Review of Development Economics, 7(3), 360–377, 2003

Structural Change and Economic Growth in China

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Abstract

This study develops a new analytical framework to account for sources of rapid economic growth in China. The traditional Solow approach is expanded to include another source of economic growth—structural change. The empirical results show that structural change has contributed to growth significantly by reallocating resources from low-productivity sectors to high-productivity sectors. It is found that the returns to capital investment in both agricultural production and rural enterprises are much higher than those in urban sectors, indicating underinvestment in rural areas. On the other hand, labor productivity in the agricultural sector remains low, a result of the still large surpluses of labor in the sector. Therefore, further development of rural enterprises and an increase in labor flow among sectors and across regions are key to improvements in overall economic efficiency.

1. Introduction

In recent years the Chinese economy has performed spectacularly well. Gross domestic product (GDP) grew at 9.8% per year from 1978 to 1998. The economy has also undergone dramatic and continuing structural changes (World Bank, 1997; Maddison, 1998). While there have been significant increases in agricultural productivity, the share of agriculture has declined as the manufacturing and services sectors have grown much faster. A large amount of surplus labor has been absorbed by the nonagricultural sectors, especially rural enterprises.

In this paper, we try to elucidate the driving forces behind past Chinese growth and assess whether those forces, in particular structural change, can continue into the future. If past rapid growth has been realized predominantly through structural change, which inevitably slows as the structure of the economy (e.g., the shares of agriculture, industry, and services) reaches a new balance, then future growth may be slower.

The standard economics literature analyzing the sources of aggregate growth considers two sources: increases in factor inputs (land, labor, and capital) and total factor productivity growth (TFPG) or technical change.[1] In this paper, we expand the traditional Solow (1957) approach to include a third: growth attributed to reallocating resources from low-productivity to high-productivity sectors.[2]

To consider the role of structural change, we divide the economy into four sectors: urban industry, urban services, agriculture, and rural enterprises. The rural enterprise sector includes all nonfarm activities such as rural industry, construction, transportation, and commerce. The separation of rural enterprises from other sectors is particularly important, as we will show that the development of the rural nonfarm sector has been the major engine of growth in the economy since the institutional reforms in 1978.

In section 2, we examine the structural changes in the Chinese economy over the past several decades. Next we present a conceptual framework to decompose economic

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growth into different components. We then describe data sources and estimate production functions for the four sectors. Based on the estimations, we further analyze the sources of economic growth. Finally, we conclude by offering some insights into potential sources of future economic growth in China.

2. Structural Change in the Chinese Economy

In large part due to the institutional reforms and industrialization, the Chinese economy has experienced massive structural transformation over the past several decades (Figure 1). In 1952, agriculture accounted for more than half of GDP and the

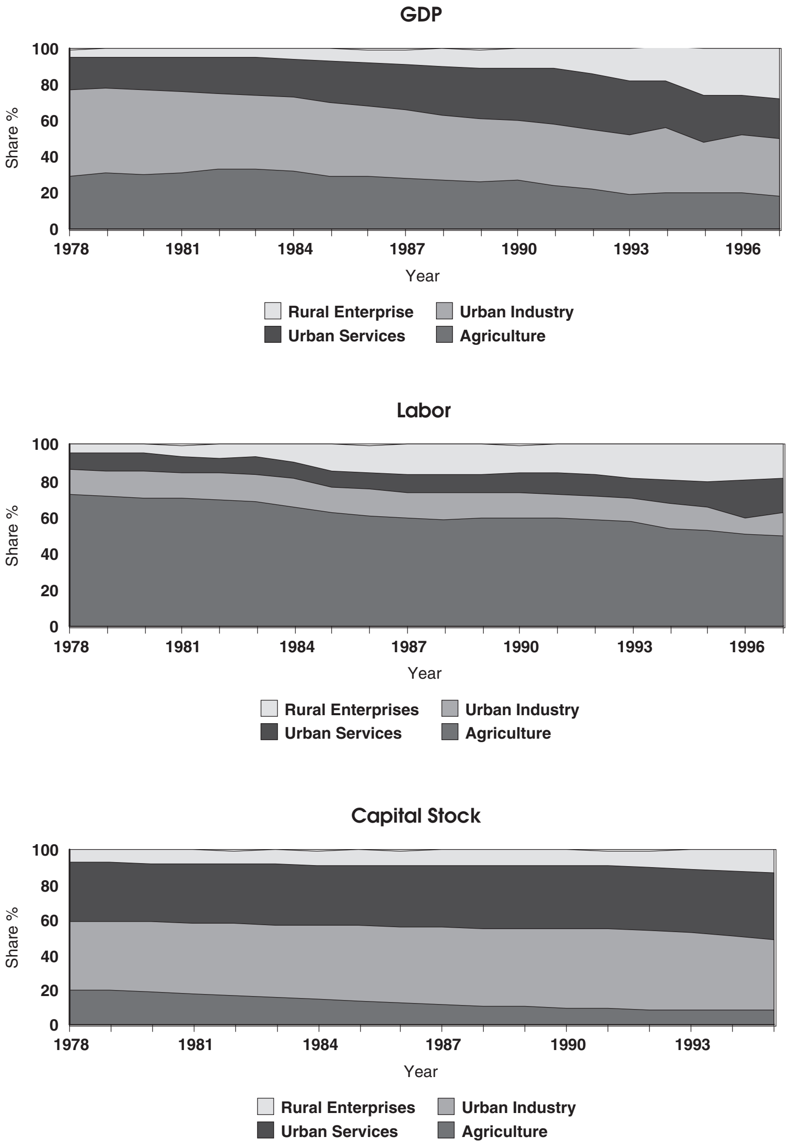

Figure 1. Structural Shift of GDP, Labor, and Capital, 1978–1995

Chinese economy was largely agrarian. But by 1997 the share of agriculture had declined to about 20% of GDP—a decline of about two-thirds of a percentage point per year, indicating a rapid rate of structural change. The most dramatic change has been the rapid increase of rural enterprises. In 1997, rural enterprises accounted for more than a quarter of aggregate GDP, while this sector was almost nonexistent even as late as 1978.

Labor shifts among sectors have been phenomenal.[3] In 1997, less than half of the labor force was engaged in agricultural activities, compared to about 80% in 1952. More than 13% was in the urban industry sector, and 10% in the urban service sector. Rural enterprises employed over one-fifth of the total labor in 1997 (Figure 1).

In 1978, agriculture accounted for 20% of the total capital stock, while urban industry and services accounted for 38% and 33%, respectively, and rural enterprises accounted for only 6%. By 1997, given slow growth in agricultural capital investment, the share of agriculture in the total capital stock declined dramatically to 8.8%. Both urban industry and services have increased their shares to 44.5% and 38.7%, respectively. Although the total absolute amount of rural enterprise capital stock has grown rapidly (13% per year), the growth has been slower than the growth in the sector's GDP over the period 1978–95 (Figure 1).

The rapid transformation indicates there has been a large difference in productivity growth among sectors (Tables 1 and 2). The absolute level of labor productivity in the rural sectors (agriculture and rural enterprises) is lower, but the growth has been

Table 1. Labor Productivity Growth by Sector

Year	*Average*	*Agriculture*	*Urban industry*	*Urban services*	*Rural enterprises*
			1978 constant yuan/worker		
1978	903	362	3,335	1,738	808
1979	950	419	3,197	1,759	833
1980	992	424	3,201	1,911	873
1981	1,012	459	3,037	2,245	748
1982	1,065	511	2,963	2,720	677
1983	1,152	558	3,109	2,615	844
1984	1,278	627	3,298	3,051	775
1985	1,401	670	3,958	3,510	665
1986	1,484	706	4,021	3,764	767
1987	1,608	758	4,278	4,064	884
1988	1,739	793	4,444	4,641	1,027
1989	1,777	776	4,473	4,904	1,152
1990	1,597	727	4,087	4,024	1,088
1991	1,720	721	4,290	4,471	1,219
1992	1,942	737	4,884	5,193	1,561
1993	2,178	754	5,353	6,051	2,086
1994	2,423	901	6,639	4,867	2,395
1995	2,648	1,026	5,601	5,177	3,276
Annual growth rate					
1978–89	6.35	7.18	2.70	9.89	3.27
1990–95	10.64	7.13	6.51	5.17	24.67
1978–95	6.54	6.32	3.10	6.63	8.58

Sources: Calculated from various SSB publications.

Table 2. Capital Productivity Growth by Sector

Year	*Average*	*Agriculture*	*Urban industry*	*Urban services*	*Rural enterprises*
		1978 constant yuan per 100 yuan capital stock			
1978	39	55	48	20	24
1979	39	63	46	20	23
1980	39	63	46	22	23
1981	39	69	42	23	23
1982	40	78	40	24	23
1983	41	85	40	25	25
1984	43	91	41	27	28
1985	43	93	41	28	35
1986	43	97	38	29	39
1987	43	102	38	30	43
1988	44	106	36	33	47
1989	42	105	34	33	48
1990	41	111	30	33	48
1991	42	107	30	36	51
1992	44	106	32	38	59
1993	46	103	34	37	74
1994	47	109	40	33	74
1995	46	109	32	33	90
Annual growth rate					
1978–89	0.88	5.97	–3.19	4.60	6.73
1990–95	2.52	–0.30	1.07	–0.27	13.17
1978–95	1.09	4.07	–2.43	2.82	8.15

Sources: Calculated from various SSB publications.

fast. On the other hand, capital productivity in rural sectors is not only higher in absolute level, but also has the most rapid growth.

3. Conceptual Framework

Despite the importance of structural change on economic growth, few economists have tried to quantify the contribution to aggregate growth from reallocating resources among sectors over time. Robinson (1971) presented a model which explicitly accounts for the contribution to aggregate growth of resource transfers between agriculture and nonagriculture, and estimated the model using cross-country data. Feder (1986) used the same analytic model to estimate, also using cross-country data, the contribution to aggregate growth of transfers of resources between nonexports and export sectors. Sonobe and Otsuka (1997) demonstrated the significance of changing industrial structure in economic growth in prewar Japan by decomposing labor productivity. In these models, the gap in marginal productivity of factors across sectors is assumed to be constant over time, and sectoral production functions are not explicitly estimated.

In this paper, we develop a unified analytic framework that includes explicit sectoral production functions, using a flexible functional form that supports econometric estimation and can incorporate different types of productivity growth, as well as capture the effect of resource transfers on aggregate growth.

To decompose the impact of resource transfers on growth, start by defining *allocatively efficient GDP* as the value of GDP when total social welfare is maximized (we will use the term "efficient GDP" hereafter). Based on the first theorem of welfare economics, this is a typical central-planner problem where perfect competition leads to a Pareto-optimal allocation of goods and services. Under this condition, marginal returns to all inputs are equal across sectors. The efficiency index, E, is the ratio of actual GDP, Y, to efficient GDP, Y^*:

$$E = Y/Y^*. \tag{1}$$

For many reasons, including policy changes, sectoral allocative efficiency may change over time. Growth in actual GDP can be decomposed into growth in efficient GDP and changes in efficiency:

$$\partial \ln Y/\partial t = \partial \ln Y^*/\partial t + \partial \ln E/\partial t. \tag{2}$$

Since $Y^* = \Sigma_i Y_i^*$, where the subscript i refers to sectors, we have

$$X^*_{ijt} \tag{3}$$

where $S_i^* = Y_i^*/Y^*$ is the share of i in total GDP.

To perform sources accounting using this equation, we need (1) to have an explicit specification of sectoral production functions, and then (2) to determine the allocation of factors across sectors so that sectoral marginal products are all equal—the allocation consistent with competitive equilibrium in all factor markets. We start by assuming that real-value added (GDP) by sector follows a well-behaved, neoclassical production function:

$$Y_{it} = f_{it}(X_{i1t}, \ldots X_{ijt}, \ldots X_{imt}, T), \tag{4}$$

where X_{ijt} is input j for sector i in year t. A thornier question is what functional form of the production function should be used. Considering both econometric estimation and theoretical consistency, we specify the following functional form:

$$\ln(Y_{it}) = a_{i0} + a_{it}t + \sum_j b_{ij} \ln(X_{ijt}) + \sum_j b_{ijt} \ln(X_{ijt})t + a_{itt}t^2; \tag{5}$$

or

$$\ln(Y_{it}) = A_{it} + \sum_j B_{ijt}\ln(X_{ijt}), \tag{6}$$

where $A_{it} = a_{i0} + a_{it}t + a_{itt}t^2$, and $B_{ijt} = b_{ij} + b_{ijt}t$. Within each time period (fixed t), the production function is Cobb–Douglas in form. The marginal product of each factor is given by

$$\partial Y_{it}/\partial X_{ijt} = B_{ijt}(Y_{it}/X_{ijt}). \tag{7}$$

Over time, both neutral and biased technical changes are allowed in every sector, since all the coefficients potentially vary over time.

For any given year, the efficient allocation of resources can be determined by computing the allocation of resources such that the marginal product of each factor j is the same across all sectors i. The computational problem is equivalent to solving a small computable general-equilibrium model with an objective function of maximizing social welfare subject to technology and resources constraints. A more detailed description of the model is provided in the Appendix. The result is a set of efficient resource allocations, X^*_{ijt} and outputs Y^*_{it}. Taking the first derivative of (6) with respect to time t, the growth of efficient production in sector i can be decomposed as

$$\partial \ln Y_{it}^{*} / \partial t = \partial A_{it} / \partial t + \sum_{j} (\partial B_{ijt} / \partial t) \ln X_{ijt}^{*} + \sum_{j} B_{ijt} \partial \ln X_{ijt}^{*} / \partial t. \tag{8}$$

The three terms of equation (8) represent the effects of neutral technical change, biased technical change for sector *i*, and increased use of inputs, respectively. For simplicity, we aggregate the first two terms as the total effects of sectoral technical change (or productivity growth).[4]

4. The Data

Gross Domestic Product

Both nominal GDP and real GDP growth indices for various sectors are available from SSB's *The Gross Domestic Product of China* (SSB, 1997a). The data sources and construction of national GDP estimates were published by the State Statistical Bureau (SSB, 1997b). This publication indicates that the SSB has used the UN standard SNA (system of national accounts) definitions to estimate GDP for 29 provinces by three economic sectors (primary, secondary, and tertiary) in mainland China for the period 1952–95. Since 1995, the *China Statistical Yearbook* has published GDP data every year for each province for the same three sectors. Both nominal and real growth rates are available from SSB official publications.

We use four sectors in our analysis: agriculture, urban industry, urban services, and rural enterprises. The agriculture sector is equivalent to the primary sector used by SSB. The following procedures were used to construct GDP for the other three sectors. Until 1996, China published an annual gross production value for rural industry and services. In 1996, they began to publish value-added figures; i.e., GDP originating in the sector. The Ministry of Agriculture published data on both gross production value and value added for rural industry (including construction) and services in *China's Agricultural Yearbook 1996*. The data on nominal value added for rural industry and services prior to 1995 were estimated using the growth rate of gross production value and 1995 value-added figures, assuming no change in the ratio of value added to gross production value.

GDP for rural industry was subtracted from GDP for industry as a whole (or the secondary sector as classified by SSB) to obtain GDP for urban industry. Similarly, GDP for rural services was subtracted from aggregate service sector GDP (or the tertiary sector as classified by SSB) to obtain GDP for the urban service sector. GDP for rural enterprises is the sum of GDP for rural industry and rural services. The implicit GDP deflators by province for the three sectors are estimated by dividing nominal GDP by real GDP. The deflators for urban industry and services are then used to deflate nominal GDP for rural industry and services to obtain their GDP in real terms.

Labor

Labor input data for the primary, secondary, and tertiary sectors at the provincial level after 1989 can be found in SSB's *Statistical Yearbooks* (various issues), while provincial labor data prior to 1989 are available in SSB (1990). Labor is measured in stock terms as the number of persons at the end of each year. For rural industry and services, prior to 1984, labor input data at the township and village level, but not at the individual household level, are available in SSB's *Rural Statistical Yearbooks*. The omission of individual-household, nonfarm employment data will not cause serious problems, as the share of this category in rural employment was minimal prior to 1984. Urban industry labor is estimated by subtracting rural industry labor from total industry labor, and urban service labor is similarly estimated as total service labor net of rural service labor.

Capital Stock

Capital stocks for the four sectors are calculated from data on gross capital formation and annual fixed asset investment. For the three sectors classified by SSB, the data on gross capital formation by province after 1978 were published by SSB (1997a). Gross capital formation is defined as the value of fixed assets and inventory acquired minus the value of fixed assets and inventory disposed. To construct a capital stock series from data on capital formation, we used the following procedure. Define the capital stock in time t as the stock in time $t-1$ plus investment minus depreciation:

$$K_t = I_t + (1-\delta)K_{t-1}, \tag{9}$$

where K_t is the capital stock in year t, I_t is gross capital formation in year t, and δ is the depreciation rate. *China Statistical Yearbook* (SSB, 1995) reports the depreciation rate of fixed assets of state-owned enterprises for industry, railway, communications, commerce, and grain for the years 1952 to 1992. We use the rates for grain and commerce for agriculture and services, respectively. Since 1992, SSB has ceased to report official depreciation rates. For the years after 1992, we used the 1992 depreciation rates.

To obtain initial values for the capital stock, we used a similar procedure to Kohli (1982). That is, we assume that prior to 1978, real investment has grown at a steady rate (r), which is assumed to be the same as the rate of growth of real GDP from 1952 to 1977. Thus:

$$K_{1978} = I_{1978}/(\delta + r). \tag{10}$$

This approach ensures that the 1978 value of the capital stock is independent of the 1978–95 data used in our analysis. Moreover, given the relatively small capital stock in 1978 and the high levels of investment, the estimates for later years are not sensitive to the 1978 benchmark value of the capital stock.

Estimates of capital stocks for rural industry and services are constructed using the annual fixed asset investment by province from 1978 to 1995, which are available in the annual *China Statistical Yearbook* and in *China Fixed Asset Investment Statistical Materials, 1950–95*. Initial values are calculated using equation (10), but the growth rate of real investment prior to 1978 is assumed to be 4%. Again, the initial capital stock is low, so that the estimated series is not sensitive to the benchmark starting value.

Capital stock for rural industry was subtracted from that of total industry (or secondary industry as classified by SSB) to obtain capital stock for the urban industry sector. Similarly, capital stock for rural services was subtracted from the aggregate service sector (or tertiary sector as classified by SSB) to obtain the capital stock for the urban service sector. Finally, capital stock for rural enterprises is the sum of capital stocks for both rural industry and services.

Prior to constructing capital stocks for each sector, annual data on capital formation and fixed-asset investment was deflated by a capital investment deflator. The SSB began to publish provincial price indices for fixed-asset investment in 1987. Prior to 1987, we use the national price index of construction materials to proxy the capital investment deflator.

Land

Land in agriculture is taken to be arable land, and data are available in various issues of *China's Agricultural Yearbook, China's Statistical Yearbook*, and *China's Rural Statistical Yearbook*. The official data on arable land areas are known to be inaccurate. Various new estimates indicate that official figures under-report actual acreage by as much as 30–40%. However, it is difficult to judge how this under-reporting varies over time and across regions. In this study, we simply use the official data. We also use the sown areas as the land input variable in the estimation of the agricultural production function. The coefficient of the land variable was sensitive to changes in the definition of the land variable, but using different land data had almost no impact on the coefficients of labor and capital.

5. Estimation of Production Functions

We have data for 18 years (1978–95) for 28 provinces, which represents a panel of 504 observations. Tibet is excluded mainly because of lack of data. Hainan province, which was separated from Guangdong as a separate province after 1987, is still included in Guangdong province. In order to avoid the heteroskedasticity problem due to large regional differences, regional dummies were added to the production functions. The division of the seven regions is as follows: (1) northeast: Heilongjiang, Liaoning, and Jilin provinces; (2) north: Municipalities of Beijing and Tianjin; Hebei, Henan, Shangdong, Shanxi, Shaanxi, and Gansu provinces; (3) northwest: autonomous regions of Nei Monggol, Ningxia, Xinjiang, and Tibet; Qinghai province; (4) central: Jiangxi, Hunan, and Hubei provinces; (5) southeast: Shanghai municipality, Jiangsu, Zhejiang, and Anhui provinces; (6) southwest: Sichuan, Guizhou, and Yunan provinces; and (7) south: Guangxi autonomous region; Fujian and Guangdong provinces.

The results of the estimated production functions are presented in Table 3. Regressions R1, R2, R3, and R4 present the results of different specifications of the production functions for agriculture. Regressions R1 and R2 include land as a separate input, in addition to labor and capital, because land is treated differently from agricultural capital (buildings, machinery, and livestock) in the SSB data (SSB 1997b). We exclude land area as an input in regressions R3 and R4 for comparison. Because agricultural output is measured as value added, intermediate inputs such as fertilizer are excluded from output measures by definition.

Results from regression R1 indicate that, over the period 1978–95, labor still played an important role in Chinese agricultural production with an elasticity of 0.367. The elasticity of the land input is slightly smaller than that of labor at 0.317, while that of capital is the smallest. The strong, positive coefficients of the time-trend variables imply that technical change played a vital role in promoting Chinese agricultural production during the study period.

Results from regression R2 show that the importance of labor in agricultural production has declined, while the role of capital has increased. The declining role of labor is particularly significant, with its production elasticity declining from 0.53 to 0.26. The elasticity of capital increased from 0.15 to 0.30. There was, however, no significant change in the role of land in agricultural production (the estimated elasticity went from 0.443 in 1978 to 0.409 in 1995). Without land as an input, the coefficient of labor in the regressions is greater and that of capital changes very little in 1978, while both coefficients would be overestimated in 1995 (regressions R3 and R4).

As shown in regression R6, the labor elasticity for urban industry was large in 1978, at 0.63, and declined marginally to 0.50 in 1995 (the decline is also not statistically

Table 3. Production Function Estimates by Sector

	Agriculture				Urban industry		Urban services		Rural enterprises	
	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10
Labor	0.367	0.543	0.627	0.805	0.581	0.634	0.428	0.337	0.249	0.314
	(9.24)*	(9.26)*	(29.63)*	(19.01)*	(16.07)*	(10.02)*	(17.25)*	(8.25)*	(6.20)*	(4.75)*
Capital	0.227	0.136	0.285	0.155	0.386	0.330	0.374	0.398	0.719	0.482
	(8.14)*	(2.82)*	(10.04)*	(13.06)*	(8.81)*	(4.41)*	(19.95)*	(11.03)*	(18.33)*	(6.56)*
Land	0.317	0.268								
	(7.55)*	(5.39)*								
Time trend	0.046	0.121	0.041	0.141	0.041	–0.091	0.059	0.079	0.101	–0.091
	(18.22)*	(5.16)*	(16.02)*	(7.91)*	(9.26)*	(–5.00)*	(22.05)*	(5.25)*	(19.67)*	(–5.00)*
Labor*t		–0.016		–0.017		–0.009		0.013		0.009
		(–3.66)*		(–4.86)*		(–0.94)		(2.95)*		(1.60)
Capital*t		0.009		0.013		0.009		–0.004		0.012
		(2.17)*		(2.89)*		(0.96)		(–6.92)*		(1.99)*
Land*t		0.003								
		(0.76)								
Time trend^2		–0.0019		–0.002		0.0007				0.005
		(–3.76)*		(–3.96)*		(0.85)				(6.25)*
R^2	0.920	0.924	0.910	0.918	0.891	0.891	0.925	0.933	0.923	0.939

Notes: Estimates of regional dummies are not reported. Figures in parenthesis are t-values. * Indicates that estimates are at the 5% significance level.

significant). Capital elasticity was low at 0.34 in 1978, but increased to 0.49 in 1995. These results indicate that a rapid transformation occurred in the sector—it has become increasingly more capital-intensive and less labor-intensive. The urban service sector followed a different path. The labor elasticity increased over time from 0.35 in 1978 to 0.58 in 1995, while the capital elasticity changed very little (regressions R7 and R8). In contrast to urban industry, the urban service sector has become increasingly labor-intensive.

The most striking phenomenon in the rural enterprise sector is that both labor and capital elasticities have increased over time (regressions R9 and R10), implying increasing returns to scale in the industry. In particular, the labor elasticity increased from 0.32 in 1978 to 0.47 in 1995; and the capital elasticity became the highest of all sectors, increasing from 0.49 in 1978 to 0.70 in 1995.

Differences in estimated elasticities for the same input across sectors reflect differences in technology, but do not provide any indication of how efficiently resources are allocated. Efficiency of resource allocation depends on differences in the marginal productivity of inputs across sectors. Given the estimated parameters, the marginal product of each factor can be computed from equation (8). The results are shown in Figure 2. Over the study period, the marginal return to labor in agriculture increased very little, while that of rural enterprises rose sharply. In 1978, labor productivity in rural enterprises was over 50% larger than that in agriculture, implying the existence of large potential gains from reallocating labor from agriculture to rural industry.[5] From 1978 to 1995, more than 130 million rural labor workers were shifted from agricultural production to rural nonfarm activities. This shift is perhaps the major source of efficiency gain since the reform. In the urban areas, the marginal returns to labor in

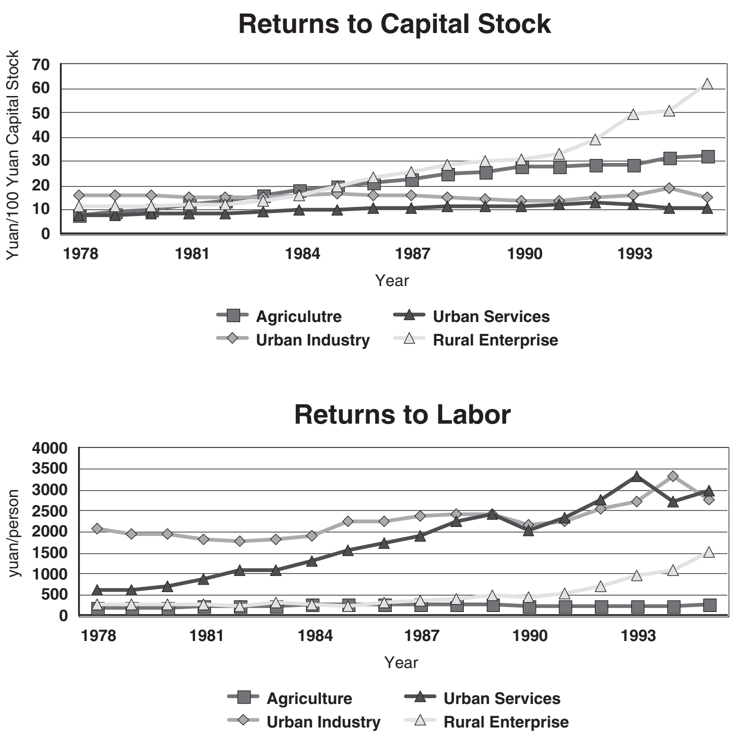

Figure 2. Marginal Returns to Labor and Capital Stock

urban industry were highest among all sectors in 1978, but increased rapidly in the urban service sector, rising to a level 33% higher than in industry by 1995.

Capital in the urban industry sector had the highest marginal return in 1978. But the return in rural enterprises, although slightly lower than the value in urban industry in 1978, rose dramatically. In 1995, the return in rural enterprises was 3.6 times that in urban industry. The marginal return in agriculture was low and similar to the level in the urban service sector, but over time it increased more than three-fold, and in 1995 its return was 2.0 and 2.9 times those in urban industry and service sectors, respectively, but only 51% of the value in rural enterprises.

Having discussed the trends of marginal returns for each sector, we can evaluate the overall divergence of marginal returns to capital and labor using the Gini coefficient. The Gini coefficient of the marginal returns to labor decreased from 0.47 in 1985 to 0.33 in 1995, while the Gini coefficient of the marginal returns to capital declined from 0.16 in 1978 to 0.11 in 1985, and thereafter went up to 0.21 in 1995. In terms of the magnitude, the disequilibrium for the labor market is more serious than for the capital market, indicating that there still exist institutional barriers to labor flow. However, the trend of the Gini coefficients is very different—the marginal returns to labor narrowed, but the marginal returns to capital widened.

The fragmentation of the labor market is mainly caused by the *Hukou* system (household registration system), which pretty much confined people to the village or city of their birth. With the success of rural reform, which freed labor from agricultural production, migration from rural areas to nearby towns and cities became easier, narrowing the gap in the marginal returns to labor. However, there are still large barriers that prevent labor from moving freely among sectors, and further reforms of the *Hukou* system are called for (Kanbur and Zhang, 1999). The initial decline in the variations in marginal returns to capital prior to 1985 is consistent with Chow's (1993) finding. However, the trend reversed after 1985, indicating that the capital market in China is still embryonic and needs to be further developed. The government still controls a large share of investment resources through its budget allocation and five major state banks. Continued flows of financial resources to inefficient state-owned enterprises are a major source of inefficient capital allocation.

Overall, in spite of movements of factors, there are indications of continuing disequilibrium in factor markets. Continuing intersectoral variations in marginal factor returns and in scale economies indicates significant opportunities for achieving efficiency gains by reallocating factors across sectors.

6. Accounting for Sources of Economic Growth

In order to account for the contribution of structural change to economic growth, we need to calculate the allocative efficiency index. For each year we solve the maximization problem of social welfare subject to technology and resource constraints and obtain optimal allocation of inputs and outputs among sectors and shadow prices of outputs for four sectors.

The difference between the optimal and actual input shares for each sector is presented in Table 4. Apparently there exists a large surplus of labor in the agriculture sector, and these workers should be moved to the urban sectors to improve economic efficiency. Since rural enterprises are being operated in a more free-market environment, misuse of resources in the sector is minimal. In terms of capital input, urban sectors are more capital-intensive than they should be. Allocating more capital to the agriculture and rural enterprises sectors will gain higher economic efficiency.

Table 4. Difference between Optimal and Actual Allocation of Inputs

	Labor				*Capital*			
	Agriculture	*Urban industry*	*Urban services*	*Rural enterprises*	*Agriculture*	*Urban industry*	*Urban services*	*Rural enterprises*
1978	–45	41	5	–1	–7	13	–6	–1
1979	–45	40	6	–1	–6	12	–6	–1
1980	–46	40	7	–1	–5	12	–6	–1
1981	–45	38	9	–2	–3	10	–6	–1
1982	–44	36	11	–3	–2	8	–6	–1
1983	–44	35	11	–2	–0	8	–7	–1
1984	–43	34	12	–4	1	7	–8	0
1985	–42	36	14	–8	0	7	–9	2
1986	–42	35	15	–7	1	5	–9	3
1987	–43	34	16	–7	1	4	–9	4
1988	–44	33	18	–7	1	3	–10	6
1989	–46	32	19	–5	2	2	–10	7
1990	–47	31	19	–4	2	0	–11	8
1991	–47	32	19	–4	3	1	–12	8
1992	–48	30	21	–3	2	0	–12	8
1993	–48	27	21	0	1	–1	–14	8
1994	–46	26	18	3	1	–2	–16	8
1995	–46	22	16	7	0	–3	–18	8

Note: The number indicates the difference between optimal and actual shares.

Table 5 shows the shadow prices of outputs for the four sectors and the optimal allocation of GDP. Shadow prices for agricultural output have been more than one, indicating that the sector's output has been undervalued, while urban sectors (both industry and services) have been overvalued. The difference between optimal and actual GDP has been narrowed over time, indicating strong allocative efficiency gain. More GDP in agriculture (by using more capital and less labor) and rural enterprises (by using both more capital and labor) and less GDP in urban industry and services will improve allocative efficiency.

The annual efficiency index was then calculated as the ratio of actual GDP to efficient GDP. Figure 3 presents estimates of the allocative efficiency index for the period 1978–95. The index was about 0.57 in 1978 and rose steadily to 0.68 in 1985, reflecting the effect of rural reform in shifting surplus labor from agricultural production to nonfarm activities. Allocative efficiency improved very little from 1985 to 1991, the period when the effects of the first phase of rural reforms were largely exhausted, and urban sectors were struggling with gradual reforms. Since 1991, the index has begun to rise steadily, probably reflecting aggressive government policy reforms in the urban sectors, and an increase in market competition.

The contribution of structural change is then calculated as the change in the efficiency index as a percentage of the change in GDP (equation (2)). Using estimated parameters from regressions 2, 6, 8, and 10 in Table 3, the sources of growth of GDP can be decomposed as shown in Table 6. Structural change contributed 1.7 percentage points to aggregate GDP growth, and accounted for 17% of the total GDP growth rate of 9.9% per year from 1978 to 1995 (Table 4). This share seems comparable to those reported by Maddison (1998) and the World Bank (1997).[6,7] The annual contribution

Table 5. Shadow Prices and Optimal Allocation of GDP

	Shadow price				*Difference between optimal and actual output shares*			
Year	*Agriculture*	*Urban industry*	*Urban services*	*Rural enterprises*	*Agriculture*	*Urban industry*	*Urban services*	*Rural enterprises*
1978	1.983	0.395	0.973	1.296	28.78	–29.48	–0.49	1.19
1979	1.956	0.417	0.965	1.286	24.95	–26.29	–0.04	1.39
1980	2.016	0.434	0.94	1.308	24.58	–25.31	–0.86	1.60
1981	1.956	0.465	0.843	1.411	22.29	–22.16	–2.46	2.32
1982	1.886	0.496	0.773	1.512	20.08	–19.03	–4.07	3.02
1983	1.862	0.51	0.82	1.381	18.57	–17.64	–3.44	2.51
1984	1.844	0.535	0.803	1.456	17.06	–16.23	–4.14	3.31
1985	1.946	0.527	0.805	1.52	16.52	–16.41	–4.67	4.55
1986	1.95	0.559	0.79	1.361	15.35	–13.89	–5.53	4.07
1987	1.984	0.582	0.786	1.285	14.13	–12.26	–5.78	3.91
1988	2.095	0.606	0.777	1.18	13.23	–9.81	–7.09	3.67
1989	2.095	0.634	0.768	1.108	13.26	–8.13	–8.15	3.01
1990	2.083	0.648	0.816	1.032	9.86	–6.03	–6.98	3.16
1991	1.989	0.649	0.815	1.042	13.45	–5.70	–10.04	2.30
1992	2.128	0.677	0.803	1.039	11.77	–5.10	–9.96	3.29
1993	2.175	0.709	0.784	1.009	11.07	–4.51	–10.05	3.49
1994	2.133	0.708	0.896	0.956	7.38	–9.12	–4.73	4.75
1995	2.078	0.754	0.949	0.88	5.02	–1.94	–5.28	2.20

Note: The optimal output value is equal to the optimal output multiplied by the shadow prices as outlined in the Appendix.

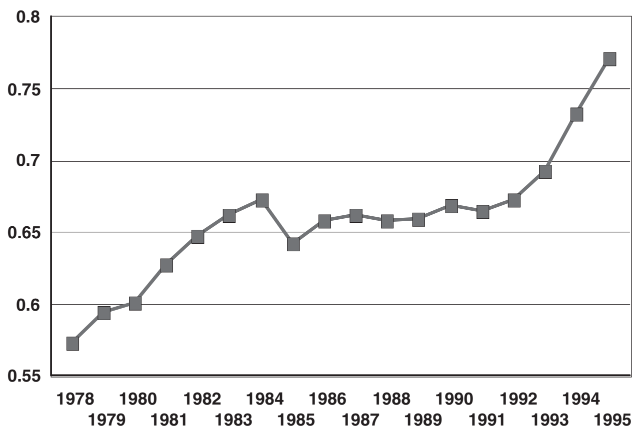

Figure 3. Sectoral Allocative Efficiency and Contribution to Growth

of the structural change to economic growth is depicted in Figure 4. The contribution dominated overall economic growth in the initial stage of the reforms, accounting for 30–80% of overall economic growth from 1978 to 1982. However, the structural change contributed very little during 1983–91. Since 1991, the contribution has begun to increase owing to the government's progressive structural change and macroeconomic reforms.

Table 6. Sources of Growth, 1978–95

Sources	*Whole economy*	*Agriculture*	*Urban industry*	*Urban services*	*Rural enterprises*
GDP growth	100.00	100.00	100.00	100.00	100.00
Input	40.91	20.68	61.88	49.52	47.06
Labor	15.44	10.72	23.07	16.51	18.01
Capital	25.73	9.96	38.81	33.01	29.04
Sectoral productivity	41.63	79.32	38.12	50.48	52.94
Structural change	17.47				

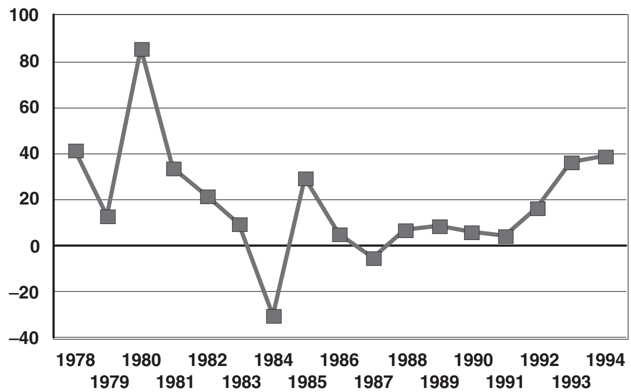

Figure 4. Contribution of Structural Change to Growth in GDP

To calculate the contribution of growth in productivity within a particular sector, we first calculate the contribution of increased use of each input by multiplying input growth by its production elasticity. Productivity growth in the sector is then calculated as the residual, the growth in GDP minus contribution of the growth in inputs. Contributions of sectoral productivity growth and increased use of inputs in the entire economy are calculated as a weighted (by GDP shares) average of their respective contributions in each sector.

For the economy as a whole, 42% of total GDP growth was from sectoral productivity growth, while 41% was from the increased use of inputs. Total factor productivity growth (total growth in output minus aggregate input growth, or the sum of the contributions of sectoral productivity growth and structural change) for the economy as a whole accounts for 59% of total GDP growth. This share is much higher than Maddison's estimate of 30%, and slightly higher than the World Bank estimate of 43–46%.

Within the agriculture sector, growth in productivity explains nearly 80% of sectoral GDP growth. This figure seems very high when compared with previous studies. Fan (1991) attributes 16% of total output growth in agriculture to technical change and 27% to institutional reforms for the period 1965–85. But Fan's study covers the period in which agricultural production was institutionally constrained (e.g., the cultural revolution period from 1966 to 1976). Moreover, the contribution of both institutional and technical change (43%) in Fan's study can be regarded as growth in productivity in the current study. In Fan and Pardey's (1997) study, these two effects plus a residual accounted for 75.8% during 1979–84 and 79.9% from 1985 to 1993. Thus, considering all these factors, the estimated contribution of productivity growth to output growth differs little from other studies.

In urban industry, sectoral productivity growth accounts for 38% of sectoral GDP growth from 1978 to 1995, while increased input use accounts for 62%. Increased capital input alone accounts for more than 49% of total growth, while labor growth accounts for only 23%. Jefferson et al. (1992) also concluded that a large share (or more than 70%) of output growth from 1980 to 1988 was from increased use of inputs, particularly capital.

The annual growth rate of urban services was nearly 50% higher than that of urban industry. Growth in sectoral productivity accounts for 51% of the total growth, and the remainder is accounted for by increased use of inputs. Growth in capital explains about 33%, while growth in labor accounts for 17%. There have been no studies of the urban service sectors, so it is impossible to compare our estimates with others.

The rapid growth in rural enterprises is explained equally by the increased use of inputs (47%) and improvement in total factor productivity (53%). In terms of percentage of contribution to GDP growth, productivity growth is in the same range as for the urban industry and service sectors, but in terms of absolute contribution to GDP growth it is the highest among all sectors. Growth in productivity contributed more than 12 of the total of 22 percentage points of GDP growth in rural enterprises over 1978–95. The contributions are 3.9%, 3.0%, and 5.6% for agriculture, urban industry, and urban services, respectively.

7. Conclusion

In this paper, we have developed a conceptual framework that explicitly incorporates the contribution to aggregate growth of reallocation of resources across sectors. We used new data on GDP by sectors at the provincial level for 1978–1995 to estimate sectoral production functions that incorporate the possibility of biased technical change. Using the estimated parameters and a computational procedure for calculating the "allocatively efficient" level of GDP, we found that about 17% of aggregate growth in China over this period is due to structural change—shifting resources from lower to higher productivity sectors. This efficiency gain is attributed mainly to intersectoral labor movements. There were severe policy constraints on capital mobility, and capital reallocation appears to have actually hindered efficiency.

Sectoral productivity growth accounts for 42% of aggregate growth, which is relatively low when compared with the experience of developed countries.[8] However, in absolute terms, TFP growth contributed 4.2 percentage points to the aggregate annual growth rate, which is very high by any international standard. The increased use of inputs accounts for 41% of growth. Growth in labor input explains only a small part of China's rapid economic growth (15%), while capital growth explains more than 26%.

The results of this study support an optimistic view of prospects for future economic growth in China. The continuing large differences in both labor and capital productivity across sectors suggests that China still has great potential for further efficiency gains through continued structural change. To realize this potential, however, many restrictions on the intersectoral movement of resources need to be removed. For example, higher capital returns in rural areas (in both rural enterprises and agriculture) suggest that more aggressive government policies should be sought to increase investment there, or at least not hinder their movement. Such policies will not only improve overall economic performance, but also narrow the development gap and inequality between the rural and urban sectors. Similarly, the government should also encourage labor movement from agriculture to rural enterprises, urban industry, and service sectors as labor productivity in these sectors continues to be much higher than in the agriculture sector.

The results indicate that intersectoral differences in marginal returns to capital have grown during the reform period. The puzzle is why there has not been more investment in higher-productivity sectors such as rural enterprises and agriculture. One plausible explanation is the sluggish reform of the financial sector in China. Efficient capital markets that can funnel new investment to sectors with higher returns still need to be developed.

The results also show the dramatic role of technical change in fostering rapid growth in China. It may well be that serious reform efforts allowed the economy to exploit opportunities that had long been present but could not be pursued in the earlier system of command planning. The results concerning the continuing role for structural change indicate that such opportunities are not exhausted. However, possibilities for "easy" increases in productivity may well be more difficult to find in the future. To maintain the historically high rates of aggregate growth in the future undoubtedly requires increased investment in R&D, infrastructure, and human capital, as well as continuing policy reform.

Appendix: Estimating the Optimal Allocation

Given the estimated sectoral production technologies and assumed social welfare function, we can solve a central planner's problem to obtain the optimal input allocations:

$$\max_{(Y_i, K_i, L_i)} \quad W = \prod_i Y_i^{s_i}$$

subject to

$$\begin{aligned} &\text{Production technologies: } Y_i = F_i(K_i, L_i) \\ &\text{Endowments: } \sum_i K_i = \overline{K}; \sum_i L_i = \overline{L}. \\ &K_i \geq 0, L_i \geq 0, \end{aligned} \qquad \text{(A1)}$$

where i represents a production sector. W is a social welfare function in the Cobb–Douglas form with the real output shares s_i as weights. By assuming that each sector's production function is concave, strictly increasing, and differentiable and has constant returns to scale, it is guaranteed that interior solutions and shadow output prices for constraint (A1) exist. For the agricultural sector, an additional factor, land, is also included. Under this setting, the central planner's problem is equal to the outcome of competitive equilibrium (see Mas-Colell, Whinston, and Green (1995) for details).

The shadow prices of outputs for each sector are defined as the changes in social welfare value due to one unit of change in output. Since for the economy as a whole only the relative price matters, we normalize the estimated shadow prices such that weighted output price is one using output shares as weights. By replacing constraint (A1) with a set of constraints that fix the labor and capital inputs at the actual levels, we can further calculate the shadow prices for labor and capital in each sector where the actual output instead of optimal output is produced. We solve for the above problem using the GAMS software (Brooke et al., 1992).

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Notes

1. Technical change in this study is broadly defined to include both changes in technology and improvements in technical efficiency.
2. There have been numerous studies analyzing the sources of growth in China, but few have considered the role of structural change. See Maddison (1998), World Bank (1997), Kim and Lau (1996), and Wu (1995).
3. A similar large intersectoral transfer of labor has also been observed in other East Asian countries (Young, 1995).
4. Since even within a sector, productivity can also increase by reallocating resources, the first and second terms may reflect within-sector allocative changes. The two terms together measure growth in sectoral total factor productivity (i.e., total output growth minus aggregate input growth).
5. The low level and stagnation of returns to labor in agriculture was also found by Chow (1993).
6. Maddison (1998) provided a crude measure of the impact of labor reallocation on GDP growth. He attributed 0.92 percentage points of the annual GDP growth (or 21%) to labor reallocation from 1952 to 1978, and 1.44 percentage points (or 19%) from 1978 to 1995. However, the average (instead of marginal) productivity of labor was used in calculating the impact. He recognized that his approach was very rough and pointed out that there is a need for more sophisticated analysis of structural-shift effects that require disaggregated information on the physical and human capital stock, which is the approach used in the present study.
7. World Bank (1997) estimates that the contribution from labor reallocation was about 1.0 percentage points to GDP growth (or about 10% of the total growth) between 1985 and 1994. However, the methodology used is not clear to the authors. The footnote on the methodology (p. 107) was missing in the study. In the exercise of projecting the future growth of the Chinese economy in the same study, a simple CGE model was applied to simulate the impact of resources reallocation on GDP growth. The model assumes no changes in sectoral technologies, and assumes a perfect capital allocation in the base year and a declining friction of distortion during the projection period. These assumptions are largely *ad hoc*, and thought to be inappropriate by the evidence obtained from the present study.
8. For many developed countries, increased productivity often accounts for more than half of the total economic growth (Chenery et al., 1986).