

Explaining China's Growth

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Abstract

China has achieved impressive growth over the last three decades of reform. However, there has been debate over the sources of the growth, and the role of the intensive versus extensive margins. Young (2003) suggests for the non-agricultural sector that China followed a path similar to some of her Asian counterparts, and that most, if not all of the growth came from increases in capital and skill intensity rather than from increases in TFP. Growth accounting exercises at the aggregate level (Perkins and Rawski, 2008; Bosworth and Collins, 2008) suggest a more important role of TFP growth. In this paper, we develop a dynamic three sector model to help bridge these two perspectives, focusing on the contribution to TFP and aggregate output growth of two potentially important structural transformations: from agriculture to non-agriculture, and within non-agriculture, from state to non-state. We find only a modest role for the former, but a more important contribution of the latter. Disaggregating the non-agricultural sector into its state and non-state components has an added advantage: it helps identify rapid TFP growth in the non-state non-agricultural sector as a key driver of China's growth. In contrast, the much less efficient state sector, which continues to command more than half of investment resources, is a drag on growth. This difference in behavior has important policy implications for China as it tries to rebalance its growth path. Finally, in light of important concerns over data, we examine in the paper the robustness of our key results to alternative data series.

1 Introduction

China has achieved impressive growth over the last three decades of reform. However there has been continued debate over the sources of the growth, and the role of the intensive versus extensive margin. In an influential article, Young (2003) suggests for the non-agricultural sector that China followed a path similar to some of her Asian counterparts, and that most, if not all of the growth came from rapid increases in capital and skill intensity rather than from increases in TFP. Growth accounting exercises at the aggregate level however suggest a more important role of TFP growth on the order of 3-3.5 percent per annum (Bosworth and Collins, 2008; Perkins and Rawski, 2008).

The two observations may not be entirely contradictory. Young provocatively suggests that China's "miracle" may lie in the TFP growth of the agricultural sector. In principle agricultural growth could contribute to aggregate growth in two ways: Directly, through increases in output per worker in the sector and indirectly, through relaxation of constraints that facilitate the reallocation of labor from agriculture to non-agriculture. This reallocation, commonly referred to as the process of "structural transformation", could be a source of aggregate TFP growth if there were differences on the margins in the returns to labor between the two sectors. Prima facie, there are reasons for believing this may have been the case. At the start of the reforms, 70 percent of the labor force was in agriculture. Moreover, a variety of institutional restrictions tied these individuals to the land and severely limited their choice of economic activity, thereby resulting in lower returns to labor in agriculture than outside the sector.

Reallocation of labor from agriculture to non-agriculture is not the only transformation that China has gone through the last three decades. There has been substantial reallocation of labor and other resources within the non-agricultural sector: from the state to the non-state sector. Between 1978 and 2004, the share of labor in the non-agricultural sector working in state enterprises and institutions declined from 52 percent to 15 percent. In the urban sector, the reduction has been even sharper, from 78 percent in 1978 to 25 percent in 2004. Because of soft budget constraints and

other preferential policies favouring the state sector, TFP growth in the state sector has consistently lagged that in the more dynamic non-state sector by a wide margin (Jefferson and Rawski, 1994). The reallocation of resources from the state to the non-state sector, then, may also have been an important source of aggregate TFP growth.

Because the reallocation of labor across sectors is endogenous and generally depends on sector-level TFP growth as well as frictions in the labor market, its contribution to aggregate TFP and output growth cannot be quantified without taking into account the impact of these factors. In this paper, we develop a dynamic three sector model that explicitly takes into account the interactions between those factors and the labor reallocations. The sectors include agriculture, and within the non-agricultural sector, the state and non-state components. Our model allows us to quantify the role of capital accumulation and productivity growth within each sector as well as the contribution to TFP and aggregate output growth of the transformations from agriculture to non-agriculture, and within non-agriculture, from state to non-state. Somewhat surprisnly, we find only a modest role for the traditional transformation from agriculture to non-agriculture. Instead, we find a much more important contribution of the transformation from state to non-state associated with economic transition.

Disaggregating the non-agricultural sector into its state and non-state components has an added advantage: it helps identify rapid TFP growth in the non-state non-agricultural sector as a key driver of China's growth. This role is obscured in more aggregate analysis that combines the state and non-state sectors. Rapid TFP growth in the non-state sector helped to offset the drag of the inefficient state sector, which continues to command more than half of investment resources (or twenty percent of GDP), and was instrumental in absorbing labor transferred out of agriculture. In absolute terms, employment in the non-state non-agricultural sector grew by nearly 400 million between 1978 and 2004. Without the TFP growth in the non-state sector, the TFP in the non-agricultural sector and in the whole economy would have grown at much lower rates. While the state sector has followed an extensive growth pattern that relies heavily on capital accumulation, the non-state sector's growth is intensive and driven mainly by TFP increases. This key difference in behavior between the state and non-state is important for thinking about rebalancing China's

growth strategy.

In section 2, we briefly examine a number of key data series, saving more detailed discussion for the appendix. Section 3 discusses the results of the standard growth accounting, followed by an examination of the behavior of sector-level productivity. We describe our benchmark model in Section 4 and discuss the driving forces of structural transformations in Section 5. A key feature of the model is the link it draws between distortions in the labor market and capital allocation. In section 6, we use this model to examine the contributions of China’s structural transformations to TFP growth, and then situate this in the context of a growth accounting in which changes in aggregate labor productivity come from either capital accumulation, TFP growth within each sector, or inter-sectoral reallocation from low to high TFP sectors. In light of important concerns over data issues in the literature, we also demonstrate that our findings are robust to the use of alternative data series for key variables.

2 Data

The starting point of our analysis is a simple growth accounting at the aggregate level, for the non-primary sector, and within the non-primary sector, for the state and non-state components separately. This requires data on nominal GDP, prices, employment and the capital stock. Ongoing debate over problems in Chinese data raises a variety of issues. We carry out this exercise using a number of alternative data series to check for robustness. In the appendix, we provide more detail, and here limit our discussion to a few key issues relating to GDP and fixed investment deflators, employment, estimates of value-added in the state and non-state sectors, as well as investment in the state and non-state sectors.

2.1 GDP Deflators

Much of the debate in the literature has been over sector-level GDP deflators needed to convert nominal GDP into real GDP. China’s implicit GDP deflators have been criticized by Ren (1995), Young (2003) and Maddison (200x) for underestimating inflation, and thus contributing to an

overestimate of real GDP growth. For the secondary sector, Holz (200x) provides a defence of their internal consistency by comparing the changes in the implicit GDP deflator with the prices of final goods and that of raw materials and intermediates.

Following Ren, Young (2003) proposes a set of alternatives: For the primary sector, the farm and sideline products purchasing index, which rose 7.9% per annum between 1978 and 1998 compared to 8.5% by the implicit deflator; for the secondary sector, the ex-factory industrial price index, which increased 6.1% annually compared to 4.4% by the implicit deflator; and for the tertiary or services sector, the consumer service price index, which rose 10.7% per annum compared to 7.1% by the implicit deflator. It is important to note that all of these “alternative” deflators are final goods deflators, as opposed to value-added deflators.

We carry out our analysis using the official implicit GDP deflators, and the alternatives proposed by Ren and Young, with one modification. We construct an alternative deflator for services that reflects the rising role of business services, and differences in the behavior of the prices of business and consumer services. Young’s alternative is based solely on the price of consumer services. Our new service price index implies a rate of inflation in between the implicit deflator and Young’s alternative.

2.2 Fixed Investment Deflators

The NBS begins to report a fixed investment deflator only in 1991. For the period between 1978 and 1995, a deflator for fixed capital formation can be backed out of NBS-reported data on the nominal and real value of fixed capital formation. This implicit deflator, which shows an annual increase in the price of investment of 7.0 percent, has been criticized for likely underestimating the rate of inflation in capital formation.

Following the earlier work of xxx and a suggestion of Young (2003), Brandt and Rawski construct an alternative deflator for fixed investment spanning the longer period between 1952 and 2006 that is based on: 1. separate deflators for equipment and structures; and 2. estimates of the percentage of total fixed investment spending in structures and equipment. Comparing this alternative with the two “official” deflators, two things are noteworthy. First, the NBS fixed investment deflator

beginning in 1991 and our alternative deflator behave very similarly. Second, the implicit deflator for gross fixed capital formation shows much less inflation than does our alternative. For the period between 1978 and 1995, the implicit index rises 7.0 percent per annum, compared to 10.2 annually by the alternative. The most likely source of the difference is the failure of the implicit deflator to reflect the rapidly rising costs of building and installation, and their influence on the costs of fixed investment.

2.3 Employment

China's NBS provides estimates of total employment and a breakdown by sector: primary, secondary (manufacturing plus construction, mining and utilities) and tertiary (services). Between 1978 and 2004, the NBS measure of employment increased from 401.5 million to 752.0 million. The NBS data also show a decline in the percentage of the labor force in the primary sector from 70.5 percent in 1978 to 50.1 percent in 2000, and then to 46.9 percent in 2004.

There are two difficulties with the official data. The first is a major discontinuity in the employment data beginning in 1990. This "break" reflects a major upward adjustment to the NBS employment series based on new information obtained from China's population censuses of 1990 and 2000. These adjustments did not extend to years before 1990, leading to a big jump in the NBS employment measure during 1989/1990.

A second issue concerns the possibility that NBS data underestimate the rate of decline in the primary sector labor force (Rawski and Mead, 1998, Chen, 1992). Critics point to several potential sources of this bias: the exclusion of employment in private and cooperative enterprises owned by households prior to 1984 (Wong, 1988, p. 14); incomplete tabulation of self-employment and part-time work outside agriculture by individuals who derived the bulk of their incomes from farming; and erroneous inclusion of out-migrants in the farm labor force.

Following Holz (2006), we use information from the 1982 Census to adjust the pre-1990 data in a way analogous to the adjustments made for 1990 and after. This results in an increase in the level of employment in 1978, and a reduction in the rate of employment growth over the entire period. We also construct an alternative estimate of primary sector employment by utilizing detailed labor

supply data for rural households disaggregated by activity collected by the Research Centre for Rural Economy as part of their annual rural household survey. These alternative estimates imply a more rapid transfer of labor out of agriculture, especially in the early years of the introduction of the household responsibility system (HRS) and rural reform. In absolute terms, employment outside agriculture grew from 144 million in 1978 to 513 million in 2004. Moreover, by 2004, our alternative estimates suggest that the percentage of the labor force in the primary sector had fallen to 31.8 percent compared to 46.9 percent in the official data.

2.4 Labor Productivity in the State and Non-state Non-agricultural Sectors

We will carry out growth accounting for the non-primary sector for the state and non-state components, separately. NBS reports data on employment and capital formation disaggregated by sector and ownership. They also decompose gross output and value-added in industry into the state and non-state components, however they do not provide a similar breakdown for the remainder of the secondary sector (construction plus public utilities) or for the tertiary sector. We utilize wage data for the state and non-state sectors to estimate such a division for the entire non-agricultural economy. To do this, we assume that wages are proportional to average value products, and that labor shares in the state and non-state sectors are the same. Information on wages in the state and non-state sector, the latter including urban collective, foreign-owned, private and township and village enterprises, suggest that wages outside the state sector were between 60-70 percent of state sector wages between 1978 and 1995, rose to nearly 85 percent by 2000, and then fell slightly thereafter.

These data conceal an important complication: they include only cash compensation and neglect the value of subsidies and in-kind wages enjoyed primarily by workers in the state sector, the largest component of which was probably housing. Rawski (1982), Bannister (2004), and Benjamin et al (2008) offer estimates of the magnitude of these benefits for various years. There is a consensus in the literature that the relative importance of such non-cash benefits has declined markedly over time, with estimates suggesting that they have fallen from rough equality with cash wages in the late 1970s, to half of cash wages by the early 1990s, to perhaps a quarter of cash wages

today. These figures imply that total compensation in the non-state sector increased relative to compensation in the state sector by about fifty percent between 1978 and 2004. Thus, the growth of labor productivity in the non-state sector relative to that in the state sector is faster than what is implied by the relative cash wages between the two sectors. Using relative cash wages as the basis for our estimate, labor productivity grows 5.70% in the non-state sector compared to 5.00% in the state sector. Incorporating in-kind payments to labor implies growth in labor productivity in the non-state sector of 7.05 percent compared to 5.03 percent, or a gap nearly three times larger than when using cash wages alone. In our analysis, we will examine the robustness of our results to revised estimates of relative labor productivity based on this alternative wage series.

2.5 Fixed Investment in the State and Non-state Non-agricultural Sectors

The NBS provides estimates of gross fixed investment for years after 1978. We need to obtain a breakdown between primary and non-primary, and in the non-primary sector, state and non-state. Investment in the primary sector is made up of investment from three sources: state, collective and households. The Fixed Investment Yearbooks provide estimates of investment in the primary sector by both state-owned and collective units for the years 1981-2004. They also provide estimates of total rural household investment, but do not break it down between primary and non-primary. Assuming that investment is proportional to net income, we use additional information on the percentage of total net business income from agriculture to obtain an estimate of household fixed investment in agriculture. Our estimate of total primary investment is then the sum of our estimate for rural households, plus the state and collective fixed investment.

Investment in the non-primary sector is calculated as total fixed investment less our investment in the primary sector. We utilize the information on total state sector investment and state-sector investment in the primary sector to obtain non-primary investment by the state sector. Beginning in 1993, the NBS begins to report separately fixed investment in shareholding companies, which were typically medium-to-large SOEs that had been restructured, but in which the state exercised

significant influence.¹ Our estimate of fixed investment in the state sector includes that by state-owned firms, plus shareholding companies.² This leaves non-primary non-state sector investment as a residual.

In Figure 1, we graph the ratio of investment in the state sector relative to the non-state sector. Even as late as 2004, the state's share of non-agriculture fixed investment, which is more than 95 percent of total fixed investment, is sixty percent.

3 Growth Accounting by Sectors

Following the standard growth accounting practice, we assume Cobb-Douglas production technologies in all three sectors (agriculture, non-state non-agriculture and state sectors):

$$Y_{at} = A_{at}Z^{1-\alpha}L_{at}^{\alpha}, \quad (1)$$

$$Y_{st} = A_{st}K_{st}^{1-\alpha}L_{st}^{\alpha}, \quad (2)$$

$$Y_{nst} = A_{nst}K_{nst}^{1-\alpha}L_{nst}^{\alpha}, \quad (3)$$

Here, Y_{it} is GDP, L_{it} employment, and K_{it} capital stock in sector i ($i = a$, agriculture, s , state and ns non-state non-agriculture), respectively. Z is the land endowment in agriculture. α is the factor share of labor, which is assumed to be the same in all three sectors.

On the basis of the national income accounts for China and the national input-output tables constructed by the NBS, the labor share in non-agriculture has remained roughly 0.5. These accounts put the labor share for the entire economy at 0.58-0.60, which implies a share for agriculture of nearly 0.7. Moreover, the falling contribution of agriculture in GDP since 1978 means that the share of labor in agriculture has been rising over time. The high and rising share of labor in

¹On the basis of the 2004 Industrial Census, for example, there were 17,427 shareholding companies out of a total of 1.37 million industrial firms. These firms however represented between 11 and 12 percent of total output and fixed assets.

²In our robustness checks we have also used narrower definitions.

agriculture is inconsistent with estimates made on the basis of household data, which suggest a labor share in the vicinity of 0.50. For all three sectors, then, we assume that the labor share is 0.5 through out the period of our study.

We assume that the land endowment in agriculture is fixed over time and normalize it to one. As a result, our estimate of TFP growth in agriculture may partially reflect changes in either the land endowment or land quality. Also note that when we calculate TFPs we do not control for the levels of human capital. Thus, the TFP differences over time and across sectors may also reflect differences in human capital.

We carry out the standard growth accounting using a number of alternative data series. Altogether, we consider three alternatives, which we spell out in Table 1.³ Our benchmark is Alternative 1, which uses the alternative deflators for both GDP and the capital stock, and the revised data on total employment and the share in agriculture. Alternative 2 uses only official data. Alternative 3 is identical to alternative 1, but uses our alternative estimate of labor productivity in the state and non-state non-primary sector that we based on a broader measure of labor compensation. We carry out the exercise for entire economy, the non-primary sector, and within the non-primary sector, the state and non-state sectors separately. In each case, we do the analysis for the full period, and then split the period into the pre and post-1991 periods. We report the results of this simple growth accounting in Table 2.

[Insert Table 1 and 2 here]

Our benchmark data imply a rate of growth in the aggregate in real output per worker of 7.1 percent per annum. Over the entire 26-year period, the contributions to growth of capital deepening and TFP are fairly evenly divided, 3.4 percent versus 3.7, or 48 and 52 percent of total growth, respectively. Splitting the data in 1991 implies an increase over the two periods in the rate of growth of output per work resulting from both higher TFP and slightly more important, more rapid capital accumulation. As a result, the contribution of capital accumulation to the growth in

³We also considered two other alternatives that we do not report here. Alternative 4 is similar to Alternative 2, but uses the revised total employment data discussed in the text. Alternative 5 incorporates the new estimates of the share in agriculture in addition to the revised total employment data. Our basic findings were robust to both.

labor productivity rises between the two periods from 39 percent to 52 percent, while that of TFP falls from 61 to 48 percent.

In the non-agricultural sector, output per worker grows less rapidly over the entire period than we observe in the aggregate, a product of both lower TFP and less rapid capital accumulation per worker. Between 1978 and 2004, output per worker in the non-agricultural sector grows 4.8 percent and TFP 2.95 percent. Note however the increase in the rate of growth between the two periods, and the contrasting behavior in the state and non-state sectors. In the pre-1991 period, rapid growth in the non-agricultural labor force of nearly 200 million contributed to a decline in the capital-labor ratio in the non-agriculture sector. All of the growth in output per worker was coming from TFP. Furthermore, the aggregate conceals stark differences between the non-state and state sectors. In the non-state non-agricultural sector the capital-labor ratio fell sharply up through 1991, but this was offset by rapid productivity growth of 4.5 percent per annum. The exact opposite occurred in the state sector. In the post-1991 period, higher rates of investment in the non-state sector helped to reverse the decline in capital per worker, but without any ensuing reduction in TFP. At the same time, massive reorganization and layoffs in the state sector, along with new investment in the sector, contributed to increases in the capital-labor ratio and growth in TFP, albeit lagging that in the non-state sector. Over the entire period, TFP in the non-state non-agriculture sector increased 4 to 5 times more rapidly than in the state sector.

3.1 Robustness

The use of official deflators and employment series only modestly modifies this basic picture. Rates of growth in output per worker at the aggregate level are very similar between the benchmark and the official data, with the effect of slightly lower rates of inflation in the official data offset by more rapid employment growth. Using the official deflator for capital accumulation however makes capital deepening slightly more important and TFP lower as a result of the more rapid growth in the capital stock. A fairly similar picture using the benchmark and official data also emerges with respect to the non-primary sector, but the increase in the output per worker and TFP between the pre and post-1991 period is not as sharp in the official data. Gains in TFP in the state sector

between the two periods are also much smaller using the official data, largely because of the more rapid rates of capital accumulation.

Growth accounting using the benchmark data plus estimates of labor productivity in the state and non-state sectors based on an alternative relative wage series that includes in-kind compensation leaves the growth accounting for the entire non-primary sectors unchanged. It also does not influence the growth in capital per worker in either the state or non-state sector. The change does influence however the rate of growth in labor productivity and our estimate of TFP. For the full period, the revision implies significantly higher growth in output per worker and TFP in the non-state sectors, and very small increases in the state sector. The reason for the latter is that larger differences in output per worker between the state and the non-state at the beginning implies that the reallocation of labor away from the state will lower the growth rate of the non-agriculture sector, which must be compensated by higher growth rates within the two sectors.

3.2 Comparison with the literature

In Table 3, we compare our results from the standard aggregate growth accounting with a number of prominent ones in the literatures constructed for similar periods. The differences are marginal.

[Insert Table 3 here]

Our estimate of TFP in the non-primary sector however is higher than Young (2003) reports for the slightly shorter period between 1978 and 1998. In an appendix, we compare his estimate with ours for the same twenty-year period and break down the reasons for the differences. Noteworthy, an upward revision to non-primary sector nominal GDP by the NBS in 2006 for the period after 1993, a revision not available to Young, and the use of our alternative deflator for the tertiary sector add nearly one and a half percent to both output per worker and TFP in the non-agricultural sector for the period between 1978 and 1998.

3.3 Behavior of Sector TFP

Over the entire period, growth in output per worker and TFP in the non-primary sector lags that in the aggregate, much as Young (2003) intimates. There are also significant differences within the non-primary sector between the state and non-state segments. Differences in the level of productivity across sectors imply potentially significant returns in the aggregate to reallocations of resources between the primary and non-primary sectors, as well as between the state and non-state sectors within the non-primary sectors. Substantial differences in the capital-labor ratio across sectors make labor productivity a misleading measure of production efficiency. For example, output per worker in the state sector has consistently been higher than labor productivity in the non-state sector, but this may reflect the state sector's easy access to capital and a higher capital-labor ratio rather than any superior effectiveness of resource utilization. To measure differences in production efficiency across sectors, we need to control for differences in the capital-labor ratio.

Figure 2 plots the TFP levels for the three sectors sectors.⁴ There has been significant growth of TFP in agriculture and the non-state non-agricultural sector, which increased at annual rates of 6.18 and 4.54 percent, respectively. By comparison, TFP growth in the state sector has been relatively sluggish, increasing only at the rate of 0.91 percent per annum. In terms of levels, in 1978 TFP in the non-state non-agriculture sector was nearly the same as that in the state sector. Due to the more rapid growth in the non-state sector, TFP levels diverge over time so that by 2004 the level of TFP in the non-state non-agricultural sector was 130 percent higher than that in the state sector. This huge gap in TFP levels supports the claim that high rates of capital accumulation in the state sector have been instrumental in maintaining high levels of output per worker in that sector.

[Insert Figure 2 here]

Given the large differences in TFP behavior across the three sectors, reallocations of resources

⁴Because the production technologies in agriculture and non-agricultural sectors are different, the TFP level in agriculture is not comparable to the TFP levels in the two non-agricultural sectors. In Figure 1, we normalize the initial level of the agricultural sector's TFP to one.

across sectors are potentially important sources for the growth in the aggregate TFP. These reallocations are also likely to be a function of the TFP differences across sectors. To fully account for the contribution of sector TFPs and the reallocation across sectors, a model of sectoral reallocation is needed.

4 A Three Sector Model of Structural Transformation and Growth

We consider a dynamic model with three sectors: agriculture, non-state non-agriculture and state. There are two goods in the economy, agricultural and non-agricultural. The agricultural good is produced in the agriculture sector and the non-agricultural good is produced by both the non-state non-agriculture and state sectors. The production technologies were given in equation (1)-(3).

Preferences:

In each period, the representative household consumes an agricultural good and a non-agricultural good. Preferences are summarized by the following utility function⁵:

$$\sum_{t=0}^{\infty} \beta^t [a \ln(c_{at} - \bar{c}) + (1 - a) \ln(c_{nt})], \quad 0 < a < 1, \quad 0 < \beta < 1.$$

Here, c_{at} and c_{nt} are the amounts of agricultural and non-agricultural goods the household consumes in period t , respectively, $\bar{c} > 0$ is the subsistence consumption of the agricultural good. The representative household's consumption allocation problem is

$$\max_{c_{at}, c_{nt}} a \ln(c_{at} - \bar{c}) + (1 - a) \ln(c_{nt})$$

subject to

$$p_{at}c_{at} + p_{nt}c_{nt} = (1 - s_t)y_t^m$$

where s_t is the saving rate, y_t^m is the nominal income, p_{it} is the price of good i , $i = a, n$.

⁵We tried using a more general CES utility function with subsistence. As it turns out, the value of the elasticity of substitution that fits the data best is close to one. For analytical simplification, then, we assume that the elasticity is exactly one.

We show in the appendix that the optimal consumption allocation is given by the following equations:

$$c_{at} = (1 - a)\bar{c} + a \frac{(1 - s_t)y_t^m}{p_{at}}, \quad (4)$$

$$c_{nt} = (1 - a) \frac{(1 - s_t)y_t^m - p_{at}\bar{c}}{p_{nt}}. \quad (5)$$

Exogenous investment rate and investment efficiency:

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

$$I_t = s_t(p_{at}Y_{at} + Y_{nt}).$$

Here s_t is the saving rate, and π_t is a variable that is inversely related to the efficiency of converting the non-agriculture good into the capital good. Both are taken as exogenous.

Frictions in the Labor Market:

There are many institutional and policy constraints that restrict movement of labor from agriculture. Although difficult to measure directly, they generally have the effect of depressing the returns to labor in agriculture relative to those in non-agriculture. Thus, the gap in returns to labor between agriculture and non-agriculture can be used as an implicit measure of the barriers to labor reallocation between the two sectors. We assume that

$$w_{at} = (1 - \mu_t)w_{nst}, \quad (6)$$

$$w_{st} = (1 + \xi_t)w_{nst}. \quad (7)$$

Here, μ_t is a wedge between the wages in the agricultural sector and the non-state non-agricultural sector. The existence of this wedge may be due to barriers to labor mobility between the two sectors. ξ_t is the wage premium that the state sector enjoys over the non-state sector. Let

$$\varphi_{st} = \frac{L_{st}}{L_{nt}}$$

be the state sector's share of non-agricultural labor force, which we assume is an exogenous variable that is set by the government.

The average wage in the non-agricultural sector is, then,

$$w_{nt} = w_{st}\varphi_{st} + w_{nst}(1 - \varphi_{st}) = (1 + \xi_t\varphi_{st})w_{nst},$$

and we have

$$w_{at} = (1 - \mu_t)w_{nst} = \frac{1 - \mu_t}{1 + \xi_t\varphi_{st}}w_{nt},$$

or

$$w_{at} = (1 - \theta_t)w_{nt}$$

where

$$\theta_t = \frac{\mu_t + \xi_t\varphi_{st}}{1 + \xi_t\varphi_{st}}. \quad (8)$$

Note that θ_t , which is the gap in wages between agriculture and non-agriculture, is increasing in μ_t , ξ_t and φ_{st} .

We do not have direct data on the average returns to labor in the agricultural and non-agricultural sectors. However, we do have data on the average value product of labor (or nominal output per worker) for the two sectors. Under the assumption that labor shares of income are the same in the two sectors, the gap in the average value product of labor equals the gap in average returns to labor and therefore can be used as a measure of θ_t .

Figure 3 plots this measure of labor market barriers. Between 1978 and 1984, the gap in average returns to labor between agriculture and non-agriculture declined sharply, from 83 percent to 52 percent. Subsequently, the gap widened, and in 2004 was equal to 68 percent. Figure 2 also plots the three components of the average wage gap: μ_t , the gap in wages between the agriculture and the non-state non-agriculture sector (wage gap 1); ξ_t , the gap in wages between the non-state and the state sector or the state sector's wage premium (wage gap 2); and φ_{st} the size of the state sector measured by the share of the state sector's share of non-agricultural employment (size gap). While the first component behaves very similarly to the overall gap, the second and the third component

declined steadily over time.

[Insert Figure 3 here]

Goods Market Clearing Condition and the Share of Labor Force in Agriculture:

For the agricultural good, the market clearing condition is

$$Y_{at} = L_t c_{at},$$

which implies that

$$l_{at} \equiv \frac{L_{at}}{L_t} = \frac{c_{at}}{y_{at}}.$$

Substituting (4) into the equation above yields the following:

$$l_{at} = (1 - \rho_t) \frac{\bar{c}}{y_{at}} + a \frac{(1 - s_t) y_t^m}{p_{at} y_{at}}. \quad (9)$$

The nominal income y_t^m is a weighted average of income from agriculture and non-agriculture:

$$y_t^m = p_{at} y_{at} l_{at} + p_{nt} y_{nt} (1 - l_{at}),$$

and therefore

$$\frac{y_t^m}{p_{at} y_{at}} = \frac{p_{nt} y_{nt}}{p_{at} y_{at}} + \left(1 - \frac{p_{nt} y_{nt}}{p_{at} y_{at}}\right) l_{at}. \quad (10)$$

Since all production technologies are Cobb-Douglas and have the same labor share α , we have

$$p_{at} y_{at} = \alpha^{-1} w_{at},$$

$$p_{nt} y_{nt} = \alpha^{-1} w_{nt},$$

which imply that

$$\frac{p_{nt} y_{nt}}{p_{at} y_{at}} = \frac{w_{nt}}{w_{at}} = \frac{1}{1 - \theta_t}. \quad (11)$$

Substituting (11) into (10) yields:

$$\frac{y_t^m}{p_{at}y_{at}} = \frac{1}{1-\theta_t} - \frac{\theta_t}{1-\theta_t}l_{at}. \quad (12)$$

Finally, substituting (12) into (9) and solving for l_{at} , we have

$$l_{at} = \frac{(1-a)(1-\theta_t)}{1-\theta_t+a(1-s_t)\theta_t} \frac{\bar{c}}{y_{at}} + \frac{a(1-s_t)}{1-\theta_t+a(1-s_t)\theta_t}. \quad (13)$$

From the production function for agriculture we have

$$y_{at} = A_{at}Z^{1-\alpha}L_{at}^{\alpha-1} = A_{at}(Z/L_t)^{1-\alpha}l_{at}^{\alpha-1}. \quad (14)$$

Substituting it into (13) yields the following:

$$l_{at} = \frac{(1-a)(1-\theta_t)}{1-\theta_t+a(1-s_t)\theta_t} \frac{\bar{c}}{A_{at}(Z/L_t)^{1-\alpha}l_{at}^{\alpha-1}} + \frac{a(1-s_t)}{1-\theta_t+a(1-s_t)\theta_t}. \quad (15)$$

We will use the last equation as a basis for calibration and predicting agriculture's share of total employment.

Thus, our model identifies three potential sources for reallocation of labor from agriculture: (1) increases in agricultural productivity that relax a subsistence food consumption constraint; (2) a reduction in barriers to labor mobility between sectors; and (3) increases in capital formation.

4.1 Capital Allocation in the Non-Agriculture Sector

The barriers to labor mobility not only affect the reallocation of labor across sectors, they also influence the allocation of capital across sectors and therefore growth in non-agriculture and the whole economy. From the labor market condition (7) we have

$$\alpha A_{st}L_{st}^{\alpha-1}K_{st}^{1-\alpha} = (1+\xi_t)\alpha A_{nst}L_{nst}^{\alpha-1}K_{nst}^{1-\alpha},$$

which implies that

$$K_{st} = \frac{\varphi_{st}}{1 - \varphi_{st}} \left((1 + \xi_t) \frac{A_{nst}}{A_{st}} \right)^{\frac{1}{1-\alpha}} K_{nst}.$$

From the market clearing condition $K_t = K_{st} + K_{nst}$, then, we have

$$K_{nst} = \frac{1}{1 + \frac{\varphi_{st}}{1-\varphi_{st}} \left((1 + \xi_t) \frac{A_{nst}}{A_{st}} \right)^{\frac{1}{1-\alpha}}} K_t, \quad (16)$$

$$K_{st} = \frac{\frac{\varphi_{st}}{1-\varphi_{st}} \left((1 + \xi_t) \frac{A_{nst}}{A_{st}} \right)^{\frac{1}{1-\alpha}}}{1 + \frac{\varphi_{st}}{1-\varphi_{st}} \left((1 + \xi_t) \frac{A_{nst}}{A_{st}} \right)^{\frac{1}{1-\alpha}}} K_t. \quad (17)$$

Finally, from the labor market clearing condition we have

$$L_{nst} = (1 - \varphi_{st})L_{nt}, \quad (18)$$

$$L_{st} = \varphi_{st}L_{nt}. \quad (19)$$

Thus,

$$k_{nst} = \frac{1}{\left[1 - \varphi_{st} + \varphi_{st} \left((1 + \xi_t) \frac{A_{nst}}{A_{st}} \right)^{\frac{1}{1-\alpha}} \right]} k_t / l_{nt}, \quad (20)$$

$$k_{st} = \frac{\left((1 + \xi_t) \frac{A_{nst}}{A_{st}} \right)^{\frac{1}{1-\alpha}}}{\left[1 - \varphi_{st} + \varphi_{st} \left((1 + \xi_t) \frac{A_{nst}}{A_{st}} \right)^{\frac{1}{1-\alpha}} \right]} k_t / l_{nt}. \quad (21)$$

When $A_{nst} > A_{st}$, more resources should be allocated to the non-state sector. However, maintaining a large share of employment with a wage premium in the state sector implies that more capital needs to be allocated to the state sector rather than the non-state sector. So, the share of capital that is allocated to the state sector is increasing in both ξ_t and φ_{st} . In other words, distortions in the labor market are supported by distortions in capital allocation.

4.2 TFP in the non-agriculture sector and the aggregate

From (20) and (21), we have

$$y_{nt} = y_{st}\varphi_{st} + y_{nst}(1 - \varphi_{st}) = A_{nt}k_t^{1-\alpha}l_{nt}^{\alpha-1} \quad (22)$$

Here

$$A_{nt} = \frac{(1 + \varphi_{st}\xi_t)}{\left[(1 - \varphi_{st})A_{nst}^{-\frac{1}{1-\alpha}} + \varphi_{st}(1 + \xi_t)^{\frac{1}{1-\alpha}}A_{st}^{-\frac{1}{1-\alpha}} \right]^{1-\alpha}},$$

is the TFP of the non-agricultural sector. Note that when $\xi_t = 0$, the TFP in the non-agricultural sector becomes

$$A_{nt} = \left[(1 - \varphi_{st})A_{nst}^{-\frac{1}{1-\alpha}} + \varphi_{st}A_{nst}^{-\frac{1}{1-\alpha}} \right]^{-(1-\alpha)},$$

which is a weighted geometric average of the two sector's TFPs, with the weights being the employment shares of the two sector. Since the TFP in the state sector has been lower than that in the non-state sector, the larger the share of the state sector's employment, the lower the TFP in the non-agricultural sector. Therefore, a potential source of TFP growth in the non-agricultural sector is the reduction in the state sector's share of employment.

For $\xi_t > 0$, we can rewrite the TFP of the non-agricultural sector as follows:

$$A_{nt} = \frac{1 + \varphi_{st}\xi_t}{\left[1 - \varphi_{st} + \varphi_{st}(1 + \xi_t)^{\frac{1}{1-\alpha}} \right]^{1-\alpha}} \left[\omega_{nst}A_{nst}^{-\frac{1}{1-\alpha}} + \omega_{st}A_{st}^{-\frac{1}{1-\alpha}} \right]^{-(1-\alpha)} \quad (23)$$

where

$$\begin{aligned} \omega_{nst} &= \frac{1 - \varphi_{st}}{1 - \varphi_{st} + \varphi_{st}(1 + \xi_t)^{\frac{1}{1-\alpha}}} < 1 - \varphi_{st}, \\ \omega_{st} &= \frac{\varphi_{st}(1 + \xi_t)^{\frac{1}{1-\alpha}}}{1 - \varphi_{st} + \varphi_{st}(1 + \xi_t)^{\frac{1}{1-\alpha}}} > \varphi_{st}. \end{aligned}$$

Note that, by Jensen's inequality,

$$\left[1 - \varphi_{st} + \varphi_{st}(1 + \xi_t)^{\frac{1}{1-\alpha}}\right]^{1-\alpha} > 1 - \varphi_{st} + \varphi_{st}(1 + \xi_t) = 1 + \varphi_{st}\xi_t,$$

and therefore

$$\frac{1 + \varphi_{st}\xi_t}{\left[1 - \varphi_{st} + \varphi_{st}(1 + \xi_t)^{\frac{1}{1-\alpha}}\right]^{1-\alpha}} < 1. \quad (24)$$

We can see from equation (23) and inequality (24) the impact of the wage premium ξ_t on the TFP in the non-agriculture sector. First, TFP in the non-agricultural sector will still be proportional to a weighted average of the TFPs in the two sectors, but with a higher weight now on the state sector. In addition, the wage premium introduces a further distortion in resource allocation across the two sectors such that the TFP in the non-agricultural sector is smaller than the weighted average of the TFPs in the two sectors. Thus, an added potential source of the TFP growth in the non-agricultural sector is the reduction in the state sector's wage premium.

In summary, the state sector's wage premium ξ_t and the employment share φ_{st} both have negative impacts on non-agricultural TFP if the TFP in the non-state sector is higher than that in the state sector.

As for the aggregate TFP, from (14) and (22), we have

$$\begin{aligned} y_t &= p_a^* y_{at} l_{at} + y_{nt} (1 - l_{at}) \\ &= p_a^* A_{at} z_t^{1-\alpha} l_{at}^\alpha + A_{nt} k_t^{1-\alpha} (1 - l_{at})^\alpha. \end{aligned}$$

Here $z_t = Z/L_t$ is land per capita, A_{nt} is the TFP in the non-agricultural sector, which is given by equation (23), and p_a^* is the relative price of agricultural output in the base year. Following the standard growth accounting exercises, the growth of output per worker in the aggregate is decomposed into two parts: growth in physical capital per worker k_t , and the growth in aggregate TFP. That is

$$y_t = A_t k_t^{1-\alpha}.$$

Thus, the expression for the measured aggregate TFP in our model is given by the following:

$$A_t = p_a^* A_{at} (z_t/k_t)^{1-\alpha} l_{at}^\alpha + A_{nt} (1 - l_{at})^\alpha, \quad (25)$$

where the TFP in the non-agricultural sector is given by equation (23).

Note how various "sectoral" factors contribute to the measured aggregate TFP. First, TFP growth in any of the three sectors, agriculture, non-state non-agriculture and state sector, contributes positively to the aggregate TFP growth. Second, if there is a positive TFP gap between the non-agricultural and agricultural sectors, the reallocation of labor away from agriculture also leads to aggregate TFP growth. Third, reduction in the state sector's share of employment and wage premium also contribute positively to the aggregate TFP growth through two channels: increasing the TFP in the non-agricultural sector and facilitating faster reallocation of labor away from agriculture.

4.3 Calibration of the Model

As we already discussed in the section on TFP, the labor share has been approximately 50 percent in both the aggregate and the non-agriculture sector in China. So we set α to 0.5. There are two more parameters that need to be calibrated, a , and \bar{c} . Our calibration strategy is as follows: We normalize the values of y_{a0} and p_{a0}/p_{n0} at one. y_{at} and p_{at}/p_{nt} are then generated based on the actual growth rates of the two series. The values of θ_t and s_t are taken directly from the data. We choose the value of a and \bar{c} to match the share of the labor force in agriculture in the beginning and ending years of the period, 1978 and 2004. The calibrated values for a and \bar{c} are 0.19 and 0.396, respectively. Figure 4 plots the employment shares of agriculture implied by the calibrated model and their counterparts in the data.

[Insert Figure 4 here]

5 Driving forces of reallocation

Our model identifies three potential sources for reallocation of labor from agriculture: (1) increases in agricultural productivity that relax a subsistence food consumption constraint; (2) a reduction in barriers to labor mobility between sectors; and (3) increases in capital formation. The potential relevance of each of these three sources in the Chinese context is discussed more fully in Brandt, Hsieh and Zhu (2008), and we only discuss the first of these briefly.

In 1977, per capita grain availability in China was slightly more than 190 kg per capita. Piazza (1986), estimates that total per capita nutrient availability was 2,247 calories, 95 percent of which was from cereals and vegetables, and places protein availability at 30.6 grams per day. These figures are 4.1 and 23.4 percent above estimated safe limits of energy and protein intake, with the margin on total energy intake especially low. These nationwide estimates ignore differences in per capita consumption between urban and rural China. They also ignore regional differences. Additional information on the rural-urban diet gap and the size of urban and rural populations implies that rural calorie adequacy in 1977 was 4 percent below safe levels.

With nearly seventy percent of the labor force in agriculture, labor force participation rates just slightly below fifty percent in the late 1970s, and negative net exports, these levels of consumption, clearly indicate the low level of productivity in pre-reform Chinese agriculture. On average, each farm worker produced only enough food to support 2.67 individuals—or even fewer if we convert the population into adult-equivalents. Low farm productivity imposed a low ceiling on the size of China’s non-agricultural labor force and population. Indeed, between 1962 and 1977, the percentage of the Chinese population living in the cities failed to grow, holding steady at slightly more than 17 percent.

We now evaluate the quantitative importance of each these three factors. To do so, we use our calibrated dynamic model to conduct a series of counter-factual exercises, each of which removes one of the factors driving labor reallocation. In each case, the difference between observed labor reallocation and the (smaller) result arising from the corresponding counter-factual trial becomes our measure of that particular factor’s contribution to observed reallocation of labor. Table 4

summarizes the results of these calculations. Figure 5 provides additional detail by tracking the trajectory for the share of labor in agriculture under the alternative scenarios.⁶

[Insert Table 4 and Figure 5 here]

5.1 TFP growth in agriculture

Our historic data show that agriculture's share of total employment fell from 69 percent in 1978 to 32 percent in 2004, a reduction of 37 percentage points. How much of this decline can we attribute to rising agricultural TFP and its role in relaxing a binding subsistence food constraint? Under the assumption of zero TFP growth in agriculture, the farm sector's terminal employment share in 2004 stands at 57 percent, only 12 percentage points below the 1978 figure. We conclude that growth of TFP in agriculture was responsible for a reduction of 25 percentage points in agriculture's overall employment share between 1978 and 2004. This implies that by relaxing a binding food constraint facing the economy, TFP growth in agriculture allowed about a quarter of China's entire labor force to leave the land in search of non-farm employment. This result pinpoints improvements in agricultural productivity as the most important driver of the transfer of labor out of agriculture. Our calculations attribute 68 percent of the historic decline in agriculture's labor force share during 1978-2004 to the growth of TFP in agriculture.

5.2 Reduction in labor market barriers

Our second counter-factual exercise begins with the assumption that barriers to labor mobility remained at their original 1978 level throughout the period of analysis. When we run a version of our model that eliminates the relaxation of restrictions on non-farm employment opportunities for rural workers, the employment share of agriculture in 2004 comes to 40 percent (as opposed to the actual share of 32 percent). This result allows us to attribute roughly 21 percent ($8/37$) of the total

⁶Note that because the different factors contribute to labor reallocation in a non-linear fashion, their contributions are not additive. That is, the combined contribution to the labor reallocation may be higher or lower than the sum of the contributions by individual factors, depending on their interaction of these factors.

reduction in agriculture's employment share to the relaxation of barriers to the mobility of rural labor. As can be seen from Figure 3, most of this contribution occurred fairly early in the reform process.

These barriers limited the ability of rural labor to enter a host of "local" non-agricultural activities, e.g. family-run business, TVEs, etc, as well as restricted movement from village to city and between the state and non-state components of the non-farm sector. In our modeling, we captured these barriers through three components: the wage premium enjoyed by workers in the state sector, the size of the state sector (as measured by its share of non-agricultural employment), and the wage gap between agriculture and the non-state sector.

The results of multiple simulations with our dynamic model show that reduction in the last component of these barriers, the wage gap between farm work and non-farm employment outside the state sector, provided the largest spur to the reallocation between agriculture and non-agriculture. The impact of the other two components on the speed of the transfer of labor out of agriculture is relatively small. This highlights the important role that relaxation on restrictions on household non-agricultural activity, entry by township and village-level firms, etc had in increasing local non-agricultural opportunities for rural labor, as opposed to those that could only be accessed through migration to the cities, and whose growth was impeded by preferential policies favoring state-sector workers.

5.3 Increases in the rate of fixed investment

Like other East Asian economies at comparable development stages, China's ratio of fixed investment to GDP increased significantly between 1978 and 2004. In 1978, the fixed investment rate was a modest 23 percent. By 2004, it has almost doubled to 44 percent. This rise in investment raised the demand for capital goods, which come mostly from the non-agricultural sector (the actual share of imports is surprisingly small). As a result, rising investment rates increased the non-agricultural sector's share of total employment. As before, we can estimate the magnitude of this effect using a version of our dynamic model in which the ratio of investment to GDP is arbitrarily fixed at 23 percent throughout the period 1978-2004. The outcome shows that with no rise in the investment

rate, agriculture's employment share in 2004 would have been modestly higher, namely, 40 percent compared to the 32 percent we observe in the data.

In summary, three factors, TFP growth in agriculture, a reduction in labor market barriers, and the increase in the investment rate have contributed to the reallocation of labor from agriculture to non-agriculture. The TFP growth in agriculture is clearly the most important factor. In absolute terms, its contribution was almost two times larger than that arising from the reduction in barriers, and more than three times larger than the increase in the investment rate.

6 Model Based Growth Accounting

We now turn to the quantification of growth contributions of various factors, including

1. Capital accumulation;
2. TFP growth within each of the three sectors;
3. Inter-sectoral reallocation of labor and capital from low TFP sectors to high TFP sectors.

The first item is a standard source emphasized in all studies of growth accounting. The rest of growth is then attributed to growth in total factor productivity. In the Chinese case, the presence of substantial structural transformation and the large cross-sector differences in TFP demands careful attention to the sources of TFP growth in the aggregate: TFP growth within each of the three sectors and more efficient allocation of labor and capital across sectors, agriculture versus non-agriculture, and state versus non-state. In particular, we will investigate the extent to which reductions in barriers have contributed to more efficient resource allocation across sectors, and therefore to economy-wide increases in aggregate TFP in the economy and in output per worker. As we have emphasized throughout, we must consider two types of barriers: obstacles to reallocation of resources between agriculture and non-agriculture, and also those within non-agriculture, between the state and the non-state sectors.

We estimate the contribution of each prospective source of growth by eliminating its influence from the model and then comparing the resulting outcome with the actual historical series. For example, to investigate how much TFP growth in the agricultural sector contributed to overall growth, we conduct a counter-factual experiment that imposes constant agricultural TFP throughout 1978-2004, and then let our model determine the paths and rates of growth of the aggregate TFP and aggregate labor productivity. We then take the difference between these hypothetical growth rates and the actual rates as our estimates of the contribution of the change in agricultural TFP to overall TFP and labor productivity growth. Table 5 provides the results from these counter-factuals.⁷

[Insert Table 5 here]

6.1 Contributions of Sector TFP growth

6.1.1 TFP growth in agriculture

In agriculture, where land is essentially fixed and the quantity of capital remains modest, the impact of TFP growth on labor productivity in agriculture is enormous: Without it, labor productivity in agriculture would have actually declined at an annual rate of -0.55 percent, compared to the 6.76 percent annual growth that we observe in the data. As we discussed in the last section, TFP growth in farming is also an important driving force for the reallocation of labor out of agriculture. Because of the higher productivity in the non-agriculture sector, the reallocation also contributed indirectly to the growth of the aggregate TFP. The combined contribution of these two effects is a 1.25 percent increase in the growth rates of both the aggregate TFP and aggregate labour productivity.

Given the remarkable 6.18 percent growth rate of the agricultural TFP, its contribution to aggregate growth—including the direct effect through labor productivity growth within agriculture and indirect effect through reallocation of labor—is relatively modest. Assuming no TFP growth in

⁷Again, the contributions of individual factors are not necessarily additive because they may influence the aggregate growth in a non-linear fashion.

agriculture, aggregate labor productivity would have still grown at a robust rate of 5.45, implying that the contribution of TFP growth in agriculture is about 1.25 percentage points, or slightly less than 20 percent of the growth in labor productivity between 1978 and 2004. An important reason for this modest contribution is that agriculture's share of GDP was already below 30 percent in 1978. By 2004, it fell to half of this. As a result, growth in that sector exercised only weak influence on the path of the economy-wide labor productivity.

6.1.2 TFP growth in non-state sector

Employment in the non-state sector grew by nearly 400 million, while its share of total employment jumped from 14.8 percent to 59.3 percent between 1978 and 2004. Despite this rapid increase, labor productivity grew at an impressive 5.7 percent annual rate. Because of the non-state sector's limited access to capital, labor productivity and TFP, which shows annual growth of 4.33 percent during 1978-2004, are closely linked. We conduct two counter-factual exercises to help quantify the importance of TFP growth in the non-state sector to aggregate output growth.

First, suppose that there had been no TFP growth in the non-state sector, but that employment in the sector had experienced the same growth as we observe in the data. In this case, the rapid increase in employment would drive labor productivity growth rates in the non-state sector and the non-agriculture sector to 0.94 percent and 0.03 percent, respectively. Without the TFP growth in the non-state sector, there would have been no TFP growth in the non-agriculture sector (0.024 percent) and a much lower TFP growth rate in the aggregate (1.78 percent). Overall, the aggregate labor productivity growth rate would have been 3.29 percent instead of 6.7 percent, a more than 50% reduction.

Alternatively, Figure 1 shows that at the beginning of the reform, the level of TFP in the non-state sector was slightly lower than that in the state sector. Without the TFP growth in the non-state sector, an efficiency-enhancing growth path would channel all workers moving out of agriculture into the state sector. This would have reduced the non-agricultural sector's labor productivity growth rate to only 1.44 percent, and aggregate labor productivity growth to 4.31 percent. In other words, without a non-state sector with rapidly rising TFP to absorb the growth

of non-agricultural employment, the annual growth of aggregate labor productivity in the economy would have been cut by 2.4 percentage points, or slightly less than a third.

6.1.3 TFP growth in the state sector

Consistent with extensive empirical work on the experience in industry (Jefferson and Rawski, 1999; Groves et. al. 1994), we find only modest growth of TFP in the state sector. Although it is significantly lower than that in the non-state sector, this growth in TFP is moderately important. If TFP in the state sector had not grown, the drag of the state sector on overall growth would have been even larger as state enterprises would have absorbed an even larger portion of China's capital formation in order to maintain its employment and wage premiums. Overall, stagnation of state-sector TFP would have reduced the non-agricultural TFP growth rate to 2.34 percent and the aggregate TFP growth rate to 3.26 percent. The labor productivity in the non-agriculture sector and the aggregate would have been 3.50 percent and 5.95 percent, respectively.

6.2 Capital accumulation and increases in the rate of fixed investment

As a result of the reallocation of labor from agriculture to non-agriculture and general increases in total employment, output in the non-agricultural sector grew rapidly. Although the investment rate has generally moved upward, capital accumulation did not catch up with the rapid employment growth in the non-agricultural sector until the last 10 years or so. Before 1995, the capital-labor ratio in the non-farm sector actually remained below its 1978 level, as non-farm employment grew faster than the corresponding capital stock. As a result, capital accumulation played a relatively minor role in the first 16 years. The last decade, however, the rate of investment increased dramatically, which lead to a doubling in the capital-labor ratio in the non-agricultural sector.

To quantify the impact of this increase in the capital-labor ratio arising from an increase in the rate of investment, we conduct a counter-factual experiment that assumes that investment remained at 23 percent of GDP throughout the 26-year period. The reduction in the investment rate would have no effect on the TFP in the non-agriculture sector and virtually zero effect on the TFP in the aggregate. The aggregate labor productivity growth rate, however, would have been

reduced to 5.55 percent.

6.3 Reallocation

6.3.1 Reallocation of labor from agriculture to non-agriculture

As we have seen, three factors influenced the reallocation of labor from agriculture: TFP growth in agriculture, a reduction in labor market barriers and distortions, and increases in the investment. In addition to promoting labor reallocation, each of these factors also has a direct effect on growth. To isolate the pure impact of labor reallocation from agriculture to non-agriculture, we conduct a counter-factual exercise in which we simply force the share of employment in agriculture to remain at the 1978 level. In this case, none of the growth would have been due to the reallocation between agriculture and non-agriculture.

In this counter-factual exercise, the growth rate of agricultural labor productivity falls to 5.27 percent compared to 6.76 percent, leaving agriculture to absorb more labor under conditions of sharply diminishing returns (i.e. adding more workers to the farm sector depresses labor productivity). The absence of labor inflows from the farm sector would actually increase the growth rate of labor productivity in the non-agricultural sector from 4.37 percent to 6.01 percent. There is a third effect related to the elimination of labor reallocation: economy-wide average labor productivity is now lower because a larger percentage of employment is allocated to the sector with lower productivity.

Taking all these three effects into account, eliminating the transfer of labor across sectors would reduce the annual growth rate of aggregate labor productivity from 6.70 percent to 5.81 percent, a modest reduction of 0.89 percentage points per year. So, this experiment with our dynamic model shows that the reallocation of labor from agriculture to non-agriculture had three impacts on growth: higher labor productivity growth in agriculture, lower labor productivity growth in non-agriculture, and more efficient labor allocation across sectors. Overall, they translate into a very modest increase of 0.89 percentage points in the growth rate of aggregate labor productivity. The impact on the aggregate TFP growth is slight larger, a one percentage point reduction, from 3.75 percent to 2.75 percent. Most of the gains from the reallocation came from the earlier period,

between 1978 and 1991.

Comparison of the model-based accounting with a simple decomposition.

Other authors have used a simple decomposition to quantify the contribution of the labor reallocation. The decomposition begins by noting that aggregate labor productivity can be expressed as the weighted average of productivities in the two sectors:

$$y_t = y_{at}l_{at} + y_{nt}(1 - l_{at}).$$

The aggregate labor productivity growth, then, can be expressed as follows:

$$d \ln y_t = \frac{y_{at}l_{at}}{y_t} d \ln y_{at} + \frac{y_{nt}(1 - l_{at})}{Y_t} d \ln y_{nt} - \frac{y_{nt} - y_{at}}{y_t} dl_{at}.$$

That is, the aggregate labor productivity growth can be decomposed into three sources: labor productivity growth in both sectors and labor reallocation. Without labor movement between the two sectors (i.e. $dl_{at} = 0$), the growth rate of aggregate labor productivity simply equals the weighted average of the growth rates of labor productivities in the two sectors, with the weights being the GDP shares of the two sectors, respectively. Any extra growth beyond this average, then, has to be related to the labor reallocation.

Table 6 uses this popular approach to decompose aggregate labor productivity growth into these three components.⁸ For the entire period, growth in output per worker in agriculture and non-agriculture contributed 27 and 49 percent, respectively to total labor productivity growth. These estimates imply that about a quarter of the growth in labor productivity can be attributed to the reallocation of labor from agriculture to non-agriculture. Decompositions for the two sub-periods, 1978-1991, and 1991-2004, reveal that the contribution of labor reallocation from agriculture to non-agriculture to overall growth occurred mainly near the start of China's reform process. During

⁸See, for example, OECD (2005), pg. 32, which performs similar calculations in the context of three-sector model for period 1983-2003. They find that a fifth or so of the overall growth was due to sectoral reallocations of labor, and suggest the contribution could have been even larger in light of differences in the marginal (as opposed to average) products of labor. See also Bosworth and Collins (2008).

the first period, the transfer of labor to the higher productivity non-agricultural sector was the source of 47 percent of all growth. This behavior is in line with the timing of the reduction in agriculture’s share of employment, a significant portion of which occurs very early in the reforms. By comparison, reallocation only contributed 12 percent to the growth since 1991.

[Insert Table 6 here]

These simple decompositions tell us that reallocation across sectors is positively associated with growth, but the estimated magnitude of the reallocation effect resulting from this analysis is likely to be biased. There are two primary reasons for believing that this is the case.⁹ First, the reallocation of labor may be a result of the growth in TFP in the two sectors. If that is the case, the decomposition may overestimate the role of the reallocation and underestimate the role of labor productivity growth within sectors.¹⁰ And second, labor productivity growth within each of the two sectors will depend on labor reallocation. Because of diminishing returns, all else equal, the gap in productivities between the two sectors will narrow as labor is reallocated from agriculture to non-agriculture. Simple decompositions ignore all these potentially important considerations surrounding inter-sectoral productivity and labor flows.¹¹ They provide no more than an upper bound for the actual contribution of labor reallocation out of agriculture to overall growth during China’s reform period.

The contribution of labor reallocation to growth obtained from counter-factual simulations based on our dynamic three-sector model is significantly less than the estimate from the “naive” simple

⁹There is also a third potential bias. The decompositions implicitly assume that the “gaps” in average and marginal productivities of labor between sectors are the same. The returns to reallocation depend on differences in marginal productivity however the decompositions are based on information on averages. If the underlying production technology is Cobb-Douglas and labor shares in the two sectors are the same, the ratio of average and marginal productivity between sectors will be the same, but this does not hold true for other functional forms. It is an empirical matter as to how sensitive the returns to reallocation are to alternative assumptions about the underlying technology. Based on sensitivity analysis we carried out, this is not an important consideration here.

¹⁰This bias generally exists in standard growth accounting in which the contribution of capital accumulation is overestimated, and that of TFP is underestimated.

¹¹The problems of using these simple decomposition methods are also revealed in trying to estimate the returns to reallocation of labor between the state and non-state non-agricultural sector. At the beginning of reform, average labor productivity in the state sector was actually higher than that in the non-state. This would imply negative returns to the reallocation. However, differences in TFP between the two sectors offset this.

decomposition. For the period between 1978 to 2004, the contribution of the reallocation is only 13 percent compared to the 24 percent estimate using the simple decomposition method. The difference is even larger for the first sub-period, when nearly half of the reallocation occurred. Our model-based accounting suggests that the contribution of labor reallocation to overall labor productivity growth is only 1.13 percentage points, while the simple decomposition implies a contribution that is two times as large, 2.38 percentage points. These differences point to the shortcomings of the simple decomposition method.

6.3.2 Reallocation of Labor from State to Non-state Sector

To quantify the contribution of the second structural transformation, i.e. the reallocation of labor from state to non-state sector, we do a counter-factual simulation that is similar to the one we described above. Instead of keeping agriculture's employment share constant, we let the state sector's share of non-agricultural employment remain at its 1978 level. Under this scenario, growth of aggregate labor productivity falls to 5.12 percent a year, or 1.58 percentage points lower than the 6.70 percent growth rate observed in the data. The contribution of this reallocation is smaller in the first sub-period than the second sub-period. The contribution to overall growth of reallocation of labor from state to non-state is 0.91 percentage points between 1978 and 1991, but 2.27 percentage points between 1991 and 2004. This is not surprising given that most of the reallocation of labor from the state to the non-state sector occurred in the second sub-period.

In summary, while the reallocation of resources from the state to non-state sector has contributed significantly to the overall growth in China, there is still significant gains from further reallocation of resources from the state sector, especially the re-direction of investment from the state to non-state sector. Perhaps this should be the focus of China's growth rebalancing strategy rather than shift from investment to consumption that has been emphasized by many.

6.4 Robustness

So far we have focused our discussions of the model-based accounting using the benchmark data set. Most of the results do not change much when we conduct the exercises using alternative date sets.

Most important, it remains true that the TFP growth in the non-state sector and the reallocation of labor from the state to the non-state are the two largest contributors to aggregate TFP and labor productivity growth. Table 7 presents the main results using all five data sets.

6.5 Implications for China's Future Growth Path

Despite the significant reduction in the state sector's share of employment and the substantial gains to the economy from the reallocation, the state sector continues to be a drag on the overall growth in the economy. Figure 6 plots the returns to capital in the state and the non-state sector and the capital-labor ratios for the two sectors, respectively. Note the enormous gap in the returns to capital between the two sectors that persists through 2004. Yet, the capital-labor ratio in the state sector has increased much faster than that in the non-state sector. This rise in the capital to labor ratio is a result of the government's policy of continuing to support the state sector in spite of the widening gap in TFP levels between the state and the non-state sector. While the investment rate in China is high, a significant portion of the investment is in the less efficient state sector where the return to capital is close to zero. Even as late as 2004, nearly 60 percent of fixed investment was going to the state sector. At the same time, too little investment has gone to the non-state sector where the returns to capital are more than 50%.

Likely underlying these patterns are distortions in the financial markets, and the difficulty that all but the largest of non-state firms typically face in terms of obtaining credit from the formal sector (see Brandt and Zhu, 2007). The combination of high returns to the investment by non-state firms, and borrowing constraints may also help explain the rapid growth of business savings, which represents the most rapidly growing component of China's aggregate savings (Kuijss, 2005). This suggests that reform of China's financial sector, and easing of financing constraints facing non-state reforms could play an important role in helping to rebalance China's economy.

[Insert Figure 6 here]

7 Conclusion

Our purpose in this paper has been to try to reconcile a number of competing perspectives on China's growth process and the contribution of TFP. Our starting point are two important institutional features of China's economy that have been present to various degrees the last thirty years: restrictions on the mobility of labor out of agriculture, and biases in favor of China's non-agricultural state sector. In principle, relaxation of these constraints and the reallocation of labor and other resources into higher-valued activity can be an important source of growth in both TFP and labor productivity. We construct a dynamic three-sector model that allows us to assess not only contributions of capital accumulation and sector TFP to aggregate growth, but also the role of the reallocation of resources across these sectors to China's overall growth. In our analysis, we have also been especially sensitive to data issues.

Capital accumulation plays an important role, but over the entire period TFP contributes nearly half to labor productivity growth. Especially important to the TFP growth are the reallocation of labor and other resources out of the state sector and into the non-state sector, and the rapid growth of TFP in the non-state non-agriculture sector itself. Our analysis helps to corroborate the view that rapidly rising productivity growth in the non-agriculture sector has been a key driver of China's economic success, and suggests the need in future analysis to get inside the black box and identify the sources of this growth.

While institutional constraints on resource mobility have weakened significantly, our analysis also highlights the continued drag of the state sector. Even as late as 2007, more than half of all resources for investment went to the state sector. Analysis at the aggregate level misses this stark contrast in behavior between the state and non-state sectors, and the role of the dynamism in the non-state sector in absorbing nearly 400 million workers. Significant gains exist from further reallocation of resources from the state sector, especially the re-direction of investment from the state to non-state sector. Perhaps this should be the focus of China's growth rebalancing strategy rather than a shift from investment to consumption as emphasized by many.

8 Appendix: Comparison with Alwyn Young

Alwyn Young's estimates of output growth and TFP in the non-primary sector are often cited as an important benchmark in the assessment of Chinese data. Our purpose here is to compare our estimates with those Young provides for the period between 1978 and 1998 and to identify the underlying reasons for the differences. We do this in Table 8. We focus on four key components: nominal GDP estimates, deflators, employment, and the capital stock.

First, our estimates of nominal GDP growth are slightly higher than Young's (15.74 versus 15.37) reflecting the effect of the 2006 NBS revision to GDP estimates. Most of the revision occurred in the tertiary sector. These revised estimates were not available to Young. Second, as discussed in the text, we construct an alternative deflator for the tertiary sector to reflect the growing role of businesses services, and the differences in the rate of inflation in business services compared to consumer services. Our alternative deflator for the tertiary sector shows 2.5 percent less inflation per year. These two revisions lead to an upward revision in the rate of real GDP growth in the non-primary sector from 8.1 to 9.5 percent annum, of which 0.4 percentage points is due to the upward revision of nominal GDP estimates, and 1.0 percentage points is due to the use of alternative deflator for the tertiary sector. All else equal, they also result in an upward revision of TFP of 1.4 percentage points.

The upward revision in the rate of growth in real output in the non-primary sector is partially offset by our revisions to the employment data, and differences in the employment series used. Young extends an older employment series to cover the period between 1990 and 1998 rather than combine the pre-1990 un-revised labor series with the revised series for the post-1998 period. We combined the revised series after 1990, with our own revision to the pre-1990 data. We also construct our own estimate of the share of the labor force in the primary sector, which results in a more rapid exodus of labor out of agriculture, and more rapid growth of employment in the non-primary sector. Young's employment estimate shows growth of 4.5 percent annum between 1978 and 1998, compared to 5.6 per annum growth in our estimates. This reduces the gap in the two estimates of output per worker: 3.6 by Young, versus our estimate of 3.93.

Finally, there are small differences in the estimates of the rate of capital accumulation that reflect differences in construction, and fixed investment deflators. First, Young uses estimates of the breakdown in capital formation between the primary and non-primary sectors at the provincial level to construct national-level estimates of the nominal capital stock in the non-primary sector. A careful examination of these data makes them suspect in numerous provinces, and we selected to construct estimates on the basis of national-level fixed investment data disaggregated by sector and ownership. Second, there may be differences in the starting values used for the capital stock in 1978, which could also affect the rate of growth. In nominal terms, Young's capital stock grows at 16.6 percent per annum compared to our estimate of 16.1. Third, there are small differences in the deflators. We have tried to use identical methods, but modest differences emerge on the order of 0.6 percent per year. One potential source of the difference is the data on building costs for structures: Young uses building costs for the state sector, while we use costs for both the state and non-state. Young's estimate of the capital stock grows at 7.7 percent per annum, compared to our estimate of 6.6 percent.

To summarize, our estimate of GDP per worker grows at an annual rate of 3.93 percent compared to Young's 3.6 percent. Ignoring the role of human capital, and assuming a share of capital of 0.50, our estimates imply a rate of growth of TFP in the non-primary sector of 3.4 percent per annum compared to Young's estimate of 2.0 percent. Adjustments for human capital will lower this by between 0.5 and 1.0 percent per year.

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Figure 1. State Sector's Share of Fixed Investment in Non-agriculture
% of Total Fixed Investment

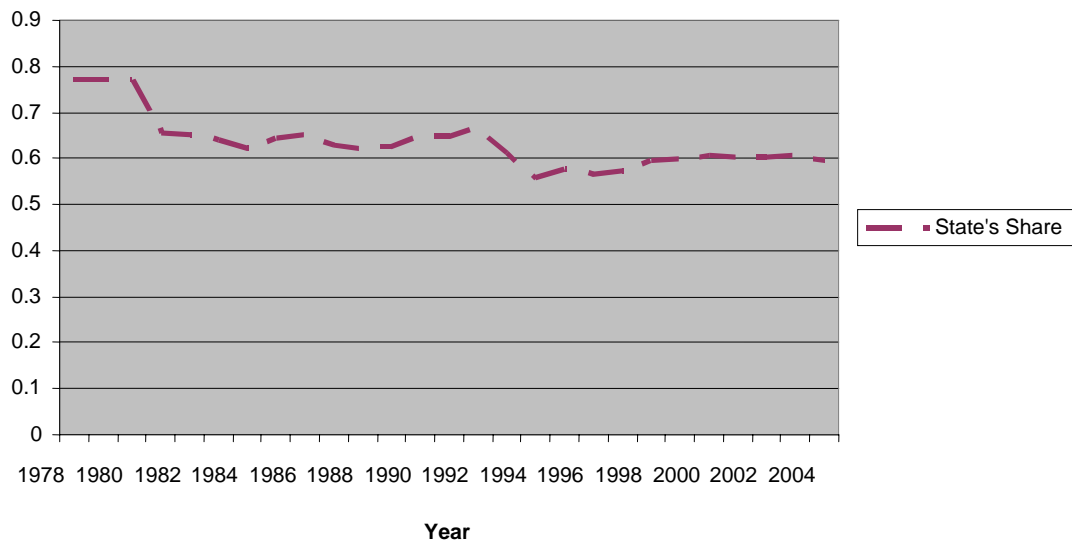


Figure 2. Total Factor Productivities

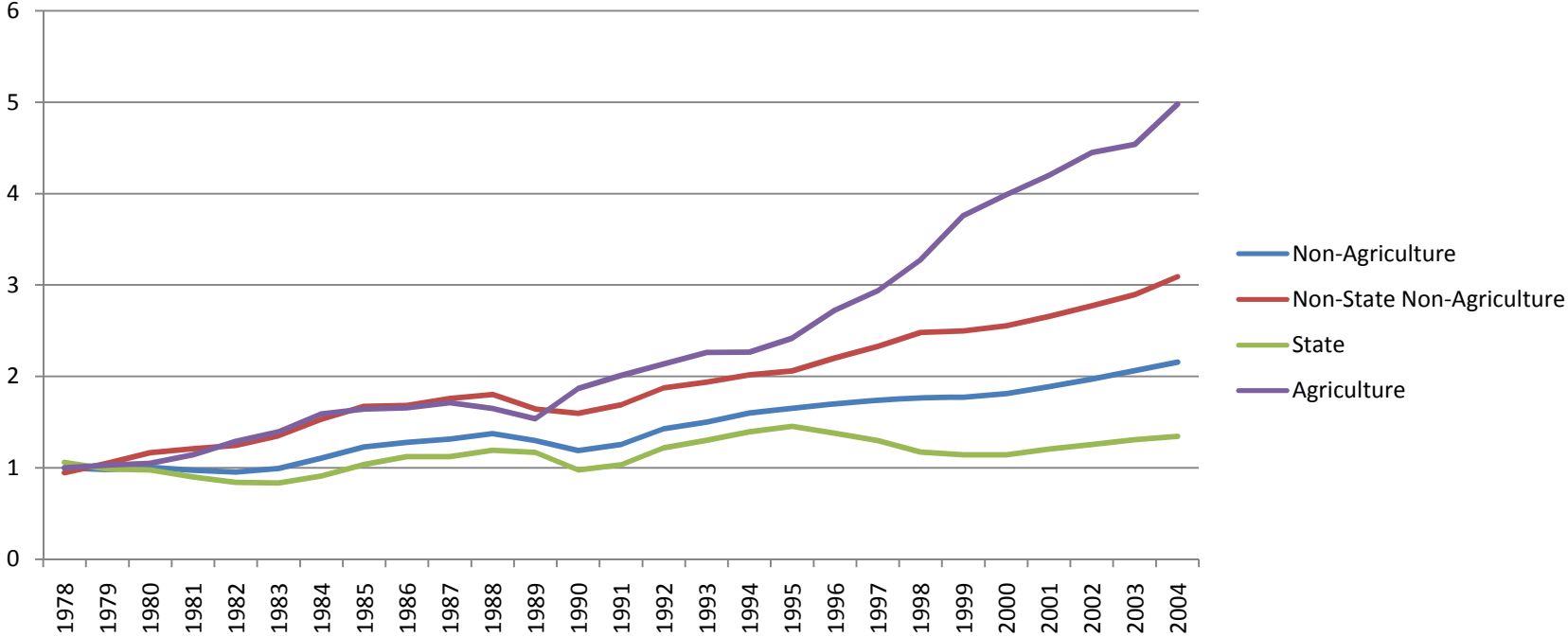


Figure 3. Labor Market Barriers

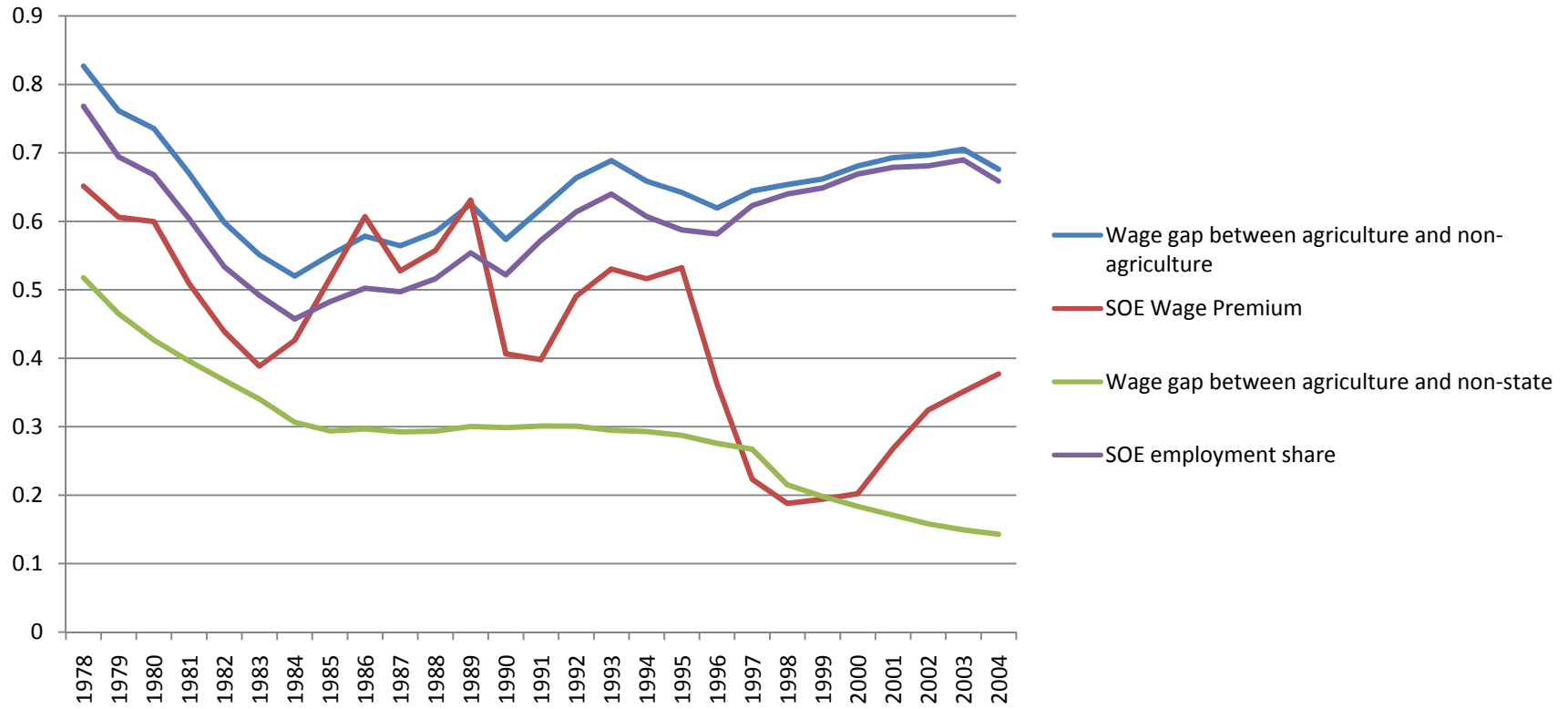


Figure 4. Employment Share of Agriculture

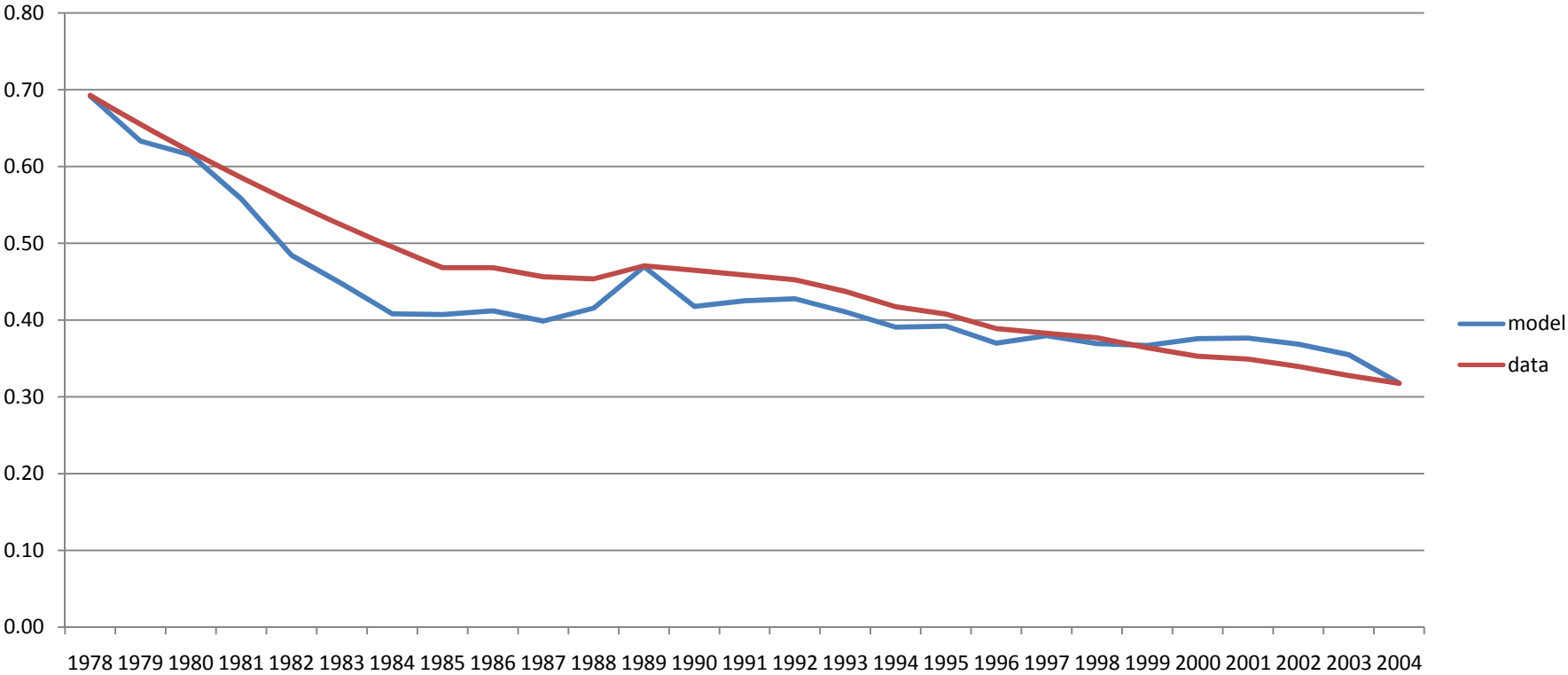


Figure 5. Agriculture's Share of Employment

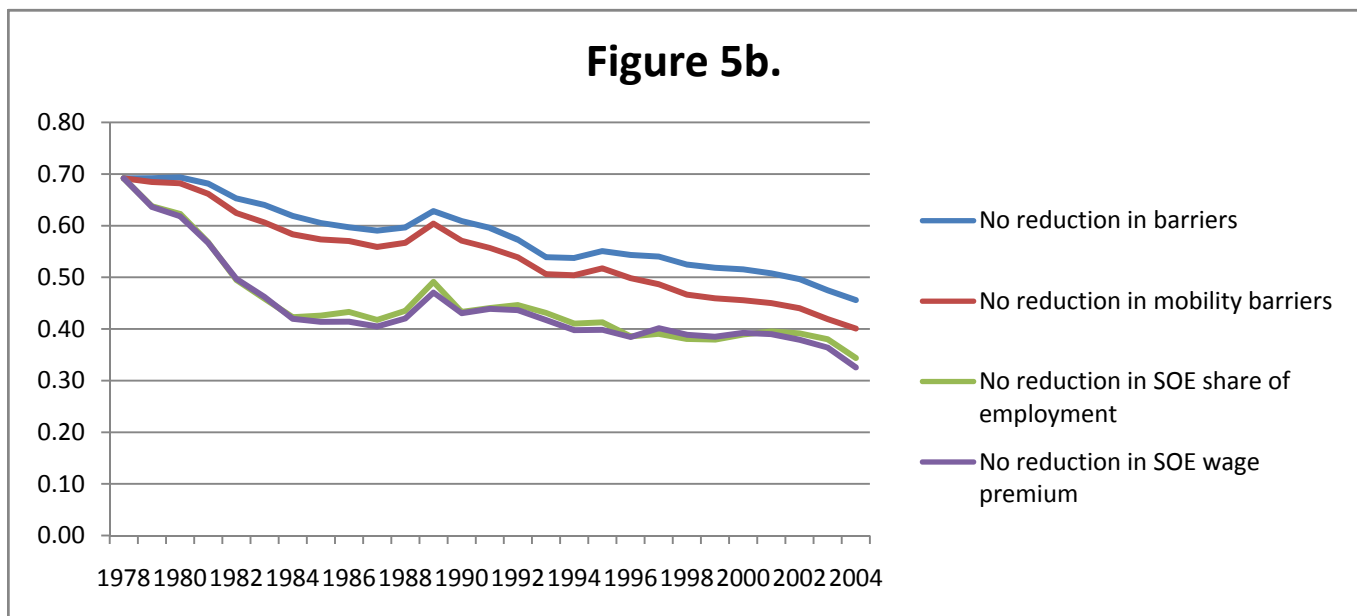
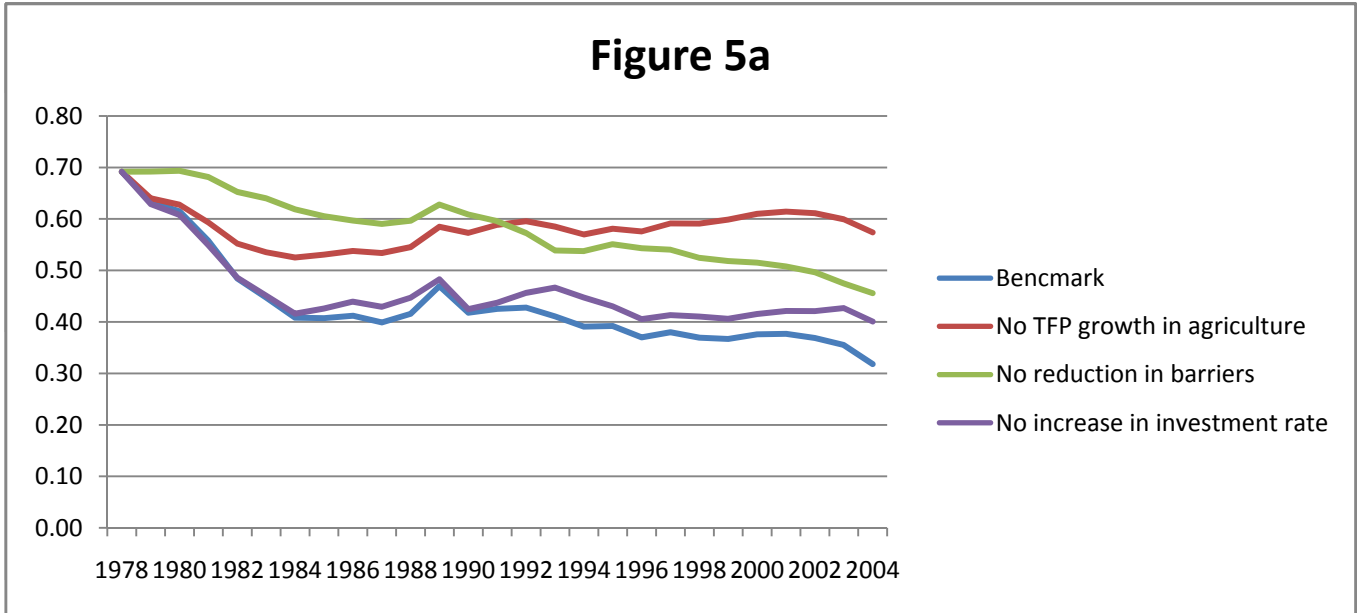


Figure 6

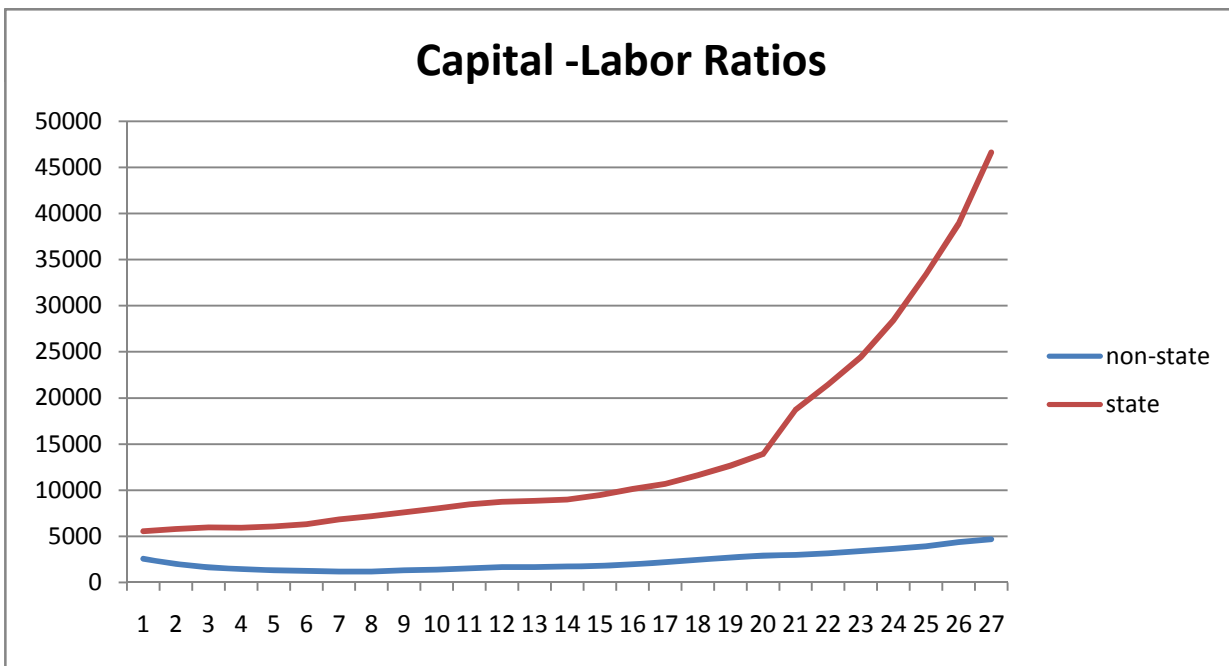
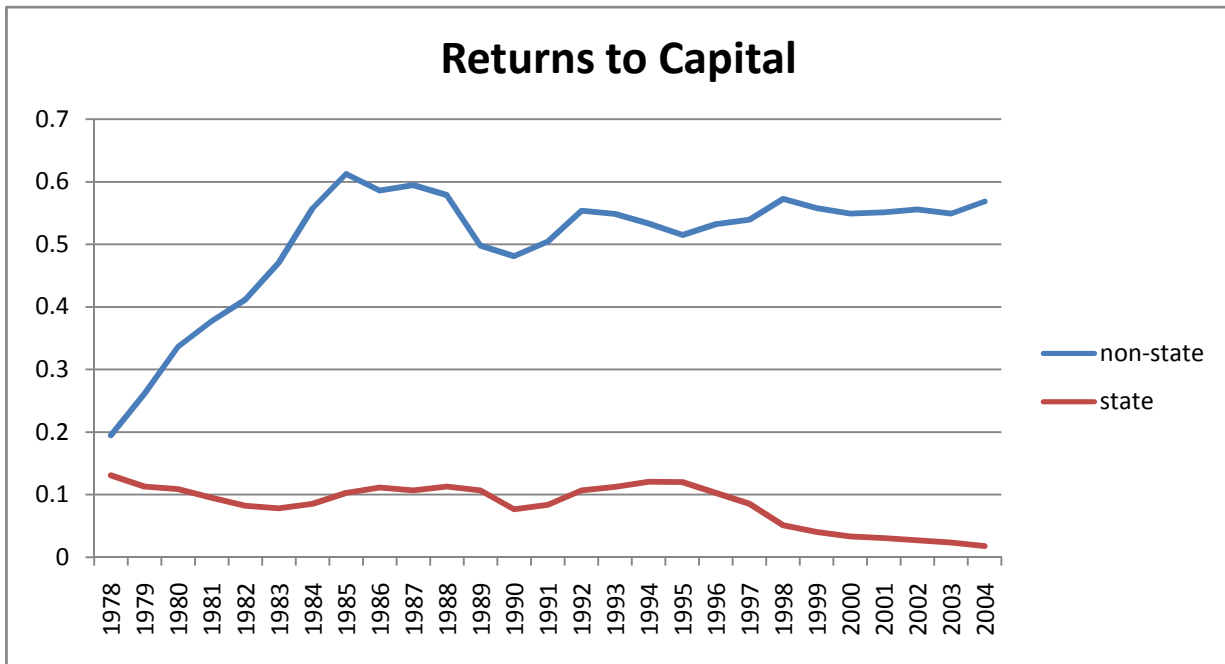


Table 1: Alternative Data Series

	Alt 1 Benchmark	Alt 2 Official	Alt 3
GDP Deflators	Revised	Official	Revised
Capital Stock Deflators	Revised	Official	Revised
Total Employment	Revised	Official	Revised
Employment Share in Primary	Revised	Official	Revised
Relative Labor Productivity	Series 1	Series 1	Series 2

Table 2. Simple Growth Accounting

Growth Accounting at the Aggregate Level				Growth Accounting by sector									
Alternative 1. Benchmark: revised deflator, revised total and primary employment				Benchmark									
	1978-2004	1978-1991	1991-2004		1978-2004	1978-1991	1991-2004	1978-2004	1978-1991	1991-2004	1978-2004	1978-1991	1991-2004
Output per worker	7.07	5.10	9.05	Output per worker	4.79	1.57	8.01	5.70	2.93	8.48	5.00	1.65	8.36
capital per worker	3.37	1.99	4.75	capital per worker	1.83	-0.19	3.86	1.16	-1.52	3.83	4.09	1.85	6.33
TFP	3.70	3.11	4.30	TFP	2.95	1.76	4.15	4.54	4.45	4.64	0.91	-0.20	2.03
Alternative 2. Official: official deflator, official primary employment and official total employment													
	1978-2004	1978-1991	1991-2004		1978-2004	1978-1991	1991-2004	1978-2004	1978-1991	1991-2004	1978-2004	1978-1991	1991-2004
Output per worker	7.14	5.13	9.14	Output per worker	5.83	3.73	7.92	6.89	5.23	8.55	6.19	3.95	8.44
capital per worker	4.11	2.68	5.54	capital per worker	2.98	1.48	4.48	1.90	-0.21	4.01	5.12	3.12	7.13
TFP	3.03	2.46	3.60	TFP	2.85	2.26	3.44	5.00	5.44	4.55	1.07	0.83	1.31
Alternative 3: benchmark data, but with alternative relative wages													
	1978-2004	1978-1991	1991-2004		1978-2004	1978-1991	1991-2004						
Output per worker	7.07	5.10	9.05	Output per worker	4.79	1.57	8.01	7.05	4.78	9.32	5.03	1.99	8.07
capital per worker	3.37	1.99	4.75	capital per worker	1.83	-0.19	3.86	1.16	-1.52	3.83	4.09	1.85	6.33
TFP	3.70	3.11	4.30	TFP	2.95	1.76	4.15	5.89	6.30	5.49	0.94	0.14	1.74

Table 3: Comparison of Growth Accounting Exercises in the Literature

	Period	Annual Growth Rate			Contribution to Y/L			Contribution to Y/L in Percent		
		GDP	L	Human Capital Adjusted Labor	Y/L	K	Education	TFP	TFP	TFP and Education
Bosworth and Collins (2008)	1978-2004	9.3	2.0		7.3	3.2	0.3	3.6	49.3	53.4
	1978-1993	8.9	2.5		6.4	2.4	0.4	3.5	54.7	60.9
	1993-2004	9.7	1.2		8.5	4.2	0.3	3.9	45.9	49.4
Perkins and Rawski (2008)	1978-2005	9.5	1.9	2.7	7.6	4.7	0.4	3.4	45.2	50.6
Zheng and Bigsten (2006)	1978-1993	9.9	2.5		7.4	3.1		4.3	58.6	58.6
	1993-2004	9.9	1.1		8.9	5.6		3.3	36.9	36.9
Brandt and Zhu (2009)	1978-2004	9.2	2.1		7.1	3.4		3.7	52.1	47.9
	1978-1991				5.1	2.0		3.1	61.0	
	1991-2004				9.1	4.8		4.3	47.5	

Note: In Brandt and Zhu, TFP is TFP plus human capital.

Table 4. Reduction in agriculture's share of employment

Source	1978-2004	1978-1991	1991-2004
TFP growth in agriculture	25	17	10
Reduction in barriers	13	17	-3
Increase in investment rate	8	2	7

Table 5. Model-based growth accounting: Results from counter-factual simulations

1978-2004	Change in agriculture's employment share	Labor Productivity Growth					TFP growth
		agriculture	NSOEs	SOEs	non-agriculture	aggregate	
Benchmark Model							
Counterfactuals:	-0.37	6.76	5.29	4.59	4.37	6.70	3.76
No TFP growth in agriculture							
No reduction in barriers	-0.12	-0.55	6.20	5.50	5.28	5.45	2.50
No reduction in ag-nonstate barriers	-0.24	6.07	2.14	2.14	2.14	4.36	2.61
No reduction in state employment share	-0.29	6.31	5.19	4.49	4.28	6.26	3.66
No reduction in state wage premium	-0.35	6.61	3.02	2.33	2.59	5.12	2.77
No TFP growth in NSOEs	-0.37	6.72	4.57	4.57	3.79	6.17	3.50
No TFP growth in SOEs	-0.37	6.76	0.94	0.24	0.03	3.29	1.75
No reallocation btw ag and non-ag	-0.37	6.76	4.41	3.71	3.50	5.95	3.26
No increase in saving rate	0.00	5.27	6.92	6.22	6.01	5.81	2.76
	-0.29	6.31	4.32	3.63	3.41	5.55	3.82

1978-1991

1978-1991	Change in agriculture's employment share	Labor Productivity Growth					TFP growth
		agriculture	NSOEs	SOEs	non-agriculture	aggregate	
Benchmark Model							
Counterfactuals:	-0.27	5.96	2.44	1.16	1.07	5.00	3.29
No TFP growth in agriculture							
No reduction in barriers	-0.10	-0.67	3.80	2.52	2.44	3.31	1.52
No reduction in ag-nonstate barriers	-0.10	4.66	0.21	0.21	0.21	2.66	2.11
No reduction in state employment share	-0.13	4.92	2.74	1.46	1.37	3.92	2.90
No reduction in state wage premium	-0.25	5.82	0.89	-0.40	0.09	4.09	2.73
No TFP growth in NSOEs	-0.25	5.83	1.46	1.46	0.60	4.51	2.93
No TFP growth in SOEs	-0.27	5.96	-0.31	-1.60	-1.68	2.87	1.94
No reallocation btw ag and non-ag	-0.27	5.96	2.67	1.39	1.31	5.20	3.38
No increase in saving rate	0.00	4.08	5.15	3.87	3.79	3.87	1.84
	-0.25	5.85	1.90	0.61	0.53	4.46	3.37

1991-2004

1991-2004	Change in agriculture's employment share	Labor Productivity Growth					TFP growth
		agriculture	NSOEs	SOEs	non-agriculture	aggregate	
Benchmark Model							
Counterfactuals:	-0.11	7.56	8.14	8.02	7.67	8.40	4.22
No TFP growth in agriculture							
No reduction in barriers	-0.01	-0.44	8.59	8.48	8.13	7.60	3.49
No reduction in ag-nonstate barriers	-0.14	7.48	4.07	4.07	4.07	6.07	3.11
No reduction in state employment share	-0.16	7.71	7.65	7.53	7.18	8.60	4.41
No reduction in state wage premium	-0.10	7.40	5.16	5.05	5.09	6.14	2.80
No TFP growth in NSOEs	-0.11	7.60	7.68	7.68	6.98	7.84	4.07
No TFP growth in SOEs	-0.11	7.56	2.19	2.08	1.73	3.70	1.56
No reallocation btw ag and non-ag	-0.11	7.56	6.15	6.03	5.68	6.71	3.14
No increase in saving rate	0.00	6.45	8.69	8.58	8.23	7.75	3.68
	-0.04	6.78	6.75	6.64	6.29	6.63	4.26

Table 6. Simple Growth Decomposition

	1978-2004	1978-1991	1991-2004
aggregate	7.07	5.10	9.05
agriculture	1.90	1.59	1.57
non-agriculture	3.44	1.13	6.40
reallocation	1.73	2.38	1.07

Table 7. Counterfactual simulations using alternative data sets

Benchmark Data	Change in Agriculture's					
	Employment Share			Growth Rate		
	1978-2004	1978-1991	1991-2004	1978-2004	1978-1991	1991-2004
Calibrated Model	-0.37	-0.27	-0.11	6.70	5.00	8.40
Counter-Factuals						
No TFP growth in agriculture	-0.12	-0.10	-0.01	5.45	3.31	7.60
No Reduction in Barriers	-0.24	-0.10	-0.14	4.36	2.66	6.07
No Reduction in mobility barriers	-0.29	-0.13	-0.16	6.26	3.92	8.60
No Reduction in SOE's employment share	-0.35	-0.25	-0.10	5.12	4.09	6.14
No Reduction in SOE's wage premium	-0.37	-0.25	-0.11	6.17	4.51	7.84
No TFP growth in non-state sector	-0.37	-0.27	-0.11	3.29	2.87	3.70
No TFP growth in state sector	-0.37	-0.27	-0.11	5.95	5.20	6.71
No reallocation of labor between agriculture and non-agriculture	0.00	0.00	0.00	5.81	3.87	7.75
No increase in investment rate	-0.29	-0.25	-0.04	5.55	4.46	6.63
Official Data	Change in Agriculture's					
	Employment Share			Growth Rate		
	1978-2004	1978-1991	1991-2004	1978-2004	1978-1991	1991-2004
Calibrated Model	-0.24	-0.14	-0.10	6.74	5.06	8.42
Counter-Factuals						
No TFP growth in agriculture	0.05	0.04	0.01	4.94	2.73	7.15
No Reduction in Barriers	-0.23	-0.08	-0.14	5.05	3.86	6.23
No Reduction in mobility barriers	-0.29	-0.12	-0.16	6.90	4.69	9.12
No Reduction in SOE's employment share	-0.21	-0.13	-0.08	5.30	4.62	5.98
No Reduction in SOE's wage premium	-0.23	-0.13	-0.10	6.22	4.64	7.79
No TFP growth in non-state sector	-0.24	-0.14	-0.10	2.47	2.29	2.65
No TFP growth in state sector	-0.24	-0.14	-0.10	5.61	4.28	6.94
No reallocation of labor between agriculture and non-agriculture	0.00	0.00	0.00	5.66	3.94	7.38
No increase in investment rate	-0.15	-0.13	-0.02	5.30	4.37	6.23
Alternative Data 3	Change in Agriculture's					
	Employment Share			Growth Rate		
	1978-2004	1978-1991	1991-2004	1978-2004	1978-1991	1991-2004
Calibrated Model	-0.37	-0.27	-0.11	6.70	5.00	8.40
Counter-Factuals						
No TFP growth in agriculture	-0.12	-0.10	-0.01	5.45	3.31	7.60
No Reduction in Barriers	-0.24	-0.10	-0.14	4.59	3.16	6.01
No Reduction in mobility barriers	-0.37	-0.19	-0.18	6.56	4.31	8.81
No Reduction in SOE's employment share	-0.33	-0.23	-0.09	5.57	4.71	6.44
No Reduction in SOE's wage premium	-0.34	-0.23	-0.12	5.43	4.06	6.80
No TFP growth in non-state sector	-0.37	-0.27	-0.11	2.16	1.72	2.59
No TFP growth in state sector	-0.37	-0.27	-0.11	5.82	4.89	6.76
No reallocation of labor between agriculture and non-agriculture	0.00	0.00	0.00	5.81	3.87	7.75
No increase in investment rate	-0.29	-0.25	-0.04	5.55	4.46	6.63

Table 8. Comparisons with Alwyn Young

	Young (2000)	BZ(2009)	Explanation for difference
Nominal GDP	15.4	15.7	Revision by NBS in 2006
Nonagr GDP	16.0	16.4	Revision by NBS in 2006
GDP deflators			
Primary	7.9	7.9	Identical
Secondary	6.1	6.1	Identical
Tertiary	10.7	8.2	We constructed new deflator that captures costs of business services. Young uses consumer service deflator
Capital stock deflator	8.9	9.5	Use nearly identical method, however we use unit building costs for all structures, while Young uses for state sector only
Real GDP	7.4	8.7	27 percent of difference due to revised nominal GDP numbers; 73 percent due to revised tertiary sector deflator
Real nonagr	8.1	9.5	
Labor	2.2	2.1	Differences in employment series used
Agr	0.8	-0.2	Differences in emplotment series used and our use of alternative estimate for share of labor in primary sector
Nonagr	4.5	5.6	Same as above
Real GDP per worker	5.2	6.6	
Agr			
Nonagr	3.6	3.9	
Labor shares nonagr			
1978	0.3		
1998	0.5	0.5	
Capital stock			
Nominal	16.6	16.1	Due to differences in construction. Young bases estimates of composition on provincial GFCF data while we construct estimates using sector estimates for state, collective and housing sector for fixed investment; may also be differences in starting values
Real	7.7	6.6	55 percent due to differences in deflator, and 45 percent due to differences in estimate of nominal capital stock
TFP excluding human capital	2.0	3.4	