China's Structural Transformation

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Introduction

This paper is a study of four key facts about China's economic growth. The first fact, presented in Panel A in Table 1, is the well-known structural transformation. For example, the share of workers in the non-agricultural sector increased by 20 percentage points from 1978 to 1998. The second fact is that output per worker in the non-agricultural sector has actually grown at a lower rate than that of the aggregate economy. For example, Young's (2003) estimates (presented in panel B of Table 1) indicate that the aggregate growth rate of output per worker in China has exceeded the growth rate of the non-agricultural sector by an average 1.6 percentage points per year. The third fact, perhaps least well known, is that the price of agricultural goods has remained roughly unchanged relative to the price of non-agricultural goods. As seen in the third panel in Table 1, the growth rate of agricultural prices does not appear to be significantly different from the growth rate of non-agricultural prices. Finally, the fourth fact is that rural wages have grown at roughly the same rate as wages in the urban sector.

The first two facts seem to present a puzzle. How can it be the case that the sector that is expanding is precisely the sector where productivity appears to be growing more slowly? However, this is in fact a key prediction of the traditional story of the structural transformation that puts the agricultural sector at the center of this process. According to this story, if food is a non-tradable necessity, productivity growth in the agricultural sector relaxes the food constraint and thus releases workers to work in the non-agricultural sector.[1] Young (2003) echoes this explanation in his discussion of the seemingly low rates of growth in China's non-agricultural sector, arguing that "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."

A central prediction of this story is that the price of agricultural products relative to the price of non-agricultural products should have fallen over time in China. After all, this is the mechanism that lowers the *value* of the marginal product of labor in the agricultural sector and thus drives the reallocation of resources out of this sector.

[1] See Timmer (1988) for a summary of the large literature on the structural transformation, and Gollin, Parente, Rogerson (2002) and Restuccia, Yang, and Zhu (2003) for formal models.

However, this prediction is inconsistent with the third stylized fact about China's growth – that the relative price of agricultural goods has remained roughly constant in China. To be clear, this relative price is by no means constant: as we'll discuss in the paper, there were sharp shifts in the relative price of agricultural goods in the early years of the reform and in the late 1990s. However, the key point is that this relative price does not display any long run trend and thus does not lend support to a story in which the steady expansion of the non-agricultural sector is driven by productivity growth in the agricultural sector.

We will argue that in order to capture all three facts, we need a model in which productivity growth in the non-agricultural sector (relative to the agricultural sector) draws resources out of the agricultural sector, and imports of food prevent the terms of trade from turning against the non-agricultural sector. If this is the mechanism underlying the structural transformation, then there is no reason to expect to see a trend in the relative price of agricultural products, as this relative price is determined in world markets. The main effect of productivity growth in the non-agricultural sector would be to increase the *size* of the non-agricultural sector, and the growth rate of wages in the non-agricultural sector would be the same as that in the non-agricultural sector.

We will argue that this is in fact what we see in the data. If we take rural wages as a proxy for wages in the agricultural sector and urban wages as a proxy for non-agricultural wages, Panel D (Table 1) suggest that the relative wage of agricultural workers (relative to non-agricultural workers) in 1978 was roughly the same as in 1998. Again, as we'll show in the paper, this relative wage is by no means constant, but the key point is that it does not exhibit any long run trend.

We proceed as follows. We first present the evidence on the aggregate trends in the reallocation of workers out of the agricultural and into the nonagricultural sector. We then present a two-sector model in which the equilibrium allocation of labor between the two sectors can be driven by changes in relative prices, changes in relative productivity, and changes in labor and capital market distortions in the two sectors. After highlighting the patterns that these forces should leave in the data, we then present the evidence on the aggregate trends in relative prices, relative capital-labor ratios, and relative average labor compensation in the two sectors.

The Labor Reallocation

The China Statistical Yearbook (CSY) provides two statistics compiled from the data from the Chinese *Labor Force of Society* that are frequently used to measure the extent of the structural transformation. First, a natural manner to measure the reallocation of labor in China is the share of the population living in urban areas. As shown in first panel in figure 1, China was predominantly a rural society in 1978: slightly under 20 percent of the population lived in urban areas. By 2000, this share had roughly doubled, to almost 40 percent. There are, however, two limitations with using the urban share of the population as a proxy for the reallocation of labor towards the non-agricultural sector. First, it is well known that many people living in rural areas are in fact working in the non-agricultural sector. Second, there could be changes in the labor force participation rates between urban and rural China.

The CSY also provides a figure for the number of workers in the agricultural and non-agricultural sectors, which potentially deals with these two problems. Here, the CSY defines workers in the agricultural sector as rural workers not employed in township and village enterprises. This measure, shown in the second panel in figure 1, evinces a slightly larger reallocation towards the non-agricultural sector. However, the number of workers in the non-agricultural sector provided by the CSY is also potentially downwardly biased, for two reasons. First, the CSY assumes that rural workers that are self-employed or employed in private sector firms are involved in agricultural activities. While this bias is likely to be small in the 1980s, it potentially has become more important over time due to the growth of the private sector firms and the number of self-employed workers. An additional limitation is that the CSY does not take into account that many rural workers are engaged in both agricultural and nonagricultural activities. Specifically, the CSY defines the sector of employment as the individual's main sector of employment. However, to the extent that the share of time spent on non-agricultural activities by rural workers has increased over time, this would also potentially understate the reallocation of workers towards non-agricultural activities.

To address these biases, we adjust the number of agricultural and non-agricultural workers provided by the CSY in two ways. First, from 1989 through 2003, we have data (from where?) on the number of rural workers employed in the private sector or that are self-employed. We use these estimates of fraction of self-employed rural workers and rural workers in the private sector to adjust the CSY's estimates of the number of workers in the non-agricultural sector. Second, a representative survey of rural households from 1986 to 1989 conducted by the Research Center for Rural Economy (RCRE) of China's Agriculture Ministry provides detailed information on each worker's allocation of labor across different sectors. We use this data to compute the fraction of time devoted to non-agricultural activities among rural workers, which we then multiply by the CSY's estimates of the number of agricultural workers. As expected, these two adjustments result in a higher share of non-agricultural workers. More importantly, with these adjustments, the extent of the sectoral reallocation of workers appears to be larger: the share of workers in the non-agricultural sector appears to have increased by almost 25 percentage points since 1978.

In sum, from 1978 through 2000, there appears to have been a reallocation of 20 percent of the population to urban areas. The shift to nonagricultural employment appears to have been larger, amounting to roughly 25 percent of the workforce. With this evidence in mind, we then turn to a model that highlights the potential forces underlying this reallocation.

A Model of Reallocation

Here, we sketch out a model in which the equilibrium allocation of labor between the agricultural and nonagricultural sector is determined endogenously as a function of relative total factor productivity (TFP), relative prices, and distortions in the allocation of labor and capital in the two sectors. Our goal is to identify the markings these forces should leave in the data.

Suppose that the production functions for the two sectors are:

$$Y_A = A_A \left(K_A^{1-\alpha_A} L_A^{\alpha_A} \right)^{\gamma} T^{1-\gamma} \tag{1.1}$$

(1.2) $$Y_N = A_N K_N^{1-\alpha_N} L_N^{\alpha_N}$$

Here, the subscript denotes the sector (A for agriculture and N for non-agriculture), K denotes capital, L represents labor, T represents land (available in fixed supply), and $\gamma <$ 1 measures the share of capital and labor in agricultural output. Notice that we have assumed that the nonagricultural sector displays constant returns in capital and labor, but that the agricultural sector displays diminishing returns to scale in capital and labor, with the degree of diminishing returns depending on the land share in the agricultural sector. There are two important implications of these production functions. First, the equilibrium wage in the economy will be determined by the marginal product of labor in the nonagricultural sector. Second, the magnitude of the labor reallocation in response to different forces will depend on the land share in the agricultural sector.

We assume that profits are given by:

(1.3) $$\pi_A = P_A A_A \left(K_A^{1-\alpha_A} L_A^{\alpha_A} \right)^{\gamma} T^{1-\gamma} - (1+\tau_{K_A}) r K_A - (1+\tau_{L_A}) w L_A$$

(1.4) $$\pi_N = P_N A_N K_N^{1-\alpha_N} L_N^{\alpha_N} - (1+\tau_{K_N}) r K_N - (1+\tau_{L_N}) w L_N$$

Here, we take τ_{K_j} to represent forces that drive up the rental price of capital. For example, difficulty in access to capital in the agricultural sector can be represented by $\tau_{K_A} > 0$, while cheap credit to state owned firms can be viewed as $\tau_{K_N} < 0$. Similarly, we represent forces that drive up the wage by τ_{L_j}. For example, overstaffing by state owned enterprises can be represented as $\tau_{L_N} > 0$. To take another example, restrictions to labor mobility that lower the agricultural wage relative to nonagricultural wages can be represented as $\tau_{L_A} < \tau_{L_N}$. We take prices as exogenous to allow for the possibility that both goods are traded and thus have their prices determined in world markets. However, it is certainly possible that there is a significant non-tradable component in both goods. If this is the case, the prices of both goods will be determined endogenously and thus can

change in response to the same forces that drive the reallocation away from the agricultural sector.

We solve for the equilibrium allocation of labor between the sectors in the following manner. First, we solve for the profit maximizing capital-labor ratio in the two sectors:

$$\frac{K_A}{L_A} \equiv k_A = \frac{1+\tau_{L_A}}{1+\tau_{K_A}} \cdot \frac{\alpha_A}{1-\alpha_A} \cdot \frac{w}{r} \tag{1.5}$$

$$\frac{K_N}{L_N} \equiv k_N = \frac{1+\tau_{L_N}}{1+\tau_{K_N}} \cdot \frac{\alpha_N}{1-\alpha_N} \cdot \frac{w}{r} \tag{1.6}$$

We then combine the expressions equating the wage to the marginal product of labor in the two sectors to obtain the equilibrium share of labor in the nonagricultural sector:

$$\frac{L_N}{L} = 1 - \left[\frac{T^\gamma}{L} \cdot \frac{(1-\gamma)(1-\alpha_A)}{(1-\alpha_N)} \cdot (1+\tau_{L_N}) \cdot \frac{P_A}{P_N} \cdot \frac{A_A k_A^{\alpha_A(1-\gamma)}}{A_N k_N^{\alpha_N}} \right]^{1/\gamma} \tag{1.7}$$

where the capital-labor ratios in the two sectors are given by (1.5) and (1.6).
Equation (1.7) highlights four forces that potentially drive the structural transformation in China:

Productivity growth in the nonagricultural sector (relative to the agricultural sector). An increase in A_N/A_A will increase the marginal product of labor in the nonagricultural sector and thus draw workers out of the agricultural sector into the nonagricultural sector. In turn, the reduction in the number of workers in the agricultural sector increases the marginal product of labor in the agricultural sector. This increases the returns to labor in both sectors. In the new equilibrium, factor returns (adjusted for τ_L) are the same in the two sectors.[2]

Increased capital-intensity in nonagricultural sector (relative to agricultural sector). An increase in k_N relative to k_A increases the marginal product of labor in the nonagricultural

[2] In a model where prices are endogenously determined, an increase in A_N/A_A might also have offsetting

sector and thus draws workers into that sector. From (1.5) and (1.6), this would be driven by an increase in $\frac{1+\tau_{L_N}}{1+\tau_{K_N}}$ relative to $\frac{1+\tau_{L_A}}{1+\tau_{K_A}}$. For example, an improvement in capital markets that lowers the cost of capital in the nonagricultural sector (relative to the agricultural sector) will increase the capital-labor ratio in the nonagricultural sector relative to the agricultural sector (this can be represented as a fall in τ_{K_N} relative to τ_{K_A}). To take another example, a reduction in mobility barriers between the agricultural and nonagricultural sectors (represented as a fall in τ_{L_A} relative to τ_{L_N}) could increase k_N relative to k_A. In both cases, the increased capital intensity in the nonagricultural sector pulls workers out of the agricultural sector into the nonagricultural sector.

Worsening terms of trade for the agricultural sector. A fall in P_A/P_N lowers the value of the marginal product of labor in the agricultural sector relative to that in the nonagricultural sector. In turn, this pushes workers out of the agricultural sector into the nonagricultural sector. In equilibrium, the reallocation of workers lowers the marginal product of labor in the agricultural sector by enough such that the *value* of the marginal product of labor is equated in the two sectors. For example, the traditional story of the structural transformation is that productivity growth in the agricultural sector (relative to the nonagricultural sector) lowers the relative price of food, which puts in play the dynamic spelled out above.

Reduction in labor market distortions in the nonagricultural sector. Here, the intuition is straightforward. A reduction in τ_{L_N} increases the equilibrium wage in the nonagricultural sector, which draws workers into this sector.

How can discriminate between these alternative explanations for the structural transformation? First, we can measure the relative price and the relative capital-labor ratios. Second, to discriminate between changes in τ_{L_N} and A_N/A_A, we can use the fact

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effects on P_N/P_A.

that the ratio of nominal labor productivity adjusted by the labor shares in the two sectors is given by:

$$\frac{\frac{Y_N P_N / L_N}{(1-\gamma)(1-\alpha_A)}}{\frac{Y_A P_A / L_A}{(1-\alpha_N)}} = (1+\tau_{L_N}) \tag{1.8}$$

Note that this ratio, basically the ratio of average labor compensation in the nonagricultural sector to the agricultural sector, is only a function of the labor market distortion in the nonagricultural sector, but is NOT a function of relative TFP.

Finally, we should mention that the one additional complication that has to be addressed before taking this model to the data is that the ratio of average labor compensation in the nonagricultural sector to the agricultural sector may also be driven by changes in the average level of human capital in the two sectors. We will deal with this by using a Mincerian specification to adjust the measure of labor force for differences in human capital. Specifically, we will measure the labor force in the agricultural sector as $L_A e^{\theta_A yeduc_A}$ and the labor force in the nonagricultural sector as $L_N e^{\theta_N yeduc_N}$, where θ_i represents the Mincerian returns to schooling and $yeduc_i$ represents the average years of schooling of workers in each sector.

Empirical Evidence

The model we've sketched out suggests that we can discriminate between the alternative explanations for the labor reallocation by examining the trends in relative prices, relative capital-labor ratios, and relative average compensation in the two sectors. It is to this evidence that we turn to now.

Terms of Trade

We begin by presenting the evidence on relative prices. Figure 2 presents three estimates of ratio of nonagricultural prices to agricultural prices from 1978 through 2000.

The first panel presents the ratio of the implicit GDP deflator in the nonagricultural sector to the GDP deflator in the agricultural sector. As can be seen, the price of manufactured goods relative to agricultural goods steadily *fell* throughout the reform period. Clearly, by this measure, there is no evidence that the terms of trade turned against the agricultural sector in the manner predicted by the traditional story of the structural transformation. This story requires that the productivity growth in the agricultural sector drive workers out of the sector by lowering the relative price of agricultural goods. Instead, the evidence is consistent with the notion that price liberalization in the agricultural sector *improved* the agricultural sector's terms of trade. This would increase the value of the marginal product of labor in the agricultural sector, which would have the effect of drawing workers *into* the agricultural sector and not out of this sector which is what we see.

The second panel in Figure 2 defines the price of agricultural goods as the price of farm and side products and the price of nonagricultural goods as a weighted average of the ex-factory industrial price index and the price index for consumer services (all these prices are from the CSY). As discussed by Young (2003), these prices generally rise at a faster rate than the implicit GDP deflators, with the gap being larger in the nonagricultural sector. Specifically, the growth rate of these alternative price indices exceed the growth rate of the GDP deflator by 0.6 percentage points a year for the agricultural sector, by 1.7 percentage points a year in the manufacturing sector, and by 3.6 percentage points a year in the service sector. However, it is clear that this divergence largely appears in the 1990s. As can be seen in Panel B, this second measure of the relative price indicates the terms of trade of the agricultural sector improved from 1978 to 1989 at roughly the same as that implied by the ratio of the GDP deflators (Panel A). Again, this is consistent with the notion that agricultural price liberalization in the 1980s improved the terms of trade of the agricultural sector. After 1989, the data shown in panel B suggests that the terms of trade turned against the agricultural sector. However, even by 1997/1998, the terms of trade of the agricultural sector was exactly what it was in 1978 on the eve of the reforms, and only sharply accelerated after 1998.

However, there are good reasons to believe that panel B overstates the decline in the terms of trade in the agricultural sector after 1990, largely because the consumer price

index for services used to construct the price index for nonagricultural goods is likely to overstate the actual price increase in the service sector. Table 2 presents the price index for the four subcategories of services for which data is available for the entire time period. As can be seen, prices for recreation and health services have increased at a much faster rate than prices of transportation and telecommunication services. Yet, the employment share of personal services such as recreation and health services is significantly smaller than the share of business and wholesale trade services. Table 3 indicates that the employment share of personal services (in total employment in services) fell from 42 percent in 1978 to only 29 percent by 2000. On the other hand, the employment share of wholesale trade increased sharply from 29 percent of total service employment in 1978 to 45 percent by 2000. Therefore, it seems likely that the aggregate price of services, which is largely driven by the price of wholesale and business services, has increased at slower rate than the price of personal consumption services (driven largely by the price of recreation, health, and education expenditures).

To address this problem, we construct an alternative price index for services as a weighted average of the price of wholesale trade services, the price of business services, and the price of consumer services.[3] We then define the price of nonagricultural goods as a weighted average of this alternative service price index and the ex-factory price index. Panel C in figure 2 presents our third measure of the terms of trade of the agricultural sector using this measure for the price of nonagricultural goods. As can be seen, this figure suggests that the terms of trade of the agricultural sector has remained roughly unchanged over the last two decades.

In sum, there appears to be little evidence of secular long run changes in the terms of trade in China. There is some evidence that the terms of trade of the agricultural sector improved in the 1980s, perhaps as a consequence of price liberalization in the agricultural sector. However, this would have the effect of attracting workers into the agricultural sector and, as we know, there was a large reallocation of workers *out* of the agricultural sector over this time period. Overall, there appears to be little evidence that a secular

[3] We calculate the price index of wholesale and retail trade services by dividing the retail price index by a weighted average of the ex-factory industrial price index and the price of agricultural goods.

deterioration of the agricultural sector's terms of trade was behind the structural transformation in China.

Relative Capital Intensity

Figure 3 presents the capital-labor in the nonagricultural sector relative to the capital-labor ratio in the agricultural sector (we normalize the ratio in 1978 to 1). As can be seen, this ratio fell from 1978 until the mid 1980s, increased from the mid 1980s until approximately 1990, and has fallen steadily since 1993/1994. The rise in the relative capital-labor ratio from the mid 1980s until 1990 is consistent with the reduction of mobility barriers during this time period (is this correct?) that precipitated the labor reallocation. Nonetheless, if we look over the entire time period, it seems clear that is little evidence of long run trends in the relative capital-labor ratios in the two sectors. By 2000, the rise in the relative capital labor ratios from 1985 through 1990 was almost entirely undone by the sharp fall in the relative capital labor ratio after 1994.

Relative Labor Compensation

Finally, we turn to the evidence on relative labor compensation in the two sectors. As shown in equation (1.8), the ratio of average labor compensation in the nonagricultural sector to that in the agricultural sector can be interpreted as the labor market distortion in the nonagricultural sector. Figure 4 presents three estimates of this ratio (in all three estimates, we normalize the ratio in 1978 to 1). Our first estimate, shown in Panel A, is the ratio of average labor compensation computed from the national accounts. Specifically, we calculate average labor compensation in each sector by dividing nominal output per worker by the labor share in the sector, and then take the ratio of average labor compensation computed in this manner in the nonagricultural sector to the agricultural sector. Panel A shows clear evidence that relative wages in the nonagricultural sector to the agricultural sector has steadily fallen since 1978, with a sharp decline during first 5-8 years of the reform.

A limitation with this last figure is that does not account for possible changes in human capital between the two sectors. Clearly, it is possible that changes in average

human capital between the two sectors could change the ratio of average wages in the two sectors. To address this issue, we adjust the ratio of average labor compensation (shown in panel A) by the ratio of average human capital in the two sectors. Specifically, we measure the ratio of average human capital by $e^{\theta_N yeduc_N} / e^{\theta_A yeduc_A}$. This estimate is shown in panel B in figure 4. As can be seen, the evidence in this figure is very similar to that shown in Panel A.

Finally, the last panel in figure 4 presents the ratio of average consumption in the nonagricultural sector to average consumption in the agricultural sector as an alternative proxy of relative wages in the two sectors. As can be seen, panel C also suggests that there was a sharp decline in relative nonagricultural wages in the initial years of the reform. What is different is that this evidence also indicates that the relative nonagricultural wage recovered after the mid-1980s (which is not the case in Panel A and B in figure 4).

Assessment

In sum, there are four possible proximate forces behind the reallocation of labor: a deterioration of the agricultural sector's terms of trade, an increase in the capital intensity of the nonagricultural sector relative to the agricultural sector, a reduction in labor distortions in the nonagricultural sector, and an improvement in nonagricultural TFP relative to agricultural TFP. Figure 2 provides little evidence that the agricultural sector's terms of trade has worsened. Figure 3 suggests that the capital intensity of the nonagricultural sector relative to the agricultural sector in 2000 was roughly the same as in 1978. Figure 4 is less clear – it suggests a fall in labor market distortions in the nonagricultural sector in the initial years of the reform, but provides mixed evidence on what has happened to this distortion after 1985. Nonetheless, by default, this evidence appears to indicate that the central driving force behind the structural transformation in China has been an improvement in nonagricultural TFP relative to agricultural TFP. How much this matters (relative to a reduction in nonagricultural labor market distortions shown figure 4) will obviously depend on the magnitude of the diminishing returns parameter. In our case, this is simply the land share in the agricultural sector.

Figure 1: The Reallocation of Labor

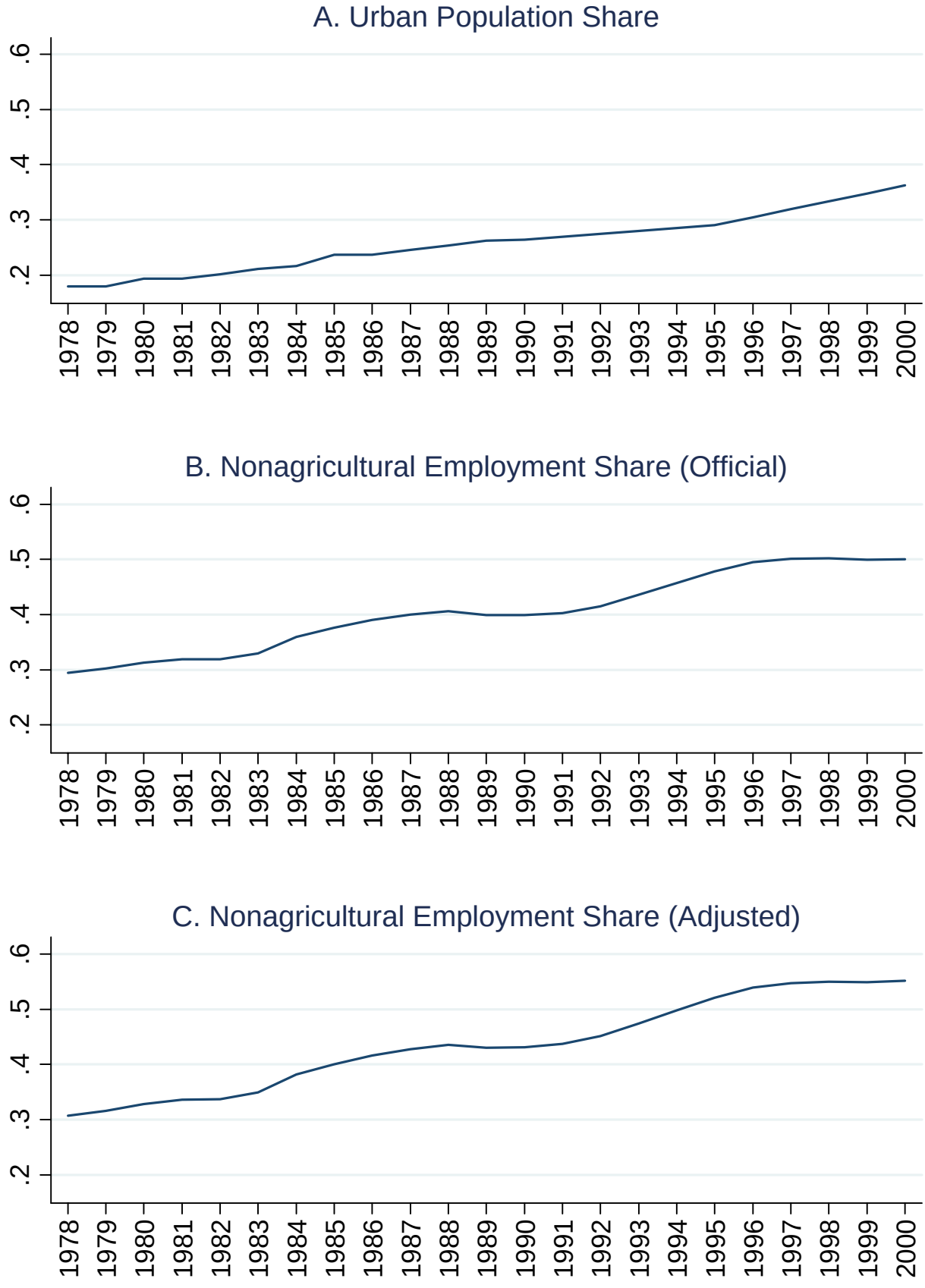

Figure 2: Nonagricultural/Agricultural Prices

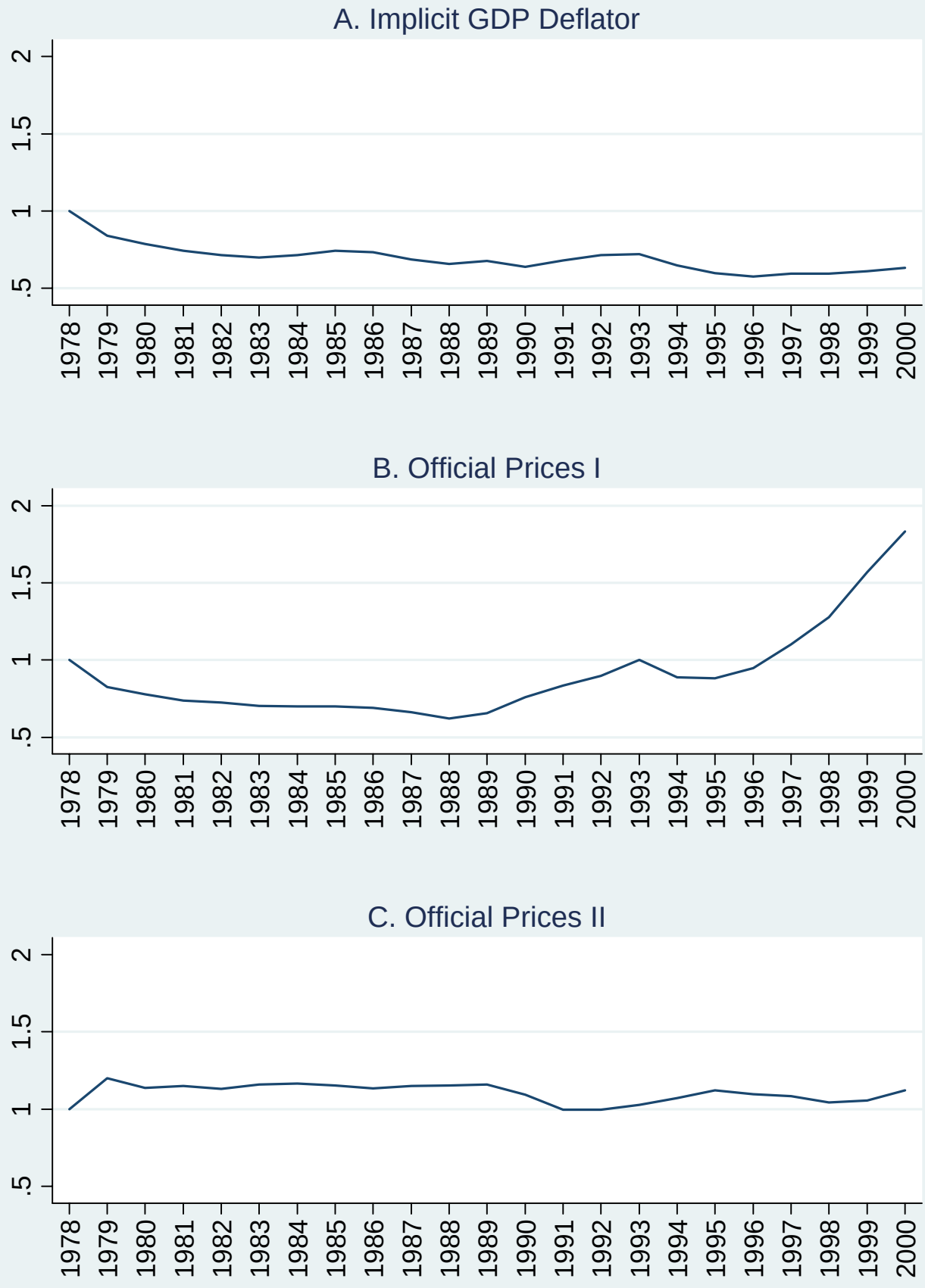

Figure 3: K/L in Nonagriculture relative to Agriculture

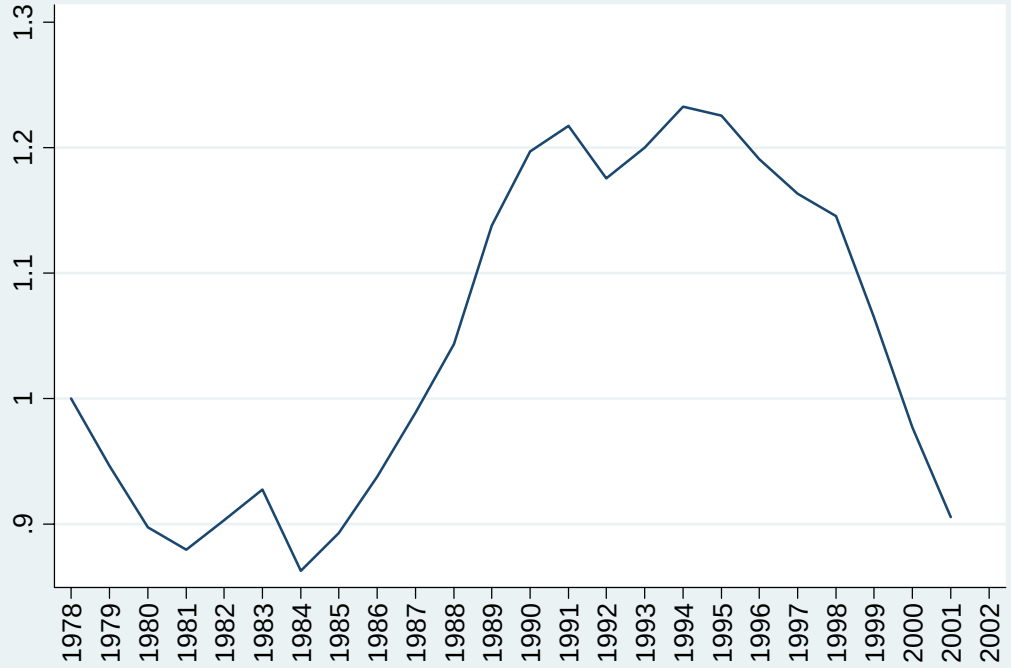

Figure 4: Average Labor Income in Nonagriculture Relative to Agriculture

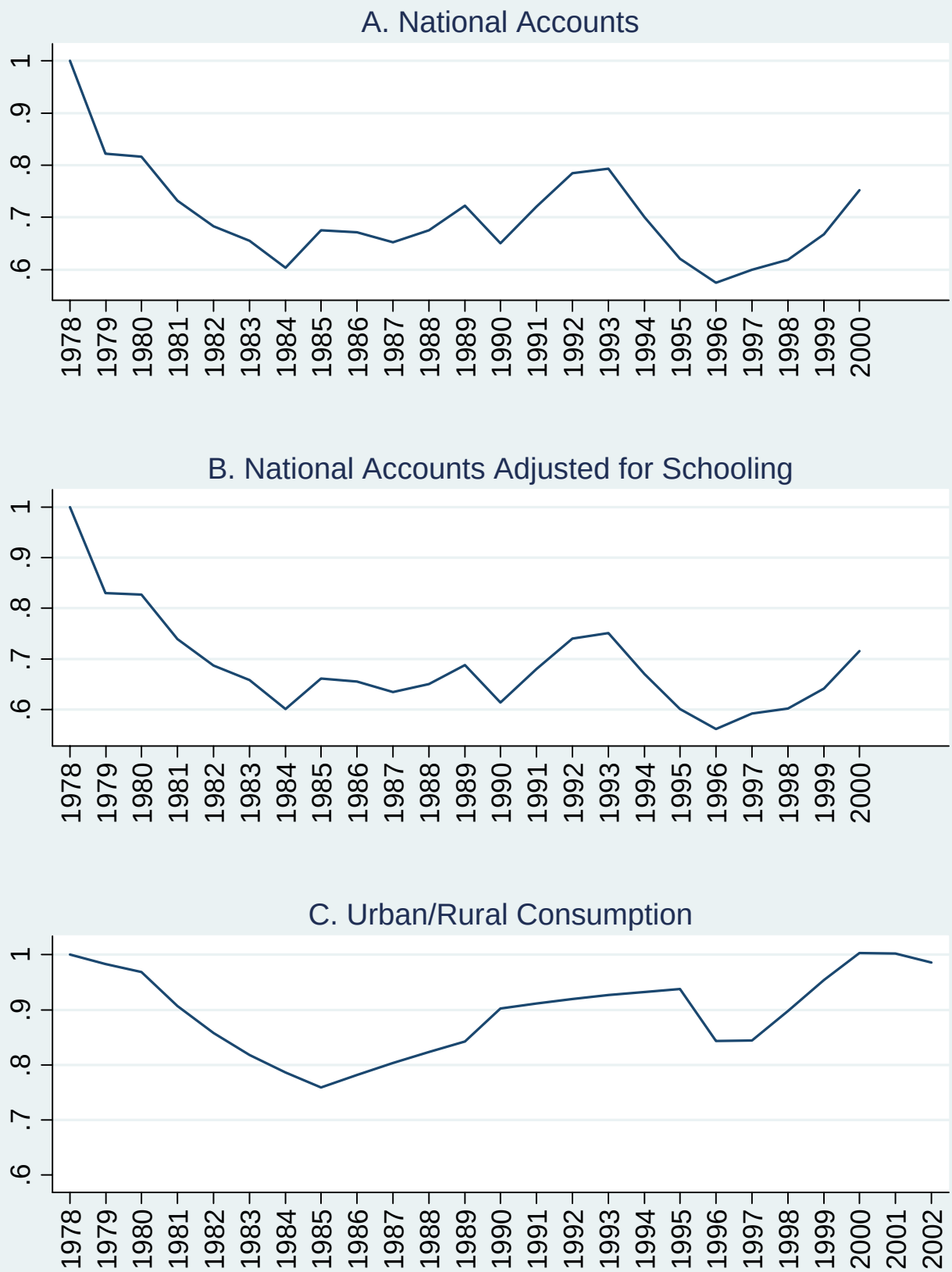

Table 1: China's Structural Transformation, 1978-1998

A: Change in Population and Employment Shares

urban population share:	15.4
non-agricultural employment share	20.0

B: Growth Rate (Output per worker)

aggregate economy	5.2
non-agricultural economy	3.6

C: Prices

agricultural	7.9
non-agricultural	8.4

D: Wages

Rural	12.4
Urban	12.2

Table 2: Price Index for Services (1985=100)

	1990	2000
transportation	206	525
telecommunica	173	526
recreation	251	1823
health	184	844

Table 3: Employment Share of Business, Personal, and Wholesale Trade Services

	1978	1990	2000
Personal Services	41.9	33.9	28.6
Business Services	28.9	28.8	26.3
Wholesale Trade	29.2	37.2	45.1