Rural Reforms and Agricultural Productivity Growth in China

by

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Abstract

The rural reforms, starting in 1979, resulted in a rapid output growth in agriculture up to 1984. This paper employs provincial level panel data covering 1965 to 1987 to evaluate empirically the relative importance of various components of rural reforms in agricultural productivity growth. There was 42.2 percent output growth in cropping sector in 1978-1984. It is found that the productivity growth due to reforms explains 43.6 percent of the output growth. Among the productivity growth, 94 percent can be attributed to the change in farming institution from the production team system to the household responsibility system. The other 6 percent is attributable to the combined effects of increases in market prices, and changes in cropping patterns and cropping intensity. The latter two items are related to reforms in the role of markets and planning. The raises in state procurement prices, however, are found to have no significant effects on productivity. This may be due to the fact that the state procurement prices, even measured with the above-quota delivery premiums, are lower than market prices. It is also found that the main reasons for the slowdown in agricultural growth after 1984 are (1) the household responsibility system reforms completed in 1983/1984; (2) the drop in the availability of chemical fertilizers; and (3) the swift out-migration of labor force from cropping sector.

Rural Reforms and Agricultural Productivity Growth in China

I. Introduction

China's agricultural growth in the socialist period prior to the reforms in late 1970s was depressive. Despite a lopsided stress of self-sufficiency, grain production and agricultural output barely kept pace with population growth (see Table I). Ceased to be an exporter, China had become a net grain importer since 1961. By late 1970s, China was one of the major buyers in the world grain market (Barnett 1981, Chap. III). The dismal picture came to an end in 1978 when China started a series of fundamental reforms in rural sector. Output growth accelerated to a rate several times the long-term average in the previous period. The annual growth rates of the three most important crops, namely grain, cotton, and oil-bearing crops, averaged respectively 4.8 percent, 17.7 percent, and 13.8 percent between 1978-1984, compared to the average rates of 2.4 percent, 1.0 percent, and 0.8 percent per year in the preceding 26 years from 1952 to 1978. For the cropping sector and agriculture as a whole, the growth were equally impressive, average annual growth rates rose from 2.5 percent and 2.9 percent to 5.9 percent and 7.4 percent (see Table I).[1] By 1985, China turned to be a net grain exporter, the first time after a quarter of century.[2]

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[1]Agriculture in Chinese official statistics consists of cropping, animal husbandry, forestry, fishery, and household sideline production. Before 1984, the output of village-run enterprises was included in the sideline sector. The figures referred in this paper have excluded village-run enterprises.

[2]In 1985 China exported 9.33 million ton of grain and the import was 5.97 million ton (State Statistical Bureau 1986, p. 569 and p. 572). The net export in 1986 was 1.69 million ton. However, because of the decline of grain output in 1985 and stagnation since then, China started to import grain in 1987. The net import was 8.81 million and 8.15 respectively in 1987 and 1988 (State Statistical Bureau 1989, p. 639 and p. 642).

Table I: Agricultural Output and Population Growth, 1952-1987

Year	Agri. Output Value (B. yuan)*,**	Crop Output Value (B.yuan)*	Grain Output (M. ton)	Cotton Output (1000 ton)	Oilcrops Output (1000 ton)	Population (million)
52	85.71	71.23	163.9	1304	4193	574.8
57	106.97	86.22	192.7	1640	4196	646.5
62	85.63	67.56	147.5	750	2003	673.0
65	117.51	89.07	187.5	2098	3625	725.4
70	142.62	106.54	239.9	2277	3772	829.9
71	146.91	114.44	250.1	2105	4113	852.3
72	145.37	111.21	240.5	1958	4118	871.8
73	157.54	121.94	264.9	2562	4186	892.1
74	162.94	126.44	275.2	2461	4414	908.6
75	167.99	130.19	284.5	2381	4521	924.2
76	167.39	127.72	286.3	2055	4008	937.2
77	166.54	126.40	282.7	2049	4017	949.7
78	180.16	138.18	304.7	2167	5218	962.6
79	193.71	147.99	332.1	2207	6435	975.4
80	196.45	141.44	320.5	2707	7691	987.1
81	209.14	149.95	325.0	2968	10205	1,000.7
82	232.76	165.26	354.5	3598	11817	1,015.9
83	250.82	178.83	387.3	4637	10550	1,027.6
84	281.56	196.53	407.3	6258	11910	1,038.8
85	291.22	192.79	379.1	4147	15874	1,050.4
86	301.08	194.50	391.5	3540	14738	1,065.3
87	318.51	204.80	404.7	4245	15278	1,080.7
Average annual growth rate:						
52-78	2.9%	2.5%	2.4%	2.0%	0.8%	2.0%
78-84	7.4%	5.9%	4.8%	17.7%	13.8%	1.3%
84-87	4.1%	1.4%	-0.2%	-12.9%	8.3%	1.3%

Source: Ministry of Agriculture, Planning Bureau (1989, pp.112-115, 146-149, 189-192); Ministry of Agriculture (1989, p. 28, p.34). State Statistical Bureau (1988, p. 97).

* Measured at the prices of 1980.

** The output value of village-enterprises is not included.

The dramatic output growth between 1978 and 1984 was a result of a package of reforms that reduced the functions of ideology and plans and gave priority to the roles of individual incentives and markets. As the rural reforms were so successful in increasing output, especially grain, the government was encouraged to take a bolder approach to the reforms in both rural and urban sectors in 1985. Although agriculture as a whole still grew at a respectable rate of 4.1 percent per year thereafter, nevertheless, the rapid growth of crop production came to a sudden halt and the outputs of grain and cotton declined (see Table I). The optimism about Chinese agriculture, as a result, is replaced by pessimism. There has emerged a view among Chinese officials, scholars, and Western observers as well claiming that the agricultural reforms were no longer succeeding (Johnson 1989). As most prominent leaders in China are grain fundamentalists, the disappointing performance of agriculture, especially grain production, has endangered the future of the market-oriented reforms. The rural reforms in China are at a crossroad.[3] It is, therefore, important for both academic curiosity and policy designs in China to identify empirically factors contributing to the magic agricultural growth between 1978-1984 and reasons for the slowdown afterwards.

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[3]Mao Zetong's teaching of yiliang weigang (take grain as key link) is deeply rooted in most Chinese people's mind, including both political leaders and scholars. Accordingly, despite agriculture's annual growth rate of 4.1 percent between 1984-1987, which is very respectable measured at any conceivable standard, the commonly held view in China is that Chinese agriculture is in a crisis. The main support for this view is the stagnation of grain production after 1984. Therefore, as commented by Johnson (1989, p.14), "There are certainly political forces that are in the direction of recentralizing the power that once rested in the hands of production team and brigade leaders. ... The stated claim that the responsibility system has not solved the grain problem becomes a rationalization for such individuals or groups to seek alternative means of increasing grain production. The failure to provide the optimum circumstances for enlargement of crop operations under the responsibility system becomes an excuse for partial recollectivization of agriculture."

Much has been written about the economic reforms in China.[4] Nevertheless, most discussions to date, as commented by Perkins (1988, p. 628) have been based on impressionistic evidences and are not definitive. There is disagreement among students of Chinese economy about the factors responsible for the remarkable increase in agricultural outputs. The reason for such a disagreement arises from the fact that many changes occurred simultaneously or in rapid succession. Major changes are as follows: First, the state procurement prices for major crops on the average increased 22.1 percent in 1979. The major institutional change that replaced the original collective system and restored the individual household as the basic unit of production management and accounting started to appear in 1979 and was essentially completed by the end of 1983. This institutional change is intended to provide the material incentives lacking under the collective system. In addition to these two changes, there have also been several other changes concerning the roles of markets and planning since 1979. The stress of local grain self-sufficiency was relaxed. Regional comparative advantages in crop production were reemphasized and limitations on interregional trade of grain and other agricultural produce were removed. These policies have resulted in a change in regional crop patterns. Especially, the traditional cotton growing provinces have substantially increased their cotton acreage.[5] In addition to the above-mentioned reforms, the inputs, particularly chemical fertilizers, also had a

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[4]For a survey of papers written by Western economists, see Perkins (1988). In addition, there are several books and conference proceedings devoted exclusively to the economic reforms in China. See for example, Perry and Wong (1985), Journal of Comparative Economics, vol. 11 (1987), and China Quarterly, no. 116 (1988).

[5]The importance of regional comparative advantage in crop production, and the losses of this advantage due to the stress of regional self-sufficiency in grain and to the restrictions of interregional trade are thoroughly examined in a pace-setting book by Lardy (1983).

substantial increase, 71.6 percent, between 1978-1984.

Identifying the factors contributing to the rapid agricultural growth in 1978-1984 is important for the future course of rural reforms in China. If the institutional changes from the collective system to the household-based farming system is the major factor underlying the magic output growth, then the future reforms should be strengthening the position of household and perfecting the other institutional arrangements that facilitating household farming. However, recollectivization will be unavoidable if the household farming institutional change was detrimental to production and its detrimental impact was covered by the rapid output growth due to the price raises, market reforms, and increase in purchased inputs.

Few attempts have been undertaken to identify the relative effects of particular components of the reforms, due to the difficulties in identifying so many simultaneously implemented changes.[6] Exceptions include Lin (1989 a), McMillan *et al* (1989), and Wen (1989). Lin's paper employed a production function approach based on a combination of time-series and cross-province data with a variable representing institutional change being the percentage of the households in each province that had adopted the household-based system for each year from 1980 to 1983. In Lin's approach, the impact of price change is treated as residual, which is estimated by year dummies in the estimated production function. Lin finds that the change from the collective system to the household-based system increased about 15 percent of the total factor productivity of a farm and about half of the crop output growth between 1980 and 1983 is

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[6]The difficulty in attributing output growth to various components of reforms and input increases is expressed by many China scholars. For example, Wiens (1983), Crook (1985), Lardy (1986), Hartford (1985, p. 56), Johnson (1989) and Perkins (1988).

attributable to the change in farming institution. He also finds that the rest of the other policy changes do not seem to have any significant effects on the total factor productivity. McMillan *et al* use the standard Dennison-Solow-type growth accounting technique and propose a procedure to decompose the total factor productivity increase in 1978-84 into a price component and an incentive component. In their approach, the impact of farming institutional reform is treated as residual. Their estimate suggests that among the 61 percent increase in the cropping and animal husbandry sector, 41 percent is attributable to total factor productivity growth. Among the total factor productivity growth, 78 percent is attributable to the farming institutional reform and 22 percent to price raises. Wen estimates the impact of the farming institutional reform by a third approach, namely fitting a supply function of total agricultural output using aggregate national time series data. He finds that the farm output was increased by 56 percent due to instituting the household-based farming system.

Although the above estimations are somewhat different, all three papers attribute the success of the output growth mainly to the household farming institutional reform. Nevertheless, there are serious drawbacks with each of these three studies. The production function estimated in Lin's paper is skeptical due to strong multicolliniarity. The reason for the multicolliniarity is the cross-province time-series data in his estimation covered only the period from 1980 to 1983. Wen's estimation suffered the same difficulty as Lin's. His estimation of supply function based on only 35 observations. According to his estimation, 72 percent of the output growth in 1952-1957, and 49 percent in 1958 to 1978 could be attributed to technical change. On the contrary, the technical change in 1979-1987 resulted in a 11.4 percent decline in output. These conclusions counter almost all the findings in the agricultural productivity

growth studies by others, such as Tang (1984, Chap. 3), Perkins and Yusuf (1984, Chap. 4), and Chow (1985, Chap. 3). McMillan *et al*'s paper also has several flaws. The customary criticisms against the Dennison-type growth accounting are applicable to their studies.[7] In addition, although their decomposition of the total factor productivity growth into a price component and an incentive component is original, it is based on strong assumptions about the form and parameters of utility function. These assumptions are intestable and their results are sensitive to the assumptions made. Furthermore, theoretically the price used in their analysis should be marginal price. Nevertheless, they used the state above-quota procurement prices instead, which in general are lower than the prices prevailed in the rural market fairs. [8]

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[7]This approach implicitly assumes that the production function is homogeneous of degree one, the industry operates in perfectly competitive product and factor markets, and these markets are in equilibrium. These assumptions allow one to approximate the relevant coefficients of the production function by relative factor share, evading the job of directly estimating it. However, agriculture production is characterized by continuous disequilibrium. The approach is thus considered as not suitable for estimating agricultural productivity growth (Griliches 1963). Moreover, in the studies of Chinese agricultural productivity, the assumption of perfect competition in product and factor markets is especially inappropriate, as the product markets are highly regulated and transactions in land and labor markets were prohibited before the recent reforms and exist only marginally after the reform. For lack of information on appropriate factor share in the studied period, they adopted factor-share proposed by Tang (1980), who based his estimates on income shares in 1952. Nevertheless, technology and the composition of inputs have changed dramatically since then. Their results are sensitive to the factor shares assumed.

[8]The government procurement prices, even after adjusted with the premium paid to the above-quota delivery are in general lower than the prices prevailed in the rural market fairs. Moreover, albeit the general trends in the state above-quota procurement prices and market prices are similar, the year to year changes are often in different directions (see Table II). Consequently, the price data they used to estimate the price effect seem to be irrelevant to their analytical model.

This paper reports an attempt to evaluate and quantify the effects of the various components of rural reforms on agricultural productivity. Because the implicit assumptions of the Dennison-Solow type of growth accounting technique are not appropriate to Chinese agriculture, the paper employs the production function approach proposed by Griliches (1963).[9] The approach is similar to Lin's previous study. However, the data used in this study are the provincial level cross-section time-series data for 28 out of the 29 provinces on Mainland China for the period of 1965, and 1970 to 1987. The expansion of observations overcomes the issue of multicollinearity in Lin's previous paper and produces credible estimates of coefficients. The novelty of the present study, however, is the inclusion of separate measures of changes in institution, price, crop pattern, cropping intensity, and technology, in addition to four conventional input categories in the estimation of production function. In this way, the impacts of these changes on productivity can be estimated directly.[10]

The major findings of this paper are as follows:

1. Changes in the farming institution from the production team system to the household-based system had significantly positive effect on the productivity. The effects were mainly derived from the increases in the output elasticities

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[9]For the criticisms about the implicit assumptions of the Dennison-Solow growth accounting technique, see Footnote 7. In the Griliches-type approach, the factor shares are estimated rather than assumed. Therefore, this approach is applicable even product and factor markets do not exist or are in disequilibrium.

[10]In the above mentioned studies, however, they measured only the effect of institution (price) change directly, treated the effect of price (institution) change as residual, and assumed away the impacts of all other changes. Price and institution are undoubtedly two major changes in the recent reforms. Other changes, nevertheless, should have affected the output growth. Especially, these changes all happened concurrently with the price and institutional change. The estimations of price effect or institutional change effect are undoubtedly biased, if the effects of other changes are neglected.

of purchased inputs, namely capital and fertilizer.

2. Changes in market price had positive significant impacts on the productivity. However, changes in the state procurement prices did not have the same effects. This phenomenon may be explained by the fact that state procurement prices are lower than the market prices, therefore, the marginal prices to farmers are market prices rather than the state procurement prices.

3. Changes in crop pattern away from grain to non-grain crops had significant effect on the growth of output value, and in cropping intensity had significant impacts on gross output.

4. Productivity growth resulted from the rural reforms explained 43.6 percent of the crop output growth in 1978-1984, growth in inputs explained 40.8 percent, and the rest of 15.6 percent was residuals. Much of the productivity growth, 94 percent to be exactly, was attributable to the household responsibility system reform. Therefore, the household responsibility system reform is indisputably the most important source of output growth for the period 1978-1984.

5. There are substantial economies of scale in the household-based farming system. In the original production team system, on the contrary, there were substantial diseconomies of scale.

6. The main reasons for the stagnation of crop sector after 1984 are the sharp increase in the out-migration of labor force (8.6 percent per year) and the slow down in the increase of fertilizer input (drop from 8.9 percent per year in 1978-1984 to 3.7 percent per year in 1984-1987).

The above findings have wider implications than simply improving our understanding of rural reforms in China. An important issue that confronts most developing countries is how to develop their agriculture rapidly in order to

support urban industrialization and to meet the ever-increasing food demand from explosive population growth. Small and fragmented holdings, which characterize the landscapes in most developing countries, are often regarded as a great obstacle for mechanization, irrigation, plant protection, efficient allocation of inputs, and so forth. Collective farming, consequently, is considered by many policy makers, not only in China but also in other socialist and non-socialist countries, as an attractive way for land consolidation and productivity improvement. However, our finding suggests that household farming is a more appropriate form of institution for the development of agriculture in the developing countries.

Our findings also suggest that, unless the state procurement prices are set equal to or above market prices, the socialist countries will not be able to use price adjustments as an instrument to affect agricultural productivity.

The organization of the paper is as follows. Section II provides an overview of rural reforms in China. The data used in the empirical evaluation are briefly summarized in Section III. Section IV discusses the estimation method and reports the empirical results. The growth accounting for 1978-1984 and 1984-1987 are reported in Section V. Finally, some concluding remarks are presented in Section VI.

II. Rural Reforms in China

Broad changes in rural policy beginning at the end of 1978. As commented by Perkins (1988), "it is unlikely that China's leaders had a worked out blueprint in mind when they set out to reform the economic system. One reform led to another until China by 1987 had moved a considerable distance from the Soviet-style command system it had introduced in the 1950s." This comment is

particularly true for the rural reforms. The change from the collective to the household-based farming system, the most far-reaching change to date in China's economic reforms, was actually prohibited in the 1978 document which kindled the whole series of reforms. The importance of giving enough incentives to farmers in order to break the bottle-neck of agricultural production was recognized. The original intention of the government, however, was to achieve this goal through raising the long-depressed government procurement prices for major crops, modifying management methods within the context of the collective system, and increasing budgetary expenditure on agricultural investment.[11]

Price Reform The most important policy change intended by the government at the beginning of the reforms was the adjustment of procurement prices for major crops. Before the reform, two distinct prices, quota prices and above-quota prices, existed in the state commercial system. Quota prices applied to crops sold in fulfillment of procurement obligations; above-quota prices to crops sold in excess of the obligation. Announced at the end of 1978 and started to be effective in 1979, quota prices increased 20.9 percent for grain, 23.9 percent for oilcrops, 17 percent for cotton, 21.9 percent for sugar crops and 24.3 percent for pigs. The average increase for the quota prices was 17.1 percent (State Statistical Bureau, Trade and Price Statistical Division, 1984, pp. 404-406). In addition, the premium paid to the above-quota delivery of grain and oilcrops was raised from 30 percent to 50 percent of the quota prices, and a 30

[11]In the 1978 document, the government called for the increase of agricultural investment in the budgetary allocation from its then current 11 percent to a level of 18 percent. However, agricultural investment fell continuously after 1979, dropped to only 5 percent of state investment in 1984 (Lardy 1986).

percent bonus was instituted for above-quota delivery of cotton.[12] The average increase for the state procurement prices was 22.1 percent (State Statistical Bureau, Trade and Price Statistical Division, 1984, p. 401). However, if only the marginal prices, that is the above-quota prices, are considered, the increase in the state procurement prices was 40.7 percent (see Column 1, Table II).

Corresponding to the increase in procurement prices, the retail prices were raised 33 percent for pork, 32 percent for eggs, and 33 percent for fishes in 1979; however, the retail prices for basic necessities, such as grain and edible oils were not changed. To compensate for the raise in retail prices in pork, egg, and fishes, each urban dweller was compensated 5 to 8 yuan a month.[13] Therefore, government's subsidies to prices increased as a result. The financial burden became especially unbearable when the unexpected output growth started to emerge in 1982 (see Table I). The price subsidies increased from 9.4 billion yuan (8.4 percent of the state budget) to 37 billion yuan (24.6 percent of the state budget) in 1984 (State Statistical Bureau 1988, p. 747 and p. 763). As a way to reduce the state burden and to increase the role of markets, the mandatory procurement quotas were abolished, for cotton in 1984 and for grain in 1985, and replaced by procurement contracts which was supposed to be negotiated between the government and the farmers and should be agreed upon by both parties. The contract price was a weighted average of the basic quota price and above-quota price. This change resulted in 9.2 percent decline in the price margin paid to farmers (see Table II). However, following the decline of grain and cotton

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[12]For a detailed chronology of the price changes in 1979 and thereafter, see Sicular (1988).

[13]Quanguo wujia gongzi huiyi jiyao (Summary of National Conference on Wage and Price) in State Statistical Bureau, Urban Sampling Survey Team (1988, pp. 8 - 14).

Table II: Price Index and Grain Price

Year	State Above-quota/ Contract Price Index (1978=100)	Rural Market Consumer Price Index (1978=100)	State Grain[1] Above-quota/ Contract Price (Yuan/100jin)	Market Fair[2] Grain Price (yuan/100jin)
(1)	(2)	(3)	(4)	(5)
65	84.1	78.2	12.61	20.99
70	97.2	80.4	13.61	19.48
71	98.4	87.4	13.61	17.86
72	98.4	94.6	13.48	24.35
73	98.1	99.6	13.57	24.35
74	98.4	101.4	13.60	25.16
75	98.7	105.5	13.78	25.97
76	99.4	109.7	13.77	30.03
77	100.0	107.0	13.64	30.84
78	100.0	100.0	14.01	25.97
79	140.7	95.5	17.04	21.91
80	140.4	97.4	19.63	20.29
81	145.1	103.0	19.65	22.72
82	144.3	106.5	19.80	21.91
83	144.9	110.9	19.95	22.72
84	142.5	110.5	20.11	19.48
85	129.4	129.5	18.13	20.28
86	130.1	140.0	-	22.72
87	130.2	162.8	-	-

Sources: Column (2) and (3) see Appendix; Column (4) and (5) are taken from Chui (1988, p. 25).

Note: 1. The grain price series given in Chui's paper is the weighted average basic quota price for wheat, rice, millet, corn, sorghum, and soybean, using the quantities sold as weights. This series is converted to the above-quota price as follows. The above-quota price for grain was introduced in 1965 and was set to 130 percent of basic quota price. After 1979, the above-quota price was raised to 150 percent of the quota price. The contract price was introduced in 1985, which was the weighted average of basic quota price (30 percent) and above-quota price (70 percent). The adjustments are made accordingly.

2. The market fair prices were the average prices in Hunan Province.

production in 1985 and stagnation thereafter (see Table I), the contracts were made mandatory again in 1986 (Sicular 1988).

It is noteworthy here that, alongside with the state commercial channels, market fairs have always existed, except 1958 and 1959, and played an important role in rural China (Perkins 1966, p. 199). Farmers, after fulfilling their quota obligations, could sell their produce in market fairs. The market prices have always been higher than the state procurement prices, even measured with the above-quota premiums (See Table II).[14] Therefore, the marginal prices to farmers are the market prices rather than the state procurement prices.

Institutional reform Unlike the price reform, the change in farming institution from the collective system to the household-based system, now called the household responsibility system (HRS), was not intended by the government at the beginning of the reforms. The farming institution after the collective movement in the late fifties was basically kept intact for about 20 years. Chinese farm families were organized into communes. Each commune was then divided into brigades, and brigades into production teams. A production team, consisting of about 20-30 neighboring households, was generally the basic production and accounting unit. All resources were collectively owned and allocated under the management of a team leader, with the exception of small plots reserved for the household's use. Team members, working under the supervision of a team leader, were accredited with work points for the jobs that they performed. At the end of a year net team income was first distributed among members according to some basic needs, and then the rest was distributed according to the work points that

[14]For rice and wheat, 1984 was an exception. The market prices for rice and wheat were about the same as the government above-quota procurement prices in 1984. For corn, the market prices were lower than the above-quota prices in 1980-1983 (Sicular 1988).

each one accumulated during the year. Work points were supposed to reflect the quality and quantity of effort that each member performed. Nevertheless, because of difficulties in providing close supervision in agricultural production, farmers in general received flat work points for each day's work regardless a the work intensity of a job and the actual effort provided. Because rewards were not tied directly to efforts, incentives to work were thus low in the production team.[15]

Although it had been recognized in 1978 that solving the managerial problems within the production team system was the key to improving low incentives, the official position at that time maintained that the production team was to remain the basic unit of production management and accounting. Subdivision of collectively-owned land and delegating production management down to individual households were considered the reverse of the socialist principle and were prohibited. Nevertheless, a small number of production teams, first secretly and later with the blessing of local authorities, began to try out the system of contracting land, other resources, and output quotas to individual households toward the end of 1978. A year later these teams brought in yields far larger than those of other teams. The central authorities later conceded to the existence of the new form of farming but required that this practice be restricted to the poor agricultural regions, mainly to the hilly, mountainous areas and poor teams in which people had lost confidence in the collective. However, this restriction was ignored by most regions. Full official recognition of the household responsibility system as universally acceptable mode of farming institution was eventually given in late 1981, exactly two years after the

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[15] Lin (1988) provides a theoretical model of the work point system and empirical testings of several hypotheses about the model.

initial price increases. By that time 45 percent of production teams in China had already dismantled and instituted HRS. By the end of 1983, 98 percent of production teams in China had adopted this new system (see Column 2, Table III). It is worth emphasizing that the household responsibility system was worked out among farmers, initially without the knowledge and approval of the central government. It was initiated by farmers themselves and spread to other areas because of its merits. It was not imposed by the central authority. In short, the shift in the institution of Chinese agriculture was not carried out by any individual's will but evolved spontaneously in response to underlying economic forces.[16]

When HRS was originally introduced, the collectively-owned land was leased to each of the households in a team for one-to-three years. Along with the land lease was a contract between the household and the team specifying the household's obligations to fulfill state procurement quotas and to pay various forms of local taxes.[17] However, a household could retain any product above the stated obligations. In the distribution of land leases, egalitarianism is in general the guiding principle. Therefore, collective land in most cases was leased to a household strictly proportional to the size of the household, without taking the inter-family differences in the size of labor force into consideration (Kojima 1988). This way of land allocation inhibited efficient land use. Moreover, at the initial distribution, land was first classified into several different grades and then a household obtained a parcel from each grade. As a

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[16]For a chronology of the policy evolution, see Ash (1988). For a summary of the development from various variants of responsibility system to the HRS, see Kueh (1984). For a discussion of some new issues related to HRS, see Kojima (1988).

[17]Crook (1985) provided a detailed analysis of a model contract.

result, a household's holding on the average is fragmented into 9 tracts although the size of holding is only about 1.2 acre. The one-to-three-year short contract was also found to have detrimental effects on the incentives to invest in land improvement and soil-fertility conservation.[18] As remedies to above issues, several new policies were introduced: (1) A household was allowed to exchange its labor with other household and to employ a limited amount of labor for farm work in 1983 (Kueh 1985). (2) For the purpose of providing better incentives for soil conservation and investment, leasehold was allowed to be extended to 15 years in 1984. (3). To make land consolidation possible and to prevent land being left idle when a household engaging in non-farm business, subleasing one's landholding to other households with compensation was also sanctioned in 1984. These policy reforms may eventually revive labor and land markets in rural China. However, so far transactions in land only exist marginally in China and labor-hiring for farm works mainly exists in certain regions in the coast provinces (Lin 1989 b).

The national policy so far still stresses the importance of maintaining institutional stability of the newly established household farming system. However, the doctrine of equating big tractor to advanced technology and large farm size to efficiency still deeply rooted in the minds of many scholars and prominent leaders (Ash 1988).[19] Because of the increasing discontent with the stagnation of grain production after 1984, the call for recollectivization under the guise of enlarging operational size to exploit returns to scale has reemerged. In some localities, this call has resulted in contract disruption

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[18]Wen (1989) provides a theoretical investigation of the possible impacts of tenure insecurity on long-term farm investments.

[19]For an insightful critique of this doctrine, see Schultz (1964, Chap. 8).

Table III: Crop Pattern, Cropping Intensity, and Weather

Year	Household Responsibility System	Sown Area			Multiple Cropping Index	Disaster Hit Area
		Grain Crops	Cash Crops	Other		
	(%)	(%)	(%)	(%)	(%)	(%)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
65	0	83.5	8.5	8.0	138.3	7.8
70	0	83.1	8.2	8.7	141.9	2.3
71	0	83.1	8.2	8.7	144.7	5.1
72	0	81.9	8.5	9.6	147.0	11.6
73	0	81.6	8.6	9.8	148.2	5.1
74	0	81.4	8.7	9.9	148.7	4.4
75	0	81.0	9.0	10.0	150.0	6.7
76	0	80.6	9.2	10.2	150.6	7.6
77	0	80.6	9.1	10.3	150.5	10.2
78	0	80.4	9.6	10.0	151.0	16.8
79	1	80.3	10.0	9.7	149.2	10.1
80	14	80.1	10.9	9.0	147.4	15.2
81	45	79.2	12.1	8.7	146.6	12.9
82	80	78.4	13.0	8.6	146.7	11.1
83	98	79.2	12.3	8.5	146.4	11.2
84	99	78.3	13.4	8.3	146.9	10.5
85	99	75.8	15.6	8.6	148.4	15.8
86	99	76.9	14.1	9.0	150.0	16.4
87	99	76.8	14.3	8.9	151.3	14.1

Source: Column (2) indicates the percentage of production teams in China that had adopted the household responsibility system. The data for 1979-1981 are from Jingjixue zhoubao (Economic weekly) (January 11, 1982). Figures for 1982-1984 are taken from Editorial Board of China Agricultural yearbook(1984, p. 69; 1985, p. 120). Figures for 1985-1987 are inferred from the fact that no major change in the farming institution since 1984. Column (3) to (7) are taken from Ministry of Agriculture, Planning Bureau (1984 p. 132; 1989, pp. 130-31, pp. 355-57) and State Statistical Bureau (1988, p. 224, p. 243, p. 276).

Note: Area hit by disasters referred to the area victimized by natural disasters and production was reduced by more than 30 percent of yield in a normal year.

before expiration without the consent of farmers (Jiang 1988). It is thus possible that the economic independence and greater freedom given to farmers in the past ten years may be deprived again (Johnson 1989).

Market and planning reform The third most important element of the reforms is the greater role given to markets, in place of planning, for guiding production in rural sector. The prevalence of planning in agriculture before the reforms was a result of the self-sufficiency in grain, which was a component of the Stalin-type heavy industry-oriented development strategy that the Chinese government pursued since 1952. Because state grain procurement prices were depressed at an artificial level, the more grain an area exported, the more tax it paid. Areas with comparative advantage in grain production were thus reluctant to raise the level of grain output. Consequently, grain-deficit areas had to increase grain production if grain demand increased due to growth in population or income. National self-sufficiency thus degenerated into local self-sufficiency. To guarantee each region would produce enough grain for its needs, planning of agricultural production was thus extensive before the reforms. Mandatory targets often specified not only sown acreage of each crops but also yields, levels of inputs and so forth. As grain was given priority in the planning, insufficient attention was given to economic consideration. For increasing grain output to meet state procurement quotas and local demands, the local government was often forced to expand grain sown area at the expense of cash crops and to increase cropping intensity, even though these practices often resulted in net loss to farmers. Such measures undoubtedly made the allocation of land increasingly diverged from the principle of comparative advantage. The loss of regional comparative advantage was especially serious in areas where traditionally depended on interregional trade of grain to facilitate the

specialization in cash crops.[20]

The loss of allocative efficiency caused by the self-sufficiency policy was conceded at the beginning of the reforms. Although planning was still deemed essential, more weights were given to market consideration. The decision to increase grain imports, cut down grain procurement quota, and reduce the number of products covered by plan control reflected such an intention.[21] Moreover, restrictions on interregional trade for agricultural product by private traders were gradually loosened (Sicular 1988). Special measures were also taken to encourage areas traditionally have comparative advantage in cotton production to expand cotton sown acreage.[22]

All the above policy changes reduced the role of direct state planning intervention and increase the function of market in guiding agricultural production. As a result cropping pattern and cropping intensity changed substantially between 1978 and 1984. The area grown to cash crops increased from 9.6 percent of total sown acreage in 1978 to 13.4 percent in 1984, a 41.6 percent increase in relative term; meanwhile, the multiple cropping index declined from

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[20]Cotton sown area dropped 16 percent nationally between 1957 and 1977/1978. However, the north provinces that initially have substantial comparative advantage in cotton production declined by a larger proportion. For example, the cotton sown area in Hebei, the province initially with the strongest comparative advantage, fell 58 percent between 1957 and 1977. Consequently, north China ceased to export cotton in the late 1970s (Lardy 1983, pp. 62-3)

[21]The net grain import increased from 6.9 million ton in 1978 to 14.9 million ton in 1982 (Ministry of Agriculture, Planning Bureau 1989, p. 522 and p. 535). Grain purchase quota was reduced 2.5 million ton in 1979 (Ash 1988). For example, the number of planned product categories and obligatory targets was reduced from 21 and 31, respectively, in 1978 to 16 and 20 in 1981 and further to only 13 categories in 1982 (Kueh 1984).

[22]In 1979 a policy that awarded above-quota delivery of cotton with low-priced grain sale was instituted. This policy made a huge expansion of cotton areas possible in the traditional cotton producing area.

151 to 146.9 (See Table III).[23] Much of the changes in crop pattern was in conformity with the regional comparative advantage. For example, between 1978 and 1984, the seven provinces traditionally specializing in cotton production increased cotton acreage 2.33 million hectare while the rest of provinces reduced 1.19 million hectare.[24] The cotton sown acreage nationally increased only 25 percent between 1978 and 1984, however, the yield increased 189 percent (see Table I). A substantial portion of this dramatic output surge was attributable to gains in comparative advantage.[25]

The climax of the market reform was the declaration at the beginning of 1985 that the state would no longer set any mandatory production plans in agriculture and obligatory procurement quotas were to be replaced by purchasing contracts between the state and farmers.[26] The restoration of household farming and the increase in market freedom prompted farmers to adjust their production activities in accordance with profit margins. The acreage sown to cash crops further expanded from 13.4 percent of the total sown acreage in 1984 to 15.6 percent in 1985 while the grain sown acreage declined from 78.3 percent in 1984 to 75.8 percent (see Table III). The expansion in animal husbandry, fishery,

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[23]The reduction in multiple cropping index may increase the net revenue to farmers, however, the gross output may decline as a result.

[24]The seven provinces traditionally specializing in cotton production are Hebei, Shanxi, Jiangsu, Shandong, Henan, Hubei, Xinjiang (Lardy 1983, p. 58). The cotton sown acreage data are taken from State Statistical Bureau (1984 a, p. 78), and Editorial Board of Agricultural Yearbook (1985, p. 150).

[25]Another reason for the rapid growth was the introduction and diffusion of a new high-yield variety called lumian yihao in early 1980s.

[26]"Zhonggong zhongyang guowuyuan guanyu jinyibu huoyue nongcun jingji de shixiang zhengce" (Ten Policies of the CCP Central Committee and the State Council for the Further Invigoration of the Rural Economy) in Editorial Board of China Agriculture Yearbook (1985, p. 1-3).

and subsidiary production were even faster. As a result of these adjustments, agriculture output still grew at a respectable rate of 3.4 percent in 1985. Nevertheless, the aggregated outputs of cropping sector declined 1.9 percent.Among the three most important crops, the output of grain declined 6.9 percent, cotton 33.7 percent; only oil-crops registered 33.3 percent increase in 1985. The stagnation of cropping sector lingered after 1985.

The market-oriented reforms aroused anxiety in some sector of the governing group from its very beginning. Concerns over "loss of control" was widely reported in early 1980s (Sicular 1988). In the face of the unprecedented success between 1978 and 1984, the pro-market group was able to push the reforms further toward the market direction. However, when the growth rates slowed down and grain output declined in 1985 and thereafter, the government retreated from its position in 1985. The voluntary procurement contract was made to be mandatory again. Formally the policy announced in 1985 is not reversed, and the government still hopes to rely on market measures to stimulate grain production.[27] Nevertheless, administrative intervention in market and production has been increasing. For example, to facilitate the fulfillment of procurement quotas, local governments often set blockages on markets of grain, cotton, silk cocoon, tobacco and so forth. The intervention in production is revealed by the fact that the acreage sown to cash crops declined after 1985 and multiple-crop index increased up to 151.3 in 1987, a level even higher than that reached in 1978 (see Table III). So far the attempts to increase grain outputs were not successful,

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[27]The government further reduced the quantity of grain procurement contract by 22 percent in 1986, and again by 10 percent in 1987. This measure increased the quantity of grain sold to government at "negotiated prices," which is higher than the contract prices and closer to market prices. The government also instituted a policy called "three-link ups," awarded subsidized credit, chemical fertilizer and diesel to grain, cotton, and selected crops (Sicular 1988).

grain yield in 1988 was still lower than that in 1984.[28] It is estimated that the grain yield in 1989 will not reach the 1984 level either. Facing the stagnation in grain output, the pressure to recourse to planning control will become stronger.

Above are the major components of rural reforms since 1978. As described, the reforms have obtained many achievements until 1984 and encountered some problems after then. How much of the output growth in 1978-1984 can be accredited to the various components of reforms and what should be responsible for the slowdown after 1984 are the focuses of the sections below.

III. Data

The data used for the empirical evaluation includes the conventional input and output series for 28 out of 29 provinces on Mainland China for 1965 and 1970-1987.[29] In addition, information on state procurement prices, market prices, and changes in farming institution, crop pattern, and cropping intensity in each provinces are also included in the data set. Data used in this study obtained from various official sources, some are published and some are unpublished. A number of adjustments are required to make the data suitable for the study. Detailed information on data sources and the adjustments are given in the appendix. Here only a summary description of the data is reported.

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[28]The grain output in 1988 was 394.08 million ton (State Statistical Bureau 1989, p. 197) which was 3.2 percent lower than the yield in 1984. .

[29]The input data for 1966-1969 are not available. The province not included in the data set is Tibet. Tibet is excluded because the lack of its output data. Since Tianjin did not obtain the provincial status until 1966, so there were only 27 provinces in 1965. The total observations, therefore, are 531.

Agricultural outputs in the study referred to crop outputs.[30] Each province's value of crop outputs is calculated from the physical outputs of 7 grain crops and 12 cash crops, using the official prices of 1980 as weights for aggregation.[31] Nationally, these 19 crops consisted of 92 percent of the total sown acreage and 72.5 percent of cropping sector's output value in 1980.[32]

Inputs in the data set include four categories: land, labor, capital, and chemical fertilizer. Land referred to the cultivated land each province endowed. Cultivated land instead of sown acreage is used because we also want to see how changes in cropping intensity affected crop outputs. Labor refers to the labor in cropping sector. Capital includes tractors and draft animals measured by horsepower. Chemical fertilizers referred to the gross weights of N, P, and K that each province consumed in each year. The size of provinces varies greatly. To prevent the size effects on the regression estimations, the output and input

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[30]In Chinese statistics, agriculture refers to cropping, animal husbandry, forestry, fishery, and sideline production. Forestry, fishery, and sideline production are in general not included in agricultural productivity studies. Animal husbandry is not included mainly for two reasons: (1) the data for the relevant output and input series of animal husbandry previous to 1979 are not available; and (2) animal husbandry had been under household operation even before the household-based farming institutional reform, therefore, the institutional reform should not have a direct impact on it. The farming institutional reform, nevertheless, may have an indirect impact on animal husbandry. The dramatic reduction in labor required for cropping after the household responsibility system reform released much labor for other activities including animal husbandry. Since the growth of animal husbandry was faster than crops, the exclusion of animal husbandry may reduce the significance of the farming institutional reform on output growth.

[31]China Agricultural Yearbook, 1980 to 1988 reports the provincial aggregated value of cropping sector measured at the 1980 prices for 1980-1987, but provincial aggregated output values previous to 1979 are not available. There is an advantage, however, in using the physical outputs to compile the output value series. The accuracy of data on physical outputs are considered to be on the top of Chinese official data (Field 1988).

[32]Those crops excluded in the data set are mainly vegetables and fruits. They command higher value than grain and cash crops.

Table IV: Index of Inputs (1978=100)

Year	Farm Labor	Labor in Cropping Sector	Land	Capital	Chemical Fertilizers
(1)	(2)	(3)	(3)	(4)	(5)
65	85.99	94.39	108.09	45.16	21.14
70	99.09	103.04	101.76	51.73	36.30
71	101.16	104.00	101.29	58.60	41.55
72	100.78	102.04	101.20	64.04	47.94
73	102.91	103.76	100.80	69.02	58.52
74	102.93	104.21	100.50	75.05	55.08
75	100.81	103.35	100.11	79.97	60.87
76	100.65	102.46	99.98	85.55	66.06
77	100.05	100.41	99.82	93.09	73.09
78	100.00	100.00	100.00	100.00	100.00
79	102.17	103.66	100.10	104.22	120.15
80	104.75	107.63	99.91	122.12	134.29
81	107.81	111.58	99.44	131.74	141.44
82	109.48	112.82	99.21	141.16	156.00
83	111.22	115.34	98.89	153.40	169.06
84	111.35	114.69	98.89	165.29	171.62
85	106.65	104.56	97.46	176.65	167.38
86	107.06	95.79	96.81	191.09	183.10
87	108.48	88.70	96.47	209.71	192.10

Source: see appendix.

data are normalized by the number of teams in each province in 1980. The summary of inputs series are reported in Table IV.

In addition to the four conventional inputs, five other measures are included in the data set to reflect the various components of reforms. These measures are the percentage of production teams converted to the household responsibility system, the index of above-quota prices and market prices, percentage of sown acreage in non-grain crops, and multiple cropping index. They are used to capture respectively the impacts of farming institutional change, state procurement price adjustments, and market reforms. The index of above-quota prices and market prices are the national index, the other three measures are provincial level data.[33]

The conglomerate nature of provinces in China reduces sharply the observed range of variation in the data for inputs and measures of reforms, and hence also the sharpness with which their individual influence on output can be estimated. The quality of Chinese agricultural statistics has also been a subject of debate.[34] Nevertheless, the data set presents an unusual opportunity for undertaking a careful analysis of the impacts of reforms, as well as an opportunity for estimating Chinese agricultural production function

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[33]Using the national index for state procurement price will not cause any trouble in the estimation, because the prices are set by the state and implemented uniformly in each province. However, market prices vary among provinces, although the general trends are the same. Using the national market price index thus may reduce the sharpness with which the influence of market prices on output can be estimated.

[34]In recent years the consensus among the students of Chinese economy seems to be that the Chinese official data are, after all, the best available data. See the volume devoted to examination of Chinese official statistical data edited by Eckstein (1980).

econometrically.[35]

IV. Functional Form Specification and Results

Production is regarded as technically more efficient when more outputs can be produced with the same quantity of inputs or the same outputs can be produced with less inputs. If production is purely an engineering relationship between inputs and outputs, except due to some random shocks, any variation in outputs would be a result of changes in inputs. However, an observed production function in general is an economic relationship, not a purely engineering one, as the intensity with which observed resources are utilized depending on economic decisions made by workers as well as managers in response to institutional arrangement, profitable opportunities, and so forth (Leibenstein 1966, Carter 1984, McMillan *et al*, 1989). As such, the technical efficiency of production can be altered by economic reforms.

Changes in output prices are expected to affect the decision between work and leisure from standard microeconomic analysis. The adjustments in crop patterns to soil, temperature, rainfall, and other regional specific characteristics are a major source of productivity growth in agriculture.[36] Changes in multiple cropping index reflect in a way how intensive land and labor inputs are utilized. Similarly, the changes in farming institution from the production team system to the household responsibility system is expected to alter the level of effort supply by each farmer. Lin (1988) argues that the

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[35]Due to the lack of cross-sectional data available to scholars, as commented by Perkins and yusuf (1984, p.46), the attempts to estimate Chinese agriculture production function have not yielded plausible production functions.

[36]This factor is especially emphasized by Lardy (1983). He attributes much of the stagnation in Chinese agriculture before the recent reform and the rapid growth after the reforms to the loss and gain of regional comparative advantages.

marginal return to an individual farmer's effort in a production team with a work point system as its compensation scheme is a function of the degree of supervision exerted by the team management. If supervision is not perfect, a farmer will only receive a fraction of the marginal value of his effort. Because the supervision of labor effort is extremely costly in agricultural production, the optimal degree of supervision is very low in a team. Consequently, the incentive to work for a farmer is very low and under-contribution of effort is epidemic in a production team. On the contrary, a farmer receives a full share of the marginal returns to his additional effort in a household farm. Therefore, a farmer is expected to contribute more effort to production in the household responsibility system than in the production team system. Because these reforms in prices, farming institution, and markets may affect the intensity that resources are utilized, to evaluate the impacts of these reforms, the production function estimated will thus be an "institutional" production function, which incorporates the farmer's response to institutional arrangements within which they work, rather than a "technical" production function, which reflects simply the technical relationships between inputs and outputs (McMillan *et al* 1989).

The agricultural production function estimated is a Cobb-Douglas function with four conventional inputs, namely land, labor, capital, and chemical fertilizer (Fert). In addition, six other variables, namely percentage of team transformed to the household responsibility system (HRS), the market price index (MP), the above-quota price index (GP), percentage of sown area in non-grain crops (NGCA), multiple cropping index (MCI), and time (T) are included in the

function (see Appendix for variable definitions).[37] The nonconventional variables are incorporated to assess the impacts of farming institutional change, price adjustments, market reforms, and technological changes on productivity. The production elasticities of the conventional inputs are allowed to vary linearly with HRS. This is an attempt to capture the impacts of the institutional change on factor productivity due to differences in the property right arrangement among the conventional inputs after the reform.[38] Because the productivity of the conventional inputs also depends on some omitted time-persistent region-specific variables, such as soil quality, rainfall, irrigation, temperature, average education level, and so forth, 27 provincial dummies are included in the production function in order to obtain consistent estimates. This specification gives rise to the estimating equation

$$(1)\quad Y_{it} = \alpha_1 + (\alpha_2+\alpha_3 HRS_{it})Land_{it} + (\alpha_4+\alpha_5 HRS_{it})Labor_{it} + (\alpha_6+\alpha_7 HRS_{it})Capital_{it}$$
$$+ (\alpha_8 + \alpha_9 HRS_{it})Fert_{it} + \alpha_{10} HRS_{it} + a_{11} MP_{t-1} + a_{12} GP_t + a_{13} NGCA_{it} +$$
$$+ \alpha_{14} MCI_{it} + \alpha_{15} T_t + \sum_{i=1}^{27} \beta_i D_i + \varepsilon_{it},$$

[37]A more general production function of the transcendental logarithmic (translog) form was also tried, but the results of estimation, involving as many as 10 independent variables, were too complicated and unreliable to make a reasonable judgement and interpretation.

[38]Labor has always been privately owned. Capital and fertilizers became privately owned after the reform. Land, nevertheless, is still collectively owned. It is leased to a household initially with a one-to-three year contract. the contract was allowed to be extended to 15 years in 1984. However, land may be assigned to other households when the contract expires. Moreover, there is risk of contract disruption before expiration. Therefore, the tenure security is improved for capital and fertilizer and is deteriorated for land after the reforms.

where α's and β's are parameters to be estimated, and ε the error term. All variables, except HRS, T, and D's, are in natural logarithm. Theoretically, the price variables included should be the expected prices, since what relevant to production decision is the expected prices. For the above-quota prices (GP), the current prices at each year were the expected prices at that year because any changes in the procurement prices were announced prior to the production season started. However, for the market prices (MP), the price expectation is a complicated function of past experiences, and other information on the economy (Muth 1961). Since no information about the structure of market price expectation in China is available, the expected market prices will be assumed simply to be the prices in the previous year.

The method to obtain a consistent estimate of Equation (1) depends on the structure of the error term ε_{it}. If ε_{it} is an independently identically distributed random variable with mean zero and variance σ^2_{ε}, then the covariance estimator of Ordinary-Least-Squares (OLS) is the best linear unbiased estimator. However, in our study setting, the error term may comprise two independent components, one with normal and the other one with one-sided distribution. The first component is the conventionally assumed error which has mean zero and is the result of factors like climate, luck, or errors of measurement in Y. Because of this component, the production frontier can vary across provinces and over time, and is thus stochastic. The second component, which is non-positive, occurs because each province's output must lie on or below a stochastic frontier. Such a deviation may result from several sources related to reforms: The institutional reform deprived the privilege of grass-roots cadres (Latham 1985). As a consequence, some communal services like management of irrigation system and insect control are disrupted. Moreover, rural collective violence is reported

to have increased after the household responsibility reform (Perry 1985). The market reforms also have some detrimental impacts on agricultural production. Some farmers are induced to engage in private trade or other more profitable activities, and leave their land idle. Due to these considerations, the structure of the error term is assumed to be

$$(2) \qquad \varepsilon_{it} = \mu_{it} - \upsilon_{it},$$

where μ_{it} has normal distribution with parameters 0 and σ^2_{μ}, and υ_{it} has positive half normal distribution with parameters 0 and σ^2_{υ}. The two parts of error are assumed to be independent. If Equation (2) is the correct formulation of the error term, the covariance estimator for the coefficients in Equation (1) will be biased. The stochastic frontier regression, developed by Aigner *et al* (1977) will, nevertheless, produce consistent estimates of the coefficients. For comparison purposes, the results of fitting Equation (1) by both methods are reported in Table V.

Columns (1) and (4) report respectively the OLS and the stochastic production frontier estimates for the production function without the interaction terms. The estimates for the production function with the interaction terms are reported in Columns (2) and (5), while Columns (3) and (6) repeat the estimations after the jointly insignificant variables, including HRS, HRS x Labor, GP, and T, are dropped.[39] From the estimates, it is found that the coefficients obtained from OLS are quite close in magnitude and level of significance to those obtained from the stochastic frontier regressions. However, the estimated σ_{υ} and σ_{μ} the

[39]The Wald test statistic (χ^2 with 4 df) is 1.84.

Table V: Agricultural Production Functions

	OLS			Stochastic Frontier		
	(1)	(2)	(3)	(4)	(5)	(6)
Land	.61	.54	.55	.54	.50	.49
	(.06)	(.07)	(.06)	(.05)	(.06)	(.04)
Land x Hrs		-.06	-.08		-.09	-.09
		(.04)	(.03)		(.04)	(.02)
Labor	.14	.24	.23	.12	.20	.21
	(.03)	(.03)	(.03)	(.02)	(.03)	(.03)
Labor x Hrs		-.03			.01	
		(.04)			(.03)	
Capital	.08	.03	.05	.10	.05	.06
	(.03)	(.03)	(.02)	(.03)	(.03)	(.02)
Capital x Hrs		.09	.11		.11	.11
		(.04)	(.03)		(.05)	(.03)
Fertilizer	.15	.16	.17	.15	.15	.15
	(.02)	(.02)	(.02)	(.02)	(.02)	(.01)
Fertilizer x Hrs		.14	.13		.15	.14
		(.03)	(.03)		(.03)	(.03)
Hrs	.22	.02		.23	-.04	
	(.02)	(.15)		(.02)	(.15)	
Price:						
Market (t-1)	.21	.19	.09	.24	.20	.10
	(.12)	(.11)	(.06)	(.11)	(.11)	(.07)
Above-quota (t)	.07	.11		.08	.10	
	(.09)	(.08)		(.08)	(.08)	
Multiple Cropping Index	.50	.46	.44	.44	.34	.34
	(.14)	(.13)	(.13)	(.15)	(.14)	(.14)
Non-grain Area (%)	.08	.08	.07	.10	.10	.10
	(.03)	(.03)	(.03)	(.03)	(.03)	(.03)
Time	-.005	-.002		-.009	.004	
	(.006)	(.006)		(.006)	(.006)	
Interception	1.63	1.57	2.73	2.01	2.16	3.33
	(1.09)	(1.04)	(.42)	(.97)	(.44)	(.39)
R^2	.961	.965	.965			
Log-likelihood	457.4	487.2	485.4	474.4	511.0	509.7
$\lambda = \sigma_v / \sigma_\mu$				2.43	3.16	3.07
				(.45)	(.62)	(.56)
$\sigma^2 = \sigma_v^2 + \sigma_\mu^2$				.15	.15	.15
				(.006)	(.006)	(.005)

Note: Figures in parentheses are standard errors or estimated asymptotic standard errors. The estimated coefficients of 27 provincial dummies are not reported. The equations estimated are linear in the logarithms of the variables (except for HRS, Time, and provincial dummies). The conventional inputs are normalized by the number of teams in each province in 1980.

stochastic production frontier regressions suggest that the one-sided component v_{it} dominates the error term (see the last two rows in Table V). Therefore, it is more appropriate to use the stochastic frontier regression model than the OLS. The log-likelihoods suggest the same preference. We will thus interpret the results of the empirical findings based on those obtained from the stochastic production frontier model.

Column (4) reports the results when the interaction between HRS and the conventional inputs are excluded. The results indicate that while changes in time (T) and government procurement price (GP) do not have any significant effect,[40] changes in the farming institution (HRS), market price (MP), percentage of non-grain crop area (NGCA), and multiple cropping index (MCI), have significant impact on the output. Column (5) suggests the same results except for HRS. The coefficient of HRS itself and interaction with labor are not significantly different from zero. However, the coefficients of interaction with capital and fertilizer are significantly positive, and with land is significantly negative. Column (6) repeats the estimation, while the jointly insignificant variables are dropped. The resulted estimates are extremely close to those in Column (5).

The above evidences suggest that the change from the production team system to the household responsibility system have a positive impact on the agricultural productivity. The impact of the farming institutional reform, nevertheless, is not neutral in the sense that it increases the productivity of each factor at the same proportion. The evidences indicate that the institutional reform increases the output elasticities, and thus marginal productivity, of purchased

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[40]If MP is dropped from the function, the estimated coefficient of GP is .002 (.05) by OLS and -.01 (.05) by the stochastic production frontier regression. Figures in the parentheses are the estimated asymptotic standard errors.

inputs, capital and fertilizer, while reduces that of land and brings no changes to that of labor. These evidences seem to be consistent with the changes in property right arrangements of these inputs.[41]

The evidences also suggest that while increases in the market price expectation have positive impact on the productivity, probably due to more effort will be contributed to production, changes in government procurement prices do not have the same effect. This phenomenon may be explained by the fact that the marginal prices to farmers are the market prices rather than the state procurement prices, even with the above-quota delivery premiums (see Table II).[42]

The changes in crop pattern and multiple cropping index, which resulted from reforms in the role of market and planning, affected the agricultural productivity significantly, as expected. The evidences indicate that, given the

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[41]The property right proposition argues that increasing (decreasing) the security of ownership right of a specific factor, among other things, increases (decreases) the incentives to invest in the quality improvement of that factor, and to allocate that factor more efficiently. Therefore, the increase in ownership security of a factor will increase the marginal productivity of that factor. As such, the output elasticity of that factor also increases. When the farming institution changed from the collective system to the household responsibility system, the security of ownership right for capital and fertilizer is improved, for land is deteriorated, and has no changes for labor. Therefore, the results of the estimates are consistent with the predictions of the property right proposition. For a theoretical model of the impacts of ownership security on the behavior of land investment and some empirical evidences, see Wen (1989).

[42]This finding contradicts that of McMillan *et al* (1989). They attribute 22 percent of the productivity growth between 1978 to 1984 to the raise in government procurement prices. However, although it is recognized by them that the appropriate prices for their analysis are the marginal prices, they used the above-quota prices instead of the market prices in their growth accounting. Therefore, their finding seems to be a result of using inappropriate prices data. A word of caution is in order. Both the present study and that of McMillan *et al* focus on the impact of reforms on productivity, not on the output growth. The state procurement prices may affect the output growth through the demand for conventional inputs. However, it requires a whole paper to devote to the study of the impact of state procurement price on the demand for inputs and thus on output. It is beyond the purview of the present paper.

same level of inputs, the value of output is increased by shifting the crops from grain to non-grain.[43] The coefficient of multiple cropping index is positive. Therefore, although it might increase the net return to farmers, the decline in the cropping index between 1978 and 1984 had a negative impact on the output growth.

The estimated coefficient of time (T) indicates that there were no significant technological changes in Chinese agriculture. This estimate, however, may understate the impact of technological change. The major component of technological changes in China has been seed-improvement, like the disseminations of semi-dwarf varieties in 60s-70s and hybrid rice in 70s-80s (Stone 1988). Because the dissemination of seed-improvement technology is accompanied with the growth of chemical fertilizer use. Therefore, much of the impact of technology on productivity is captured by the coefficient of fertilizer in the production function.

In sum, although the impact on productivity from changes in government procurement prices are negligible statistically, the change from the production team system to the household responsibility system and the market reforms seem statistically to have a positive impacts. How important the economic reforms is to agricultural growth in 1978-1984 and what should be responsible for the slowdown thereafter are the next questions to be discussed.

V. Sources of Agricultural Growth

[43]Since the prices of grain and non-grain are different, part of the impact may be a result of the differences in the price of grain and non-grain. Therefore, not all the measured effects can be attributed to gains in comparative advantages.

To attribute the agricultural growth to various components, the output elasticities are first considered. The implied output elasticities of crop pattern, multiple cropping index and market price expectation can be obtained directly from Column (6), Table V. The output elasticities of conventional inputs are reported in Table VI, also using the estimates from Column (6), Table V. These estimates are .49 for land, .21 for labor, .06 for capital, and .15 for fertilizer before the institutional reform; and .40 for land, .21 for labor, .17 for capital, and .29 for fertilizer after the reform. These estimates are in conformity with the findings of factor shares in various farm surveys before 1949 and the estimates of the agricultural production functions in other land-scarce labor-abundant economies. [44] As indicated by the sums of elasticities and the Wald tests in the bottom of Table VI, the estimates indicate that there were substantial diseconomies of scale in the production team system. On the contrary,

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[44]The farm surveys conducted by John L. Buck and others before 1949 found that the tenant paid about 40 to 60 percent of gross crop output as rent (quoted in Lippit 1974, pp. 46-50; and Cheung 1969, pp.56-58). The estimated land output elasticities of .49 before the reform and .40 after the reform are in conformity with these findings. Our estimates are also close to the estimates by others for agricultural production functions in land-scarce labor-abundant economies. To name just a few examples: Okhawa's estimates of rice production for Japan in 1937-1939 found the output elasticity was .2 to .3 for labor, .4 to .5 for land, and .3 for current inputs (quoted in Hayami *et al* 1975, p.99). Jamison and Lau (1982, pp. 108-109) estimated the agricultural productions in Thailand and found the output elasticity was .19 to .30 for labor, .08 to .13 for chemical inputs, .002 to .041 for capital, and .51 to .57 for land. The estimates in the present study, however, differ from those estimated by Hayami *et al* (1985 p.97) for Japanese agriculture, and by Hayami and Ruttan (1985, p.151) for developing countries. The former study estimated that the output elasticity for Japan was .4 for labor, .15 for capital, .3 for fertilizer, and .15 for land before World War II; and .3 for labor, .3 for capital, .2 for fertilizer, and .2 for land in the postwar period. The latter study estimated that the output elasticity was .45 for labor, .1 for land, .2 for livestock, .15 for fertilizer, and .1 for machinery for developing countries. However, the findings by the above two studies are not considered to be inconsistent with the estimates in the present study. In addition to crop output, the output value in the above two studies also included livestock, which is less dependent on land.

Table VI: Estimated Elasticities

	Pre-reform	Post-reform
Land	.49	.40
Labor	.21	.21
Capital	.06	.17
Fertilizer	.15	.29
Sum	.91	1.07
Hypothesis:	sum=1.0	sum=1.0
Wald test χ^2(1 df)*	10.49	4.71

Note: The critical value for 5 percent significant level is 3.84, and for 1 percent is 6.63.

the economies of scale in the household responsibility system are substantial. These findings are interesting. Since there are substantial economies of scale in the household farming system, the argument of using collectivization as a vehicle to exploit the economies of scale can not be rejected. However, the empirical evidences suggest that the scale of production team system was so large that it reached the range of diseconomies of scale. Therefore, the concept of "the bigger the better" is not valid.

The growth accounting for the period 1978-1984 is reported in Table VII. The total output increased 42.2 percent in 1978-84. The sources of growth are divided into three components: the growth in conventional inputs, productivity growth due to reforms, and unexplained residuals. From the accounting, we find that, among the total output growth, 40.8 percent came from the increased in the inputs. The most important input growth was the increase in fertilizer use. About three-fifth of the output growth that arose from inputs can be attributed to increase in fertilizer use alone.

The productivity growth due to reforms consists of two different components: the changes in output elasticities due to the household responsibility system reform and the growth related to market reforms. From Table VII, we find that the contribution of household responsibility system reform was the dominant factor. About 94 percent of the productivity growth derived from the household responsibility system reform. In term of the absolute magnitudes, the household responsibility system reform alone contributed to the output growth as much as the combined contributions of the four conventional inputs. The increases in non-grain area and market prices also contributed to the output growth. Nevertheless, the combined effects from decline in multiple cropping index, and increases in non-grain area and market prices are very small. They

Table VII: Growth Accounting, 1978-1984

	Coefficient	Factor Growth	Contribution to Output Growth	Share of Output Growth	Component Share
Total Growth			42.2%	100.0%	
	(1)	(2)	(3)	(4)	(5)	(6)
Source of Growth:						
A. Input Growth:				17.2%	40.8%	(100.0%)
Land	.49	-1.1%	-.5%			(-2.9%)
Labor	.21	14.7%	3.1%			(18.0%)
Capital	.06	65.3%	3.9%			(22.7%)
Fertilizer	.15	71.6%	10.7%			(62.2%)
B. Productivity Growth:				18.4%	43.6%	(100.0%)
I. Household Responsibility System Reform				17.3%		(94.0%)
Land x Hrs	-.09	-1.1%	.1%			
Capital x Hrs	.11	65.3%	7.2%			
Fertilizer x Hrs	.14	71.6%	10.0%			
II. Other Changes				1.1%		(6.0%)
Multiple Cropping Index	.34	-2.7%	-.9%			
Nongrain Area (%)	.10	9.0%	.9%			
Market Price$_{t-1}$	.10	10.5%	1.1%			
C. Residuals				6.6%	15.6%	

Note: (3) = (1) x (2).
(5) = (4)/42.2.
(6) = (3)/(4).

consisted of only 6 percent of the productivity growth, and resulted in only 1.1 percent increase in total output in 1978-1984.[45]

A substantial portion, 15.6 percent, of the output growth in 1978-84 is attributed as residuals in the growth accounting. The good weather in 1984 was probably one of the main sources of this component. As shown in Column (7), Table III, the area hit by natural disasters decreased from 16.8 percent of total sown acreage in 1978 to 10.5 percent in 1984. The disaster-hit area reported in Chinese statistics is the area victimized by natural calamities and had a 30 percent or more reduction in total output compared to the yield in a normal year. Suppose the disaster-hit area on the average had a 50 percent reduction in yield, then due to the relatively good weather in 1984, there would have been a 3.2 percent increase in total output in 1984 compared to 1978, which would consist of 7.6 percent of the total output growth in 1978-84.

The rapid output growth slowed down after 1984. Several causes were responsible for such a change. The dominant factors for the dramatic output growth in 1978-1984 were the household responsibility system reforms and the fast growth in inputs, especially fertilizer, as Table VII shown. The household responsibility system reform completed in 1983-1984. Therefore, even without other causes, the rate of output growth would have reduced 40 percent from the previous records. In addition, the growth rate of chemical fertilizer input dropped from 8.9 percent per year in 1978-84 to 3.7 percent in 1984-87. Moreover, there was a swift out-migration of labor force from cropping sector. The growth

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[45]In international trade literature, it is also found that in most cases the direct loss due to misallocation of resources arising from restriction in trade is lower than one percent of GNP (World Bank 1987, p. 90). The indirect loss due to rent-seeking, however, is much larger (Kruger 1974). Therefore, the direct gain that can be obtained from removing trade restriction is small compared to the gains in the reduction of rent-seeking activities.

Table VIII: Growth Accounting 1985-1987

	Elasticity	Factor Growth	Contribution to Output Growth		Share of Contribution
Total Growth				4.2%	100.0%
	(1)	(2)	(3)	(4)	(5)
Source of Growth:					
I. Input growth				2.3%	54.8%
Land	.40	-2.4%	-1.0%		
Labor	.21	-22.7%	-4.8%		
Capital	.17	26.9%	4.6%		
Fertilizer	.29	11.9%	3.5%		
II. Productivity Growth				4.4%	104.8%
Multiple Cropping Index	.34	3.0%	1.0%		
Nongrain Area (%)	.10	6.9%	.7%		
Market Price$_{t-1}$	.10	26.7%	2.7%		
IV. Residual				-2.5%	-59.5%

Note: (3) = (1) x (2).
(5) = (4)/4.2.

rate of labor force dropped from 2.3 percent per year in 1978-84 to -8.6 percent per year in 1984-87. The out-migration of labor force alone had caused the output to fall 4.8 percent compared to the level in 1984. Therefore, as Table VIII showed, the total output growth in 1984-1987 was only 4.2 percent, even though the productivity growth, which was related to multiple cropping, crop pattern and market prices, increased from 1.1 percent in 1978-1984 to 4.4 percent in 1984-1987.

VI. Concluding Remarks

The paper attempts to evaluate and quantify the impacts of various components of reforms on agricultural productivity growth in China. The findings indicates that the dominant source of productivity growth in 1978-1984 was the change from the production team system to the household responsibility system. This finding confirms the claims and observations made by Chinese officials and scholars within and without China. It is also found that the changes in crop pattern away from grain to non-grain crops had a positive impact on the growth of output value and the decline in cropping intensity, measured by multiple cropping index, had a negative impact on the growth of gross output. However, both effect were very small in magnitude. The empirical results also suggest that while the increases in market prices had a positive effect, the raises in state procurement prices did not have any significant effect on productivity growth. Such a contrast can probably be explained by the fact that the state procurement prices, even measured at the above-quota prices, are lower than the market prices. This evidence implies that unless the procurement prices are higher than market prices, the government will not be able to use procurement prices as an instrument to raise agricultural productivity. The growth accounting indicates

that the rapid input growth, especially chemical fertilizer, was another reason for the dramatic output growth in 1978-1984.

It is noteworthy that the impact of the household responsibility system reform on productivity growth may be underestimated in the present study, because this reform may have a dynamic impact on productivity growth which is not measured in the present study. This is because this institutional change increases the elasticities, hence the marginal productivity, of purchased inputs, namely capital and chemical fertilizer. As such, the incentives to use the purchased inputs increased. Because most of the modern technologies are either embodied in capital or accompanied by the increasing use of chemical fertilizers. Therefore, the diffusion of modern technology will be accelerated in the post-household responsibility system reform period. Consequently, the household responsibility system reform have an indirect impact on the dynamic growth of productivity.

The study suggests that there are substantial economies of scale after the household responsibility system reform. It is thus important for China's agricultural growth to have an institutional environment that facilitates the farms to increase their operational scales. Recollectivization, nevertheless, should be excluded as a possible choice. The empirical findings in the paper indicate that there were substantial diseconomies of scale in the original production team system. Hence, a preferable arrangement is probably to institute policy reforms that encourage market exchanges in land and labor. However, what are the implications of such reforms on income distribution deserves further studies.

Finally, although the study indicates that changes in state procurement prices had no significant impact on agricultural productivity, this finding does

not imply that changes in state procurement prices will not affect output growth at all. It is still possible that changes in state procurement prices may affect input use and, thus, the output growth. For police design this would be useful to know. Other studies will have to establish how strong the procurement price-output links may be in China and other socialist countries.

Appendix: Data Source and Adjustments

The appendix documents the data sources and describes the various calculation and adjustments made to make the panel data suitable for the econometrical analysis. The following abbreviations are adopted.[46]

ZGNYNJ --- Editorial Board of China Agriculture Yearbook Zhongguo nongye nianjian (China Agricultural Yearbook), Beijing: Agriculture Press, annual, 1980-1988.

JGNCGNYTIZL --- State Statistical Bureau, Jianguo 30 nian chuanguo nongye tongji ziliao, 1949-1979 (National Agricultural Statistics for the 30 Years since the Founding of the People's Republic of China, 1949-1979), Beijing: State Statistical Bureau, 1980.

CGNYTJZL --- State Statistical Bureau, Chuanguo nongye tongji ziliao (xubain), 1978-1983 (National Agricultural Statistics [continuation], 1978-1983), Beijing: State Statistical Bureau, 1984.

ZGTJNJ --- State Statistical Bureau, Zhongguo tongji nianjian (China Statistical Yearbook), Beijing: China Statistical Press, annual, 1981 to 1989.

GMSRTJZL --- State Statistical Bureau, Division of Statistics on Economic Balance, Guominshouru tongji ziliao huibain, 1949-1985 (A Compilation of National Income Statistics), Beijing: China Statistical Press, 1987.

ZGMYWJTJZL --- State Statistical Bureau, Trade and Price Statistical Division, Zhongguo maoyi wujia tongji ziliao, 1952-1983 (China Trade and Price statistics, 1952-1983), Beijing: China Statistical Press, 1984.

ZGWJTJNJ --- State Statistical Bureau, Urban Social, Economic Survey Team, Zhongguo wujia tongji nianjian, 1988 (China Price Statistical Yearbook, 1988):

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[46]Since the page numbers are too numerous to list, detailed information will be provided by the author on request.

Beijing: China Statistical Press, 1988.

A. Gross Value of Crops Each province's value of crop outputs are calculated from the gross physical outputs of 7 grain crops (rice, wheat, potato, sorghum, millet, and soybean) and 12 cash crops (cotton, peanut, rapeseed, sesame, jute, ramie, sugar cane, sugar beet, tobacco, tussah silk cocoon, mulberry silk cocoon, and tea), using the official prices at 1980 as weights for aggregation. The date for 1979 to 1987 are taken from ZGNYNJs, 1980 to 1988. The data for 1965, 1970 to 1978 are taken from JGNCGNYTJZL. The data on the 1980 prices are taken from State Statistical Bureau (1980 b).

B. Land The data on cultivated land for 1965 to 1979 are taken from JGNCGNYTJZL, for 1980 to 1983 from CGNYTJZL, and 1984 to 1987 are provided by Agricultural Division, State Statistical Bureau. The data for 1987 can also be found on p. 224, ZGTJNJ, 1988. Among all the data, the cultivated land are the least reliable. A note under the table of cultivated land in p. 224, ZGTJNJ, warns that the figures are under-reported. The summary of national aggregation of land and other input series are reported in Table IV.

C. Labor force in cropping sector The data on labor force in cropping sector are not directly available. They are estimated from the data on farm labor force. The data of farm labor prior to 1980 are provided by Agricultural Division, State Statistical Bureau, and for 1980 to 1987 are taken from ZGNYTJNJs, 1981 to 1988. The farm labor included those working in cropping, animal husbandry, forestry, fishery, and sideline production. To obtain the labor force in cropping sector, the farm labor forces are weighted by the value share of crop output in total agricultural output. Crop output values are those calculated in A. The gross value of agriculture for each province prior to 1986

are obtained from GMSRTJZL, and the values for 1986 and 1987 are from ZGTJNJ, 1987, 1988. The reported values were measured at current prices in each year. They are converted to the values at 1980's prices by deflated with the state procurement price index in p. 401, ZGMYWJTJZL, with the index in 1980 being set to 100.[47] Other weighing methods, for example, using the square root of the value share as weight, are also tried. The results of the estimations are not significantly affected. However, the regression model's goodness of fit is not as goods if other weights are used. Because crop and agricultural output may fluctuate from year to year due to the random impacts of weather and so forth, the values of three year's average are used in computing the weights.

Capital is measured by the horsepowers of tractors and draft animals. Data on the numbers of tractors for 1965, 1970, 1975 to 1978 are taken from JGNCGNYTJZL. Data on the number of tractors for 1971 to 1974, and on draft animals prior to 1979 are provided by Division of Agriculture, State Statistical Bureau. Data on the numbers of tractors and draft animals after 1978 are taken from ZGNYTJNJ, 1980-1988. To convert the physical numbers into horsepowers, the following weights are used, 18 hp for big tractor, 12 hp for walking tractor, and 0.7 hp for draft animal. These weights are recommended by the State Statistical Bureau.

Chemical fertilizer is the gross weight of fertilizer consumed. Data for 1965, 1970, 1975, 1979 are take from JGNCGNYTJZL, for the rest of years prior

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[47]Technologically, the labor intensity of cropping sector is lower than that of animal husbandry, fishery, and sideline production. Therefore, in perfect competitive markets, using the value share of crop output in total agricultural output as weight may overstate the labor force in cropping sector. However, crop outputs in China in general command a lower value-added than outputs in other sectors. Therefore, using the value share as weight may understate the labor force in cropping sector. These two considerations may cancel each other.

to 1980 are provided by Agricultural Division, State Statistical Bureau, and for the year after 1979 are taken form ZGNYNJ, 1981 to 1988.

Changes in farming institution are measured by the percentage of team in each province that had converted to the household responsibility system by the end of respective year. All the households were in the production team system before 1979, and after 1984, over 99 percent of teams adopted the household responsibility system. The percentage of production team in each province that had adopted the household responsibility system by the end of each year for 1981 and 1982 are provided by the Research Center for Rural Development of the State Council, and for 1983 and 1984 are available in ZGNYTJNJ, 1984, 1985. However, detailed information about the change in the farming institution for each province are not available for 1979 and 1980. Nationally, 1.02 percent of team converted to the household system in 1979 and 14.4 percent in 1980. Because detailed provincial information are not available for 1979 and 1980, it will be assumed that the farming institution in each province was still the production team system for these two years. Information on the national aggregation is reported in Table III.

Index of state above-quota prices What relevant to the study should be the above-quota prices. However, the price index for grain and cash crops in ZGMYWJTJZL was quota prices. The quota price index were converted to the above-quota price index by the following adjustments. (1) The above-quota price series for grain is calculated. Before 1965, there was only one price for the state procurement. The above-quota price for grain was introduced in 1965 and was set to 130 percent of basic quota price. After 1979, the above-quota price was raised to 150 percent of the quota price. The contract price was introduced in 1985, which was the weighted average of basic quota price (30 percent) and above-quota

price (70 percent). Adjustments were made accordingly. (2) The above-quota prices for cash crops was inferred. Since the percentage bonus for above-quota delivery differs among crops. The conversion was made in accordance with the adjustments in the cotton prices. The 30 percent above-quota bonus was instituted in 1979. The contract price was introduced in 1984, which was the weighted average of the basic quota price (20 percent) and the above-quota price (80 percent) in the North. The weights were changed to 30/70 in 1985, to 40/70 in 1986, and then to 30/70 in 1987 (see Sicular 1988). The above-quota price index for cash crops were calculated according to those adjustments. (3) The above-quota price index for crop output are calculated as the weighted average of the above two series, using each year's percentage shares of grain and cash crops in the total output as weight. The original series set the index in 1950 equal to 100. For ease of interpretation, the series are converted with the 1978 index being set as 100. The resulted above-quota price index series is reported in Table II.

Index of market prices Table II also reports the series on market prices. The market prices were prices for consumer goods in rural market fairs which are available in ZGWJTJNJ. The index in 1978 was set as 100.

Percentage of area sown to nongrain crops is obtained by dividing sown acreage of nongrain crops by total agricultural sown acreage. The data on total sown acreage for 1965, 1970, 1975, and 1979 are taken from JGNCGNYTJZL; for the rest of year prior to 1979 are provided by Agricultural Division, State Statistical Bureau; and for years after 1979 are from ZGNYNJ, 1981-1988. Data on nonagricultural sown acreage are obtained from the difference between total agricultural sown acreage and total grain sown acreage. Data on total grain sown acreage prior to 1980 are from JGNCGNYTJZL, and after 1979 from ZGTJNJ, 1981 to 1988. Table III reports the percentages of sown area in grain, cash crops, and

other crops in national level, which are taken from Ministry of Agriculture, Planning Bureau (1989, pp. 130-31), and State Statistical Bureau (1988, p. 243).

Multiple cropping index are calculated from the total agricultural sown area dividing by the cultivated land in each province. The series of multiple cropping index at the national level for 1952 to 1983 reported in Table III are taken from Ministry of Agriculture, Planning Bureau (1984, pp. 132); and for 1984 to 1987, are calculated form the total sown acreage and total cultivated land.

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