Gold into Base Metals: Productivity Growth in the People's Republic of China during the Reform Period

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With minimal sleight of hand, it is possible to transform the recent growth experience of the People's Republic of China from the extraordinary into the mundane. Systematic understatement of inflation by enterprises accounts for 2.5 percent growth per year in the nonagricultural economy during the first two decades of the reform period (1978–98). The usual suspects (i.e., rising participation rates, improvements in educational attainment, and the transfer of labor out of agriculture) account for most of the remainder. The productivity performance of the nonagricultural economy during the reform period is respectable but not outstanding. To the degree that the reforms have improved efficiency, these gains may lie principally in agriculture.

I. Introduction

Between 1978 and 1998, gross domestic product per capita in the People's Republic of China, as reported in official statistics, grew 8.0 percent per year, a performance that makes China the most rapidly growing economy in the world during this period, as well as all of recorded human history.[1] While the unprecedented growth of the Chinese economy can be taken as evidence of the success of its economic reforms, its breathtaking magnitude and inordinate endurance have led others

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[1] All growth rates cited in this paper are ln growth rates; all data, unless otherwise noted, come from the annual issues of the *China Statistical Yearbook* (CSY).

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to seek less favorable, statistical, explanations. Thus Summers and Heston (1994), in version 5.6 of their popular international data set, cite the fact that "it is widely felt that [China's] growth rates are too high" and, accordingly, arbitrarily lower the reported growth of consumption and investment during the 1980–93 period by 30 percent and 40 percent, respectively. In this paper I take a slightly different approach. Rather than discount the Chinese statistical record, I embrace it. Accepting all the numbers the statisticians of the People's Republic produce, but making systematic adjustments using their own data, I show that one can (*a*) reduce the growth rate during the reform period to levels previously experienced by other rapidly growing economies, so that (*b*) once one takes into account rising labor force participation, the transfer of labor out of agriculture, and improvements in educational attainment, labor and total factor productivity growth in the nonagricultural economy are found to be 2.6 and 1.4 percent per year, respectively; a respectable performance, but by no means extraordinary.

This paper proceeds as follows: Section II begins with a short review of the methodology of total factor productivity computations for the uninitiated. Sections III–VII then explain, step by step, how I derive estimates of output, labor input, human capital, physical capital, and factor income shares to implement this methodology. In these sections I discuss problems with Chinese statistics and the basis on which I have chosen among alternative series. While the estimated growth of productivity is lowered by some choices (e.g., when I substitute alternative price indices, showing higher rates of inflation, for the national accounts deflators), it is raised by others (e.g., when I substitute a slower-growing labor series for the official data). In each case, however, I follow the precept of accepting the Chinese statistical record, making adjustments only when other official series are available, and then only in cases in which the deficiencies of the commonly emphasized measures are well known or easily recognized. Section VIII brings the different components together, estimating total factor productivity growth in the nonagricultural economy, and Section IX concludes the paper.

The data of most economies are filled with apparently inconsistent series. By choosing among them, one can produce almost any estimate of productivity growth imaginable. Consequently, the only value added in a paper of this sort lies in its treatment and exposition of data, following which the actual total factor productivity results are a mere afterthought. In this paper I depart from standard practice, minimizing the discussion of productivity methodology and results, and devoting almost the entire paper to a discussion of Chinese data. To keep the task manageable, I focus on the reform period (1978–98) alone, eschewing any temptation to delve into the data of the plan period, which involve a variety of additional issues. I explore the construction and

biases of each of the alternative data series available for the reform period. In the process, I show that the measures of outputs and inputs I select, combined with other data on the Chinese economy, form an internally consistent whole, with, for example, my measures of labor growth matching demographic and participation trends, as well as output, wage, and factor share data. Readers can, however, see the steps I take to reach this conclusion and decide what problems exist in my methods and what alternatives they would prefer.

This paper restricts its analysis of total factor productivity growth to the nonagricultural sector. Land is of great importance in agriculture, but any measure of this input faces the formidable problem of its proper valuation relative to the other elements of the economy's capital stock. Land, however, plays less of a role in the nonagricultural segments of the economy.[2] In developing economies, much of the investment in agriculture involves livestock and labor-intensive land improvement (e.g., irrigation works). These components are rarely captured in the national accounts measures of capital investment in machinery and construction, which fuel the capital stock estimates of most total factor productivity studies. Finally, the annual yield of agriculture is heavily influenced by the weather, which has to be controlled for in estimating productivity growth. In sum, the study of agriculture, while of great importance, involves a host of unique data and estimation problems. I avoid them by concentrating on the nonagricultural economy alone.

II. Methodology

Let value added be a constant returns to scale function of capital and labor inputs

$$Y = F(K, L, t), \tag{1}$$

where the appearance of t, time, as an independent argument on the right-hand side highlights the fact that the production function evolves over time. Totally differentiating and dividing by value added, one finds that

$$\frac{dY}{Y} = \left(\frac{F_K K}{Y}\right)\frac{dK}{K} + \left(\frac{F_L L}{Y}\right)\frac{dL}{L} + \frac{F_t}{Y}dt, \tag{2}$$

where F_i represents the partial of F with respect to argument i. With competitive markets, factors are paid their marginal products, so that the terms in parentheses on the right-hand side represent the share of

[2] For example, Kim and Park (1985, table 5-13) estimate that land input accounts for only 4 percent of Korean nonagricultural, nonresidential income during the 1960s and 1970s.

each factor in total factor payments. Total factor productivity growth, the last term on the right-hand side, represents the proportional increase in output that would have occurred in the absence of any input changes and is calculated as a residual item by subtracting the contribution of capital and labor from output growth:

$$\text{TFP growth} = \frac{dY}{Y} - \Theta_K \frac{dK}{K} - \Theta_L \frac{dL}{L}$$

$$= \Theta_K \left(\frac{dY}{Y} - \frac{dK}{K} \right) - \Theta_L \left(\frac{dY}{Y} - \frac{dL}{L} \right), \tag{3}$$

where I have made use of the fact that given constant returns to scale, Θ_K and Θ_L, the shares of capital and labor in total factor payments, sum to one. As shown by (3), the assumptions of constant returns to scale and competitive markets provide a formal justification for the rather intuitive notion of evaluating overall productivity growth as a weighted average of the growth of partial productivities, with weights given by the share of each factor in total income.

Labor and capital inputs are quite differentiated, and variations over time in the composition of these inputs may play a role in explaining growth. To this end, let, for example, overall labor services be a constant returns to scale function of N types of labor:

$$L = H(L_1, L_2, \ldots, L_N). \tag{4}$$

Differentiating, one finds the growth of overall labor services to be a weighted average of the growth of each type of differentiated labor:

$$\frac{dL}{L} = \sum_i \theta_i \frac{dL_i}{L_i}, \tag{5}$$

where $\theta_i = H_i L_i / H$. Under the assumption of competitive markets, the relative productivities of different types of labor (H_i/H_j) are revealed by their relative wages, and equation (5) places greater weight, relative to their share of the total number of workers, on the growth of types of labor with higher relative wages.[3] The difference between the growth of this weighted aggregate and the growth of the overall labor force, undifferentiated by type, may be taken as the contribution of "human capital." Capital input may be similarly disaggregated, although, given

[3] Conceptually, H is identified only up to a scalar multiple, since one could double the effective labor associated with each type of labor input, doubling H and halving the marginal product of labor in F, without meaningfully changing the productive relationships in the economy. Equation (4) allows the *relative* productivities of labor types to differ, which, as highlighted by (5), has implications for the calculation of their contribution to growth.

the limitations of Chinese data, I shall not pursue such adjustments here.

To implement the preceding methodology, it is necessary to develop measures of the growth of real value added, labor input (differentiated by type), and capital input, along with estimates of relative wages and overall capital and labor income shares. The remainder of the paper is devoted to these tasks.[4]

III. Output

China's national income statistics are, in the main, based on the reports of local officials, which are passed up through the bureaucracy and aggregated to produce the national figures circulated by the State Statistical Bureau (SSB). Since officials are rewarded for superior performance and punished for failing to meet targets, it is not surprising that they have a tendency to modify their statistical reports in accordance with central policy objectives, as has been documented, repeatedly, by none other than the Chinese themselves.[5] On the basis of press reports, official opinion appears to be that local officials overstate the growth of output, while understating investment and births.[6] In the absence of a history of independent and comprehensive survey data, there is no systematic way to evaluate or correct the bias in local reports. It is possible, however, to identify and quantify biases introduced by the statistical methods of the SSB. I discuss these biases, and possible corrections, in

[4] To apply the continuous-time methodology sketched above to the case of discrete data, I make use of ln growth rates for factor inputs and Tornqvist (average of initial and final) factor income weights. This can be justified, explicitly, by reference to a translog production function (Christensen, Jorgenson, and Lau 1973), which in turn can be taken as a second-order approximation to any given production function.

[5] Some fairly frank reporting on the problem of statistical exaggeration, and its foundation in the incentives and rewards faced by lower-level officials, can be found in the following sources (as reported and translated by the Foreign Broadcasting Information Service): Changsha Hunan Provincial Service, 1100 GMT, 1 December 1985; Cheng Ming no. 198, 1 April 1994, p. 1; Guangming Ribao, 24 March 1995, p. 1; Hsin Pao, 24 November 1993, p. 22; Liaowang, 20 February 1995, p. 1; Renmin Ribao, 18 March 1985, p. 1; 13 February 1994, p. 2; 24 June 1994, p. 5; 17 August 1994, p. 1; and 15 December 1999, p. 4; Xinhua Domestic Service, 0222 GMT, 13 June 1994; 0513 GMT, 17 January 1995; and 1013 GMT, 2 March 1995; and Zhongguo Tongxun She, 1137 GMT, 1 January 1995. I should note that the rewards for reporting good performance involve, in some cases, clearly stipulated targets and benefits. Thus, in some localities, township officials "may be promoted to deputy county level positions so long as the output value of the township enterprises exceeds 100 million yuan" (Zhongguo Tongxun She, 1137 GMT, 1 January 1995); a State Council decree of 1984 established output targets, varying with population size, that would allow counties to be reclassified as cities, thereby automatically entitling them to a greater share of enterprise profits and, apparently, higher state subsidies (Chan 1994, pp. 273–76). On the flip side, local officials may be punished for failing to meet particular targets, as reported, e.g., in a Xinhua, 1516 GMT, 5 March 1995, broadcast.

[6] See Renmin Ribao, 17 August 1994, p. 1, and 22 April 1995, p. 1, as well as a Xinhua Domestic Service, 2041 GMT, 28 June 1995, broadcast.

TABLE 1
GROSS INDUSTRIAL OUTPUT AND VALUE ADDED (100 Million Yuan)

	GROSS OUTPUT							
			State Enterprises		Township and Village		NATIONAL ACCOUNTS VALUE ADDED	
	Original	Revised	Original	Revised	Original	Revised	Original	Revised
1990	23,924	23,924	13,064	13,064	4,835		6,858.0	6,858.0
1991	28,248	26,625	14,955	14,955	5,935		8,087.1	8,087.1
1992	37,066	34,599	17,824	17,824	8,957	7,166	10,284.5	10,284.5
1993	52,692	48,402	22,725	22,725	13,950	10,537	14,143.8	14,143.8
1994	76,909	70,176	26,201	26,201	23,423	17,760	18,358.6	19,359.6

SOURCE.—Original, 1995 CSY; revised, 1996 and later CSY.

this section, examining problems in the measurement of nominal value added and the techniques used in its deflation.

A. Nominal Value Added

With regard to the measurement of nominal quantities, the SSB's reluctance to revise downward official figures and the approach it has taken in bringing its statistical system in line with international precepts have, arguably, imparted an upward bias to the growth of nominal value added in the industrial and service sectors.

The SSB appears reluctant to revise national accounts figures substantially downward once they have been released. The most compelling example of this problem is given by the revision of the gross industrial output series, which took place in the mid-1990s. In table 1, I report the original gross industrial output series, up to 1994. Following a nationwide audit of statistical reports, the 1994 gross industrial output estimates were revised downward by about 9 percent, with most of the adjustment falling on township and village enterprises, whose output was deemed to have been exaggerated by about a third. As shown in the table, the output series for earlier years was "smoothed" in accordance with the new, lower, output estimates.[7] In the table I also report the national accounts industrial value added series prior to and after

[7] Following the 1995 Industrial Census, a new definition of gross output (excluding value-added taxes and redefining the gross output measure for outsourced production) was introduced that reduced the gross output estimates further. The revised data for 1990–94, which drew on reduced estimates of output, should not be confused with this later revision, based on new definitions of output. The 1997 CSY clearly indicates that the revised 1990–94 figures (presented in table 1) are based on the old definitions and, in fact, links the old and new series by presenting comparable figures for 1995. Zhongguo Xinxi Bao (4 May 1995, p. 1; as translated by the Foreign Broadcasting Information Service) also reports that the reduced estimates for 1994 and earlier were the result of the auditing and correction of exaggerated reports.

the revision of the industrial output series. As the reader can see, the national accounts industrial value added for 1994 was revised upward, whereas for earlier years it was kept unchanged. Hsueh and Li (1999) provide a comprehensive official description of Chinese statistical methods. They explain that the SSB estimates industrial value added by taking the gross output series and applying information on the use of intermediate inputs gleaned from its more detailed surveys of "independent accounting" (principally, large and state) enterprises.[8] Consequently, a 9 percent downward revision in the gross output series, with no change in the estimates for state enterprises, should have led to an equivalent downward revision of nominal value added. No such revision took place. While the Chinese government has conducted laudable campaigns against statistical misrepresentation, recording no less than 70,000 such cases in 1994 and 60,000 in 1997,[9] this information has difficulty in finding its way into revisions of the GDP estimates.

Regarding the service sector, under the Material Planning System, that is, the statistical system used under the plan, only the production and distribution of material goods were considered a source of output or income. Thus freight transport, commerce, and even post were considered as output, but items such as passenger transport, real estate, television and radio broadcasting, education, research, finance, insurance, and public administration were not. With the exception of a few limited areas, such as passenger transport, where detailed statistics were kept through the years, the measurement of most service sectors was neglected. Consequently, when, during the reform period, the SSB switched to a System of National Accounts, with its more standard definition of output and income, it was ill-equipped to provide a proper measure of the service sector. Acknowledgment of this defect led to the 1991–92 Census of Services, which produced a dramatic revision of the national accounts.

Table 2 reproduces the SSB's estimates of the GDP of the service (tertiary) sector, as reported in the CSY. Beginning with the 1995 issue of the publication, the GDP estimates were revised on the basis of the data from the Census of Services. As the reader can see, the estimated value of service sector output in 1993 was raised by about a third, whereas the estimates for 1978 were hardly changed at all. In other words, when the SSB improved its measurement of the service sector, it concluded that virtually all the newly discovered, and hitherto unrecorded, value

[8] This approach is consistent with that taken, in numerous areas, in other economies (see also Sec. VII below). Typically, aggregate information is limited to a few crude measures, such as gross output, which are then transformed into value-added estimates using more detailed surveys of large enterprises.

[9] See Zhongguo Tongxun She, 0730 GMT, 23 February 1995; Zhongguo Xinxi Bao, 4 May 1995, p. 1; and Beijing Xinhua, 1014 GMT, 25 January 1999.

TABLE 2
NOMINAL GDP OF THE SERVICE SECTOR
(100 Million Yuan)

	1994 CSY	1995 CSY
1978	824.8	860.5
1980	918.6	966.4
1984	1,527.0	1,769.8
1985	2,119.2	2,556.2
1986	2,431.0	2,945.6
1987	2,851.2	3,506.6
1988	3,656.0	4,510.1
1989	4,491.6	5,403.2
1990	4,946.9	5,796.3
1991	5,797.5	7,227.0
1992	6,863.4	9,135.9
1993	8,485.4	11,204.5

added had developed during the reform period. While the development of nonmaterial sectors was neglected under the plan, so was their measurement. Consequently, the approach adopted by the SSB seems somewhat extreme, since it is likely that a fair amount of the newly discovered nonmaterial output was present in 1978. As an alternative, one might assume that the ratio of unmeasured to measured activity found in 1993 existed in 1978 as well. If so, the SSB's adjustments overstate the growth of service sector nominal output between 1978 and 1993 by 1.6 percent per year.

Despite the problems discussed above, in this paper I defer to the SSB estimates of nominal value added. Any assumption about the quantity of unmeasured service sector output in 1978 is equally arbitrary, whereas an adjustment of the entire industrial value added series based on gross output revisions for the 1990–94 period would be heroic in the extreme. The growth of industrial and service nominal value added may be overstated, but it cannot be credibly adjusted.

B. Deflators

The statisticians of most countries estimate real GDP by deflating nominal GDP using separate, independently constructed, price indices. This is not the procedure in the People's Republic. Beginning with the case of secondary industry (mining, manufacturing, utilities, and construction), in China, enterprises are called on to report the value of output in current and constant (base year) prices. The difference between the two series produces an implicit deflator, which is then used to deflate nominal value added (also reported by the enterprises). Historically, this statistical method dovetailed neatly with the reporting requirements of the plan and, despite a general movement away from socialist statis-

tical methods, remains in use today. In regard to the primary sector (farming, fishing, forestry, and animal husbandry), a similar approach is taken, although double deflation of value added is achieved by combining the enterprise implicit output deflators[10] with separate price indices for intermediate inputs. Finally, in regard to the tertiary sector (services), a variety of methods are used, ranging from single deflation using enterprise-provided implicit output deflators (telecommunications and wholesale and retail trade), to extrapolation using real volume indices (transport), to single deflation using specialized price indices, some of which are woefully inappropriate (e.g., interest rates in finance!).[11] Despite these riders and exceptions, it is fair to say that, overall, the SSB remains heavily dependent on enterprise-provided, output-based implicit deflators to deflate nominal value added.[12]

Ruoen (1995) and Woo (1995) argue that the implicit deflators provided by Chinese enterprises are systematically biased. Enterprises are well aware of the current value of output and the nominal material value expended in its production, and so they can easily report these values to statistical officials. However, the construction of accurate constant price estimates in the base year of the SSB's choosing is an arduous task that, with the relaxation of government control over state enterprises and the development of nonstate firms during the reform period, is increasingly unlikely to be seriously undertaken. Ruoen and Woo argue that many firms assume that the constant price value of output equals the nominal value, that is, that the implicit deflator always equals one. This simplifying assumption has been taken by *statisticians* in other countries (e.g., Singapore [Young 1995, p. 658]), and it seems likely that Chinese firms would find it to be a time-saving approach. More generally, enterprises might assume that the inflation rate has some constant value.

[10] As there has been a general privatization of agriculture during the reform period, the SSB uses reports from the remaining state and military farms, supplemented with surveys of the agricultural sector (Hsueh and Li 1999, p. 94).

[11] The use of nominal interest rates to deflate the loan income of banks would measure increases in the nominal value of loans brought about by inflation as an increase in the real volume of financial intermediation! While the preceding discussion lays out the formal SSB statement of its procedures (Hsueh and Li 1999), there are indications that, in practice, these methods are not exactly followed. For example, the value added of wholesale, retail, and restaurant trade is supposedly deflated using the enterprise implicit output deflators (p. 107). However, between 1978 and 1982, the implicit deflator for this sector, in the national accounts, fell 16.6 percent per year! During the same period, the overall GDP deflator rose 2.3 percent per year, and the retail price index rose 3.0 percent per year. It is impossible to believe that even the most brazen enterprise directors would report a total collapse of final commercial prices during a period of moderate retail and GDP inflation.

[12] The expenditure side of the accounts depends more on independent price indices but makes use of a number of grossly incorrect procedures (e.g., using the consumption basket of government workers to deflate nominal government expenditure) to balance the two accounts. Section VI discusses the expenditure accounts in detail.

TABLE 3
AVERAGE RATES OF INFLATION (1978–98)

Sector	Index	Rate of Inflation
Primary sector	Implicit deflator	8.5
	Farm and sideline products purchasing price index	7.9
Secondary sector	Implicit deflator	4.4
	Ex-factory industrial price index	6.1
	Industrial products rural retail price index	5.3
	Retail price index	6.6
Tertiary sector	Implicit deflator	7.1
	Consumer price index (services)	10.7

Regardless, the assumption of a constant inflation rate, be it zero or positive, will make the GDP deflators insufficiently responsive to a surge in the underlying rate of inflation, such as has occurred during the reform period. Fortunately, the SSB does actually compile independent price indices of its own. It simply does not use them to deflate output! Ruoen (1995) argues that these independent price indices can credibly substitute for the existing implicit deflators in the estimation of the growth of real output.

Table 3 compares the average rates of inflation recorded by the implicit GDP deflators with those of the independent price indices compiled by the SSB. Beginning with the secondary sector, the ex-factory industrial price index, recommended by Ruoen as an alternative to the GDP deflator, covers the factory gate prices of raw materials, electric power, industrial and construction inputs, and commercial final goods. This index shows 1.7 percent more inflation per year than the implicit secondary deflator. Alternatives to the ex-factory price index are the industrial products rural retail price index and the retail price index. Both indices include the profit margins of commercial establishments. In addition, the coverage of the industrial products rural retail price index is, obviously, restricted to rural areas, whereas the retail price index is basically a consumer goods index. Regressing the growth of the implicit secondary deflator on the growth of all three indices, I find that only the ex-factory index is significant.[13] For all these reasons, the ex-factory price index is arguably a superior choice as a replacement

[13] For the period 1978–98, the coefficients in the regression of the growth of the implicit secondary deflator on the growth of the industrial products rural price index, the retail price index, and the ex-factory price index are −.16 (.27), .17 (.25), and .64 (.17), respectively (standard errors in parentheses). The industrial products rural price index and the retail price index are, individually, positively and significantly correlated with the secondary deflator, but only insofar as they are correlated with the ex-factory price index.

deflator. It is significant, nevertheless, that during the reform period, all three SSB price indices show more inflation than the implicit secondary deflator. The exaggeration of industrial output growth brought about by the use of enterprise deflators has also been independently confirmed by the SSB, which, in a study of Hunan province for the period 1982–87, found that a real quantity index, using individual commodity outputs, implied 3.9 percent less growth per year than indicated by the implicit deflators (Ruoen 1995, p. 86).

In the primary sector, the long-standing farm and sideline products purchasing price index, recommended by Ruoen as an alternative to the primary deflator, measures the average cost of primary-sector goods purchased by commercial enterprises (of all ownership types), covering products as varied as grains, fruits, vegetables, meat, animal by-products (e.g., furs), fish, and lumber. This index evinces somewhat less inflation than the implicit GDP deflator, lending no support to Ruoen and Woo's argument.[14] Finally, for the tertiary sector, Ruoen suggests the use of the only available service price index, that is, the service price index subcomponent of the consumer price index (CPI), which covers post and telecommunications, transport, housing, medical and child care, and other personal and recreational services. The service CPI grew out of the staff and worker cost of living index, which, up until 1985, covered urban areas alone. In the absence of any alternative, I use the urban service price index for 1978–85 and the overall service price index thereafter. As shown in the table, the service sector CPI reports the existence of substantially more inflation than is indicated by the implicit tertiary deflator.

The joint stochastic behavior of the implicit GDP deflators and the alternative price indices collected by the SSB is crudely summarized by figure 1, which graphs the difference between the growth of each sector's official deflator and its alternative price index against the inflation present in the alternative price index. As the reader can see, the official deflators are insufficiently responsive to changes in the underlying inflation rate as measured by the alternative price indices. In periods of high inflation, the official deflators show smaller price rises (a negative difference in measured inflation rates), whereas in periods of falling prices, they evince smaller declines (a positive difference in measured inflation rates). This is precisely the pattern one would expect if enterprises economize on effort by assuming price stability or some fixed inflation rate. I have confirmed this result in a formal analysis, treating

[14] The reason may be that the implicit deflator is a double-deflated value-added price index. With the prices of agricultural goods rising relative to industrial intermediate inputs, the value-added deflator will rise faster than the output deflator. Consequently, it is still possible that the agricultural enterprise output deflator grows less than the farm products price index.

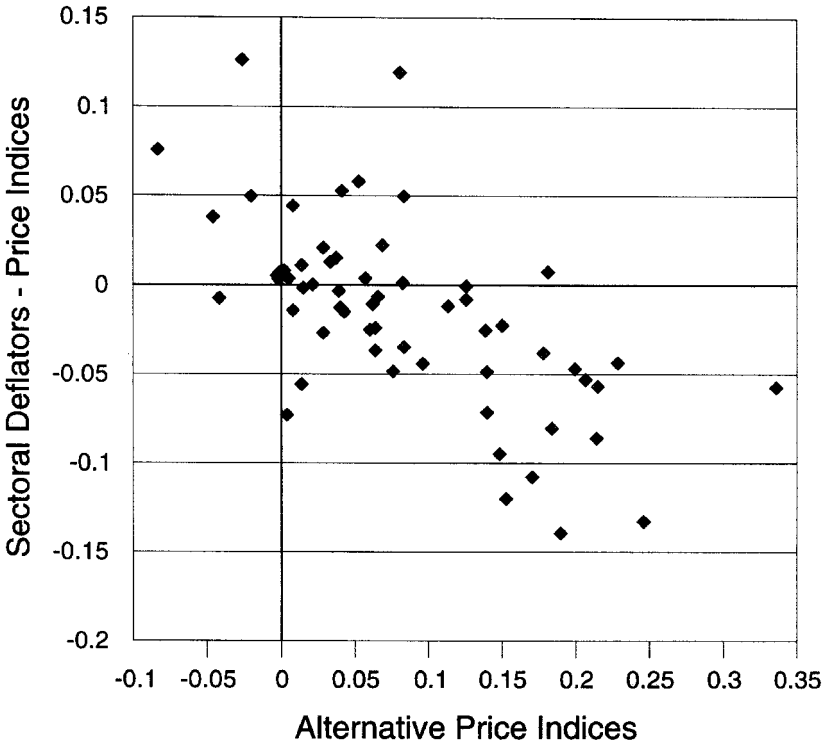

FIG. 1.—Relative inflation rates (annual, 1978–98)

both the implicit GDP deflators and the alternative price indices as noisy measures of underlying inflation and making full use of the covariance in the sectoral inflation rates, finding that the official deflators capture only about 70 percent of the innovations in prices and that the overall growth of the alternative price indices provides a good approximation to underlying inflation rates.[15]

In this paper I follow the suggestion of Ruoen, substituting the SSB price indices he recommends for the implicit deflators of the primary, secondary, and tertiary sectors of the national accounts.[16] Table 4 com-

[15] Obviously, measurement error in the alternative price indices alone could generate a downward-sloping relation such as that seen in fig. 1. By using the covariance of all the price measures, in effect, I instrument for the underlying price movements. The analysis is presented in Young (2000).

[16] It is possible to improve on Ruoen's suggested procedure, decomposing output into more sectors, using more price indices, and double-deflating value added to take into account the relative movement of input and output prices. After all these adjustments, one arrives at estimated real value-added growth rates slightly below those developed using Ruoen's simple single-deflated three-sector approach. Consequently, to keep the analysis as transparent and reproducible as possible, I opt for Ruoen's suggested method. The reader can find the more complicated approach in Young (2000).

TABLE 4
ESTIMATED GROWTH OF REAL GDP (1978–98)

	Aggregate	Nonagricultural
Official	.091	.106
Alternative	.074	.081

pares the official Chinese growth rates with the alternative estimates of GDP growth.[17] As the table shows, the use of the alternative SSB price indices to deflate output lowers the growth of aggregate and nonagricultural GDP by 1.7 percent and 2.5 percent, respectively. These adjustments are substantially less than those made by Summers and Heston version 5.6, which, for the period 1978–92, when official GDP grew 8.9 percent per year, reports an adjusted aggregate GDP growth rate of 5.6 percent.[18] Figure 2 graphs the official and price index–adjusted annual growth of GDP achieved since 1978. All of the downward adjustment in the growth rate brought about by the deflator substitution comes after 1986, with growth from 1986 to 1998 averaging 6.2 percent per year, 3 percent less than the officially reported figure of 9.2 percent. In 1989, a year of economic retrenchment, GDP is now seen to have fallen by 5.2 percent, as opposed to the 4.0 percent positive growth reported in official figures. This provides some insight into the forces that precipitated the political unrest of that year.

IV. Labor

In the People's Republic there are two sources of data on the total and working population: the annual administrative and survey-based estimates reported in the CSY and the tabulations of the occasional population censuses. In table 5, I compare the figures found in the two sources. As the reader can see, the annual population estimates are quite close to those reported by the censuses. This is not surprising since the former, although based on residence registration and sample sur-

[17] Official Chinese growth rates are computed using Laspeyres price weights. I compute aggregate growth rates as the Tornqvist weighted sum of the sectoral growth rates, i.e.,

$$g(t) = \sum_i g_i(t)\left[\frac{s_i(t) + s_i(t-1)}{2}\right],$$

where $s_i(t)$ is the share of sector i in the nominal value added of year t, and $g_i(t)$ is the constant price growth of the output of sector i between years $t-1$ and t. In reporting "official" growth rates in the table, I reestimate the official growth rate using this procedure, which lowers the official growth rate by 0.2 percent per year.

[18] For the same period, my adjustments lower the growth of aggregate GDP to 7.7 percent per year.

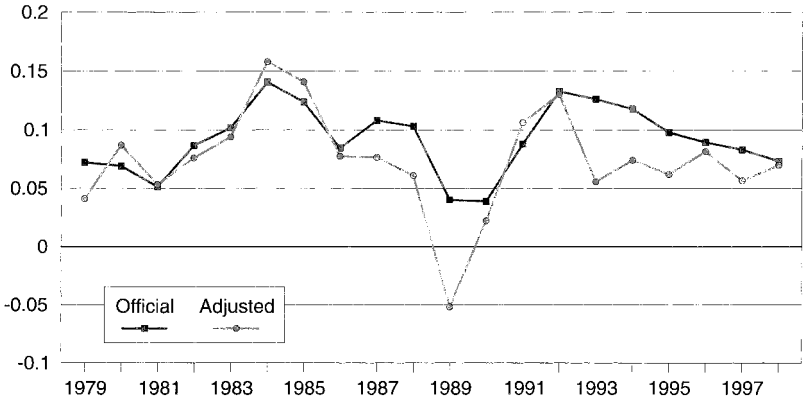

FIG. 2.—GDP growth during the reform period

TABLE 5
CHINESE POPULATION AND LABOR FORCE DATA (Millions)

	CHINA STATISTICAL YEARBOOK			CENSUS SOURCES	
		Employment			
	Population	Old Series	Revised	Population	Working Population
1978	963	402	402		
1982	1,017	453	453	1,008	522
1989	1,127	553	553		
1990	1,143	567	639	1,134	647
1997	1,236	637	696		
1998	1,248	624	700		
Growth:					
1982–90	1.5	2.8	4.3	1.5	2.7
1978–98	1.3	2.2	2.8		

NOTE.—Total population numbers include the military, whereas the working population figures do not. Old series employment data for 1997–98 are based on author's calculations.

veys, are adjusted in accordance with the results of the latter.[19] In regard to employment, however, there are large discrepancies both between the census and the annual estimates and, within the annual estimates themselves, between the old series and its recent revision. These discrepancies require some explanation.

Under the plan, the SSB, using departmental reports and surveys,

[19] See the 1999 CSY, p. 110. I should note that the census population figures I report in the table do not agree with the numbers reported in popular sources (e.g., the CSY) since I have adjusted the census population numbers to agree with the definition used in the annual series, i.e., adding in the members of the People's Liberation Army. The data presented in this section and the next, in addition to the CSY, draw on the 1982 and 1990 population censuses (People's Republic of China 1982, 1993), the 1987 and 1995 1% Population Sample Surveys (People's Republic of China 1988, 1995), and the annual issues of the *China Population Statistics Yearbook*.

collected data on the "labor force of society," which forms the basis for the "old" CSY series reported in the table. Referring to the working population, this series had a fairly stringent definition of employment, requiring, for example, that young people in cities and towns with temporary employment[20] earn, as a minimum, the wage level of local grade 1 workers in order to be included in the series (see Chen and Niu 1989, p. 203; Hsueh, Li, and Liu 1993, p. 565). In contrast, the census definition of employment includes all those earning wage or management income, whether through permanent or temporary employment.[21] Not surprisingly, the census numbers tend to be greater. In 1997 the employment series reported in the CSY was revised on the basis of the results of the annual Survey of Population Change. While the figures for earlier years were retained, the numbers from 1990 on rose substantially. As the reader can see, on the basis of the similarity of the estimates, the employment definition used by the population survey appears to correspond more closely with that used in the census.[22] The linking of the old data on the labor force of society (prior to 1990) with the new labor force series (from 1990 on) in current official publications is regrettable, since it generates spurious labor force growth, which, unfortunately, has been used by some economists as a measure of employment growth. While the labor force of society is no longer reported as the official aggregate employment series, these data continue to be collected and can be inferred from the detailed tabulations of the CSY.[23] I use these data to extend the "old" series to 1998, as reported in table 5. However, I am not able to avoid a further discontinuity, introduced in 1998, when the definition of workers in urban enterprises was revised

[20] That is, while waiting to exercise their "right" to employment, participation in the military, or further schooling.

[21] Both censuses required those with temporary employment to work 16 or more days in the month before the enumeration (1982 census, pp. 606–7; 1990 census, 4:515) and restricted the working population to those aged 15 and above.

[22] The *China Population Statistics Yearbook* reports the population survey results but gives no detail as to the underlying definitions. In any case, although the revised annual labor force series represent an adjustment "in accordance with the data obtained from the sample surveys on population changes" (*China Statistical Yearbook* 1999, p. 133), they are not literally the population survey results, since the survey indicates even more working persons than are reported in the CSY (compare *China Population Statistics Yearbook* [1998, p. 72] and *China Statistical Yearbook* [1999, p. 133]). I should also note that much of the revised industry and enterprise (e.g., state vs. collective) details reported in the early 1990s appear to be based on simple "fudge factors"; i.e., if the revised series indicated 9 percent additional aggregate employment, then the revised estimates of employment by industry or enterprise were increased, similarly, by 9 percent. As its name implies, the original emphasis of the Survey of Population Change concerned demographics, not the details of employment.

[23] While the summary tabulations on industry and enterprise employment in the CSY are adjusted to reflect the revised totals, the tables on the detailed industry structure of employment continue to be based on the old series, which, consequently, can be extended by summing the relevant categories.

TABLE 6
PARTICIPATION RATES BY AGE AND SEX

	1982 CENSUS		1990 CENSUS		1997 SURVEY	
	Male	Female	Male	Female	Male	Female
Overall	.57	.47	.61	.53	.62	.56
15–19	.71	.78	.62	.68	.44	.47
20–24	.96	.90	.93	.90	.92	.89
25–29	.99	.89	.98	.91	.97	.91
30–34	.99	.89	.99	.91	.98	.92
35–39	.99	.88	.99	.91	.98	.92
40–44	.99	.83	.99	.88	.98	.91
45–49	.97	.71	.98	.81	.97	.85
50–54	.91	.51	.93	.62	.93	.72
55–59	.83	.33	.84	.45	.82	.53
60–64	.64	.17	.63	.27	.62	.37
≥65	.30	.05	.33	.08	.34	.16

NOTE.—The 1982 and 1990 censuses exclude military personnel from the numerator and denominator. The 1997 data do not specify.

to include only those actually working and receiving income (as opposed to those who retained employment contracts, without actually working in the unit). This resulted in a substantial reduction in the estimated working population, particularly in manufacturing.

As table 5 indicates, all sources show labor force growth substantially exceeding the growth of the population. To explore the basis of this result, in table 6 I report the participation rates by age group and sex implied by census and survey data.[24] Between 1982 and 1990, according to the census, participation rates for the youngest age groups fell, and those for middle-aged and elderly women rose slightly. The data of the 1997 Population Change Survey extend these trends. These developments are consistent with growing investment in education and the gradual aging of Communist-era women, who are likely to have had a greater history of lifetime market labor force participation than their predecessors. They are, however, largely offsetting. Of the increase in the overall participation rate from .52 to .57 between the censuses of 1982 and 1990, only 1.1 percent is due to changes in the age-specific participation rates, with fully 98.9 percent attributable to the evolving age distribution of the population.

Since demographic trends play such an important role in explaining the rise in participation rates, it is important to examine them in greater detail. Table 7 reports the distribution of the population of each sex by

[24] Prior to the 1982 census, only fragmentary data on the characteristics of the workforce in particular sectors are available (e.g., Chen 1967, p. 484). The labor force of society series, in particular, did not collect information on the characteristics of workers. Consequently, it is not possible to estimate labor force participation rates by age group prior to 1982.

TABLE 7
DEMOGRAPHIC TRENDS

	DISTRIBUTION BY AGE GROUP						SURVIVING/ORIGINAL MEMBERS			
	1982 Census		1990 Census		1997 Survey		1990/1982		1997/1990	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
0–4	.10	.09	.10	.10	.07	.06	1.03	1.03	1.09	1.10
5–9	.11	.11	.09	.09	.10	.09	.99	.99	1.02	1.01
10–14	.13	.13	.09	.09	.09	.09	.97	.98	.84	.85
15–19	.12	.13	.11	.11	.08	.07	1.01	.99	.89	.95
20–24	.07	.07	.11	.11	.08	.08	1.03	.99	.98	1.02
25–29	.09	.09	.09	.09	.10	.11	.98	.98	1.02	1.05
30–34	.07	.07	.08	.07	.10	.10	.99	.99	.99	1.03
35–39	.06	.05	.08	.08	.06	.06	.97	.98	1.01	1.05
40–44	.05	.05	.06	.06	.08	.08	.96	.97	1.03	1.08
45–49	.05	.05	.04	.04	.06	.06	.93	.95	1.00	1.08
50–54	.04	.04	.04	.04	.05	.05	.90	.93	.99	1.08
55–59	.03	.03	.04	.04	.04	.04	.83	.88	.95	1.03
60–64	.03	.03	.03	.03	.04	.04	.74	.81	.89	.95
≥65	.04	.06	.05	.06	.07	.08	.47	.54	.61	.67

age group as reported in the two censuses and 1997 survey and, more importantly, compares the population of each census/survey with its surviving members (suitably aged) in the succeeding study.[25] As shown, between 1982 and 1990, the cohort of 1982 infants grows, which is consistent with underreporting of births (to avoid official sanction), as does the cohort of 20–24-year-old males, many of whom would have been in the military in 1982 (neither distribution includes active service military).[26] Overall, however, the two censuses are broadly consistent. In particular, the working-age population does not miraculously expand. The same cannot be said for the 1997 survey, which appears to undersample youths of 17–26 years of age (in 1997) and grossly oversample middle-aged women. One can correct for this, however, by "aging" the 1990 census population (using the annualized 1982–90 age-specific survival rates) and applying the 1997 Population Survey age-specific participation rates to arrive at a synthetic 1997 working population.

Between 1982 and 1990, according to the census, the working population grew 2.7 percent per year. Comparing the 1997 synthetic working population with the 1990 census, one finds that the working population grew 1.4 percent per year during this period. Extending the 2.7 percent growth rate to the entire 1978–90 period and the 1.4 percent growth

[25] I use the data on the population by single year of age and then aggregate into the quinquennial age groups reported in the table.

[26] While the 1990 census reports (in separate tabulations) the age distribution of active service military, the 1982 census does not. To keep the columns consistent, I report the civilian age distribution for both years.

TABLE 8
DISTRIBUTION OF THE WORKING POPULATION BY ECONOMIC SECTOR

	Labor Force of Society		Population Census	
	Agricultural	Nonagricultural	Agricultural	Nonagricultural
1978	.71	.29		
1982	.68	.32	.73	.27
1990	.60	.40	.72	.28
1998	.53	.47		
Absolute growth:				
1982–90	1.3	5.6	2.5	3.3
1978–98	.8	4.5		

to the 1990–98 period, one derives an average estimated working population growth of 2.2 percent between 1978 and 1998. As can be seen from table 5 above, this agrees exactly with the growth reported by the "old" labor force of society employment series (particularly after it removed, in 1998, absent workers). In sum, a working population growth of 2.2 percent per year, in excess of the 1.3 percent rate of population growth, is completely consistent with reasonable participation and demographic trends and may be deemed fairly accurate.

To complete this section, I need to derive estimates of the growth of the working population in the nonagricultural sector alone. Table 8 summarizes the distribution of the working population by economic sector, as reported in the labor force of society data and the census. The labor force of society data indicate a substantial movement of labor out of agriculture into the industrial and service sectors of the economy. In contrast, the census data show an extraordinary stability in sectoral shares. Given the well-known explosion of rural industrial activity during the reform period, these data strain credulity. The shift of labor out of agriculture into the industrial sector is confirmed by the industrial censuses of 1985 and 1995, which, as shown in table 9, indicate industrial labor force growth that exceeds that reported in the data of the labor force of society.

The Chinese population censuses are unusual in that rather than ask the respondents to specify their area of industrial activity, they ask them to provide the *name* of their place of work, which is then used to determine the industrial sector. Thus the 1982 census contains detailed instructions for enumerators on how the enterprise name should be recorded, even requiring, in the case of large enterprises, a precise specification of the department name. The 1990 census provides similar instructions but, perhaps frustrated by the large number of respondents reporting "agriculture" in the earlier census, emphasizes that peasants *must* report the name of their enterprise (but, still, not its industrial sector). In any case, the instructions then completely undermine the

TABLE 9
INDUSTRIAL EMPLOYMENT (Millions)

	Labor Force of Society	Population Census	Industrial Census
1982	72	72	
1985	83		94
1990	97	87	
1995	110		147
Absolute growth:			
1982–90	3.7	2.4	
1985–95	2.8		4.5

NOTE.—Industrial refers to mining, manufacturing, and utilities, i.e. the secondary sector other than construction.

accuracy of the statistics by noting that for households that contract land and operate as an independent economic unit, *all* working members of the household should report the main household product as the enterprise name. The confusion created by the use of a single question to collect two pieces of information, industry of employment and a record, with associated personal names, of each individual's place of work, is obvious.[27] In contrast with the census, the labor force of society, since it is based partly on enterprise reports, is much better equipped, albeit not perfectly so, to track the movement of labor between sectors.[28]

One can make use of a national income identity to verify the accuracy of the intersectoral transfer of labor reported in the labor force of society data series. The share of labor in nonagricultural GDP equals the sum of worker wages divided by total value added:

$$\theta_{L_{NA}} = \frac{\sum_i w_i L_i}{Q_{NA}} = \frac{\sum_i w_i s_i}{Q_{NA}} L_{NA}, \tag{6}$$

where the index i denotes the various subsectors of nonagricultural GDP and s_i their corresponding shares of total nonagricultural labor. From this, it follows that the growth of nonagricultural labor should equal the (ln) growth of nominal nonagricultural GDP, minus the growth of weighted wages, plus the growth of the share of labor. Table 10 presents the relevant data. Between 1978 and 1998, nominal nonagricultural GDP grew 16.1 percent per year. Weighting the official series on the wages of staff and workers by detailed sector using the detailed employment distributions of the labor force of society data, I find that weighted nominal nonagricultural wages grew 12.5 percent per year. Finally, as will be seen in Section VII, the national accounts show the income share

[27] The statistical purpose served by collecting workplace names is mystifying since this information cannot be meaningfully aggregated.

[28] I should note that the broader census definition of employment cannot explain the difference between the two series. As shown in table 9, the census actually reports lower absolute industrial employment in 1990, despite the fact that its overall employment estimate substantially exceeds that reported in the labor force of society series (table 5).

TABLE 10
CONSISTENCY BETWEEN NATIONAL INCOME, WAGE, AND EMPLOYMENT DATA
(Nonagricultural Growth Rates, 1978–98)

Nominal GDP	16.1
Weighted wages	12.5
Share of labor	1.4
Implied employment growth	5.0
Reported employment growth	4.5

of nonagricultural labor rising 1.4 percent per year. Together, these data imply a 5.0 percent annual growth in nonagricultural employment. The labor force of society indicates growth of 4.5 percent per year. Thus, if anything, this series may understate the growth of nonagricultural employment.[29]

In this paper I use the data series on the labor force of society to measure the growth of labor input. As shown above, the overall growth of the working population in this series is perfectly consistent with reasonable demographic and participation data, whereas its nonagricultural component, by the standards of the industrial surveys and national income and wage data, is modestly conservative.

V. Human Capital

As noted earlier, a proper measure of the growth of labor input should account for differentiation in the human capital of the workforce. While the labor force of society data series provides a reasonable measure of the overall growth of the labor force and its sectoral distribution, it does not contain any information on the characteristics of workers. To adjust for the changing characteristics of workers, one must turn to census and occasional survey data. Table 11 summarizes the sex, educational, and age characteristics of the working population, as indicated by the 1982 and 1990 censuses, the 1987 and 1995 1% Sample Population Surveys, and the 1997 Survey on Population Change. As the table shows, the various censuses and surveys indicate a gradual rise in the proportion of female workers, aging of the labor force, and improvement in its educational attainment. In the pages that follow, I examine the accuracy of these trends. To shorten the discussion, I focus on the changes from 1982 to 1990 (census to census) and 1990 to 1995 (census to survey),

[29] Alternatively, one can interpret the data in table 10 as indicating that the growth of nominal output is overstated by about 0.5 percent per year.

TABLE 11
DISTRIBUTION OF THE WORKING POPULATION BY SEX, EDUCATION, AND AGE CHARACTERISTICS

	1982	1987	1990	1995	1997
			A. Sex		
Male	.563	.555	.550	.543	.535
Female	.437	.445	.450	.457	.465
			B. Educational Attainment		
None	.282	.229	.169	.126	.116
Primary	.344	.363	.378	.372	.348
Secondary	.366	.396	.434	.473	.501
Tertiary	.009	.012	.019	.029	.035
			C. Age Group		
<20	.178	.140	.120	.070	.057
20–24	.133	.191	.177	.138	.120
25–29	.167	.119	.152	.168	.167
30–34	.132	.144	.123	.147	.164
35–39	.098	.114	.127	.116	.103
40–44	.085	.083	.092	.123	.124
45–49	.077	.069	.068	.088	.095
50–54	.057	.059	.055	.060	.065
55–59	.038	.041	.042	.044	.045
60–64	.021	.023	.024	.027	.031
≥65	.015	.017	.019	.020	.029

since I shall use these two discrete growth periods to measure the growth of human capital during the reform period.[30]

The preceding section established the reasonableness of the demographic and employment trends by sex and age present in the Chinese census data. I now turn to the educational data. Table 12 reports the distribution of educational attainment by age cohort in the aggregate Chinese population as recorded in the 1982 census. The table then subtracts this distribution from that present in the (suitably aged) equivalent cohort in the 1990 census. While a rise in the educational attainment of young cohorts, who would still be pursuing formal schooling, is to be expected, in the Chinese data, improvements in educational attainment extend deeply into older age groups. Better-educated persons are likely to have lower mortality rates (which will shift the educational distribution up as cohorts age), but, as panel C of the table shows, this does not explain the Chinese data, where the absolute number of educated persons in older age cohorts rises from one census to the other!

[30] I do not have access to data on the educational attainment of the total population for the 1997 survey. As I need this information to generate a synthetic educational attainment (see below), I rely on the 1995 survey instead.

TABLE 12
RISE IN THE EDUCATIONAL ATTAINMENT OF 1982 CENSUS COHORTS

	None	Primary	Secondary	Tertiary
	A. 1982 Distribution by Age			
15–19	.094	.282	.619	.005
20–24	.143	.231	.617	.009
25–29	.224	.335	.432	.008
30–34	.262	.443	.287	.008
35–39	.280	.431	.275	.014
40–44	.387	.385	.206	.022
45–49	.521	.331	.131	.016
50–54	.617	.272	.101	.009
≥55	.759	.187	.051	.004
	B. Shift in Distribution, 1982–90			
15–19	−.029	−.000	.004	.025
20–24	−.043	.044	−.014	.014
25–29	−.070	.054	.004	.011
30–34	−.070	.041	.018	.010
35–39	−.046	.024	.013	.008
40–44	−.039	.022	.011	.006
45–49	−.039	.026	.009	.004
50–54	−.027	.021	.003	.003
≥55	−.026	.019	.006	.002
	C. Increase (Millions), 1982–90			
15–19	−3.67	−.18	.18	3.15
20–24	−3.13	3.51	−.49	1.06
25–29	−6.70	4.40	−.35	1.01
30–34	−5.23	2.61	1.08	.74
35–39	−2.81	.67	.33	.42
40–44	−2.51	.33	.15	.23
45–49	−3.27	.16	−.01	.15
50–54	−3.22	−.19	−.23	.07
≥55	−28.76	−5.18	−1.36	−.02

The political campaigns of the Cultural Revolution (1966–76) disrupted the lives of many in the People's Republic, preventing them from pursuing formal education to the level they might otherwise have chosen. To compensate for this, the Chinese government provides equivalency exams that individuals, after self-study or adult education, may take to increase their formal certification.[31] Table 13 reports data from the 1995 1% Population Survey on the share of those claiming tertiary or secondary educational attainment who achieved that standard through adult education. As shown, an extraordinarily large percentage of older age groups achieved their educational status through adult

[31] Both the 1982 and 1990 censuses indicate explicitly that persons taking such exams may claim the corresponding formal attainment.

TABLE 13
PROPORTION OF INDIVIDUALS REPORTING TERTIARY AND SECONDARY EDUCATION ATTAINED THROUGH ADULT EDUCATION (1995 Survey)

	Tertiary		Upper Secondary	
	Male	Female	Male	Female
15–19	.22	.23	.04	.05
20–24	.29	.35	.07	.08
25–29	.36	.40	.08	.08
30–34	.47	.52	.07	.07
35–39	.58	.59	.07	.08
40–44	.59	.55	.12	.14
45–49	.52	.46	.14	.12
50–54	.32	.23	.12	.08
55–59	.22	.14	.11	.07
60–64	.22	.14	.11	.08
≥65	.17	.09	.09	.06

TABLE 14
MAINSTREAM AND ADULT EDUCATION (1998)

	Mainstream			Adult		
	Students	Graduates	Full-Time Teachers	Students	Graduates	Full-Time Teachers
Primary	139,538	21,174	5,819	5,386	5,485	64
Secondary	73,407	21,241	4,312	66,760	88,530	342
Peasant technical training				59,830	82,019	140
Tertiary	3,409	830	407	2,822	826	97

SOURCE.—CSY 1999, tables 20-1, 20-21.
NOTE.—Numbers are thousands of persons.

education courses.[32] Data on the annual flow of students in mainstream and adult education schools (table 14) confirm the relative importance of continuing education. These data also show, however, the inferior quality of adult education programs, since they tend to be shorter, with a high ratio of graduates to students, and have much higher student-teacher ratios. While not all such graduates could claim mainstream equivalency, the mixing of mainstream and adult education in the census data on improving educational attainment is clearly problematic, since the two types of certification would, most likely, command different market prices. To alleviate any concerns on this dimension, in the analysis below I develop a synthetic 1990 labor force, in which any improve-

[32] Not surprisingly, younger age groups also avail themselves of the opportunity to achieve higher levels of certification through this channel.

TABLE 15
CONSISTENCY BETWEEN 1990 CENSUS AND 1995 SAMPLE SURVEY

	GROWTH OF 1990 COHORT SIZE		SHIFT IN EDUCATIONAL DISTRIBUTION BY AGE COHORT			
	Male	Female	None	Primary	Secondary	Tertiary
0–4	1.13	1.13				
5–9	1.09	1.09				
10–14	.94	.94				
15–19	.86	.93	−.010	−.046	.025	.031
20–24	.95	1.03	−.012	−.001	.006	.007
25–29	1.01	1.07	−.014	.018	−.012	.008
30–34	1.00	1.05	−.019	.012	−.002	.009
35–39	1.04	1.08	−.022	.014	.000	.007
40–44	1.05	1.10	−.017	.017	−.006	.006
45–49	1.04	1.10	−.013	.015	−.007	.005
50–54	1.02	1.07	−.015	.012	−.003	.006
55–59	1.00	1.06	−.007	.008	−.006	.005
60–64	.96	1.03	−.022*	.016	.003	.003
≥65	.75	.80				

NOTE.—Growth of cohort size includes military personnel in both population estimates. Shift in educational distribution does not include military personnel in 1990 figures.
* The numbers in this panel refer to those aged ≥60.

ment in the educational distribution of cohorts aged over 25 in 1982 is disallowed.[33]

I turn next to the 1995 1% Sample Population Survey. Table 15 ages the quinquennial age cohorts of the 1990 census and compares the resulting distribution to the population recorded by the 1995 survey. Once again, the cohort of 1990 infants expands, reflecting the underreporting of births. More worrisome, however, is the underreporting of youths and oversampling of middle-aged men and, particularly, women, patterns that, as discussed in the preceding section, appear in the 1997 Population Survey as well.[34] To correct for changes in the sampling distribution, in the analysis below I construct a synthetic 1995 working population by aging the 1990 age cohorts (using the 1982–90 annual survival rates) and then applying the age × sex labor force participation rates recorded by the 1995 Sample Survey. A comparison of the cohort-specific distribution of educational attainment indicates, as was the case in the 1982–90 period, a systematic rise in the educational attainment of older cohorts (table 15). Again, to allay concerns on this dimension, I construct an alternative synthetic estimate in which I disallow all improvements in the educational attainment of cohorts aged over 25 in 1990.

[33] I allow younger cohorts to improve their attainment, since they could still have been pursuing formal schooling between 1982 and 1990.

[34] This appears to be a characteristic of the 1990s surveys. The 1987 survey, in contrast, is quite consistent with the age distribution of the 1982 and 1990 censuses.

TABLE 16
MEASURES OF WORKER CHARACTERISTICS: DISTRIBUTION OF WORKING POPULATION

	BASELINE*			ALTERNATIVE†	
	1982	1990	1995	1990	1995
	A. Sex				
Male	.563	.550	.552	.550	.552
Female	.437	.450	.448	.450	.448
	B. Educational Attainment				
None	.282	.169	.119	.195	.152
Primary	.344	.378	.369	.361	.346
Secondary	.366	.434	.483	.429	.481
Tertiary	.009	.019	.029	.015	.021
	C. Age Group				
<20	.178	.120	.075	.120	.075
20–24	.133	.177	.157	.177	.157
25–29	.167	.152	.174	.152	.174
30–34	.132	.123	.142	.123	.142
35–39	.098	.127	.115	.127	.115
40–44	.085	.092	.117	.092	.117
45–49	.077	.068	.082	.068	.082
50–54	.057	.055	.056	.055	.056
55–59	.038	.042	.041	.042	.041
60–64	.021	.024	.024	.024	.025
≥65	.015	.019	.017	.019	.017

* The baseline measures for 1982 and 1990 come from census data; that for 1995 comes from aging 1990 census population cohorts and applying 1995 educational distribution and sex × age × education participation rates.

† The alternative measure for 1990 comes from aging 1982 census cohorts, retaining 1982 educational distribution, and applying 1990 sex × age × education participation rates. The alternative measure for 1995 comes from aging the alternative 1990 cohorts, retaining alternative 1990 educational characteristics, and applying 1995 sex × age × education participation rates.

Table 16 summarizes my measures of the sex, age, and educational composition of the workforce. The baseline measure accepts the 1982 and 1990 census data and estimates the age distribution of the 1995 population by aging the 1990 census population using the annualized 1982–90 survival rates, using the 1995 survey to determine the participation rates and educational characteristics of each quinquennial age cohort. The alternative measure disallows any improvement in the educational attainment of cohorts aged over 25 between 1982 and 1990 but uses the age × sex × education participation rates of the 1990 census to determine the labor force participation of the resulting educationally demoted population. The alternative 1990 population is then aged further from 1990 to 1995, disallowing any improvements in the educational attainment of cohorts aged over 25 in 1990, and uses the age × sex × education participation rates of the 1995 survey to determine labor force participation of each group in that year. The resulting marginal distributions are summarized in the table.

Published data on the relative labor incomes of Chinese workers by

worker characteristic are, basically, nonexistent. However, the SSB's Urban Household Survey has a history of asking for the characteristics and individual labor income of the members of the survey households. I have been able to acquire the survey files for the years 1986–92. I supplement them with the files of the Household Survey (urban and rural) executed in 1988 and 1995 by the Chinese Academy of Social Sciences, which contain similar data. (These data can be purchased from the Universities Service Centre, Chinese University of Hong Kong.) While the surveys cover a large number of provinces and cities, they are by no means a balanced sample (e.g., some provinces are not represented, and the samples, both rural and urban, are heavily biased toward better-educated households). The survey responses also have substantial coding errors and internal inconsistencies, with, for example, non–labor market participants reporting positive earnings. I narrow the samples considerably by requiring that the respondents consistently, across a variety of questions, identify themselves as working employees in the nonagricultural sector. The final sample size is 222,281 observations. I regress the ln wage of each individual on age, sex, and education dummies, these dummies interacted with time, and a dummy for each survey (year or urban/rural), the latter controlling for overall wage growth and differences in the definition of income used by the different surveys. The R^2 of the regression is .83, with a partial R^2, netting out the survey dummies, of .16.

Table 17 reports the estimated education, age, and sex income profiles in the People's Republic and contrasts them with 1980/81 estimates for the newly industrializing countries (NICs).[35] In China, wages rise with educational attainment, but at a slower rate than in the other economies. Similarly, for given age and educational characteristics, women earn lower wages, but considerably less so than in the NICs. The age income profile in most of the NICs follows an inverted-U pattern, reflecting, perhaps, the competing forces of experience, vintage effects in human capital, and physical aging. In contrast, experience (or seniority) in the People's Republic confers permanent income advantages. It is unclear whether these differences reflect genuine differences in relative marginal products or socialist wage distortions aimed at promoting income equality and protecting the elderly. The Chinese trend coefficients argue

[35] The Taiwanese profile is estimated using the individual labor income of nonagricultural wage earners (excluding self-employed and unpaid workers) in the 1980 Survey of Personal Income Distribution. For Hong Kong, Singapore, and South Korea, I do not have individual files and base my estimates on census data and wage surveys (see Young 1995). For these economies, I regress my estimates of the average labor incomes of each sex × age × education cell on the appropriate dummies. I focus on 1980 on the grounds that the technology and factor supplies in use in these economies at that time might, heroically, approximate those at play in China during the 1980s and 1990s. I should note that the Korean data refer primarily to the manufacturing sector.

TABLE 17
LN WAGE PROFILES BY EMPLOYEE CHARACTERISTICS (Relative to Base Group)

	China		Hong Kong	Singapore	South Korea	Taiwan
	1986	Trend	1981	1980	1980	1980
			A. Education			
None	−.32	.001	−.08	⇓	⇓	−.33
	(.022)	(.007)				
Primary	base	base	base	base	base	base
Secondary	.16	.000	.42	.94	.44	.22
	(.008)	(.002)				
Tertiary	.25	.015	1.09	1.60	.99	.51
	(.010)	(.002)				
			B. Age			
<20	−.25	−.014	−.37	⇓	−.30	−.28
	(.014)	(.004)				
20–24	base	base	base	base	base	base
25–29	.30	−.000	.24	.49	.29	.26
	(.010)	(.002)				
30–34	.49	−.003	.39	.76	.36	.41
	(.009)	(.002)				
35–39	.54	.007	.39	.87	.39	.51
	(.009)	(.002)				
40–44	.58	.011	.35	.90	.45	.54
	(.009)	(.002)				
45–49	.66	.004	.37	.96	.49	.53
	(.010)	(.002)				
50–54	.71	−.001	.36	1.04	.58	.54
	(.011)	(.003)				
55–59	.67	.004	.27	.90	.54	.47
	(.014)	(.003)				
60–64	.60	−.074	.14	.59	.69	.38
	(.023)	(.006)				
≥65	.55	−.118	−.07	⇑	⇑	.16
	(.033)	(.009)				
			C. Sex			
Male	base	base	base	base	base	base
Female	−.12	−.004	−.44	−.47	−.55	−.37
	(.005)	(.001)				

NOTE.—The ⇑ or ⇓ signifies "included in adjacent group." Standard errors are in parentheses.

in favor of the latter interpretation, since reform appears to have led to a declining relative female wage, rapidly rising premium for tertiary-educated workers, and sharp movement toward an inverted-U age profile (with elderly workers earning substantially lower incomes). Nevertheless, rather than make ad hoc adjustments to the Chinese data, I accept them as they are, using the relative wage estimates to weight the changing composition of the workforce.[36]

[36] I use the estimates for 1990 and 1995 to weight the working population of those years and the point estimate for 1986 to weight the working population of 1982; i.e., I do not extrapolate the wage trends out of sample.

TABLE 18
GROWTH OF HUMAN CAPITAL (1978–98)

	INCOME WEIGHTS					
	China	Hong Kong	Singapore	South Korea	Taiwan	Average NIC
Original	.011	.011	.019	.010	.011	.013
Baseline	.011	.011	.018	.010	.011	.013
Alternative	.010	.010	.016	.009	.010	.011
Nonagricultural	.008	.012	.017	.010	.008	.012

Table 18 reports my estimates of the average growth of human capital in the People's Republic during the reform period.[37] The baseline working population, with the use of Chinese income weights, suggests a growth rate of 1.1 percent per year. This is not substantially different from the estimates one arrives at using the original data (which, in 1995, introduce older workers and more females) or my alternative estimates (disallowing educational improvements for those over 25). The use of NIC income weights, with their steeper profiles, would, on average, raise these estimates slightly. As explained in the previous section, I reject the census data on the distribution of the working population across sectors as being highly unrealistic. Consequently, I also reject the census detail on the characteristics of workers by sector, taking the data on the improvement of the human capital of all workers as being a more accurate reflection of overall and sectoral trends.[38] Nevertheless, for the reader's information, I report in the table the growth of human capital calculated using data on the characteristics of nonagricultural workers

[37] Following the wage profiles reported in table 17, I differentiate labor into 11 age × 4 education × 2 sex categories, for a total of 88 groups. The growth of human capital, as reported in table 18, is the growth of the workforce weighted by relative wages (as in eq. [5] above) minus the growth of the overall working population. I calculate the growth rate of human capital separately for the 1982–90 and 1990–95 periods and arrive at an average growth rate for 1978–98 by combining them with 12/8 weights (i.e., assuming that these rates held throughout 1978–90 and 1990–98, respectively).

[38] Focusing on the characteristics of the total working population also allows me, as shown above, to evaluate the overall accuracy of the data and develop alternative estimates. This is not possible at the sectoral level. I should note that the 1995 1% Sample Survey, like the census, shows virtually no transfer of labor out of agriculture. This survey continues the tradition of trying to use one question to gather both industrial and personal information. Thus, following the disappointing results of the previous censuses, the survey instructions excoriate peasants not to report "agriculture," emphasize that villagers with stable employment in enterprises should report the enterprise as their place of work, and even provide an area (within the item) for detail on the actual industry of employment, while continuing to make the recording of the enterprise (and subdepartment) name the main objective of the questionnaire including, this time, a special emphasis on determining the exact legal status of the enterprise. As shown above, the survey's overall sample is biased and needs to be adjusted, so I do not include it in Sec. IV's discussion of the intersectoral allocation of labor. Nevertheless, since it shares a questionnaire very similar to that of the census, it is not surprising that it yields similar results.

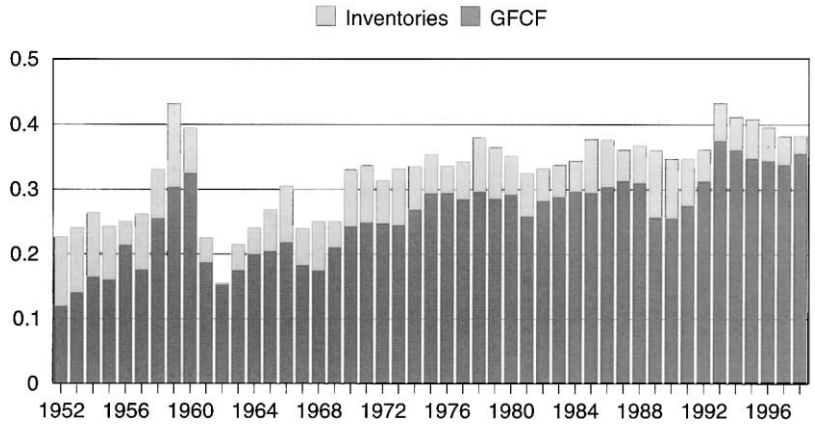

FIG. 3.—Investment over GDP

alone. This lowers the growth rate somewhat when calculated using Chinese income weights, but has a negligible impact on the estimates derived with the NIC income weights. The NIC income weights place a greater premium on tertiary education, which contributes more to the rise in the human capital of nonagricultural workers, as reported in these sources.

In this paper I take the growth of human capital in the nonagricultural sector of the Chinese economy between 1978 and 1998 to be 1.1 percent per year. As table 18 clearly shows, both slightly lower and moderately higher estimates are plausible, but all estimates are tolerably concentrated around a value of 1.1 percent.

VI. Physical Capital

Figure 3 graphs the ratio of inventory accumulation and gross fixed capital formation (GFCF) to nominal GDP in the People's Republic. In my experience, the "changes in stocks" figures reported in the national accounts of developing countries are frequently a residual, fabricated, item used to conceal large discrepancies between the production and expenditure sides of the accounts. In addition, the proper measurement of inventory changes, including the adjustment for differences between current valuations and accounting conventions, is technically more challenging than the measurement of the flow value of investment in fixed capital. Finally, in the context of the People's Republic, considering the unsold inventories of state enterprises as a productive element of the capital stock would seem to be an egregious error. For these reasons, I

exclude inventories from my measure of the capital stock and focus on GFCF alone.

As emphasized in the Introduction, this paper focuses on the nonagricultural sector of the Chinese economy, using reproducible capital alone as a measure of the capital stock. Although the published Chinese national accounts do not provide information on the sectoral distribution of GFCF, the provincial accounts do. For the period 1978–95, Hsueh and Li (1999) report the sectoral distribution of gross fixed capital formation in 26 provinces (all provinces other than Jiangxi, Guangdong, Hainan, and Tibet), accounting for an average of 78 percent of the annual value of national GFCF. I assume that aggregate GFCF during this time period has the same agricultural/nonagricultural distribution and extend the series forward by assuming that investment shares in 1996 and 1997 were the same as in 1995. For the period 1952–77, I draw on data in the CSY on the sectoral distribution of the gross fixed capital formation of state-owned units, which accounted for an average of 57 percent of the annual value of national GFCF during this period, to allocate the overall national fixed capital formation between the agricultural and nonagricultural sectors of the economy. As shown in figure 4, the proportion of state enterprise investment in agriculture is well below the provincial average (which includes the activity of collective enterprises), so my use of state enterprise investment to allocate investment during the period 1952–77 produces a discontinuity in 1978, when, as I switch to the provincial sample, the proportion of investment in agriculture jumps. This introduces a slight downward bias into my estimate of capital growth in the nonagricultural sector.

With a measure of nonagricultural investment in hand, it is necessary to derive an appropriate fixed capital formation deflator. The official deflator for GFCF is presumably an inappropriate choice since it relies on enterprise output deflators[39] and is, consequently, likely to be characterized by the same understatement of inflation that plagues the People's Republic's production estimates. An alternative independent price index is available in the form of the price index of investment, but this index has been available only since 1990, which does not provide a sufficiently long time series. A third approach is possible: exploiting the national income accounting identity equating the GDP deflator calculated from the production accounts with the same deflator calculated from the expenditure accounts. Alternative price indices for the noncapital components of final expenditure are available or are easily constructed. Combining them with the revised production deflators used

[39] Most of capital formation is construction (see below), which is deflated using the implicit enterprise output deflator for the construction industry (Hsueh and Li 1999, p. 148).

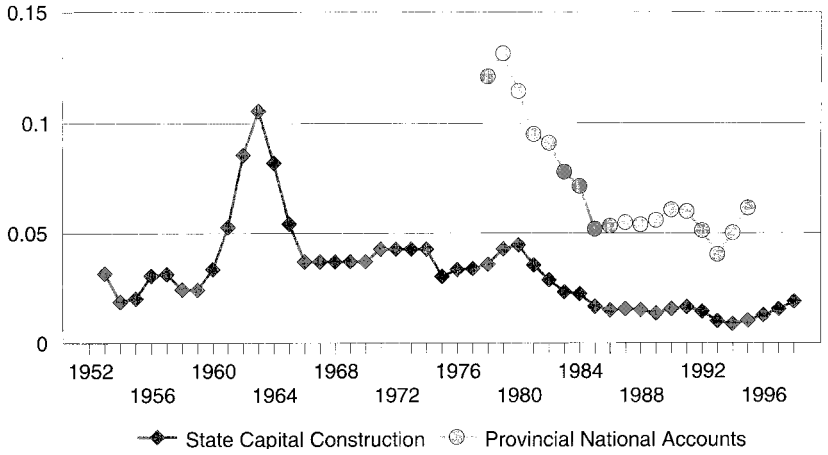

FIG. 4.—Agricultural share of investment

TABLE 19
GROWTH OF OFFICIAL AND ALTERNATIVE DEFLATORS

	OFFICIAL	ALTERNATIVE	
	1978–95	1978–95	1978–98
GDP (production)	7.1	8.9	8.1
Farm consumption	7.1	7.8	7.1
Nonfarm consumption	8.4	8.6	7.8
Government consumption	5.6	9.4	9.2
Inventories	7.9	7.8	6.5
Exports		11.3	9.5
Imports		11.0	8.8
GFCF	7.0	10.1	8.8

in Section III, one can construct an implicit GFCF deflator as part of the process of developing an internally consistent set of production and expenditure accounts.

Table 19 summarizes the growth of the expenditure accounts deflators, official and alternative. While the standard Chinese statistical sources never report the deflators (or real growth) of the expenditure components of GDP, Hsueh and Li (1999) provide some such information, for the period 1978–95, in their comprehensive review of Chinese national income accounting methodology. In the first row of the table, I list the growth of the implicit GDP deflator, calculated from the production side of the accounts,[40] along with my alternative estimates.

[40] This is not, precisely, the official deflator since I replace the official Paasche weights with Tornqvist weights, which raises the growth of the deflator 0.2 percent per year (see n. 17 in Sec. III).

The expenditure share weighted average of the growth of the component deflators should equal this number. To begin with the simplest item, private consumption expenditures, the Chinese national accounts deflate them using various components of the CPI, plus the implicit enterprise deflator for construction.[41] I replace the official deflators with the rural and urban CPIs,[42] which report very similar inflation rates.

I now turn to government consumption. The official (Hsueh and Li 1999, p. 148) methodology is to deflate government employee salaries by the consumption basket of those workers (!) and the goods and service components of government purchases using the retail and service price indices. Not only is this approach grossly incorrect, it is also, apparently, not implemented. At 5.6 percent per year, the growth of the official government expenditure deflator is well below the growth of the retail price index, the CPIs, or the (CPI) service price index. The extremely slow growth of this deflator plays an important role in offsetting the high inflation recorded in other components of the expenditure accounts, thereby bringing the official expenditure accounts in line with the production side. To replace the official deflator, I calculate the share of employee salaries (taken as the value of government output on the production side of the accounts) in government expenditures and arbitrarily divide the remainder, about 80 percent of the total, equally between purchases of goods and services. I then use these weights to construct an expenditure deflator by combining the growth of the average wage of staff and workers in government and party agencies and social organizations[43] with the growth of the retail and services price indices.

With regard to inventories, the official deflator divides inventory accumulation into agricultural, industrial, and commercial components and deflates them using price indices such as the farm and sideline products procurement price index. I adopt a similar approach, using the detailed capital formation accounts of the 26-province sample noted earlier to separate inventory accumulation into primary, secondary, and tertiary sectors, which I then deflate using the farm and sideline products, ex-factory, and retail price indices, respectively. It is reassuring that my measure of overall inventory inflation is close to the official estimate. Finally, for exports and imports, no official deflator that I know of has been circulated. From earlier work (Young 1999), I have quantity and value data on Hong Kong's trade with the Mainland during the period

[41] Peculiarly, the consumption accounts include an adjustment for the depreciation of private housing (Hsueh and Li 1999, p. 147).

[42] The rural CPI is available only from 1984 on. I extend it back to 1978 using the growth of the urban CPI.

[43] Less a 1.1 percent per year adjustment to reflect the changing characteristics of workers, as per my analysis in the preceding section.

1984–96 broken down into 823 consistent import and 899 consistent export product categories. I use these data to construct a weighted unit value index for that period and extend the analysis to the years 1996–98 and 1981–84 using data on the values and quantities of principal import and export products published in the CSY.[44] For the period 1978–81, I use the retail price index to deflate both imports and exports. The import and export price indices show about 9 percent inflation per year, although the movement in dollar prices is considerably less, since the effective yuan/dollar exchange rate (computed by dividing the value of exports and imports in yuan by their value in dollars, as reported in the CSY) depreciates 7.9 percent per year.

Finally, I turn to fixed capital formation. The official deflator increases 7.0 percent per year between 1978 and 1995. Taking as given my estimates for the other elements of the expenditure and production accounts, I produce an alternative GFCF deflator, as a balancing residual, which grows 10.1 percent per year during the same period. It is interesting to note that the official deflator, which relies heavily on the enterprise deflators in secondary industry, shows about 0.7 of the inflation recorded in the alternative GFCF price index, which agrees with my estimates of the bias in the implicit production deflators of the national accounts (see the discussion in Sec. III and the analysis in Young [2000]). As another consistency check, I note that between 1978 and 1998 the machine-building industry component of the ex-factory price index increases 4.3 percent per year, and the unit cost of construction activity, calculated from data on state and overall construction costs,[45] grows 10.6 percent per year. Weighting them by the annual investment shares of machinery and construction (with construction accounting for about 0.7 on average),[46] one arrives at an annual GFCF inflation rate of 8.9 percent for the 1978–98 period. This compares, very favorably, with the 8.8 percent GFCF inflation rate for 1978–98 calculated, as a residual, in table 19. In sum, three independent ways of calculating the average growth of the GFCF deflator all yield highly similar estimates.

[44] The Hong Kong data account for an average of 30 and 19 percent of the value of Chinese exports and imports, respectively; the CSY data cover about two-thirds of the total value of exports and imports in 1981–84 and one-third of their value in 1996–98. The CSY data contain only about 150 export and 70 import categories. Consequently, for the period 1984–96, I rely on the Hong Kong data, which, despite their smaller share of the value of trade, contain much finer product detail.

[45] I combine the construction component of the price index of investment, available for 1990–98, with data on the unit cost per square meter of state capital construction for 1978–90, both as reported in the CSY.

[46] I use the CSY data on fixed asset investment by use of funds (e.g., 1999 CSY, table 6-1). These data include a category "other," which encompasses noncapital costs such as training, product research, etc. I remove these items, focusing on equipment and construction alone. According to Hsueh and Li (1999), many, but not all (e.g., research), of these elements are removed in producing the national accounts estimates of GFCF.

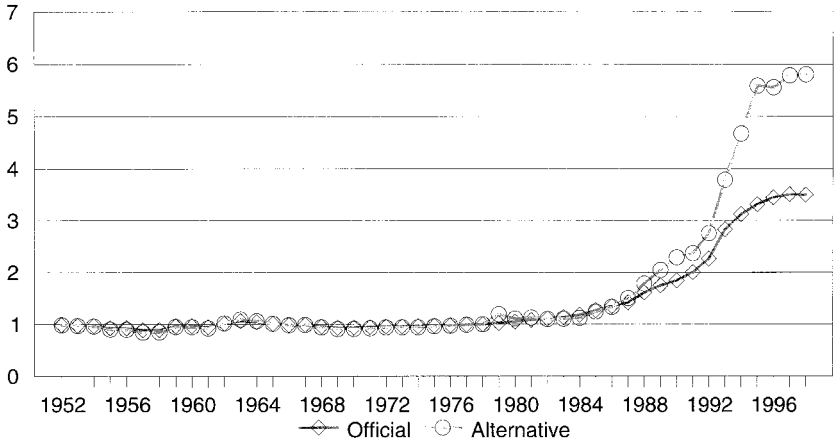

FIG. 5.—Official and alternative GFCF deflators (1978 = 1.00)

Figure 5 graphs the official and alternative GFCF deflators. For the period 1978–98, I take as the alternative deflator the residual inflation calculated above. However, I lack the price indices to reproduce this analysis for 1952–77. Consequently, for that period, I assume that officially recorded GFCF inflation is 0.7 of actual. As shown, the plan period was one of relative price stability, so that the notion that the official deflator is *any* multiple of the underlying inflation rate amounts, in effect, to the assumption of a constant capital deflator. With these deflators in hand, I calculate the capital stock using the perpetual inventory method and a 6 percent depreciation rate. I initiate the capital stock in 1952 by assuming that the real investment growth recorded in the first five years of the data extends into the infinite past.[47] With 26 years of data before the beginning of the analysis, the initial capital stock is fairly irrelevant, and any assumption will do equally well.

Table 20 summarizes my estimates of the growth of the capital stock. Using the official deflators, the nonagricultural capital stock increases 9.2 percent per year. With the alternative deflator it grows only 7.7 percent. Despite a fairly constant investment to GDP ratio during the reform period, both the official and alternative data indicate a falling nonagricultural capital-output ratio, driven by an almost 1 percent annual increase in the relative price of capital.[48] As noted above, machinery

[47] Specifically, the capital stock in 1952 is given by real investment in 1952 divided by .06 (the depreciation rate) plus the average annual growth of real investment between 1952 and 1957.

[48] Between 1978 and 1998 the official and alternative nonagricultural GDP deflators grew 5.5 and 7.9 percent per year, respectively; the corresponding capital deflators increased 6.3 and 8.8 percent per year. I should note that, as described earlier, Hsueh and Li's data on the official GFCF deflator end in 1995. To compute the "official" estimates, I extend the deflator to 1998 using the growth of the price index of investment.

TABLE 20
NONAGRICULTURAL GROWTH RATES (1978–98)

	Capital	Capital/Output
Official Data	9.2	−1.4
Alternative	7.7	−.4

prices are rising relatively slowly, but the growth of the price of construction (whether measured officially or with alternative price indices) is very high, and construction dominates fixed capital formation.

VII. Factor Income Shares

Table 21 reports the ratio of compensation of employees to GDP at factor cost in the People's Republic, estimated using data from the national accounts and input-output tables. As the reader can see, the figures produced by the two sources are in broad agreement, although the data in the input-output tables are quite volatile. The overall economywide share of labor appears to be about 0.6, whereas in the nonagricultural sector it averages slightly below 0.5. At first glance, these figures appear to be somewhat low. As shown in table 22, in my 1995 analysis of total factor productivity growth in the NICs, for example, I used (adjusted) shares of labor in nonagricultural GDP on the order of 0.6, 0.7, and even 0.75. Only in the case of Singapore did my estimate of the share of labor in nonagricultural activity fall as low as 0.5. These figures, however, involve a modification of the underlying data. In table 22, I also report the actual share of labor, that is, compensation of employees divided by GDP at factor cost, recorded by the national accounts and input-output tables of the NICs. At this level, the NICs are quite similar to the People's Republic and to each other as well, with nonagricultural labor shares of 0.5 appearing to be the norm rather than the exception. To understand the adjustments I made, why these adjustments were so minimal for Singapore and so substantial for the other economies and why no such adjustments are necessary for China, requires some explanation of the methods of the national accounts.

While the standard precepts of national income accounting require the imputation of some sources of income (e.g., the implicit rental on owner-occupied housing), they explicitly exclude such imputations in the case of labor. "Compensation of employees," as defined in the System of National Accounts, includes all wages, salaries, and supplements earned by employees, the value of any income in-kind (lodging, etc.) they receive from their employers, and employer payments for their social or private pensions. The implicit labor income of proprietors, unpaid family members, and the self-employed is supposed to be cap-

TABLE 21
SHARE OF LABOR IN GDP AT FACTOR COST

	National Accounts		Input-Output Tables	
	GDP	Nonagriculture	GDP	Nonagriculture
1978	.57	.42		
1979	.59	.42		
1980	.58	.43		
1981	.60	.43		
1982	.61	.44		
1983	.61	.43		
1984	.61	.44		
1985	.60	.45		
1986	.60	.46		
1987	.59	.46	.60	.49
1988	.59	.47		
1989	.59	.47		
1990	.61	.49	.63	.52
1991	.60	.49		
1992	.58	.48	.52	.40
1993	.59	.50		
1994	.59	.51		
1995	.61	.53	.54	.44
1996				
1997			.63	.56
Average	.60	.46	.58	.46

NOTE.—Input-output data for 1987 and 1990 are calculated from GDP at market prices and include under labor remuneration a residual category, "other," consisting of some payments to labor and elements of enterprise material consumption.

TABLE 22
NONAGRICULTURAL LABOR SHARES IN THE NICS (as Estimated in Young [1995])

	Adjusted				Unadjusted			
	Hong Kong	Singapore	South Korea	Taiwan	Hong Kong	Singapore	South Korea	Taiwan
1961	.62				.50			
1966				.74				.55
1970	.66	.50	.69	.74	.56	.39	.47	.53
1975	.67		.63		.55		.45	
1980	.57	.53	.76	.74	.49	.44	.50	.55
1985	.62		.70		.53		.49	
1990	.60	.48	.78	.76	.52	.43	.56	.59
Average	.62	.50	.71	.75	.53	.42	.49	.56

NOTE.—Hong Kong data for 1970 on refer to the year plus one, e.g., 1971 instead of 1970. Hong Kong and Singapore data refer to the entire economy, but the agricultural sectors are negligible.

tured, along with elements of the return to capital, under items such as "income from unincorporated enterprises" (United Nations 1953). Since compensation of employees is restricted to employees, a natural adjustment suggests itself: Impute to each nonemployee worker an hourly wage equal to the average hourly wage of employees with the same age, sex, and educational characteristics. Aggregating across em-

ployee and nonemployee hours of work then provides an estimate of total explicit and implicit labor income. Multiplying the unadjusted share of labor (compensation of employees over GDP at factor cost) in the national accounts by one plus the ratio of implicit to explicit labor income yields an estimate of the "true" share of labor.[49] This is the procedure I used in my 1995 analysis of the NICs. Unfortunately, it systematically overstates the share of labor.

While national income accountants are not supposed to impute labor income to nonemployees, in practice they do so, albeit unintentionally. To understand why, the reader might consider how he or she would go about constructing an estimate of total compensation of employees in a data-poor developing country. The cost shares of large incorporated enterprises are somewhat known, from sectoral surveys or tax records. In the case of small unincorporated enterprises, however, officials have little data, since the costs of data collection and monitoring limit the information, where it exists, to the most basic items, for example, declared output. Bereft of data, the national income accountant can assume either that (*a*) unincorporated enterprises pay no compensation to employees or that (*b*) the share of compensation of employees in their total output is the same as that appearing in larger incorporated enterprises. The latter assumption is more palatable and appears to be used in practice (see, e.g., Republic of China 1997, pp. 235–39). Since the share of unpaid workers in small firms is substantially higher than in large firms, this procedure automatically imputes labor income to the unpaid workers of small firms. In table 23, I list my 1995 estimates of the adjusted share of labor in sectors such as wholesale and retail trade and personal, social, and community services, which have large numbers of nonemployee workers. Imputing an implicit income to unpaid workers frequently results in a labor share exceeding one as payments to labor more than exhaust the total output of the sector.[50] This is precisely what would arise if one double-counted the implicit income of unpaid workers.[51]

The data on compensation of employees reported by national income

[49] One cannot use the estimates of implicit and explicit labor income drawn from labor force survey and census data directly, since they typically do not include income in-kind or pensions. Multiplying by the national accounts estimate of compensation of employees scales for these factors, as well as adjusts for any inconsistency between the overall level of employee income reported by workers and firms.

[50] The trends in the share of labor derive from the trends in the share of self-employed workers (falling in wholesale and retail trade and rising in community, social, and personal services) as the unadjusted national accounts estimates of compensation of employees over GDP at factor cost are fairly constant.

[51] In a similar vein, Denison (1979, app. G) found that business income (net of labor and material payments) in unincorporated enterprises in the United States was insufficient to cover an implicit labor and capital income equal to that of business sector employees and incorporated enterprise capital.

TABLE 23
NONAGRICULTURAL LABOR SHARES BY SECTOR IN KOREA AND TAIWAN
(Adjusted for Unpaid Workers, as Estimated by Young [1995])

	Wholesale and Retail Trade	Community, Social, and Personal Services
	A. South Korea	
1970	1.20	.98
1975	1.01	.96
1980	.95	1.04
1985	.86	1.04
1990	.68	1.07
	B. Taiwan	
1966	1.50	.98
1970	1.92	1.06
1980	1.18	1.03
1990	1.09	1.02

accountants lie somewhere between the accounting precepts of the System of National Accounts and a measure involving a full imputation of the implicit labor income of unpaid workers. As a lower labor share will typically yield lower estimates of total factor productivity growth, to avoid criticism on this dimension, in Young (1995), I assumed that the national accounts followed, precisely, the conventions of the System of National Accounts and made a full adjustment for the implicit income of unpaid workers. The difference between Singapore and the other economies does not lie in the national income data, but rather in the fact that Singapore has far fewer unpaid workers operating in small family-run enterprises. While my labor share estimates for Singapore are often criticized as being too low, it is more likely the case that, if anything, the estimates for the other economies are too high.

In the People's Republic, self-employment is fairly rare.[52] Moreover, the Chinese national accounts *explicitly* impute labor income to the self-employed, assuming that in industrial and construction enterprises in which self-employment is found, all income is labor income, and going so far as to conclude that the *entire* output of some sectors (e.g., personal and social services) contains no net capital income component whatsoever, allocating all of the output of the sector between compensation of employees and depreciation (see Hsueh and Li 1999, pp. 111, 114–15, 123). Consequently, there is no reason to modify the reported Chinese estimates of the share of labor. The share of labor in the nonagricultural economy in China is similar to that reported in other economies. Once adjustment is made for unpaid workers, the ratios of other economies

[52] According to the 1999 CSY (table 5-4), self-employed individuals accounted for only 3 percent of the working population in 1990. This figure rises to 9 percent by 1998.

TABLE 24
GOLD INTO BASE METALS (Chinese Growth Rates, 1978–98)

	Official	Adjusted
Aggregate:		
Output per capita	7.8	6.1
Output per worker	6.9	5.2
Nonagricultural:		
Output per worker	6.1	3.6
Output per effective worker	5.0	2.6
Output per unit of capital	1.4	.4
Total factor productivity	3.0	1.4

are higher, which may or may not reflect an overstatement. In either case, given the methodology of the Chinese national accounts and the small number of self-employed in that economy, this fact provides no basis on which to modify the Chinese estimates. In this paper I use the average share of labor reported in the Chinese national accounts in preference over the more volatile figures of the input-output tables.

VIII. Total Factor Productivity Growth

Table 24 summarizes this paper's deconstruction of Chinese growth during the first two decades of the reform period. From official data, the sustained growth of output per capita, at 7.8 percent per year, is unprecedented. If one substitutes the SSB's own price indices for its GDP deflators, the growth of output per capita is reduced to 6.1 percent, an extraordinary, but not unheard of, achievement. From here, the usual factors, present in other high-growth economies, take over. Rising participation rates lower the growth of output per worker to 5.2 percent. Removing the agricultural sector raises the growth of GDP, but the growth of employment rises even further, lowering the growth of labor productivity to 3.6 percent. Accounting for the aging and improving educational attainment of the workforce then brings this number down to 2.6 percent. The movement from 7.8 percent to 2.6 percent summarizes, in full, the main result of this paper. A few simple adjustments reduce the Chinese growth experience to a reasonable and comprehensible number.

Table 24 also presents, as an afterthought, the growth of the output-capital ratio and total factor productivity. The growth of total factor productivity is a moderate, but respectable, 1.4 percent per year. As there is no capital-deepening (in fact, the opposite), this result, conveniently, reemphasizes a point I have made in previous papers (e.g., Young 1994, 1995): labor-deepening (the rise in participation rates, transfer of labor out of agriculture, and improvements in educational

attainment) and *not* capital-deepening is the key force explaining the extraordinary improvements in per capita living standards, in the presence of moderate total factor productivity growth, achieved by the high-growth economies of East Asia.

The total factor productivity estimates of this paper should not, by any means, be taken as definitive. As table 24 shows, if one merely accepts the official GDP deflators but keeps all other elements of the analysis unchanged, the growth of total factor productivity jumps to 3.0 percent. Beyond this, an impressive range of estimates is possible. A quick and dirty optimist (Dr. Pangloss) might focus on the official (Laspeyres) growth of aggregate output per capita, denying the improvements in participation rates, ignoring changes in the composition of the workforce, and assuming a constant capital-output ratio and a 0.7 labor share (in line with the developed world), to produce a total factor productivity growth estimate of 5.6 percent per year. At the other extreme, the data-mining pessimist (Dr. Doom) might take my estimates as a baseline but lower the growth of nominal output by 1 percent (to correct for exaggeration), use the current official series on employment (with its discontinuity in 1990), and weight the growth of human capital using Singaporean relative wages in 1980, to produce a nonagricultural total factor productivity growth estimate of −0.4 percent per year. These parodies highlight the ease with which one can raise or lower estimates of total factor productivity growth. It is hoped that the reader can make use of the lengthy discussion of data in this paper to adjust the estimates presented in table 24 and attach to them the appropriate standard error.

IX. Conclusion

Having pressed through countless pages of dry data analysis, the reader should, arguably, be rewarded with some free-ranging interpretation and speculation. The finding of moderate nonagricultural labor and total factor productivity growth can be viewed as either positive or negative. On the one hand, when contrasted with the experience of other reforming economies, sustained 2.6 percent labor productivity growth can be seen as nothing short of miraculous. On the other hand, given that the estimates presented in this paper are by no means the lowest possible (in particular, there is no adjustment for the exaggeration of nominal growth) and given the presumed inefficiency of central planning, one might have expected greater gains in a "successfully" reforming economy. In this regard, moderate productivity growth might be seen as reflecting enduring problems, such as the failure to reform state enterprises and the inefficiencies introduced by local government intervention in industrial production and trade. Both interpretations are valid since the Chinese glass is, clearly, both half full and half empty.

Like many magicians and alchemists, this paper buries its trickery in the setting of the stage. Excluding agriculture, at the very beginning, from the analysis incorporates the transfer of labor out of that sector as an input, while excluding agricultural total factor productivity growth and the efficiency gains brought about by movement of labor from the measurement of output. The sustained growth of agricultural output during the reform period, in light of its rapidly declining share of the labor force, is a testament to the misguided nature of plan policies that kept the peasantry tied up in agriculture, by restricting rural-urban migration and limiting the development of rural nonagricultural activity, while saddling it with inefficient and alien organizational structures. The reversal of these policies may be one of the greatest, and easiest, achievements of the reforms, although agriculture remains distorted in many respects (e.g., with local procurement and price controls). A proper analysis of the agricultural sector, lying well beyond the abilities of the techniques used in this paper, might find rapid productivity growth in that sector and large gains from the release of its pent-up "surplus" labor.

Along with rising participation rates, educational attainment, and capital investment, the transfer of labor out of agriculture, whether driven by productivity growth in that sector or the equalization of labor's marginal product with other sectors of the economy, has played an important role in the growth of economies such as Korea and Taiwan. It plays an equally significant role in fueling the growth of the People's Republic. Despite the popular academic emphasis on industry and exports, a deeper understanding of the success of the world's most rapidly growing economies may lie in that most fundamental of development topics: agriculture, land, and the peasant.

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