. Regional trends in yields and sown areas have some implications for the potential growth of output. Because of the scarcity of arable land and taking into consideration the experience during the past years of the reform, grain-sown areas are unlikely to increase in any regions in the long-run, though the government administrative measures may temporarily halt the trend of decline. Therefore, yields will remain the key factor in determining the future growth of output.

[6]Yield figures are calculated by grain output divided by sown areas. It has been widely recognised that in China's official statistics, the figure for crop-sown areas and output are underreported. Therefore, there may be a gap between the calculated yields and the real yields. However, this gap may have little effect on the analysis of yield trends since the degree of underreporting is likely to be consistent in a given region over a certain period of time.

(a) Southern regions



(b) Northern regions



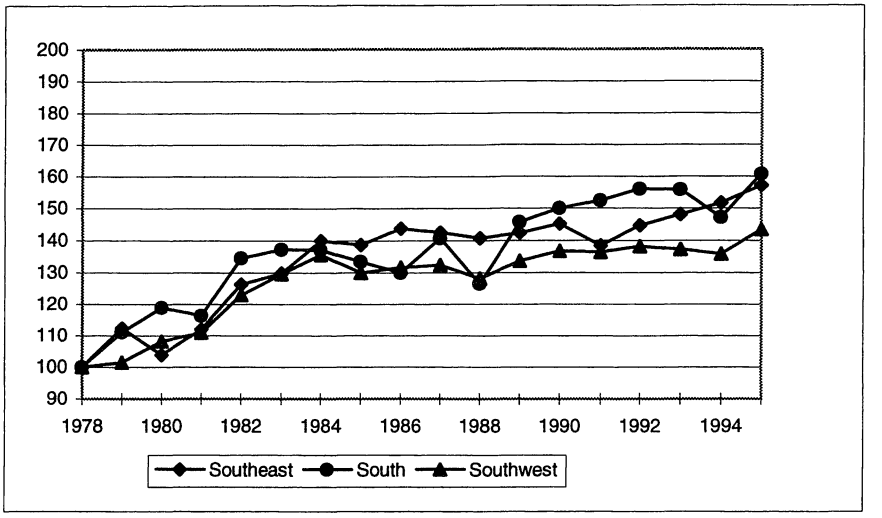
Source: Same as Table 1.

Fig. 2. Trends in grain-sown areas by regions, 1978–1995.

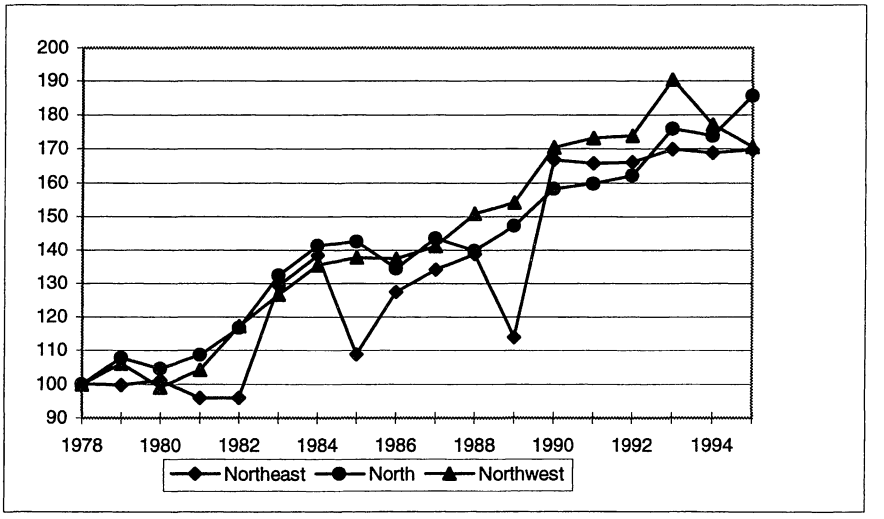
Fig. 3 shows that in the southern regions, stagnation of yields has been a trend evident since the mid 1980s. For the northern regions, the increase was relatively rapid in the 1980s. Nevertheless, since the 1990s, the pace of growth has decelerated. In the northern region, yields have actually stagnated.

The questions that should be asked then are why the growth of regional grain production has been

(a) Southern regions



(b) Northern regions



Source: Same as Table 1.

Fig. 3. Trends in grain yield by regions, 1978–1995.

uneven during the reform period and what is the potential for output growth in different regions and associated crops. Answers to these questions will help a better understanding of the changes in China's interregional grain transfers and international trade during the past years of reforms and predict the likely trends in the future. The following analysis approaches the answers from respects of availability of new technologies, resource endowments, opportunity costs and relative prices between China's domestic markets and international markets.

4.2. Factors affecting potential growth of grain output

4.2.1. Availability of new technologies

It has been widely acknowledged that the availability and adoption of new technologies have been an important source of the growth in grain output during the reform period. According to a study by Huang and Rozelle (1996), the contribution of new technologies accounted for about 40% of the increase in rice yield between 1978 and 1990. This, however, was mainly benefited from the application of technologies invented in the previous period. During the reform period, there has been no major breakthrough in rice and wheat technologies (Huang and Rozelle, 1996). Thus, when the effect of the previous technologies gradually reached their frontier, growth would slow down. This may partly explain the stagnation in rice and wheat output in the 1990s. For maize production, the introduction of the plastic film cover technique and hybrid maize varieties in the 1980s brought about a rapid growth of maize yield in the later years of that decade (Huang et al., 1990).[7] In the northern and northeastern regions, where maize production is concentrated, the application of these technologies led to a swift increase in average yields. Since the 1990s, however, no significant technological innovations for maize have been recorded.[8] This is expected to slow the increase in maize yield for the years to come.

The lack of technological progress in grain production is closely related to the rural institutional reforms and the reduction of agricultural research funds since the 1980s. The implementation of the Household Responsibility System, to a large extent, weakened the function of collectives in supporting agricultural infrastructure construction, maintenance and technology extension, tasks difficult for individual households to fulfill (Watson, 1989). The aging of agricultural infrastructure and shortage of construction funds have become serious problems facing agricultural production. For individual farmers, although the increasingly scarce (and hence more expensive) land resources encouraged a search for technical alternatives that can save land, few effective technological measures are available for them. Recognising these problems, since the late 1980s, there has been a call for re-consolidating the role of collectives in promoting technologies and organising large scale capital constructions (Hu, 1989 and Chen and Shi, 1991). However, so far little has been done in this regard.

Since the 1980s, the government has gradually reduced investment for agricultural research. For example, in 1980, about 130 million yuan was invested by the government for this purpose. In 1994, this figure reduced to 103 million yuan in real terms (SSB, 1995). This has undermined the basis of agricultural research for new technologies. Meanwhile, the poor remuneration system has meant that few incentives have been provided for agricultural scientists, such as seeds breeders, to undertake the research. It has been well documented that China's agricultural research system is weakening or collapsing as many agricultural researchers have turned away from the basic types of research work. Despite there is market demand for new technologies, limited private resources have been attracted to agricultural research due in part to the absence of effective enforcement of patent and licensing laws in China (Lin, 1991). The situation is particularly serious considering that innovations of new technologies usually need several or many years' research and experiment before being put in to commercial practice. Therefore, even if the government increases investment for agricultural research now, it may have to wait for several years or decades for fruition.

It is worth pointing out that compared with the international standards, grain yields in China remain relatively low. According to the World Bank's estimation, the average maize yield is less than half of that in the United States (based on the revised sown area figure) (World Bank, 1997). This may imply a large potential for increasing maize yield if foreign technologies can be transferred into China and if prices of maize are profitable for farmers. The same source shows that the gap between domestic and international standards for rice and wheat yields is smaller than that for maize. However, the potential for improving the yields of these crops is still quite considerable.

[7] It is reported that the effect of the plastic film cover technique is dramatic in the areas where the spring temperature is low. An experiment in Shanxi province shows that maize yield increased by 25–30% on the plot covered by plastic film (Huang et al., 1990).

[8] Chinese Agricultural Statistical Yearbook reports major technological innovations occurring in each year. No significant technological breakthough is recorded in this source in recent years.

Despite the potential for increasing yields, the absence of patent and licensing laws in China has impeded the transfer of foreign technologies into China. For example, an American seeds company reckons that its production could improve China's maize productivity by 10% without changing current farming practice. The reason for the company not to step in is that China has not passed laws to protect the valuable intellectual property contained in the seeds (Holloway, 1995). This situation suggests an importance for the government to take urgent steps to deal with the matter.

Consumption preference can also influence farmers' adoption of new technologies. With increase in income demand for high-quality food also rises. This requires new varieties to have not only high yields but also high quality (and high profits) to attract farmers to apply. Officials admitted that the decrease in rice output in recent years has been partly induced by the decline in the demand for hybrid rice (Huang and Rozelle, 1996). In spite of its high yield, the taste of it is not preferred. The increase in incomes has made consumers, including farmers, tend to consume more high quality rice, such as japonica rice (single-crop rice). Sown areas of hybrid rice thus decreased.

4.2.2. *Resource constraints and environment degradation*

Apart from the scarcity of arable land which has put persistent constraint on grain production, there has been an increasing concern about the effects of water shortage and environment degradation on grain production.

In northern China, annual precipitation is generally low, which has been unfavourable for grain production. Sharp fluctuations in annual and seasonal rainfall have aggravated this effect. In the northwestern region, where the rainfall is extremely scarce, agriculture is dependent primarily on irrigation. The expansion of sown areas is limited by the lack of water resources. In the northeern region, the major wheat producing areas in China, water supply has tended to decrease over the years. It has been reported that the level of ground water in the North China Plain (where the northern region is situated) has been declining since the 1970s (He, 1991). In recent years, the discharge of many rivers in this region has also decreased (Cheng, 1991). During the dry season, some rivers have no discharge at all. According to the official news on the Chinese Central Television, in 1995 the lower reaches of the Yellow River had totally dried for 3–4 months. The situation worsened in 1997, when the lower reaches of the river did not have any discharge for about 250 days! Since the level of yields in the region is heavily reliant upon the availability of irrigation, the reduction of water supply presents a threat on grain production. As the northern region is the major wheat producing area, water shortage will especially hit national wheat output. This may increase China's dependence on the international market to meet the demand for wheat.

In the northeasten region, where maize is concentrated, rain-fed production is the dominant type of farming practice. Output is vulnerable to weather fluctuations. Nevertheless, compared with the northern and northwestern regions, water restriction in the northeastern region is less severe. The surface run-off in this region is higher than that in the other two northern regions (Cheng et al., 1993). Meanwhile, the low temperature in the northeastern region allows only one crop each year. Thus, less water is needed for agricultural production than that in the northern region, where multiple cropping is widely practiced. Currently, in the northeastern region the proportion of irrigated areas in total crop-sown areas is low. It is expected that if more water conservation projects can be built, the volatility of grain production in the region will be alleviated and maize output will increase.

In southern China, water is generally adequate. The major problem is how to make use of water. As mentioned previously, since the reform, water conservation facilities have been aging and left out of repair in many areas. This has not only reduced irrigation capacity, but also aggravated the effect of natural disasters (mainly floods) on grain production (especially rice) in the southern regions. Official statistics show that the figure for areas affected by natural disasters has increased over the years (SSB, ZTN, 1996). Obviously, policies which can bring capital and labour to the construction and maintenance of water conservation facilities are necessary for the southern regions to increase grain output.

Environmental pollution and degradation are also serious problems undermining China's grain production and agriculture as a whole. It has been estimated that at the moment, about 20% of rivers are too

polluted to be used for irrigation (Lepkowski, 1996). Meanwhile, in many areas, wastewater is discharged into waterways for downstream use without pre-treatment. If this situation continues, grain irrigated by untreated wastewater may be contaminated, exacerbating the food problem in China.

4.2.3. *Opportunity costs and the convergence of China's domestic grain prices with international prices*

China's rural economic development has been fueled by the boost of non-agricultural sectors. This has pushed a continuous increase in opportunity costs of grain production and been a major factor driving farmers' investment away from the grain sector (Yu and Buckwell, 1991). However, as the regional development has been uneven, opportunity costs of grain production also vary. In the southern developed areas, more non-agricultural opportunities are available. Opportunity costs of grain production are higher. In the northern areas, the rural economy is less developed. Few opportunities outside agriculture are available. Grain production remains the major income generator for most of farmers. Opportunity costs of grain production are thus lower. This situation can be reflected by different labour divisions in Guangdong and Jilin. According to a rural household survey, on average labourers in Guangdong spend more than 150 days per annum in non-agricultural activities. In Jilin, a lagging province in the northeastern region, such a figure is less than 30 days (Yang, 1997). As opportunity costs of grain production in the southern regions are higher than that in the northern regions, a shift of grain production from former to latter is inevitable.

A noteworthy point related to opportunity costs is the change in cropping system in rice production. Fig. 2 shows that during the reform period, the decrease in sown areas in the southern regions was drastic. A scrutiny reveals that this is partly the result of the shift from double-crop rice to single-crop rice. Between 1978 and 1992, sown areas of double-crop rice dropped from 174.37 million tonnes to 137.16 million tonnes (ECCAY, ZNN, 1996). Conversely, sown areas of middle-season and late rice (single-crop rice) expanded by more than 80 million tonnes during the same period. The inverse trends in the sown areas of single-crop and double-crop rice partly reflect the farmers' concern with opportunity costs of labour in rice production. The shift from double-crop rice to single-crop rice, however, tends to reduce total rice-sown areas (given the fixed arable land). If this continues, increase in total rice output will become more difficult.

Another crucial factor affecting China's domestic grain production is the rapid increase in market prices. Current studies of China's grain trade show that since 1993, market prices of grain in China have approached world prices (World Bank, 1997). This convergence is likely to suppress China's domestic grain production. For the southern coastal developed regions, producing grain has been economically inefficient and practically unnecessary as opportunity costs there are high and as the people there can afford to buy grain from international markets. If the central government releases the monopoly control over international grain trade, these regions are expected to increase grain imports. The demand for northern grain may thus decrease, which will curb grain production there. Although at the moment, grain imports and exports are subject primarily to the government quotas, in the long run it will become increasingly difficult for the government to hold the control. As far as policy-makers are concerned, there is a trade-off between the economic losses from increasing domestic grain output at high costs and the political gains from safeguarding national grain supply. However, the real situation may not be a zero-sum game. As retaining self-sufficiency lowers efficiency of resource allocation, policies which can assist in short-term food security may impede long-term security. Given this concern, administrative means applied in the Provincial Governors Responsibility System is likely to be short-lived. The recovery of grain-sown areas and output may soon be displaced by a larger decrease.

The above analysis suggests that different natural and socio-economic conditions have imposed specific impacts on regional grain production and, consequently, on the respective crops. Production of rice is constrained by a lack of new technologies as well as high opportunity costs associated with the rapid development in non-grain sectors in the southern areas. For wheat production, apart from the lack of technological support, limited water supply in its major growing areas has set a long-term constraint on production. In the northeastern region, the potential for increasing maize output is relatively high as few opportunities

outside grain production are available and relatively less restrictions are presented on water supply. Substantially low yield of maize in comparison with the international standards also implies more room for increasing yield. However, as will be addressed in the next section, there are some unfavourable factors which have hindered the release of this potential.

5. Impacts of regional trends on interregional transfers and implications for international trade

5.1. Changes in interregional grain transfers

Regional variations in the grain production generated needs for interregional transfers. In China, there are two systems for grain transfers: the state system and the market system. With the progressive decentralisation of administrative controls and marketing liberalisation, the proportion transferred through the state system is declining and through the market channels increasing. In spite of these opposing trends, the role of the state in interregional grain transfers remains crucially important. Currently, around 65% of the marketed grain is handled by state grain bureaus (World Bank, 1997). Given China's lack of market integration for grain transactions (Cheng and Wu, 1995), the state transfers are particularly important for balancing the nationwide supply. As for the transfers through the market channels, little data are recorded in Chinese official statistics. Nevertheless, there seems no reason to doubt that the prevailing direction of market transfers is consistent with that in the state system.

Fig. 4 shows changes in the quantity of state grain net transfers among regions.[9] It can be seen that the southern and southwestern regions have been the major grain importers. The amount transferred into these regions increased steadily over the years. In the southeastern region, the out-flow is predominant, while the quantity transferred varied from year to year. In the mid 1980s, the quantity of exports was large. Between 1987 and 1989, the region became an importer. After 1990, the out-flow was again the dominant stream. However, the quantity tended to decline.

The picture in the northern regions is different. Before 1990, the northern region was a major importer. Entering the 1990s, the in-flow decreased substantially. In some years, the region even had a net out-flow. The similar trend is also seen in the northwestern region. In the northeastern region, the net out-flow became predominant in the mid 1980s and the quantity continuously increased in the later years.

Changes in the role of regions have had impact on the prevailing direction of grain flows in interregional transfers. Since the northern and northwestern regions have managed grain self-sufficiency, the prevailing direction of net grain transfers is dominated by flows from the northeast to the southern regions. This is opposite to the traditional direction of "moving southern grain to north", indicating a reversal of grain flows in interregional transfers.

The new spatial pattern of grain flows has increased the distance between grain supplier and recipient. Surplus grain in the northeast needs to be transferred all the way down to the southern deficit regions. This means an increase in transport costs and more pressure on transport facilities. Located in the head of the 'cock' as China's territory appears, the northeastern region has a naturally unfavourable condition in terms of trading with the rest of the regions. The sharp fluctuations in grain output and lack of storage spaces have further intensified the problem (Li et al., 1996). Obviously, more investment is needed for infrastructure constructions if the government wants the region to supply more maize. In any case, the cost of transport involved in interregional transfers is high due to the long distances between the surplus and deficit regions. The economic efficiency of such transfers is questionable as it may be cheaper for the southern regions to import maize from international markets directly.

Concurrent to the change in the prevailing direction in interregional grain flows, the contents of grain transfers are also modified. During the years when grain was transferred from south to north, rice was the dominant component. With the reversal of the direction of grain flows, maize, the major crop in the northeastern region, has become the dominant element. However, as maize is used mainly for feed,

[9]Net transfers are defined as the balance between in-flow and out-flow of grain mix. In-flow refers to grain transferred into a region from outside, including from overseas. Similarly, out-flow refers to grain transferred out from a region to other regions and/or to overseas. Interregional veriety exchanges are not considered here due to the lack of historical data.

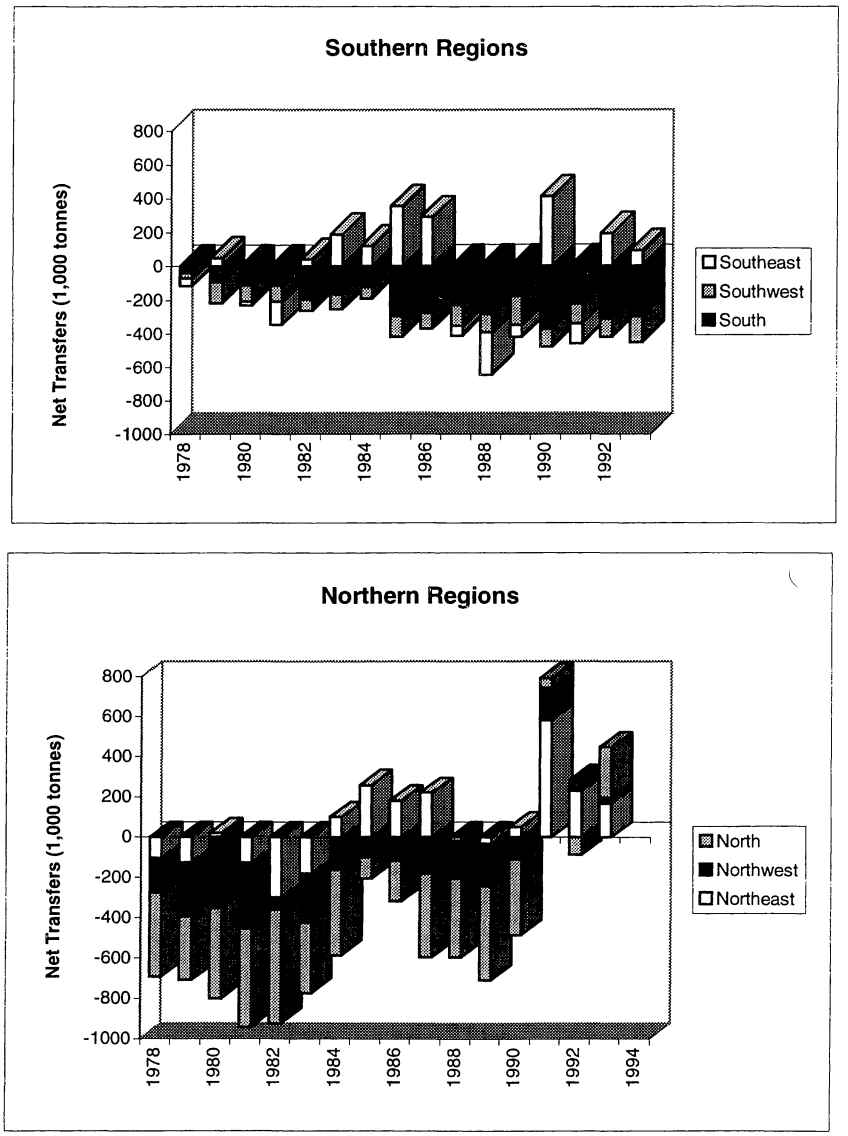


Fig. 4. The state grain net transfers by regions, 1978–1993. Source: Data for 1978–1989 are provided by the Commission for integrated survey of natural resources. Data for 1990–1992 are calculated on the basis of provincial trade values in Almanac of China's Commerce, ZSN, 1991–1993 and the state average grain purc.

increasing maize output in the northeastern region cannot meet the increasing demand for food grains (mainly rice and wheat) in the south. This may mean that the southern regions have to import grain from international markets if they cannot produce enough by themselves.

5.2. *Implications of regional trends for China's international trade*

The uneven development of regional grain production and the changes in the role of respective regions in interregional grain transfers have some important

Table 2
China's net grain international trade, 1978–1995, (mmt)

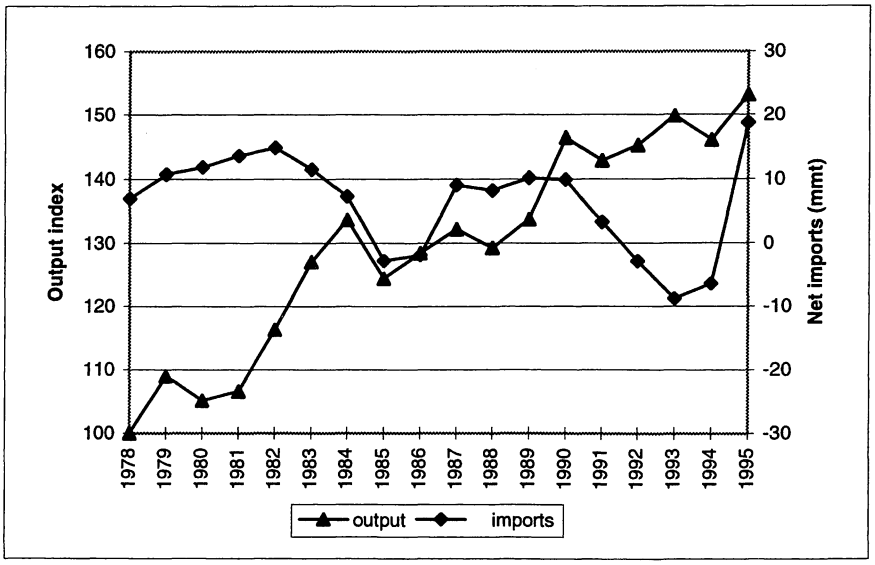
Year	Net imports			
	Total	Wheat	Rice	Maize
1978	6.96	7.67	−1.26	0.79
1979	10.70	8.71	−0.93	2.79
1980	11.81	10.97	−0.97	1.69
1981	13.55	13.00	−0.39	0.74
1982	14.87	13.80	−0.06	1.67
1983	11.47	11.11	−0.41	1.99
1984	7.32	9.87	−0.94	−0.86
1985	−2.71	5.41	−0.71	−5.88
1986	−1.81	5.75	−0.64	−5.03
1987	9.09	13.34	−0.50	−2.28
1988	8.25	13.91	−0.37	−3.32
1989	10.18	14.70	0.67	−3.40
1990	9.89	12.53	−0.25	−2.58
1991	3.32	12.37	−0.65	−7.49
1992	−2.88	10.58	−1.13	−10.43
1993	−8.79	6.42	−0.93	−11.79
1994	−6.43	7.18	−1.26	−9.93
1995	18.67	11.59	−0.00	

Source: The national figures for 1978–1994 are from the Editorial Board of the Almanac of China's Foreign Economic Relations and Trade, 1996. The figures for 1995 are from SSB, ZTN, 1996.

implications for China's grain supply arrangement and international trade.

Table 2 shows the figures for China's net grain trade between 1978 and 1995. Fluctuations are significant over the years. The volume of net grain imports was large in the early 1980s. Between 1985 and 1986, China suddenly became a net exporter. During 1987 and 1991, it turned back to be a net importer. From 1992 to 1994, China was a net exporter again. In 1995, China imported 18.67 million tonnes of grain – the highest recorded during the period studied.

Fig. 5 plots the changes in total net grain trade against the trend in total output. An inverse relationship can be detected. In the years when output was poor, the quantity of net exports increased. This situation was evident in the late 1980s and the early 1990s. When grain output increased, however, the quantity of imports also rose. This situation was typical in the early 1980s, when grain output experienced an unprecedented increase and between 1988-1990, when grain output appeared a strong recovery from the previous stagnation. In 1995, a historical record of grain output was accompanied by the largest quantity of net imports.



Source: Same as Table 1 and Table 2.

Fig. 5. Trend in total grain output and changes in net imports, 1978/1995.

The exorbitant changes in the volume of China's grain international trade may be explained by two factors. One is related to the components of grain output and trade. Table 2 shows that China's grain trade balance is held primarily by wheat and maize. During the period studied, the exports of maize have increased significantly, while the imports of wheat remain large. Because of the sharp fluctuations in maize output, quantity of maize exports has also been volatile, causing inconsistency between the grain trade balance and total output.

Another factor responsible for the inverse relationship is the centrally controlled grain international trade system. The complicated function and the bureaucratic management of the system made it impossible to handle international trade efficiently. An obvious problem in this system is that the quantity of imports and exports cannot be adjusted in time to suit the constantly changing situation in the different regions and for the country as a whole. When lagging responses to a situation comes, a new situation which is completely opposite to the old one may have occurred. The case in Jilin may well reflect this problem. The author learnt from a field interview[10] that in 1995 when domestic demand for maize was large and market prices were high, Jilin benefited from an increase in maize output. However, in 1996, a historical harvest of maize was followed by a plunge in demand and thus market prices. The reason was that the government increased maize imports to respond to the situation in the preceding year. As maize export plans did not have a corresponding adjustment, Jilin suffered a difficulty in selling maize.

The case of Jilin indicates that China's grain international trade has failed to act as a buffer to domestic markets. Instead, it has amplified the market fluctuations. The centrally controlled trade system, on the one hand, protects domestic grain production by sacrificing the efficiency of resource allocation. On the other hand, it prevents locals to make their own trade arrangements appropriate to their needs, causing further inefficiency. It is clear that a decentralisation of grain trade is necessary to the solution of these problems. In doing so, the southern regions can import grain directly from international markets. The pressure on transport facilities can also be eased. For the northeastern region, decentralisation allows it to export maize directly to the northern neighbouring countries. Meanwhile, the effect of output fluctuations in the region on domestic maize markets may be alleviated through international trade.

The question remains as to whether the government is willing to accept this arrangement. The decision is very much dependent upon the preference of policy makers. This preference, however, is strongly influenced by the progress of China's reforms and economic development and the world political situation. From what has been experienced during the past years of reform and considering the continuous relaxation of international political situation, together with the increasing integration of China's economy into the global system, it is likely that the central control over the grain international trade will be relaxed gradually. Grain imports will then increase in the south. In the meantime, exports of maize may increase in the northeastern region.

6. Concluding remarks

This study examined the trends in regional grain production during the reform period and investigated their impact on the performance of national grain production and implications for interregional and international trade.

The study revealed that although the increase in grain output was a nationwide trend, the pace of the growth varied among regions. The northern regions experienced a faster growth than the southern regions. There is a tendency to shift grain production centres towards north.

During the period studied, the momentum of growth occurred at different times for individual regions. This altered the major contributors to national growth over the years. In general, the contribution of the southern regions was relatively large in the early 1980s, whereas the northern regions have provided the bulk of national growth since the mid 1980s. The study, however, argues that with the rising role of the northeastern region in the national profile, the fluctuations in its output will intensify the volatility of maize supply in China's domestic markets.

[10]The interview was conducted in Jilin and Henan in October 1996.

The uneven growth in the regional grain output has changed the formation of interregional transfers. The traditional south–north flows have been reversed. Meanwhile, the composition of grain flows has also been modified. The proportion of maize increased and rice decreased.

The analysis of grain yields and sown areas suggests that stagnation in output in the southern regions is likely to continue due mainly to the high and rising opportunity costs of grain production and the lack of new technologies. This will have strong effects on the output and hence market supply of rice. In the northern regions, water shortage is a long-term constraint on wheat production. The potential for increasing maize output is relatively high in the northeastern region. However, the lack of transport facilities and the high transport costs have been detrimental to the release of the potential. Meanwhile, the domestic shortfalls in wheat and rice cannot be met by increasing maize output in the northeastern region. This, together with the convergence of China's domestic prices with international prices, will compel China to increase grain imports. The analysis of interregional transfers and international trade suggests a necessity for China to decentralize its grain trade. As such, China's international grain trade can be formulated into importing grain in south and exporting maize in north.

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