The Economy of People's Republic of China from 1953*

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Abstract

This paper studies growth and structural transformation of the Chinese economy from 1953 to 2012 through a lens of a two-sector growth model. The main goal of the paper is to provide a systematic analysis of both the pre-1978 reform and post-1978 reform periods in a unified framework. First, we construct a dataset that allows the application of the neoclassical model and computation of wedges, their components, and rates of TFP growth. Second, we determine the key quantitative factors behind growth and structural transformation. The changes in the intersectoral labor wedge play the dominant role in accounting for the change in the share of labor force in agriculture. TFP growth and changes in the intersectoral wedges are the two most significant factors contributing to GDP growth. Further decomposing the effects of reduction in wedges, we find that two components: the production component (the gap between the ratio of the marginal products of labor and relative wages) and the consumption component (the gap between the marginal rate of substitution and the relative prices) play a particularly large role. Third, we use the pre-reform period as a key benchmark to measure the success of the post-1978 reforms. We show that reforms yielded a significant growth and structural transformation differential. GDP growth is 4.2 percentage points higher and the share of the labor force in agriculture is 23.9 percentage points lower compared with the continuation of the pre-1978 policies. We provide extensive historical evidence for the reforms that are consistent with the evolution of the components of the wedges. The decrease in the production component of the intersectoral wedge is consistent with increased competition and demonopolization of the economy. The decrease in the consumption component of the wedge is consistent with the price and housing reforms. Finally, we project the path of the Chinese economy until 2050 and also calculate a lower bound on future growth by projecting pre-reform trends.

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"In 1949 a new stage was reached in the endeavors of successive Chinese elites to meet domestic problems inherited from the Late Imperial era and to respond to the century-old challenge posed by the industrialized West. A central government had now gained full control of the Chinese mainland, thus achieving the national unity so long desired. Moreover, it was committed for the first time to the overall modernization of the nation's polity, economy, and society. The history of the succeeding decades is of the most massive experiment in social engineering the world has ever witnessed." (MacFarquhar and Fairbank 1987, p. xiii)

1 Introduction

We study the Chinese economy from 1953, three years after the founding of the People's Republic of China, through the lens of a two-sector neoclassical growth model.[1] Our main focus is on studying wedges that hinder reallocation of resources across sectors and the changes of these wedges that are important for structural transformation.[2] The main goal of the paper is to provide a systematic analysis of both the pre-1978 reform and the post-reform periods in a unified framework.

Specifically, our model is a two-sector (agricultural and non-agricultural) neoclassical model with wedges building on Cole and Ohanian (2004), Chari, Kehoe, McGrattan (2007) and Cheremukhin, Golosov, Guriev, and Tsyvinski (2013). The intratemporal labor wedge is the cost of intersectoral reallocation of labor. The intratemporal capital wedge is the cost of intersectoral reallocation of capital. The intertemporal capital wedge is the cost of reallocating capital across time. We further decompose the intersectoral labor wedge in three components: the consumption component (the ratio of the relative prices and the marginal rate of substitution), the production component (the ratio of the sectoral marginal products of labor relative to the sectoral wages), and the mobility component (the ratio of the sectoral wages). We similarly decompose the intersectoral capital wedge into its components.

We construct a comprehensive dataset that allows the application of the neoclassical model to the study of the entire 1953-2012 period. We provide consistent data series for sectoral

[1] Our analysis takes as an initial point the year of 1953 — after the Communist Party consolidated power and launched a comprehensive modernization of economy and society. Coincidentally, this is also the start of the systematic collection of detailed economic statistics.

[2] See Acemoglu (2008) and Herrendorf, Rogerson and Valentinyi (2013) for overview of the models of structural transformation. Caselli and Coleman (2001), Fernald and Neiman (2010), Restuccia, Yang and Zhu (2008), and Lagakos and Waugh (2013) are models with sector-specific wedges.

output, capital and labor, wages, deflators, and relative prices as well as defense spending and international trade variables. Using this dataset we then infer the wedges (and other variables such as sectoral TFPs) from the computed first order conditions of the model. Given the wedges, the neoclassical model matches the data exactly. We view the construction of the dataset that can be easily used for computations of the neoclassical model and for inferring the wedges and their components as the first contribution of the paper.

We start our analysis with the pre-1978 reform economy. This period is important to study for several reasons. First, 1953-1978 was one of the largest economic policy experiments and development programs in modern history. It is important to evaluate the overall success or failure of this program as well as successes and failures of the contributing factors and policies. Second, the analysis of the 1953-1978 period is an important benchmark against which the post-1978 growth and the success of the reforms should be measured. The main question here is how the Chinese economy would have developed if the pre-reform policies continued. Thirdly, the successful First Five-Year Plan (FFYP), the Great Leap Forward (GLF), and the post-1962 period of readjustment, recovery, and political turmoil provide a range of interesting policies on their own. On one hand, the model of Chinese development was based on Soviet Industrialization which we studied in Cheremukhin, et al. (2013). On the other hand, the Chinese policies were quite distinct from their Soviet counterparts. We evaluate several of these policies and contrast them with the Soviet experience.

The first part of the analysis is to perform a wedge-accounting exercise for the entire pre-reform period to determine the main factors behind GDP growth and changes in the share of labor force in agriculture. We fix wedges at their initial values (1953) for the whole period of interest (1953-75) and simulate the economy[3]. We then compare the simulated GDP growth and the change in the share of labor force in agriculture with the actual historical path. Consider wedge accounting for 1953-1975. Compared with the counterfactual, the annual growth rate of GDP increased by 5.6 percentage points, and the share of labor in agriculture decreased by 5.9 percentage points. For GDP growth, the two most important factors were the growth of non-agricultural TFP (contributing 1.9 percentage points) and the decrease in the consumption component of the labor wedge (contributing 1.6 percentage points). The rest of the wedges

[3]The analysis for 1953-1978 delivers similar insights and only differs in a larger change in the share of labor in agriculture in 1975-1978.

worsened and contributed negatively to the growth of GDP. Overall, the worsening of wedges resulted in 0.5 percentage points reduction in the annual GDP growth. The change in the share of labor force in agriculture (-5.9 percentage points) is essentially fully determined by the decrease in the consumption component of the labor wedge (contributing -7.8 percentage points). While these are the numbers for the pre-reform period overall, changes in the intersectoral labor wedge played an even more significant role in GDP growth and changes in the share of labor force in agriculture during the Great Leap Forward and the subsequent recovery.

We also contrast the development of the Chinese economy from the beginning of the Great Leap Forward to 1967 with the development of the Soviet economy under Stalin's industrialization. If China followed Soviet industrialization and collectivization policies the results in terms of GDP growth would be comparable to a combination of the Great Leap Forward and the post-1962 retrenchment but the share of labor in agriculture would have been lower under Soviet policies. The quick reversal of the policies under the Great Leap Forward led to a significantly higher labor wedge in China but coincided with the recovery of the losses in agricultural and non-agricultural TFP.

We then study the 1978-2012 period through the lens of our model. We first perform a wedge-accounting exercise for the period of 1978-2012. Compared with the counterfactual of fixed 1978 wedges and no TFP growth, the annual GDP growth rate increased by 9.4 percentage points and the share of labor force in agriculture decreased by 36.9 percentage points. For GDP growth, two most important factors were the growth of non-agricultural TFP (contributing 5.8 percentage points) and the decrease in the intersectoral wedge (contributing 1.1 percentage points). Agricultural TFP contributed 0.8 percentage points. Two components of the labor wedge played the key role – the decrease in the consumption component (contributing 0.5 percentage points) and the production component (contributing 0.7 percentage points). Together these two components account for 1.2 percentage points of the annual GDP growth. The change in the mobility component of the intersectoral labor wedge, the intersectoral capital wedge net of consumption component, and intertemporal capital wedge play a minor role. The change in the share of labor in agriculture is predominantly determined by the decrease in the intersectoral wedges (contributing -21.6 percentage points). Two components play the key role – the consumption component (contributing -10.6 percentage points) and the production component (contributing -16.7 percentage points). These two components play the same role as the

increase in manufacturing TFP (contributing -10.6 percentage points) and agricultural TFP (contributing -12.2 percentage points). The worsening in the mobility component accounted for 6.7 percentage points of the change in the share of labor force in agriculture. We conclude that more than 50 percent of the GDP growth is explained by growth of non-agricultural TFP and 11 percent are explained by the decline in the consumption and the production component of the intersectoral wedges. The key factors behind the change of the share of labor force in agriculture are the reduction in intersectoral wedges and TFP growth in equal measures.

Second, we simulate the continuation of post-GLF (1967-75) trends of the policies for the post-1978 period to provide a benchmark against which to measure the success of the post-1978 reforms. The reforms generate 4.2 additional percentage points of GDP growth. The main factors are the faster growth of non-agricultural TFP (4.4 versus 2.0 percentage points) that generates 3 percentage points of GDP growth and the faster decrease in the intersectoral wedges that generates 1 percentage point of additional GDP growth. The dominant factors in the decrease in the share of labor force in agriculture (-23.9 percentage points) are the decrease in the production component of the labor wedge (contributing -13 percentage points) and the faster manufacturing TFP growth (contributing -6.9 percentage points). We conclude that the reforms yielded significant growth and structural transformation differentials compared with the continuation of the post-GLF trends. In other words, about 3/4 of the growth differential is due to the increased growth of the non-agricultural TFP; 1/4 of the growth differential is due to the faster reduction in the intersectoral wedges. The reduction in the production component of the labor wedge and growth in non-agricultural TFP are also dominant forces behind the change in the share of labor force in agriculture.

We then provide extensive historical evidence consistent with the behavior of the wedges through the lens of model for 1953-2012. Most importantly, we argue that the two reforms are consistent with the changes in the key components of the intersectoral wedges post-1978: price and housing reform (for the consumption component), and increase in competition (for the production component).

Finally, we project the path of the Chinese economy until 2050. Specifically, we extend the 1978-2012 trends of sectoral TFPs and wedges and then simulate the model under the chosen paths of exogenous variables until 2050. We find that China's economy can continue growing at 7-8 percent per year for another 10 to 15 years. The growth of non-agricultural, non-state

TFP plays the main role in projected growth. The reduction in the wedges – reallocation of labor from the state to non-state, non-agricultural sector and the reduction in the production and consumption components of the intersectoral wedges – account for 1.5 percentage points of growth. The growth rate of real GDP slows to around 4.5 percent by 2030 and to 3.6 percent in 2036-2050. Reallocation of labor from state to non-state firms and the decline in the production component of the wedge accounts for 1.2 percent. In other words, as the TFP growth slows, the relative contribution of the policies to reduce wedges in the economy rises from about 20 percent in the first decade of the projection to 30 percent in the third decade. Finally, we calculate a lower bound on the future real GDP growth by projecting the post-GLF trends (1966-1978) forward from 2013. This is a useful exercise as it answers the question of how the economy will perform if the reforms are significantly (and even drastically) slowed down. We find that growth will be slower at 4.5-5 percent in 2012-2036 but the movement of labor from agriculture will stop. The slower growth of the manufacturing TFP and the slower decline in the production component of the intersectoral labor wedge account for the difference between the two projections.

We now briefly discuss the literature on the topic. A body of work by Carsten Holz is the most comprehensive attempt to construct high-quality data for economic analysis of China's economy: Holz (2006) assesses availability and quality of the data and constructs a number of the key data series for the analysis of productivity growth in 1952-2005; Holz (2013a) provides a detailed guide to classification systems and data sources of Chinese statistics; Holz (2003, 2013b) studies the quality of China's output statistics. Despite the importance of the issue, there are no studies of the 1953-1978 period that use modern macroeconomic tools. Ours is the first paper that analyzes this period from the point of view of the neoclassical growth model, and provides a unified treatment of the Chinese economy from 1953 to 2012. We are aware of only one strand of papers dedicated to model-based macroeconomic analysis of the 1953-1978 period by Chow (1985, 1993) and Chow and Li (2002) whose work mainly focuses on data issues. The post-1978 period received more attention from macroeconomists but perhaps less prominence than its importance would suggest. Notable contributions are a collection of papers in a landmark book edited by Brandt and Rawski (2008), an important quantitative analysis of China's post-1978 structural transformation and sectoral growth accounting by Brandt, Hsieh, and Zhu (2008), Brandt and Zhu (2010) and Dekle and Vandenbroucke (2010, 2012), growth

accounting by Young (2003) and Zhu (2012), the model of "growing like China" with the focus on financial frictions by Song, Storesletten, and Zilibotti (2011), a study of misallocation by Hsieh and Klenow (2010), analysis of factor wedges across space and sectors of Brandt, Tombe, and Zhu (2013) and Tombe and Zhu (2015), a model of transformation of the state-owned firms by Hsieh and Song (2015).

It is useful to also compare our post-1978 results with Brandt, Hsieh, and Zhu (2008), Brandt and Zhu (2010) and Dekle and Vandenbroucke (2012) who study structural transformation of China post-1978 reforms. They find that the decrease in the barrier to labor reallocation played a relatively small role in the change in the share of labor force in agriculture. The key difference is that their notion of the barrier captures only a part of the labor wedge (that corresponds to our production and mobility components of the wedge but omits the consumption component). When the reduction in the overall wedge is taken into account, as we do here, the contribution of this factor more than doubles. We further compare our results by extending our model to a three-sector version where we divide the non-agricultural sector into the state- and the non-state sector following Brandt and Zhu (2010). We then decompose the contribution of non-agricultural TFP to the structural transformation in 1978-2012 into the contributions of TFP growth in the state- and non-state sectors, respectively, and the contribution of reallocation from the less productive state sector to the more productive non-state sector. We confirm the findings of Brandt, Hsieh, and Zhu (2008) and Brandt and Zhu (2010) of the importance of growth of non-state TFP in overall TFP growth. We also in passing note that our model with wedges (by construction) matches the data exactly while these papers rely on calibration to match some (but not all) features of the data.

More broadly, our paper is related to such studies of structural transformation as Caselli and Coleman (2001), Kongsamut, Rebelo and Xie (2001), Stokey (2001), Ngai and Pissarides (2007), Acemoglu and Guerreri (2008), Buera and Kaboski (2009, 2012), Herrendorf, Rogerson and Valentinyi (2013). The main difference with this literature is that we find that the changes in the intersectoral labor wedges (and policies associated with them) play an important role in structural transformation. Also notable is a two-sector model of growth accounting with misallocation applied to Singapore by Fernald and Neiman (2010).

2 Model

We consider a two-sector neoclassical model, similar to the one we used to analyze Stalin's industrialization (Cheremukhin et al., 2013). There are two sectors, agricultural (A) and non-agricultural (M).

The preferences are given by:

$$\sum_{t=0}^{\infty} \beta^t \frac{U\left(C_t^A, C_t^M\right)^{1-\rho} - 1}{1-\rho}, \tag{1}$$

where

$$U\left(C_t^A, C_t^M\right) = \left[\eta^{\frac{1}{\sigma}} \left(C_t^A - \gamma^A\right)^{\frac{\sigma-1}{\sigma}} + (1-\eta)^{\frac{1}{\sigma}} \left(C_t^M\right)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}},$$

C_t^A is per capita consumption of agricultural goods, and C_t^M is per capita consumption of non-agricultural goods; $\gamma^A \geq 0$ is the subsistence level of consumption of agricultural goods; η is the long-run share of agricultural expenditure in consumption; $U_{i,t}$ is the marginal utility with respect to consumption of good i in period t. The discount factor is $\beta \in (0,1)$, and σ is the elasticity of substitution between the two consumption goods. Each agent is endowed with one unit of labor services that he supplies inelastically.

Output in sector $i \in \{A, M\}$ is produced using the Cobb-Douglas technology

$$Y_t^i = F_t^i\left(K_t^i, N_t^i\right) = X_t^i \left(K_t^i\right)^{\alpha_{K,i}} \left(N_t^i\right)^{\alpha_{N,i}}, \tag{2}$$

where X_t^i, K_t^i, and N_t^i are, respectively, total factor productivity, capital stock, and labor in sector i. The capital and labor shares $\alpha_{K,i}$ and $\alpha_{N,i}$ satisfy $\alpha_{K,i} + \alpha_{N,i} \leq 1$. Land is available in fixed supply, and its share in production in sector i is $1 - \alpha_{K,i} - \alpha_{N,i}$. We denote by $F_{K,t}^i$ and $F_{N,t}^i$ the derivatives of F_t^i with respect to K_t^i and N_t^i.

Population growth is exogenous. The total population in period t is denoted by N_t. The feasibility constraint for labor is

$$N_t^A + N_t^M = \chi_t N_t, \tag{3}$$

where χ_t is an exogenously given fraction of working age population.

New capital I_t can be produced only in the non-agricultural sector. The aggregate capital stock satisfies the law of motion

$$K_{t+1} = I_t + (1-\delta) K_t, \tag{4}$$

where δ is the depreciation rate. Denoting by K_t^A and K_t^M the capital stock in agriculture and manufacturing, the feasibility condition for intersectoral capital allocation is

$$K_t^A + K_t^M = K_t. \tag{5}$$

Net exports of agricultural and manufacturing goods, E_t^M and E_t^A, and government expenditures on manufacturing goods, G_t^M, are exogenous. The feasibility conditions in the two sectors are

$$N_t C_t^A + E_t^A = Y_t^A, \tag{6}$$

and

$$N_t C_t^M + I_t + G_t^M + E_t^M = Y_t^M. \tag{7}$$

The efficient allocations in this economy satisfy three first order conditions: the intra-temporal labor allocation condition across sectors:

$$1 = \frac{U_{M,t}}{U_{A,t}} \frac{F_{N,t}^M}{F_{N,t}^A}, \tag{8}$$

the intra-temporal capital allocation condition across sectors:

$$1 = \frac{U_{M,t}}{U_{A,t}} \frac{F_{K,t}^M}{F_{K,t}^A}, \tag{9}$$

and the inter-temporal condition:

$$1 = \left(1 + F_{K,t+1}^M - \delta\right) \beta \frac{U_{M,t+1}}{U_{M,t}}. \tag{10}$$

Following Chari, Kehoe and McGrattan (2007), we define three wedges $1 + \tau_{W,t}$, $1 + \tau_{R,t}$, and $1 + \tau_{K,t}$ as the right hand sides of expressions (8), (9), and (10). We note that our analysis is an accounting procedure as competitive general equilibrium allocations with wedges match data exactly.

We also study the components of the wedges. Let $p_{i,t}$ and $w_{i,t}$ denote the prices of goods and wages in the competitive equilibrium. The right hand side of the intra-temporal optimality condition for labor (8) can be re-written as a product of three terms, to which we refer as *consumption*, *production,* and *labor mobility components*:

$$\frac{U_{M,t}}{U_{A,t}} \frac{F_{N,t}^M}{F_{N,t}^A} = \underbrace{\frac{U_{M,t}/p_{M,t}}{U_{A,t}/p_{A,t}}}_{\text{consumption component}} \times \underbrace{\frac{p_{M,t} F_{N,t}^M / w_{M,t}}{p_{A,t} F_{N,t}^A / w_{A,t}}}_{\text{production component}} \times \underbrace{\frac{w_{M,t}}{w_{A,t}}}_{\text{labor mobility component}}. \tag{11}$$

In the competitive equilibrium decentralizing the efficient allocation, all three components are equal to one. Each of these components is an optimality condition in one of the three markets. The first, consumption, component is the optimality condition of consumers. The consumption component typically measures frictions in consumer goods markets. The second, production, component is the optimality condition of competitive, price-taking firms. The production component measures frictions in the production process The third, mobility, component is equal to one when workers can freely choose in which sector to work. The mobility component measures frictions in labor allocation between sectors, conditional on the relative wages. An analogous decomposition can be done for the intersectoral capital wedge (9). As we do not have reliable data on interest rates in each sector, we will decompose the intratemporal capital wedge only into two components, *consumption* and *non-consumption components*. Note that the consumption component is common for both the intersectoral labor and capital wedge.

3 Data

In this section we discuss the construction of the data for a systematic analysis of the structural transformation of the Chinese economy from 1952 to 2012. One contribution of our paper is construction of the data for an application of a two-sector neoclassical model with wedges for this period.

3.1 Data sources and construction of the data

Our two main sources of data on China national accounts are the yearly "China Statistical Yearbooks" (CSY) and the "60 Years of New China" (60Y). Both sources are published by the Chinese National Bureau of Statistics (NBS). The second source aggregates data from previous publications for the years 1949-2009 and is also closely related with a book on pre-1996 statistics compiled by Hsueh and Li (1999), "China's national income 1952-1995" (HL).

We use nominal value added by sector and the growth rate of real value added by sector to construct indices of real value added in the agricultural (primary) sector and the non-agricultural (secondary and tertiary) sector in 1978 prices. The same sources allow us to estimate the relative prices of agricultural goods to non-agricultural goods by taking the ratio of price deflators in the two sectors. The price deflator in each sector is computed as the ratio of nominal to real value added in that sector. The ratio of price deflators equals 1 in 1978

by construction. We use gross fixed capital formation in current prices which serves as our measure of nominal investment. We convert investment (as well as other components of GDP) from nominal to real values using the GDP deflator.

We use Holz (2006), Tables 19 and 20 on pages 159-161, as our main source for the aggregate and sectoral capital stock. We use the level of capital and its ratio to GDP in 1953 to estimate the initial level of capital in 1978 prices. We apply the perpetual inventory method (with a depreciation rate of 5 percent) to our series for real investment in 1978 prices to obtain the series for aggregate capital in 1978 prices. The series that we obtain is largely consistent with Holz's estimates of aggregate capital stock for 1953-2006, with two minor differences: Holz computes capital in constant 2000 prices and uses a variable depreciation rate which ranges between 3 and 5 percent.

We also use data from Holz (2006) to divide the aggregate capital stock into capital used in the agricultural and non-agricultural sectors. This sectoral division of capital stock is only available for 1978-2012. For earlier years we use the data on sectoral investment from Chow (1993) to estimate the composition of capital stock by sector. We use net capital stock accumulation by sector from Table 5 on page 820 in Chow (1993), and then apply the perpetual inventory method to accumulate sectoral capital stock for 1953-1978. We break down the total real capital stock in 1978 prices by sector using the relative proportions implied by Chow's data. We also constructed data on sectoral capital stock using provincial data for the pre-1978 period and the results are consistent with our main series.

For labor input, we use data on population, employment and its composition from the two primary sources (60Y, CSY). We adjust the employment numbers prior to 1990 using the procedure proposed by Holz (2006), Appendix 13, page 236. The correction addresses the reclassification of employed workers that was made by the NBS in 1990.

For data on wages by sector we use average wages for staff and workers in the agricultural and non-agricultural sectors for 1952-2012. The pre-1978 data come from CSY for year 1981. The post-1978 data come from CSY for years 1996-2013. One issue with this data is that the wages of staff and workers may not be the same as labor remuneration for workers. Staff and workers are concentrated in non-agriculture, and to the extent that they are in agriculture, they are likely in state farms[4]. We address this concern by computing the ratio of labor remuneration

[4]See, for example, Holz (2014) for detailed data.

in non-agriculture to agriculture from Bai and Qian (2010). We find that the ratio of two series behaves similarly for the overlapping time period (see Data Appendix for more details).

Our primary source of data on sectoral price indexes is the CSY. We use sectoral value added deflators obtained earlier when computing real value added by sector.

The data on defense spending comes from three main sources. The earlier period of 1952-1995 is jointly covered by HL and CSY, which report nominal defense spending in yuan. For the period 1983-2012 an alternative source of data is the website of the Stockholm International Peace Research Institute (SIPRI) which reports spending on defense for a variety of countries as a percent of GDP. For the overlapping period the trends are broadly consistent but the exact estimates vary by a factor of 1 to 1.5. As there seems to be no reliable way of obtaining more precise estimates, we average the two available sources for the overlapping period. We obtain an estimate of real defense spending in 1978 prices using the share of defense in GDP from these two sources.

The main source for data on sectoral exports and imports is Fukao, Kiyota and Yue (2006). Fukao et al. report data on China's exports and imports by commodity at the SITC-R 2-digit level for 1952-1964 and for 1981-2000, obtained from the "China's Long-Term International Trade Statistics" database. Using data from Fukao et al. (2006), we construct estimates of nominal exports and imports of agricultural and non-agricultural commodities. We then subtract imports from exports to obtain estimates of net exports by sector. We use the price deflators computed earlier to estimate real net exports by sector in 1978 prices. For the 1965-1980 period, to our knowledge, there is no available data on trade by sector. We linearly interpolate the ratios of net export to value added by sector for this intermediate period. For the 2001-2012 period we use data directly comparable to that reported by Fukao et al. (2006), now available in CSY.

We convert real GDP per capita in 1978 prices to 1990 international dollars using Maddison's estimate of 4803 dollars of 1990 per person for the year 2003. We then apply real GDP growth rates (in constant 1978 prices) to construct real GDP per capita in international dollars for other years in the 1952-2012 period. This series may differ slightly from real GDP in international dollars reported by Maddison for other years, as relative prices changed. However, our index captures well the general patterns and the long-term growth rates. For more details on data construction we refer the reader to our extensive Online Data Appendix.

3.2 Summary of the data

Figure 1 shows aggregate and sectoral, agricultural and non-agricultural, data for China for 1952-2012. We divide the discussion of this period into two subperiods: pre- and post- 1978 reforms.

China 1952-1978

The Chinese economy in 1952-1978 grew rather rapidly, with a 3.6 percent average rate of growth of real GDP per capita. However, the economy did not experience structural transformation. In 1952, the primary occupation for 83 percent of the working-age Chinese population was agriculture. This fraction declined very slowly (with the exception of the brief period during the GLF when about 20 percent of the labor force temporarily moved from agriculture to manufacturing), remaining above 80 percent until 1970 and declining to 75 percent in 1977. The role of agriculture in GDP was also very important, with more than 70 percent of value added produced in agriculture in 1952, declining only to 30 percent in 1977 (with a similarly brief downward shift during the GLF). International trade was rather insignificant – China's net export of agricultural production was only 3 percent prior to the GLF and declined to zero after 1960. The imports of non-agricultural goods constituted an even smaller fraction of non-agricultural value added in the same period. Defense spending was a large component of manufacturing production accounting for 6 percent of GDP.

China 1978-2012

In 1978-2012 annual growth in real GDP per capita increased to 8.4 percent annually. This coincides with a rapid increase in investments (as a share of GDP) and reallocation of labor from agriculture to non-agriculture. The share of labor force in agriculture fell from 75 percent in 1977 to 33 percent in 2012. The share of value added produced in the agricultural sector fell from 30 percent to 5 percent respectively. Defense expenditures declined from 6 percent of GDP to 1.5 percent of GDP in the late 1980s. The relative prices of non-agricultural goods show a 40 percent appreciation in the 5 years following the reforms, and then continued to appreciate. Non-agricultural value added shows remarkable growth throughout both periods, growing at 10.5 and 10.1 percent, respectively. Agricultural value added grew much slower, at 2.0 percent per year prior to reforms, and 4.4 percent afterwards. The ratios of sectoral capital stock to sectoral GDP remain roughly stable over the whole period.

	Annual Growth Rate		
	pre-1978	post-GLF (1966-1975)	post-1978
Real GDP	6.0	5.7	9.4
Agricultural value added	2.0	2.0	4.5
Non-agricultural value added	10.5	7.8	10.2
Labor Force	2.5	2.5	1.5
Share of Labor Force in Agriculture	-0.7	-1.2	-2.2
Capital Stock	11.0	7.9	10.2

Table 1: Changes in economic indicators pre- and post-1978.

4 Measurement of wedges in the data

In this section we discuss the choice of parameters that we use to measure sectoral productivities, wedges (8), (9) and (10), and their components.

4.1 Parametrization

For our baseline preference specification we chose a commonly used Stone-Geary specification which sets $\sigma = 1$. Parameter η measures the long run share of agricultural consumption and we set it to 0.15. These parameters are consistent with the literature that used the two sector growth model to study growth and structural transformation in a variety of historical episodes[5].

We set the subsistence level to 54 yuan per capita per year in 1978 prices. This subsistence level accounts for 53 percent of agricultural consumption per capita in 1952[6]. If we set it higher than 69 percent of consumption of 1952, the simulated economy would go below the subsistence level in 1960 during the famine of the Great Leap Forward. We explore in an online appendix, how our main results change in response to alternative calibrations of γ^A.

We choose the initial capital stock to match the observed level of capital in 1952. Our technology specification is close to Hayashi and Prescott (2008). The elasticities for the agricultural sector are also in line with estimates of Tang (1984), who uses the contributions of labor, capital and land at 0.5, 0.1 and 0.25 respectively, with the remaining share of 0.15 assigned to intermediate inputs.[7] However, there is a large variation in estimates of factor shares

[5]See Caselli and Coleman (2001), Buera and Kaboski (2009, 2012), Herrendorf, Rogerson and Valentinyi (2013), Stokey (2001). Our parameters are especially close to the calibration in Hayashi and Prescott (2008). The long run share η is also consistent with food expenditure shares in most developed countries.

[6]The subsistence level is equal to 76 percent of consumption during the famine in 1960.

[7]See p.89 and Appendix Table 9, p.228 in Tang (1984) for the discussion of the consistency of these input

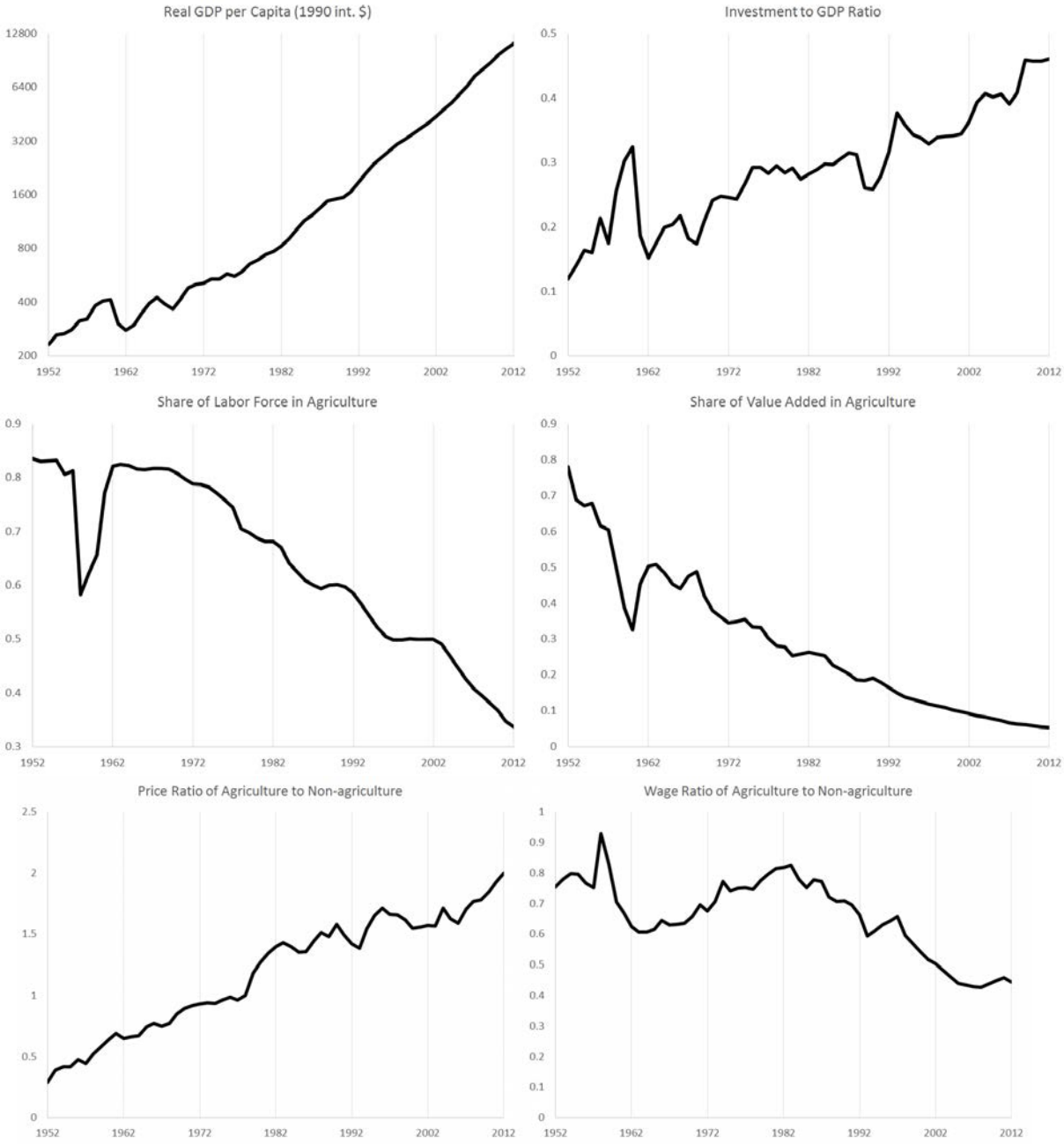

Figure 1: Macroeconomic indicators of People's Republic of China, 1952-2012.

in Chinese agriculture in the literature, neatly summarized by Wen (1993, Table 9, page 27). Finally, for χ_t, the path of the fraction of labor force in the population is pinned down by the data. All our parameters are given in Table 2.

Table 2: Parameters

Parameter	Description	Value
$\alpha_{K,A}$	Factor shares	0.14
$\alpha_{N,A}$	of the	0.55
$\alpha_{K,M}$	production	0.3
$\alpha_{N,M}$	functions	0.7
γ_A	Subsistence level	54
η	Asymptotic share	0.15
β	Discount factor	0.96
σ	Elasticity of substitution	1.0
ρ	Intertemporal elasticity	0.0
δ	Depreciation	0.05

5 Wedge decomposition

We now present the calculation of the total factor productivities X_t^M, X_t^A; the wedges $1+\tau_{W,t}$, $1+\tau_{R,t}$ and $1+\tau_{K,t}$; and the components of the wedges. We report the annual growth rates for the pre-1978 (1952-1978), post Great Leap Forward period (post-GLF, 1966-1978), and for the post-1978 period in Table 3[8]. Figure 2 plots the agricultural and non-agricultural TFP and the intersectoral wedges. Figure 3 plots the components of the wedges.[9]

We now summarize the results of this section. The 1953-1978 period is characterized by mild growth of TFP (1.9 percent per year in non-agriculture and 0.3 percent per year in agriculture), a reduction in the labor wedge driven by the consumption component, and a reduction in the capital wedge. The post-GLF period saw an acceleration of agricultural TFP (2.4 percent) and a deceleration of the reduction in the wedges. After 1978, there was a significant acceleration of TFP growth, especially in non-agriculture. The reduction in the barriers also significantly accelerated, especially the production components of the labor wedge.

weights with a number of other countries.

[8]For the sake of brevity, we refer to the consumption component of the intratemporal labor wedge as "consumption", to the production component of the intratemporal labor wedge as "production", to the mobility component of the intratemporal labor wedge as "mobility", and to the non-consumption component of the intratemporal capital wedge as "capital".

[9]We later show that the investment wedge plays a minor role and relegate this graph to the appendix.

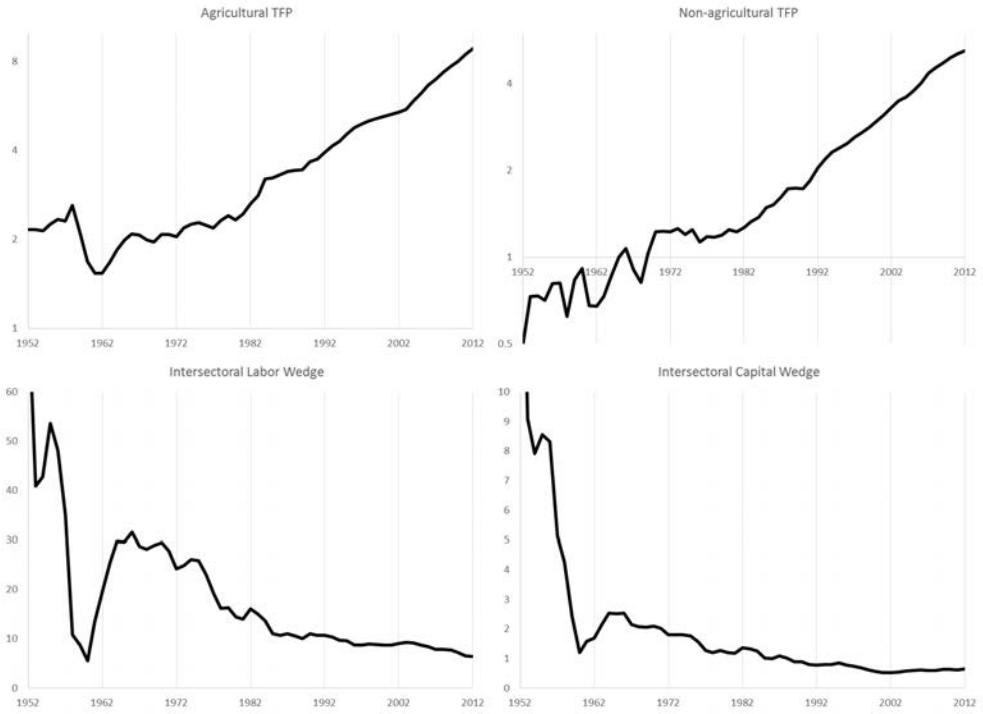

Figure 2: TFPs and intersectoral wedges

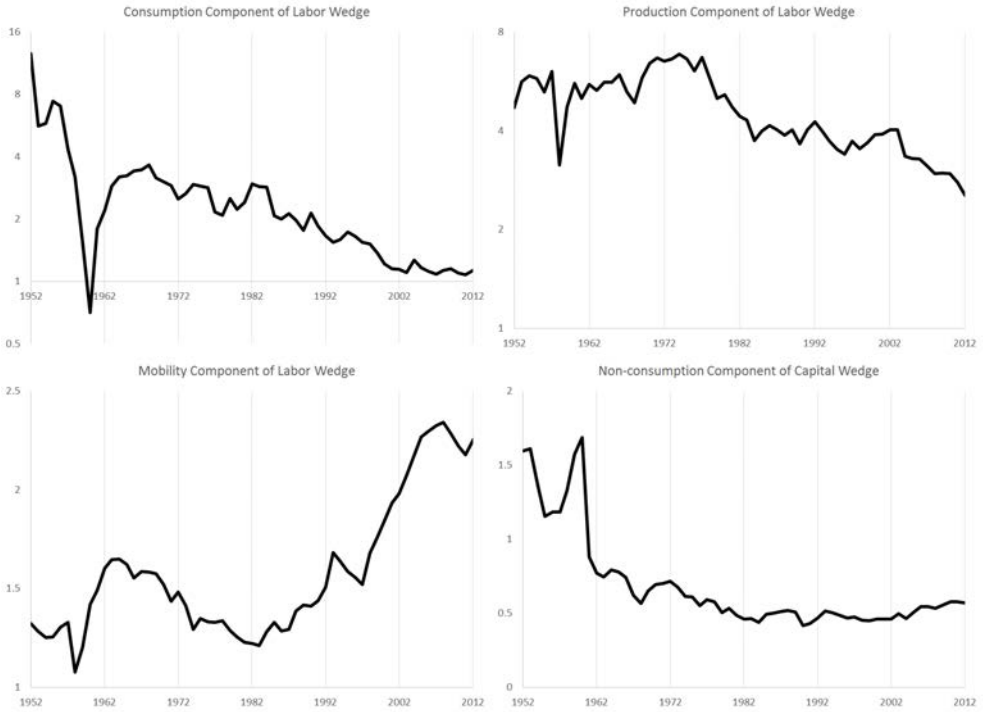

Figure 3: Components of the intersectoral wedges

	Annual Growth Rate		
	pre-1978	post-GLF	post-1978
Manufacturing TFP, X_A	1.9	1.9	4.4
Agricultural TFP, X_A	0.3	2.4	3.9
Intersectoral wedges:			
consumption	-4.0	-1.5	-1.8
production	0.1	-0.1	-2.4
mobility	0.2	0.0	1.5
capital	-4.1	-1.1	0.0

Table 3: Behavior of wedges pre- and post-1978

6 Analyzing the pre-reform economy

6.1 Wedge accounting for the pre-reform economy

In this section, we perform a wedge accounting exercise for the pre-reform economy to quantify the contribution of each component of our wedge decomposition to growth and to changes in the share of labor force in agriculture. First, we compute the path of the economy holding all wedges fixed at their 1953 levels. Second, we compute the path of the economy when all exogenous variables (including wedges and productivities) are set to values observed in the data. When all those series are set to the values observed in the data, the model matches the observed quantities and prices in the data exactly. We compare the simulated path with fixed wedges with the actual historical path by computing the difference between the rates of growth of annual GDP and the difference between the changes in the share of labor force in agriculture for the period. Finally, we compute the contributions of wedges and TFPs by removing exogenous variables one at a time and computing the relative changes in GDP and the share of labor force in agriculture for each case.[10]

Table 4 summarizes the results for the pre-reform economy. We provide calculations for two periods: 1953-1975 and 1953-1978. We choose the 1953-1975 period as the baseline because there was a significant fall in the share of labor in agriculture during 1975-1978 and a fall in the wedges. The overall results are, however, similar for either of these two periods.

[10]The accounting procedure imposes some additional technical assumptions to compute the relative contributions and keep expectations constant across counterfactuals. For more details see the appendix on computational details.

	Labor Share 1953-1975 % lab. force	GDP 1953-1975 % growth	Labor Share 1953-1978 % lab. force	GDP 1953-1978 % growth
Manufacturing TFP, X_M	-2.4	1.9	-0.9	1.4
Agricultural TFP, X_A	-0.1	-0.1	-0.2	0.0
Intersector wedges:	-2.4	-0.5	-13.5	0.3
consumption	-7.8	1.6	-19.5	1.0
production	1.0	-0.3	-0.8	-0.1
mobility	2.7	-0.9	3.8	-0.3
capital	1.5	-0.9	3.1	-0.4
Demographics	0.6	4.0	-1.8	3.3
Other	-1.5	0.3	3.9	0.7
Total	-5.9	5.6	-12.5	5.6

Table 4: Wedge accounting 1953-1975 and 1953-1978

Consider wedge accounting for 1953-1975. Compared with the counterfactual, GDP growth increased by 5.6 percentage points and the share of labor force in agriculture decreased by 5.9 percentage points. For GDP growth, two most important factors were the growth of non-agricultural TFP, X_M, (1.9 percentage points) and the decrease in the consumption component of the labor wedge (1.6 percentage points). The rest of the wedges worsened and contributed negatively to the growth of GDP: the production component (-0.8 percentage points), mobility component (-0.5 percentage points), and intersectoral capital wedge (-1 percentage points). The overall worsening of wedges resulted in -0.5 percentage points of reduction in the annual GDP growth. Demographics played a major role contributing 4.0 percentage points to GDP growth so that the growth rate of GDP per capita is significantly less than the growth rate of GDP. The change in the share of labor force in agriculture (-5.9 percentage points) is essentially fully determined by the decrease in the consumption component of the labor wedge (-7.8 percentage points). For 1953-1978, the results are similar with the exception that the change in the share of labor force in agriculture is larger (-12.5 percentage points).

We conclude that the decline in the consumption component of the labor wedge is important for GDP growth and is the only factor in explaining the decline in the share of labor force in agriculture. Importantly, agricultural TFP growth does not play any role in structural transformation. The non-agricultural TFP growth is the most important factor for GDP growth.

	Labor Share % lab. force	GDP % growth
Manufacturing TFP, X_M	0.1	2.5
Agricultural TFP, X_A	-0.8	0.5
Intersectoral wedges:	-1.7	-0.7
consumption	-3.2	0.9
production	3.0	-1.3
mobility	-2.2	0.1
capital	0.7	-0.4
Demographics	1.3	2.3
Other	-3.2	1.1
Total	-4.3	5.8

Table 5: Wedge accounting post-GLF: 1966-1975

We now turn to the wedge accounting for the post-GLF period, 1966-1975. We present it here as we use the trends from that period to evaluate the success of the post-1978 reforms. This period experienced a slightly higher GDP growth than in 1953-1975 (but significantly higher per capita GDP growth due to slower growth of population). The contributions of non-agricultural and agricultural TFP to GDP growth were also larger.

6.2 Historical evidence

Before starting the analysis of the behavior of the wedges in the context of the historical evidence, it is useful to establish the periodization of the PRC economic history. Naughton (2007) considers Economic Recovery (1949-52), the Twin Peaks of the First Five-Year Plan (1953-1956), Great Leap Forward (1958-1960), Crisis and "Readjustment" (1961-1963), Launch of the Third Front (1964-66), the Cultural Revolution (1967-69), the Maoist Model: a New Leap (1970-1972), Consolidation and Drift (1972-76), and the Leap Outward and End of Maoism (1978-).[11] Selden (1979, p.153) provides a useful summary of the main stages in China's development priorities. Ash, et al. (2003, p. 32-55) gives a detailed chronology of major economic developments in China from 1964 to 2001.

[11] Cambridge History of China (MacFarquhar and Fairbank 1987, Perkins 1991) considers the periodization as follows: Emulating the Soviet Model (1949-57) with three subperiods – Consolidation and Reconstruction (1949-52), Socialist Construction and Transformation (1953-56), Adjusting the New Socialist System (1956-57); the Search for a Chinese Road (1958-65) – with two subperiods Great Leap Forward (1958-62) and Economic Recovery (1963-65); and the 1966-82 period with the following subperiods – Disruption in the economy (1966-69), Industrial development strategy (1966-76), Changing industrial strategies (1977—80), Accelerating industrial growth, 1982—1987. Bramall (2009, p. xxiv) uses four periods: early Maoism (1949-1963); late Maoism (1963-1978); market socialism (1978-1996); and Chinese capitalism (1996-2008).

6.2.1 TFP growth

The First Five-Year Plan (1952-57) was "an unusually successful program of economic development" (Lardy 1987a, p.157). The plan was modeled on the Soviet experience of collectivization and industrialization in 1928-1939: the development program was drawn "half in Moscow, half in Peking" (Naughton 2007, p. 66), and the principal slogan was "Let's be modern and Soviet" (Selden 1979, p.153). On the other hand, there was a much more moderate attitude towards agriculture than the abrupt Soviet change[12]. The growth of TFP in non-agriculture is consistent with several facts. First, Soviet assistance played an important role. Lardy (1987a, p. 178) argues that Soviet technical assistance was "unprecedented in the history of the transfer of technology" as China "received the most advanced technology available within the Soviet Union, and in some cases this was the best in the world". Close to 6000 Soviet advisors helped establish and operate the 156 large-scale capital intensive Soviet-assisted projects (Naughton 2007, p. 66; Rawski, 1979, p. 51)[13]. These projects constituted "the core of the industrialization program" and absorbed about a half of total industrial investment (Lardy 1987a, p. 158). Eckstein (1977, p. 102) considers these large turnkey industrial installations designed in Russia, transported in full to China, installed and often operated by Soviet advisors as one of the "crucial element[s] of industrialization of China during the First Five-Year Plan". The system of planning and development was itself modeled on the Soviet Union and assisted by the advisors. Second and related to the first factor, the import of the capital intensive goods and machinery (also to a large extent from USSR) played an important role in allowing the economy to operate the "frontier technology" (Naughton 2007, p.66). Eckstein (1977, p. 235) argues that import constituted as much as 40 percent of the equipment component of investment in the 1950s. Third, the First Five-Year plan model was a technocratic approach that "paid considerable attention to complementarities, input-output relations, and technical requirements in production and enterprise management" . The management model placed great responsibilities on a director of

[12] As evidenced, for example, in Mao's Speech to the Political Bureau of the Central Committee, April 25, 1956 "On the Ten Major Relationships" which was the synthesis and perhaps the most important Mao's statement on a distinct approach China's development and the first serious criticism of the Soviet development strategy (Selden 1979, p. 315-322).

[13] Li Fuchun, then the Chairperson of the State Planning Committee in the "Report on the First Five-Year Plan for Development of the National Economy of the People's Republic of China in 1953-1957, July 5 and 6, 1955" summarized: "We must center our main efforts on industrial construction ..., the core of which are the 156 projects which the Soviet Union is designing for us, and which will lay out the preliminary groundwork for China's socialist industries" (Selden 1979, p. 296-7).

enterprises, valued and utilized technical experts, and provided some stratification in pay and benefits to improve incentives. (Eckstein 1977, p. 89-90). The plan also stressed individual material incentives (Selden 1979, p. 153). Overall, by the mid-1950s, modern technology was adopted on a large scale in industry (Lardy 1987a, p. 144).[14] The growth of TFP in agriculture during 1952-1957 is consistent with several facts. First, and unlike the Soviet Union under Stalin, agriculture was never viewed purely as a source of revenue extraction for the forced industrialization. Rural population was historically an important power base for the Chinese Communist Party. Agriculture was also viewed as an important source of raw materials for the industry. Overall, the process of collectivization in China "limited the disorder and destruction of economic resources that marked the Soviet [experience of collectivization]" (Teiwes 1987, p.111). We return to this issue in a more detailed comparison with Stalin's industrialization in Section 6.3. Second, more efficient methods of agricultural production were implemented. Nolan (1976) gives detailed figures and determines five such methods: (1) increase in irrigated areas; (2) increased multiple cropping; (3) afforestation; (4) improved seeds; (5) increased collection and application of organic fertilizers (see also Naughton 2007, Chapter 11). Thirdly, the collectivization led to consolidation in the land plots that led to improvement in the agricultural productivity, decreased the travel time between plots, and allowed the use of mechanization (Spence 2013, p. 491)

During the Great Leap Forward (1958-1962), TFP in agriculture fell by 41 percent from its peak in 1958 to the trough in 1962; TFP in manufacturing fell in 1958 by 23 percent and again in 1961 by 26 percent. One important factor that affected TFP in both agriculture and non-agriculture was worsening of incentives (Naughton 2007, p. 69; Lardy 1987b, p. 365). Material incentives, monetary rewards, bonuses were prohibited, free markets in the countryside were curtailed, and restrictions on the productive private farming plots were placed. The fall in manufacturing TFP is consistent with several factors. First, the collapse of agricultural production led to severe shortage of agricultural materials for textile and food-processing industries. Second, many small scale plants such as backyard steel furnaces were exceptionally inefficient (e.g., Eckstein, 1977, p. 124).[15] Third, the Sino-Soviet split led to the departure of

[14] Another factor that affected TFP in both the agricultural and the non-agricultural sectors of the economy is the advances in basic hygiene, disease, and pest control that affected productivity and longevity (see, e.g. Spence 2013, p. 488).

[15] Selden (1979, p. 100) gives the following estimates for these furnaces. In July 1958, there were 30-50 thousand small furnaces, in October – close to 1 million. By October 1960, only over 3000 were still operational,

virtually all Soviet advisors in the late summer and early fall of 1960. This meant that a large number of capital-goods projects had to be suspended (Eckstein, 1977, p.203; Selden 1979, p. 97). The reversal of the manufacturing TFP fall after 1961 is consistent with the general "readjustment and consolidation" policies that refocused industrial production to more specific and high productivity projects (e.g., petrochemical and fertilizer) rather than advancing on a broad front, and to a revival of material incentives (Eckstein, 1977 p. 126).

The fall in TFP in agriculture is consistent with several factors. One factor was that productivity fell due to poor management of agriculture under the commune system.[16] Communes that comprised over 5000 members became a predominant form of organization in agriculture, and due to their size and organization were very difficult to effectively manage. Considering the negative productivity impact of the communes Lardy (1987b, p. 370) argues that the most important factor was in the poor construction and design of the irrigation projects which reduced rather than raised yields.[17] The unusually bad weather in 1960 also had serious adverse effects on the yields.[18] Li and Yang (2005) argue that the most important causal factors in the collapse of agricultural output between 1958 and 1961 were: (1) the diversion of resources from agriculture, which was responsible for 33 percent of the decline; (2) excessive procurement of grain affecting physical strength of the peasantry accounting for 28.3 percent of the decline; (3) bad weather contributing 12.9 percent of the decline. The fall in productivity was reversed only after 1962.[19]

The period of 1962-1966 was a period of recovery from the disaster of the Great Leap Forward. In 1962, the government backtracked by reducing the size of communes to "production teams" of about 20-30 households per team (Lin, 2012, p. 89, p. 153.). 20 million workers were sent back from cities to the countryside. Mao recognized that "backyard furnaces" were a

and the rest shut down. He further quotes an editorial from People's Daily of August 1, 1959: "We must face the problem frankly: Last year's small furnaces could not produce iron".

[16]Lin (1990) discusses a variety of hypotheses and presents a view emphasizing the role of incentives in the fall of productivity. See also Donnithorne (1987, Chapter 2) for the detailed description of the evolution of the communes.

[17]See also Cheng (1982, p. 267).

[18]See e.g. Selden (1979, p. 97) or a more recent study based on the meteorological data (Kueh 1995). The low agricultural output was further exacerbated by miscalculation in the 1959 plan to reduce the area and resources allocated to grain production. This decision followed the successful harvest of 1958 and was done under the false supposition of the new era of significantly increased productivity in agriculture and following the massive falsification of data on yields (Naughton 2007, p. 70).

[19]See also an extensive discussion in Bramall (2009, p.128-134) of the literature on the causal factors of the collapse of agricultural production and the famine.

mistake (Mao Tse-tung, "Speech at the Lushan Conference," 23 July 1959, in Stuart Schram, ed. "Chairman Mao talks to the people," 142-43, cited by Perkins, 1991, p. 478). "Agriculture first" strategy included reopening of private plots (Lardy 1987b, p. 389), decentralization of commune management, and greater reliance on material incentives (Eckstein, 1977 p. 60-61). These policies continued throughout the Cultural Revolution, the last years of Mao and the first post-Mao years — until the beginning of reforms in 1978. (Perkins, 1991, p. 486) The planning and Big Push ideology persisted but was softer and less brutal than in the 1950s. Agricultural TFP grew by 35 percent from the low of 1962 to the peak of 1966, but was still 25 percent below the peak of 1958. The increase in agricultural TFP is consistent with the continuation of the "readjustment and recovery" policy in agriculture. Manufacturing TFP grew quickly — recovered to the pre-crisis peak of 1957 in 1964, and increased by almost 60 percent from the low of 1961 to the peak of 1966.

The next subperiod (1967-69) is that of the peak of the Cultural Revolution.[20] Despite the exceptional importance of the events of the Cultural Revolution for the country, the economic implications were much more muted. The fall in agricultural and manufacturing TFP in 1967 and 1968 was relatively minor, and agriculture was affected less than manufacturing. Sectoral TFPs reached or exceeded the peak of 1966 already in 1970. This is consistent with the conclusion of Perkins (1991, p. 482-483) that "In short, all of the worker strikes, the battles between workers and Red Guards, and the use of the railroads to transport Red Guards around the country had cost China two years of reduced output but little more, at least in the short run... the contrast between the disruption caused by the Cultural Revolution and that resulting from the Great Leap Forward of 1958-60 is striking" and that "The Cultural Revolution at its peak (1967-68) was a severe but essentially temporary interruption of a magnitude experienced by most countries at one time or another." (Perkins 1991, p. 486). Naughton (2007, p. 75) reaches the same conclusion that "From an economic standpoint, the Cultural Revolution (in the narrow definition [1966-69]) was, surprisingly, not a particularly important event". Eckstein (1977, p. 204-205) also argues that the economic disruptions were minimized, at least, in agriculture with perhaps the largest impact being on transport. Spence (2013, p. 549) provides an additional argument that PLA kept the Red Guards out of its production plants, importantly,

[20]Historians typically define the period of Cultural Revolution starting in late 1965 and ending with the convocation of the Ninth National Congress of the Chinese Communist Party in April 1969 (e.g., Harding 1991, p. 111) .

from the Daqing oil fields.

The period of 1966-76, as Perkins (1991, p. 486) argued, was very similar to the original 1950s vision of the First Five-Year Plan and that the early changes to the strategy started happening only in 1977. Naughton (1996, p. 76) argues for a slightly more nuanced breakdown. The New Leap in 1970 was a period of militarization of the economy that also instituted some principles of the Great Leap Forward. The 1972-1976 period was that of consolidation and drift. It started with the economic problems of the 1970s whereas the heavy industry development was both increasingly inefficient and outstripped the agricultural facilities to provide food. A new more moderate course was started in 1972-74 by Zhou Enlai.

6.2.2 Wedges

In contrast with several detailed studies of TFP behavior during the pre-reform period described above there is much less work on the potential wedges. That is why, rather than focusing on the detailed exposition that we have done for the TFP, we view this section as describing evidence that is broadly consistent with the patterns of the wedges.

Consumption component of the intersectoral wedges The consumption component of the wedge starts from the very high level in 1952-1953 and is driven by the very low level of consumption of non-agricultural goods. The reason is as follows. We calculate this consumption as the residual of non-agricultural output after investment. Since we assume in the model that all investment is done in non-agricultural goods, the level of this component and the overall wedge for those years is very sensitive to the data on investment. Almost certainly, we overestimate the level of this component of the wedge for these years. At the same time, as we discussed in the previous section this was the period of the First Five Year Plan that placed heavy emphasis on investment and this is consistent with the high level of the consumption wedge.

During the Great Leap Forward, the dominant factor driving the consumption wedge was the catastrophic collapse of agricultural consumption that moved aggregate consumption very close to the subsistence level. This approaching of the subsistence level of consumption and the shortages of agricultural goods are both consistent with the consumption component of the intrasectoral wedges falling significantly.

The disaster of the Great Leap Forward followed the reported exceptional results of the 1958 harvest. Partially, the harvest was indeed good but falsification of reports by those who did not want to disappoint the authorities also played a role. "Evidently dazzled by claims that rural production under commune management had doubled, increased tenfold, or even "scores of time", the Central Committee issued the ecstatic vision of the Great Leap forward" (Spence, 2013, p. 518). This resulted in higher grain procurement quotas and higher targets of rural industrial production. At the same time, the complete destruction of incentives as well as poor harvests had a dramatic negative effect on agricultural output.

A useful proxy for the degree of intervention in the agricultural markets is the level of state procurement. Depending on how exactly procurement is modeled, it can represent itself in various wedges – either in consumption or in the production component of the wedge, or as we argued in the previous section – in the TFP wedge. The changes in the agricultural policy during the Great Leap Forward were so large and abrupt that most likely procurement affected a variety of wedges. Since the TFPs and wedges behaved similarly – experiencing a rapid fall and then a rapid recovery – we use procurement to provide indirect evidence for the behavior of wedges.

The level of state procurement of grain reached its peak in 1959 and rural retentions per capita reached the trough in 1960 (Lardy 1987b, p. 381 Table 7; Li and Yang 2005, Table 1). The combination of high plans (and therefore procurement quota) and low output resulted in severe shortage of agricultural goods and a great famine which cost about 30 million lives (Meng et al., 2013). For example, retained grain per person fell from 273 kilograms per capita in 1957 to 193 kilograms in 1959, and to 182 kilograms in 1960 (Li and Yang 2005, Table 1); or from 227 kilograms in 1959, to 215 kilograms in 1960, and to 207 kilograms in 1961 if one accounts for re-sales (Ash 2006, Table 5). Ashton et al. (1984, Table 5) estimate that average daily calorie consumption was a shocking 1534 Kcal in 1960. Lardy (1983, p.150) documents severe shortages of food in 1961 and 1962. Lardy (1987b, p. 375) cites the evidence of the shortage represented in the "extraordinary increase in rural [unregulated] market prices of available foodstuff". Following the agricultural crisis, first attempts to scale back procurement were evidenced in 1961. Also, in the winter of 1961, the fixed procurement prices were raised (Lardy 1987b, p. 385). In 1961-2, procurement was drastically reduced (Li and Yang, 2005,

Table 1; Lardy 1987b, p. 388)[21]. The average food consumption recovered to 2026 calories in 1964. This decrease in the procurement levels and the eased shortages of the agricultural goods are consistent with the consumption component of the intersectoral wedge decreasing and then increasing. Post-1965, grain procurement net of resales stabilized at about 40 percent of output (Ash, 2006, 1985).

We now discuss a variety of additional evidence that is consistent with the high level of the consumption wedge and its behavior. A sizable literature studies price scissors in China (e.g., Yu and Lin 2008). Most of it focuses on the price scissors defined as the observed terms of trade between the agricultural and the non-agricultural sector. There are, however, several papers that study the difference between observed prices and prices that would occur if various policies (such as rationing) were removed. Such comparison between the observed and undistorted prices is similar to our concept of the consumption wedge. While the models and the dates in these papers vary, we view them as a useful supplement to our analysis supporting our main point that the agricultural prices were too low, and non-agricultural prices were too high compared with the undistorted benchmark.[22] Imai (2000) studies a static, two sector model of the pre-reform (1964-1978) period in which a planner chooses a proportion of the non-agricultural good to be invested, and thus rations the non-agricultural. This implicit tax changes the terms of trade between agriculture and non-agriculture. While Imai (2000) allocates all of this tax to the labor wedge and does not calculate the consumption wedge, the difference in the terms of trade compared with the undistorted optimum parallels our consumption wedge. He finds that the undistorted agricultural prices would be 35-50 percent higher. The undistorted purchases of the non-agricultural goods would be on average 59 percent higher (67 percent higher in 1970-1978). Sheng (1993b) constructs an index of the prices of agricultural goods on the free markets compared with the state list prices and argues that this ratio ranged from 1.3-1.4 in the 1950s and 1964-1970, and 1.5-1.8 in the first part of the 1970s. During the Great Leap Forward the ratio increased to 4.12 in 1961 and then decreased to 2.7 in 1962 and 2.2 in 1963. Finally, Table 7 in Zhang and Zhao (2000) summarizes a variety of estimates by Chinese economists of the degree of unequal exchange between agriculture and manufacturing. These estimates are based on the Marxist labor theory of value and are not directly comparable with the analysis

[21] Net of resales procurement as a proportion of grain output started falling in 1960 (Ash 2006, Table 5).

[22] See also Naughton (2007, p. 60) who argues extensively that such price wedge was a key feature of the command economic system in China.

here. Still, the broad comparison of the trends is useful. The estimates of unequal exchange in the 1950s range from 20 to 65 percent. The estimates of the state purchasing price being below the "real value" for agricultural goods range from 20 percent in the 1950s, 40-80 percent during the Great Leap Forward, and about 50 percent in the 1970s.[23] Nolan and White (1984) summarize: "Chinese economists now are generally agreed that serious "unequal exchange" has existed throughout the post-Liberation period (and thus does today) in the sense that the "price" of industrial commodities is much greater than their "value" (in terms of embodied labour) and the "price" of agricultural commodities is much below their "value"".

Mobility component of the labor wedge We start the discussion of the mobility component with its increase in 1955. This is consistent with the start of the implementation of the hukou system of registration of urban and rural population and the restrictions on their movement. Cheng and Selden (1994) give a detailed account of the origins of this system which can be be traced to the 16th of July 1951 when the Ministry of Public Security issued "Regulations Governing the Urban Population". At that stage, the system was just a registration system. On 12 March 1954, the Ministry of the Interior and Ministry of Labour issued an important "Joint Directive to Control Blind Influx of Peasants into Cities" that was aimed at the cities and started to curb migration. Finally, in 1954-1956 a set of measures was introduced to further limit and disincentivize migration including, importantly, food rationing. While the hukou system and migration controls were still in the incipient stage and far from the scope and strictness of the later years, the evidence is consistent with the increase in the labor wedge starting from mid-1950s.[24]

The mobility component decreased by 82 percent from 1957 to 1960 and then increased, returning to its 1957 level in 1964. It is not surprising that this was accompanied by an unprecedented increase in the agricultural labor force. The reversal of the barrier is also consistent with the massive forced resettlement of urban population to the countryside. In 1961-62, about 30 million urbanites were thus moved to the countryside (Lardy 1987b, p. 387).

[23] We also refer the reader to Cheng (1982, Chapter 7) and Chinn (1980) for extensive description of rationing and coupons for both agricultural and non-agricultural goods. While the magnitude and evolution of the relative wedge is difficult to assess, Cheng (1982, p. 217) argues that "The most detrimental effect is caused by the separation of production and consumer demand".

[24] Nolan and White (2007) also argue that the measures to control migration started to be effective after 1955. For a comprehensive history of the hukou system see Chan and Zhang (1999).

From 1962 to 1966 the mobility component of the wedge continued its increase which is consistent with Ministry of Public Security starting to rigorously control and enforce the restrictions on rural to urban migration (Chan and Zhang 1999).

Liu (2005) discusses hukou conversion process as a crucial aspect of rural–urban migration whereas recruitment by state-owned enterprises was the main channel for individuals in rural areas to obtain an urban hukou during the 1960s and 1970s. The policy of hukou conversion is consistent with the decline in the mobility component of the wedge, even though it likely accounts only for part of this decline. Wu (1994) also discusses the policy of sending about 18 million urban youth to villages during Cultural Revolution and their gradual recall back to the cities. This policy likely had a mixed impact on the mobility wedge – first an increase and then a decrease. Moreover, in 1971, the government, for the first time since the collapse of the Great Leap Forward, relaxed control over the increase in permanent positions in the urban/industrial sector. This policy is consistent with the decrease in the mobility wedge. Another force affecting the mobility component of the wedge is the return to human capital. Lower returns to education manifest themselves in the lower non-agricultural wage and a lower mobility wedge. Fleisher and Wang (2005) provide evidence that returns to schooling measured as the ratio of the income of college graduates to income of individuals with only elementary schooling declined from a ratio of 1.8 in the years prior to 1960 to a ratio of about 1.3 in the years around 1980. They argue that three factors contribute to the decline in the wage gap: (1) decreased differential between traditionally good (for example, high paying employers owned by the central government) and bad jobs (Zhou 2000); (2) decreased differential in pay between workers who differ in schooling within jobs; (3) discrimination in the assignment of college graduates to jobs in favored occupations, industries, and geographical locations, as evidenced, for example by sending high school graduates to rural jobs (see discussion in Zhou and Hou 1999).

Production component of the labor wedge There is very little data on the size of the production component of the labor wedge. The only direct evidence we are aware of is the study by Dong and Putterman (2000) who argue that monopsony in the pre-reform industry was a significant impediment to structural transformation. They calculate the difference between the marginal product of labor and wages, including welfare benefits and subsidies, in Chinese state

industry. The study finds that the mean gap was 169 percent and the median gap was 189 percent for 1952-1984.

Intersectoral capital wedge In this section, we discuss the non-consumption component of the capital wedge in Figure 3, panel 4. The total intersectoral wedge is the combination of the consumption wedge and this component.

In 1952-1957 the intersectoral capital wedge decreased significantly. This is consistent with the main strategy of the First Five-Year Plan that placed the "overwhelming allocation of investment resources to industry" and production of capital goods (Lardy 1987a, p.158). Selden (1979, p. 153) states that the order of economic priorities for that period was: heavy industry, light industry, agriculture. Lardy (1987a, p. 158) and Eckstein (1977, p. 188) give details of investment allocation to industry and agriculture to also argue about the low priority of agricultural investment.[25]

The intersectoral capital wedge decreased significantly to the trough in 1960 and then started its reversal. This behavior is consistent with several facts. The first years of the GLF strategy were based on a massive infusion of capital both to the industries developed in the First-Five Year plan, and importantly to small-scale industrial plants such as "backyard furnaces" (Lardy 1987b, p. 365)[26]. The reversal of the wedge afterwards is consistent with several facts. There was a massive closure of the construction of industrial projects after the disastrous first years of the GLF (Lardy 1987b, p. 387) and a corresponding increase in investment allocated to agriculture. The "Agriculture first" strategy most significantly increased chemical fertilizer production, electricity allocation, and the production of small agricultural implements (Eckstein, 1977, p. 60). These measures also are consistent with the increase in the intersectoral wedge in those years.[27]

From 1962-1966 the declining capital wedge is consistent with the arguments that the period of readjustment did not mean that fundamentally the growth strategy shifted to prioritize

[25] The report by Li Fuchun gives the following state investment priorities: industrial departments – 58.2 percent of total; agriculture – 7.6 percent; transport, post and telecommunications – 19.2 percent; trade, banking, and stockpiling – 3 percent; urban public utilities – 3.7 percent (cited in Selden 1979, p. 296-7).

[26] While often the first years of the Great Leap Forward are associated with the small scale projects such as backyard furnaces (see, e.g. discussion in Spence 2013), Lardy (1987b, p. 367) gives detailed statistics on the preponderance of investment allocation to the medium and large-scale industrial plants.

[27] For example, special allocations of materials to produce small instruments such as hand tools and carts were implemented in 1962, and the availability of these items was restored to the pre-GLF years (Lardy 1987b, p. 391).

agriculture. Rather, the moderates in the government – Zhou Enlai and Chen Yun, among others – were successful in extending the period of readjustment until 1965 and in deferring the Third Five-Year plan until 1966. In particular, they won in a critical debate on the target for steel production, and were able to scale it down. However, the moderates only slightly and temporarily altered the growth strategy of the primacy of the industrialization to allow a respite with "agriculture first" (Lardy 1987b, p. 396)[28]. The fact that the capital wedge did not increase to reflect the priorities in agriculture is also consistent with the program of the "Third Front". Mao worried about US involvement in Vietnam and about the rift with the Soviet Union that potentially could lead to a war. The "Third Front" was a massive construction program in the inland provinces of the entire industrial base that would not be vulnerable to the attacks by the Soviets or Americans.[29] The Third Front was important even during the Cultural Revolution, but the rapid expansion of the first phase was stopped by the Cultural Revolution. The decline in the non-consumption component of the capital wedge, the consumption and mobility component of the intersectoral labor wedge are consistent with the argument of Perkins (1991, p. 486) who concludes that the period of 1966-76 was very similar to the original 1950s vision of the First Five-Year Plan. The declining behavior of these wedges support this argument.

Considering the whole period of 1952-1978, the behavior of the capital wedge is consistent with the classification of the evolution of China's development strategies by Cheng (1982, Table 9.3) who ranks the sectoral priorities. Only during the Readjustment period of 1961-1965 agriculture received priority consistent with the increasing capital wedge; in all other periods heavy industry ranked first in the list of priorities consistent with the decline of the capital wedge.

6.3 Great Leap Forward and Comparison with Soviet Industrialization

We first simulate the behavior of the economy assuming that the Great Leap Forward did not happen. Figure 4 plots the behavior of the actual and simulated GDP, shares of labor force in agriculture, wedges and sectoral TFPs. We linearly extrapolate TFP in both sectors and

[28] Eckstein, however, argues that the basic tenets of the "Agriculture first" strategy – higher priority of agriculture and the industries that supply inputs to it – held even during and after the Cultural revolution (Eckstein, 1977 p. 61).

[29] See Naughton (1988) for a detailed discussion of the industrial policies under the Third Front.

the components of the labor and capital wedges between 1957 and 1964. The key differences with the actual wedges are as follows. There is no drop in the manufacturing TFP. There is no jump in 1958 and then no consequent fall in agricultural TFP. There are no jumps in the consumption and production components of the labor wedge and so there is no decrease in the overall labor wedge.

Figure 4: No GLF

Figure 4 plots the behavior of actual and simulated real GDP and the share of labor force in agriculture. Fluctuations in most of these variables are dampened in the absence of the GLF. In contrast to the actual path, the counterfactual lshare of labor force in agriculture increases to 93 percent and then comes back.

The changes in the intersectoral labor wedge play a dominant role in explaining the changes in the share of labor force in agriculture during the GLF. The temporary decrease in the labor wedge accounts for the bulk of the movement of peasants to the manufacturing sector and then back. However, there is only a temporary positive effect on GDP, with a slowdown and famine that followed.

Overall, the GLF was a very short episode of the disruption of the economy with a temporary negative impact. We note the importance of the changes in the labor wedge for the behavior of the share of labor force in agriculture and GDP during that period.

The conclusion that Great Leap Forward significantly reduced the labor wedge while resulting in a significant fall in TFP naturally leads to the comparison with the policies of the Soviet Union under Stalin.

We perform the following counterfactual simulations. We start Stalin's policies in 1957 (1957 thus being 1928 of Stalin's policies). This choice of timing is guided by the idea that the peak of the reforms in China under the Great Leap Forward (1960) should coincide with the peak of Soviet collectivization (1932). This is done to isolate GLF, and to study similarities as well as differences between the GLF and the most intense phase of Stalin's collectivization. This comparison highlights Mao's way of transforming agriculture that was even more radical than Stalin's.[30]

Specifically, we use the wedges computed in (Cheremukhin, et al. 2013) for Soviet Russia's industrialization and choose the timing of Stalin's policies to coincide with those of the GLF. We impose the wedges and sectoral TFPs for Stalin's 1928-1939 economy on our model of the Chinese economy over the period 1956-1967. We do this by multiplying each wedge by period-over-period relative changes in wedges implemented by Stalin. We then compare the actual data for the Chinese economy to the simulated Chinese economy with Stalin's policies imposed. That is, the model in 1957-1968 has the same innovations to wedges and sectoral TFPs as that of Stalin. After 1968, the economy returns to the same growth rates of wedges and the sectoral

[30]For a survey of the existing literature on exactly this comparison see Yang (2008).

TFPs as in the baseline model.

Figure 5 plots both actual Chinese wedges and the simulated economy with Stalin's wedges. There are similarities between these economies and some important differences. The main result of Stalin's policies would be much lower share of labor force in agriculture while the behavior of GDP per capita is broadly the same.

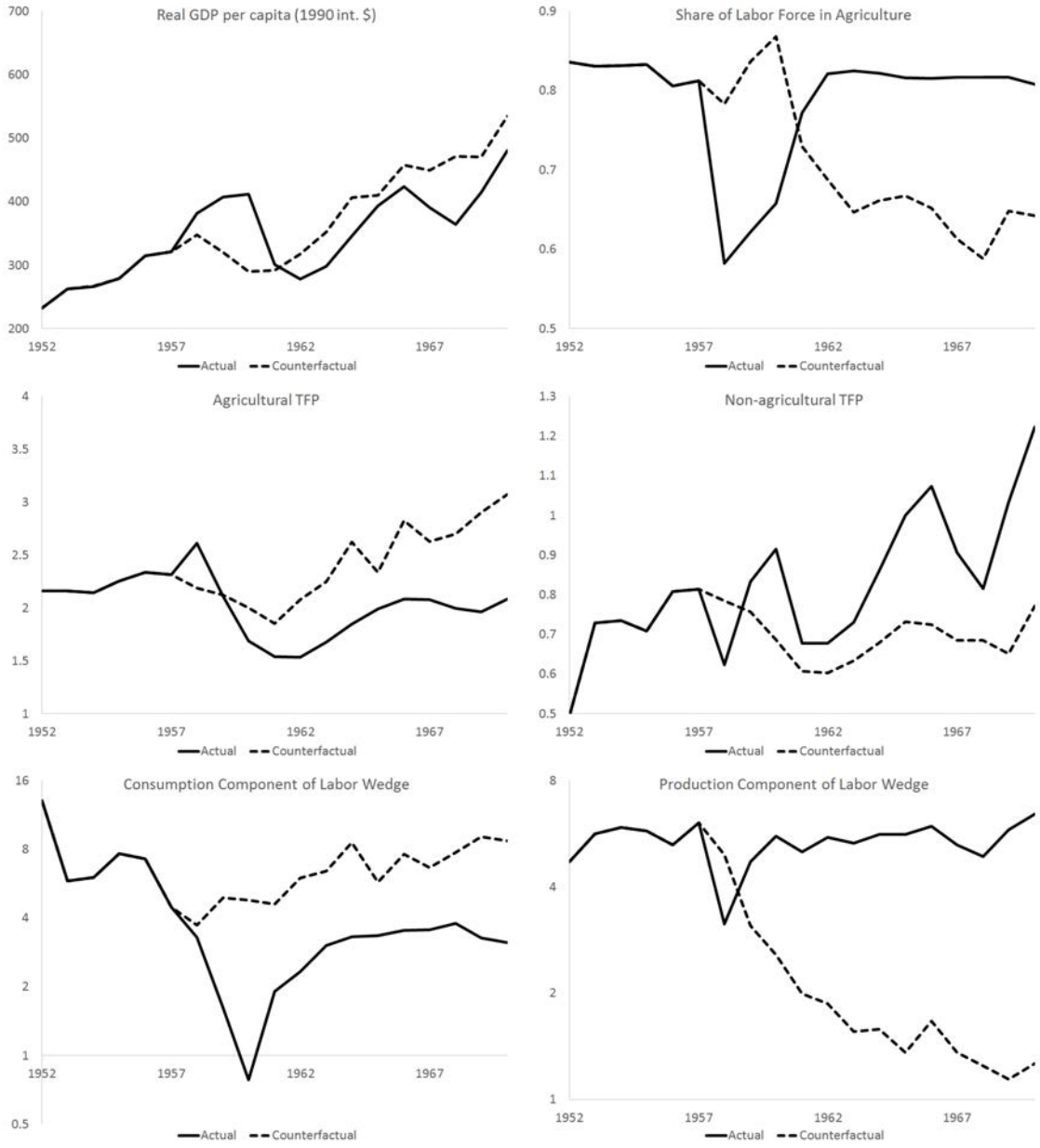

Figure 5: Soviet collectivization vs GLF

We now compare the behavior of the wedges. First, the fall in agricultural TFP was more significant in China compared with Soviet Russia. The fall in agricultural TFP from peak to trough was 20 percent in Soviet Russia versus 41 percent in China. This is consistent with the more radical way of transforming agriculture in China during the Great Leap Forward. The rates of recovery post 1962 in China and post 1932 in Soviet Russia were rather similar with a slightly higher trend growth in China (7.6 percent from 1962 to 1966 in China versus 5.8 percent from 1932 to 1938 in Soviet Russia). Second, non-agricultural TFP recovered quickly in China and had faster trend growth (1.9 percent from 1960 to 1976 in China versus 1.7 percent from 1933 to 1940 in Soviet Russia). Third, the intersectoral labor wedge was permanently lowered in Soviet Russia while recovered to the pre-GLF levels in China. The behavior of the components of the wedge were also different. The consumption component of the wedge in Russia fell less than in China reflecting a less severe fall in agricultural consumption and being farther away from subsistence. The production component of the intersectoral labor wedge was permanently lowered in Soviet Russia compared with a decline and then recovery in China.

Table 6 shows the contribution of each factor. We summarize the results as follows. If China followed Soviet industrialization and collectivization policies the results in terms of GDP growth would be comparable to a combination of the Great Leap Forward and the post-1962 retrenchment but the share of labor would have been lower under Soviet policies. The quick reversal of the policies under the Great Leap Forward led to a significantly higher labor wedge in China but coincided with the recovery of the losses in agricultural and non-agricultural TFP. In contrast, Soviet collectivization would have achieved a long-term reduction in the labor wedge at a cost of a long-term reduction in manufacturing TFP. The decline in the intersectoral labor wedge in the counterfactual would have happened due to two opposing factors. On one hand, there is a significant decrease in the production component of the wedge, that we emphasized as an important feature of Stalin's policies in Cheremukhin et al. (2013). On the other hand, a milder effect of disruption in consumption of agricultural goods resulted in a smaller fall and a higher level after recovery of the consumption component of the wedge in the counterfactual.

	Labor Share % lab. force	GDP % growth
Manufacturing TFP	1.7	0.0
Agricultural TFP	-2.8	0.1
Intersectoral wedges:	-13.5	-0.7
consumption	16.3	-0.1
production	-29.8	-0.3
mobility	-1.2	-0.2
capital	1.3	-0.1
Total	-14.6	-0.6

Table 6: Soviet collectivization vs GLF: contribution of wedges 1957-70

7 Analyzing the economy in 1978-2012

In this section, we first perform a wedge-accounting exercise for the period of 1978-2012, using the same procedure as in the last section. Second, we simulate the continuation in the post-GLF (1967-75) trends of the policies in the post-1978 period to provide a benchmark against which to measure the success of the post-1978 reforms. We then discuss extensive historical evidence consistent with our findings. Finally, we describe an extension to the three sector model with private and state firms and provide further decomposition of TFP growth in non-agriculture.

7.1 Wedge Accounting 1978-2012

Table 7 summarizes the results. Compared with the counterfactual of fixed 1978 wedges and no TFP growth, annual GDP growth increased by 9.4 percentage points and the share of labor force in agriculture decreased by 36.9 percentage points.

For GDP growth (9.4 percent per year), two most important factors were the growth of non-agricultural TFP X_M (5.8 percentage points) and the decrease in the intersectoral wedges (1.1 percent). Agricultural TFP contributed 0.8 percentage points. Two components of the labor wedge played the key role – the decrease in the consumption component (0.5 percent) and the production component (0.7 percentage points) of the wedge. Together these two components account for 1.2 percentage points of GDP growth. The change in the mobility component and intersectoral capital wedge plays a minor role.

The change in the share of labor force in agriculture (-36.9 percentage points) is predominantly determined by the decrease in the intersectoral wedges (-21.6 percentage points) and

the combined effect of sectoral TFP growth. Two components of the intersectoral wedges play the key role – the consumption (-10.6 percent) and the production (-16.7 percentage points) components. These two subcomponents play the same role as the increase in manufacturing TFP (-10.6 percentage points) and agricultural TFP (-12.2 percentage points). The worsening in the mobility component accounted for 6.7 percentage points of the change in the share of labor force in agriculture.

The investment wedge overall plays a minor role for the whole period and we report it as the part of the other category in the table. However, we also performed a finer decomposition by the subperiods and find that it was an important contributor to growth in the 1990s and 2000s. The average wedge was negative and implied an investment subsidy in the order of 5 percent. The main effect of the wedge was that it led to an increase in investment as a share in GDP. Compared with the counterfactual of no subsidy, the investment wedge accounts for 1.1 percentage points of annual growth in the 1990s and for 1.5 percentage points of annual growth in the 2000s.

We conclude that more than 50 percent of GDP growth is explained by growth in non-agricultural TFP and 11 percent are explained by the decline in the consumption and production components of the intersectoral wedges. The key factors behind the change of the share of labor force in agriculture is the reduction in intersectoral wedges and TFP growth in equal measures.

	Labor Share % lab. force	GDP % growth
Manufacturing TFP	-10.6	5.8
Agricultural TFP	-12.2	0.8
Intersector Wedges:	-21.6	1.1
consumption	-10.6	0.5
production	-16.7	0.7
mobility	6.7	-0.2
capital	-1.0	0.1
Demographics	2.9	1.3
Other	4.6	0.4
Total	-36.9	9.4

Table 7: Wedge Accounting 1978-2012

7.2 Comparison with post-GLF trends

In this section, we consider an important benchmark against which to measure the success of the reforms. Specifically, we compare the data for 1978-2012 to the simulated Chinese economy with the post-GLF trends in wedges and TFPs.[31] In Figure 6, the paths in the data are represented by solid lines, the paths used in the wedge accounting exercise by dashed lines, and post-GLF trends are represented by dotted lines. The results of the simulations are presented in Figure 7 where the dotted line is the counterfactual behavior of the post-1978 economy without reforms.

Table 8[32] summarizes the results. The reforms generate additional 4.2 percentage points of annual GDP growth. The main factors are the faster growth of non-agricultural TFP (4.4 versus 2.0 percentage points) that generates 3 percentage points of GDP growth and the faster decrease in the intersectoral wedges that generates 1 percentage point of additional GDP growth. The faster decrease in the consumption component (-1.8 versus -1.5 percentage points) generates 0.2 percentage points of growth; the faster decrease in the production component (-2.4 versus -0.5 percentage points) generates 0.6 percentage points of additional growth, and the faster decrease in the intersectoral capital wedge (-1 percent versus 0 percentage points) generates 0.2 percentage points of growth.

The dominant factors in the decrease in the share of labor force in agriculture (-23.9 percentage points) are the decrease in the production component of the labor wedge (-14 percentage points) and faster manufacturing TFP growth (-6.9 percentage points).

We conclude that the reforms yielded a significant growth and structural transformation differential compared with the continuation of post-GLF trends. About 3/4 of the growth differential is due to the increased growth of non-agricultural TFP; 1/4 of the growth differential is due to the faster reduction in the intersectoral wedges. The reductions in these components are also dominant forces behind the change in the share of labor force in agriculture.

[31] Note that we are keeping population growth the same as in the post-1978 data and do not consider the effects of demography.

[32] The first two columns of the table are the contributions of each factor to the change in the share of labor force in the agriculture and to GDP growth of the data versus the counterfactual simulation, as in all of the other tables. The last two columns are the post-GLF and 1978-2012 growth rates of each factor.

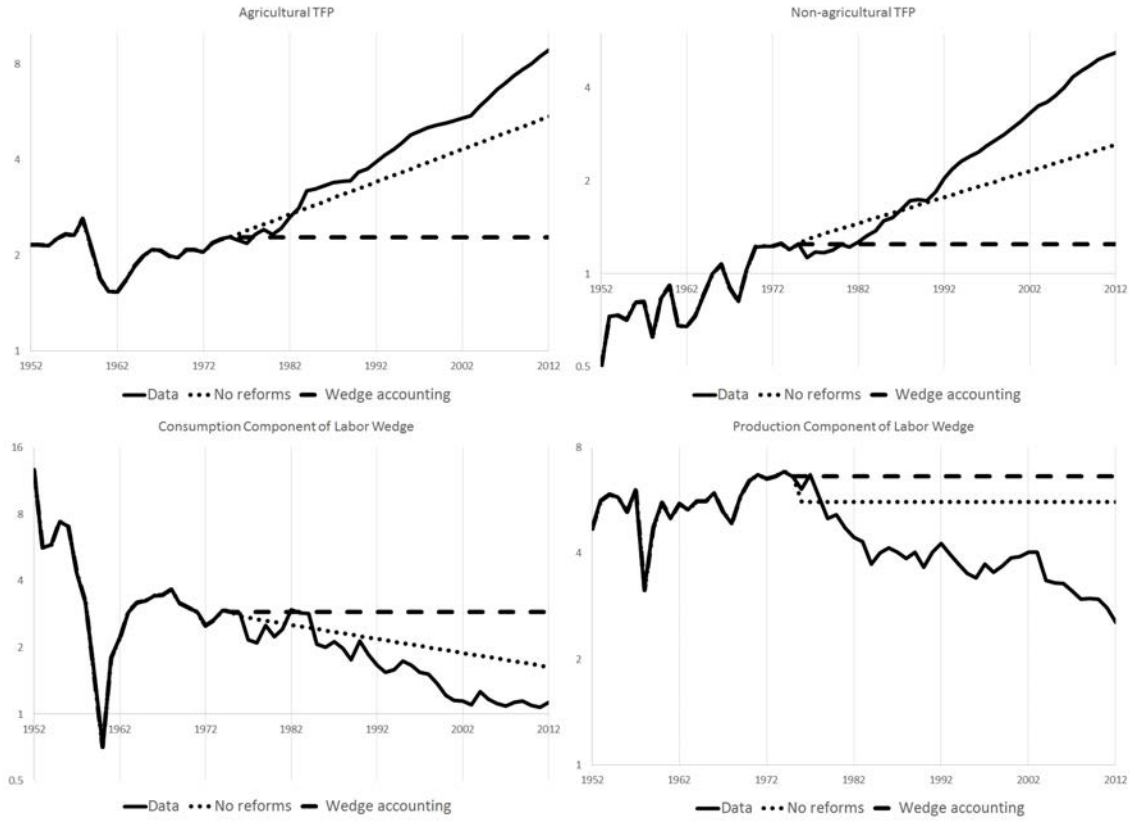

Figure 6: Wedges with and without reforms

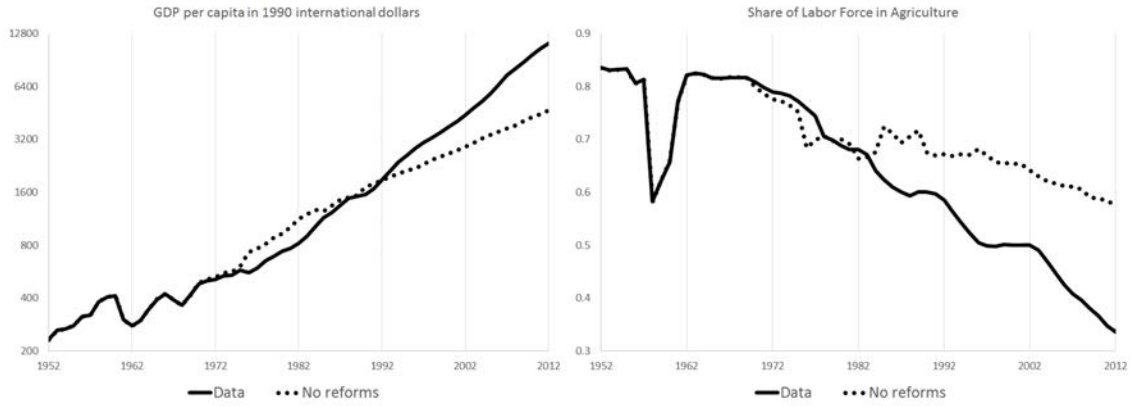

Figure 7: GDP per capita and share of labor force in agriculture People's Republic of China, 1952-2012.

	Labor Share % lab. force	GDP % growth	Post-GLF % growth	1978-2012 % growth
Manufacturing TFP	-6.9	3.0	2.0	4.4
Agricultural TFP	-2.5	0.3	2.4	3.9
Intersector Wedges:	-13.9	1.0	-1.8	-3.7
consumption	-3.0	0.2	-1.5	-1.8
production	-12.9	0.6	-0.5	-2.4
mobility	4.0	-0.1	0.2	1.5
capital	-2.0	0.2	-1.0	0.0
Other	-0.6	0.0		
Total	-23.9	4.2		

Table 8: Effect of post-1978 reforms

7.3 Historical evidence

In this section, we discuss historical evidence that is consistent with the behavior of the wedges and their components in the decomposition above.

7.3.1 TFP growth

The trend post-GLF TFP growth before 1978 was 2.4 percent per year in agriculture and 1.9 percent per year in the non-agricultural sector. After 1978, these growth rates increased to 3.9 percent and 4.4 percent, respectively. The acceleration of productivity growth was however uneven across time and across sectors.

In 1978-85, TFP in agriculture grew 4.7 percent annually - faster than non-agricultural TFP at 3.4 percent annually. After 1985 agricultural TFP growth slowed down to 3.7 percent and was outpaced by the growth of non-agricultural TFP at 4.6 percent annually. We now discuss the reforms of 1978-1985 in more detail. The reforms started by the Third Plenary Session of the 11th Central Committee of the Communist Party (December 1978) which (i) scaled down production teams, (ii) raised agricultural prices both for within-quota (by 17 percent) and above-quota production (by 30-50 percent), and (iii) allowed farmers to sell their produce in local and remote markets (Lin, 1988, Lin, 2012, p. 155). Another key change, the move from collective farming to the household responsibility system (HRS), was not a top-down reform but instead emerged from the bottom up. In December 1978, the peasants of the Xiaogang village — forced by bad weather and low harvest of 1978 – secretly agreed to effectively break the commune into individual household production units where each household would be

responsible for its own production. This brought outstanding results which were discussed in the Central Rural Work Conference in the end of 1979. The Conference decided to allow the introduction of the HRS in the poorest areas. Following its success in 1980, the government made a decision to spread the system to all households in 1981 — even though the very Third Plenum of the 11th Central Committee in 1978 officially banned decollectivization (Xu, 2011). By the end of 1981, 45 percent of rural households were in the HRS, and by the end of 1984 this number reached 99.8 percent (Lin, 2012). At this point, the HRS assigned the land to individual households for 15 years (Lin, 1992).

There is a consensus in the literature that the fast growth of agricultural productivity in 1978-85 is due to agricultural market liberalization. It is useful to divide the effects of agricultural reforms into two primary factors: (1) the direct increase in the incentives and, consequently, efficiency, due to the introduction of the Household Responsibility System and (2) the indirect effect on incentives and efficiency of the market and price reform. The empirical studies of the effect of these reforms (Lin, 1988, McMillan, Whalley, and Zhu 1989; Lin 1992, Wen, 1993, see a survey in Huang, Otsuka, Rozelle, 2008) show that improved incentives due to the introduction of the household responsibility system explained the vast majority of TFP growth in agriculture during this period. Both McMillan, Whalley, and Zhu (1989) and Lin (1992)[33] also find a significant effect of the increase in agricultural prices albeit the effect of prices is much smaller than the effect of the HRS.[34] There are other factors that were consistent with the increase in the productivity during this period. Fan (1991) confirms the predominant importance of the institutional change but also attributes about a third of the output growth to technological change which, however, may also be attributed to institutional reforms (Wen, 1993). Huang and Rozelle (1996) argue that technological adoption played the most significant role (and slightly higher than that of the institutional reform) in the productivity growth and rice yields and that the effects of the reform may be overestimated.[35] Zhang and Carter (1997) argue that the magnitudes of the effects of institutional reforms in the previous studies may be

[33] See also Qian (2008).

[34] The immediate impact of the reform may seem implausible. Indeed, the reforms in agriculture were just announced in the end of 1978; their full impact could only be salient in 1980 at the earliest. The improvements in productivity in the years 1978 and partially 1979 may therefore be consistent with the factors related to the rise of Deng to leadership and the general improvements in quality of governance after the chaos of late Maoism (MacFarquhar, 1991).

[35] They also argue that the HRS system might have in some cases slowed down technology adoption – e.g., slowed adoption of hybrid rice by 12 percent in the early 1980s.

somewhat overestimated if one takes into account the weather fluctuations.

After 1985, agricultural TFP continued to grow — although at a much lower rate (2.8 percent per year on average). This slowdown is consistent with the following facts. First, the fast growth of 1978-85 was difficult to sustain as it started from a very low base and the initial gains were relatively easy to achieve through introducing basic incentives and raising procurement prices (Lin, 2012). Second, after the impressive results in agriculture, the government's focus moved to developing the urban rather than the rural sector. The government even reduced the relative agricultural prices after 1984 (Lin, 1992). Huang (2012) argues that "the rural policy reversals coincided closely in timing with the assumption of power by a new group of leaders in the aftermath of the 1989 Tiananmen crackdown." The pro-rural economic policymakers lost power to urban technocrats from Shanghai (Huang and Qian 2010) who focused on the urban infrastructure investments at the expense of the rural sector. Third, further agricultural reforms were postponed. Most importantly, land remained state-owned. Tenure security and tenant rights were strengthened only in the early 2000s. The Rural Land Contract Law was adopted in 2002 and took effect in 2003 (Huang, Otsuka, and Rozelle, 2008).[36] Article 20 of the Law established tenure length for arable land to be 30 years (with grassland ranges at 30-50 years and forestland for 30-70 years). At the same time, the market liberalization and price reforms intensified post-1985 (we discuss them in more detail later) and played a more significant role than in 1978-1984 in the increase in productivity (see e.g., Figure 1 in de Braw, et al. (2004) for the estimates of the yearly impact of the gains of the market reforms in 1985-1995 and a comparison with the incentive reforms). There are also several studies that argue for the importance of technological progress. Huang and Rozelle (1996) argue that in 1985-90, technology adoption accounts for all of the increase in rice yields. Liu and Wang (2005) show that the technological progress plays a dominant role in the recovery of agricultural production during 1991-1999 following the stagnation of the late 1980s. Chen et al. (2008) studying the TFP growth in agriculture in 1990-2003 reach the same conclusion with regards to technological progress attributing it to the delayed effect of the market reforms in the late 1980s. For a more detailed overview of the developments in agriculture in the post-reform period we refer the reader to Huang, et al. (2008).

[36]The length of land use tenure is an important determinant of productive incentives and therefore of TFP; see Brandt, Li, and Rozelle (1998) for empirical evidence.

In contrast with agricultural productivity, in 1978-85 the growth of non-agricultural TFP was relatively slow (3.4 percent per year) — although higher than in 1952-78 (1.9 percent per year). Kuan et al. (1988) studies productivity change in Chinese industry from 1953 to 1985 and argue that "post-1978 shift in the relative contribution of factor accumulation and productivity growth represents a dramatic departure from the previous 25 years of industrial growth [in favor of growth of TFP]". They argue that the increase in productivity growth may be due to several factors: (1) simultaneous changes in policy (such as reduced state procurement in investment goods) and institutions (decentralization of authority over production and investment); (2) increased emphasis on the consumer goods manufacturing; (3) delayed effect of redirection of the funds from the underdeveloped provinces towards coastal industrial areas.

Only after 1985 did non-agricultural TFP growth accelerate to 4.6 percent per year. This is consistent with the fact that China undertook substantial pro-market reforms in the non-agricultural sector but these reforms mostly started in 1985.[37] Before that, the incentives within large urban non-agricultural firms basically remained the same as in the command economy of the pre-1978 period. Before 1985, the only two exceptions in the non-agricultural reforms were the introduction of foreign-owned firms and the small rural firms. The Law on Chinese-Foreign Equity Joint Ventures was passed already in 1979 but the contribution of FDI to China's macroeconomic performance remained very small. The firms funded by foreign capital employed only 60 thousand people in 1985, 660 thousand in 1990, and 18 million people in 2010 (Huang, 2012). The contribution of small rural firms (so called "township and village enterprises", or TVE) was much more important[38]. These firms did not exist in 1978; but by 1985 12 million TVEs already employed 70 million people (Huang, 2012). These firms were spawned by the rural reform as labor was freed by growth in agricultural TFP and the rural residents were allowed to get non-farm jobs (see Yang and Zhou, 1999). The TVEs were not controlled by the central government, and it was in the interest of the local governments to make them grow to reduce poverty (Xu, 2011). The growth of TVEs — which continued after 1985 as well — was also supported by the financial reform. Huang (2012) cites a 1980 Politburo document on the reform of rural credit cooperatives that foresaw the expansion of rural credit. The reform took place in 1983, when the Agricultural Bank of China decentralized its control

[37] While government started to increase autonomy and profit retention for some firms already since 1980, the scale of this reform was too small until 1985 (Jefferson and Rawski, 1994, Groves et al., 1994).

[38] See an extensive discussion of the TVEs and the causes of their growth in Naughton (1996, p. 144-169).

of rural credit cooperatives (Huang, 2012).

The growth of TVEs is consistent with a moderate acceleration of TFP growth in 1978-85 relative to pre-reform era. But the most important changes in the non-agricultural sector came after 1984; this is consistent with the rapid acceleration of non-agricultural TFP growth in 1985-2012 (4.6 percent per year on average). Building on the success of the household responsibility system in agriculture, the government introduced a dual-pricing system and a contract management responsibility system in state-owned industrial enterprises (Wu and Zhao, 1987, Groves et al., 1994, Chen, 1995, Lau et al., 2000). This decision was made in several steps. In May 1984, the State Council issued the "Ten Regulations" (more formally, "On Further Expansion of Decision Making Power on the Part of State Run Industrial Enterprises" called "Ten Regulations") which distinguished between the planned economy and the non-planned economy. The latter was supposed to function as a market economy provided that the enterprises fulfilled the plan; however, prices for above-the-plan production could not be more than 20 percent higher or less than 20 percent lower than state prices (Lau et al., 2000). In October 1984, the Third Plenum of the 12th Central Committee adopted "A Decision on Economic Reform" which foresaw market pricing for agricultural goods and dual pricing for raw materials and producer goods (Wu and Zhao, 1987). In February 1985, the State Price Administration and the State Material Administration cancelled the 20 percent limit.

The contract management responsibility system (CMRS) provided the state-owned industrial enterprises with autonomy to retain profits and flexibility to set wages and bonuses. The system was rolled out gradually and by 1987 it covered 95 percent of state-owned enterprises (Choe and Yin, 2000). Groves et al. (1994) show that the introduction of the CMRS had a significant positive effect on productivity. Furthermore, Li (1997) shows that over 87 percent of industrial TFP growth in the 1980s was attributable to improved incentives, intensified product market competition, and improved factor allocation.

These policies of "marketization and corporatization" of the state-owned enterprises (SOE) were then followed by their partial and full privatization. Although the above mentioned Central Committee's "Decision on Economic Reform" (October 1984) clearly stated the commitment to public ownership, already in the mid-1990s the Chinese government decided to start a privatization program. In September 1993, the Third Plenum of the 14th Central Committee admitted the possibility of small-scale privatization. Selected provinces had started privatizing

small SOEs already since 1992 (Cao et al. 1999), but only in 1995, the central government announced small-scale privatization as a national policy ("retain the large, release the small" policy). Small-scale privatization was soon followed by large-scale privatization. In 1997, the 15th Party Congress decided that large state-owned enterprises should also be privatized (Cao et al., 1999). The effects of privatization on firm-level TFP were generally positive (see surveys of microeconomic studies in Guriev and Megginson, 2007, and Estrin et al., 2009), especially in those firms that were privatized by the management (Gan et al., 2010). Although the largest SOEs were privatized only partially (with the government remaining a majority shareholder), even in these firms privatization brought higher transparency and some improvement in corporate governance.

We now summarize some available estimates of the productivity growth in Chinese industry, recognizing that we only mention a small number of them. First, we refer to Brandt, Rawski, and Sutton (2008) for a comprehensive study of China's industrial development. Jefferson and Rawski (1994, Table 4) and Jefferson, et al. (2000) discuss enterprise reform in Chinese industry and argue that from the 1980 to early 1990s there was a modest increase in productivity for the state industry but the collective-sector productivity (urban and township and township-village enterprises) appears considerably higher. At the same time, there is uncertainty due to data limitations about the extent of the productivity growth of TVEs. Jefferson, et al. (2000) find that there was a deceleration of productivity growth in the 1990s. Chen, et al. (2011, Table 1) summarize various estimates of the productivity growth noting that there is large variability in them. Dougherty et al. (2007) find significantly higher productivity growth in private compared with the public firms and attribute these to the progress towards building market economy. Brandt et al. (2012) study a panel of firms between 1998 and 2007 and present the comprehensive set of firm-level productivity estimates for Chinese manufacturing that spans China's entry into the World Trade Organization (WTO). They find rapid productivity growth and argue that about two-thirds of it can be contributed to net entry and the growth of entrants. Finally, Tian and Yu (2012) provide the results of the metastudy of TFP growth in China.

7.3.2 Consumption component of the intersectoral labor wedge

The first important policy that affected the behavior of the consumption component of the labor wedge is the reform of the price and distribution system. The economy experienced a

gradual shift from the system in which a large number of prices were planned, agricultural and non-agricultural goods were rationed, and the severe shortages were a norm.[39] It is useful to organize the discussion of the chronology of the main stages of the price reform from its start to the late 1980s following Wiemer and Lu (1993): the adjustment period (1979-1984) and the liberalization period (1985-1988). In 1978-1983, the prices received by farmers were rapidly increased by a series of decrees but the state distribution system remained largely in place. By 1984, Whyte (1996, p. 61) argues that the most significant shortages of the key agricultural goods had been substantially decreased. At the same time, the significant shortages remained in the non-agricultural goods, especially, energy and raw materials (Naughton 1996, p. 222). The increase in the agricultural prices and the reduction in rationing, and the decrease in shortages of food are consistent with the increase in the wedge during that period. The speed of liberalization significantly increased in 1984 with an effort to decontrol the prices of the non-staple foods such as poultry and vegetables (Naughton 1996, p. 248). Importantly, the price reforms also majorly expanded to non-agriculture. In 1984, for 30 types of products including raw materials in the short supply such as copper and zinc, the out-of-plan market activity was permitted (Wiemer and Lu, 1993 p.124). In April 1985, prices were freed for many consumer durables such as sewing machines and watches.[40] The markets for key items with the intense excess demand were also gradually freed – such as famous-brand bicycles in 1986 and famous brand cigarettes and liquor in 1988. (Wiemer and Lu, 1993, p. 132). This experience is consistent with a significant decline in the consumption component of the wedge. The concerns over inflation in the late 1980-s brought partial retrenchment of the price reforms and reimposition of some controls consistent with a brief upward increase in the price wedge. In the late 1980s, the main focus was on market liberalization by reduction in the restrictions on trading of commodities and commercialization of the state grain trading system.[41] The

[39]Hsu (1991) describes evolution of economic theories in China in 1979-1988 and their influence on policy development. He argues (p. 23-24, and Section 5 for the detailed analysis of the price reform) that Kornai's (1980) theory of shortage as the systemic feature of the socialist economies became widely accepted in China and shaped the increased support of reforming the price system (see also Wong 1986). Of particular interest is the discussion of the two schools of thought: (1) that enterprise reform should precede the price reform (Li Yining was the leader of this "enterprise (ownership) reform school), and (2) that the price reform should be implemented together with the enterprise reform (Wu Jinglian was the leader of this "(integrated) price reform school) (Hsu 1991, p. 157).

[40]Decline in rationing of some non-agricultural goods happened slightly earlier. Derationing of textile and cloth led to virtual disappearance of coupons for cloth by 1983. During 1982-1983 price controls were eliminated on more than 500 small consumer goods such as shoelaces and buttons (Naughton 1996, p. 126).

[41]For the detailed account of price and procurement reforms in 1979-1988 see Sicular (1988a,b)

1992-1993 saw the renewal of the price reforms with a rapid progress toward market prices, particularly for crucial producer goods such as steel and full decontrolling of petroleum prices in 1993 (Naughton 1996, p 289-290). Overall, by the beginning of the 1990s China's price and distribution system became essentially dominated by the markets. Yang and Li (2008) cite China Reform and Development Report Expert Group (CRDR) that in 1993 the central government only intervened to set the prices of 7 food commodities in retail markets, 6 farm products in agricultural procurement, and 33 producer goods versus 158, 113 and 1,086 number of goods in 1978, respectively. By 1991, household consumption expenditure on rationed goods was only 5 to 10 percent in the cities and virtually zero in the villages versus 60 to 80 percent in 1978 (Weimer and Lu, 1993, p. 134)[42]. Huang et al. (2007) summarize: "with the disappearance of the wedges from the marketing and procurement system [in agriculture], the remaining wedges after the mid-1990s reflect only trade policies and not trade and domestic policies." We conclude that by the beginning of the 1990s, the main effects of the price reform for agricultural and non-agricultural goods and the corresponding reduction in the consumption component of the wedge have been completed. One important exception was the primary energy sector, especially coal production that supplied 70 percent of China's energy needs in 1992. This sector had a very high level of price and quantity control. The reform of the sector started only in 1992 and was gradually implemented over the next five years. This likely contributed to the decline in the consumption component of the wedge even post 1993.[43]

The second important factor behind the decline in the consumption component of the labor wedge is the housing reform. While housing shortage was prevalent since at least 1950s, it was particularly severe at the end of the Cultural Revolution in 1976. The average floor space per person then was 3 sq.m. (Wang and Murie 1996; Tables 1-3 in Lee (1988) for the decline in the residential floor space since 1952). In 1990, the average living space available per person in the urban areas was only 6.7 square meters, well below the housing norm of 8 sq.m. per person. (Chai 1996, p. 274). Wang and Murie (1996) argue that very low rents, when the rent for a typical flat in a city cost less than a pack of cigarettes, were the main cause of the

[42] See also Gao et al. (1996) and Wang and Chern (1992) for models of demand in China under rationing.

[43] The price wedges remained for some staple foods such as rice and maize and on cotton because of the desire to provide low-cost input for processing sector (Anderson, et al. 2008). In the first half of the 1990s, the most important changes were the significant reduction in the compulsory quotas and further increases in the proportion of the procurement done at market prices. The late 1990s saw further decrease in the wedges on rice, reductions in trade protection and restrictions on export and import and by 2000 "virtually disappeared" (Anderson, et al. 2008). These relatively minor changes likely had a small effect on the price wedge.

shortages and the low quality of the housing. Fleisher et al. (1997) provide some evidence that the migration to the higher income provinces was hindered by the availability of housing due to below equilibrium prices. Wang and Kinsey (1994) argue that strict rationing of housing (and only partial rationing of food) was prevalent at least until 1987.

The major nationwide housing reform started in 1994[44] with the formal publication of the resolution of the conference The Decision on Deepening the Urban Housing Reform[45]. The key provisions of the housing reform were (Table 2 in Wang and Murie 1996): (1) to change the nature of the housing from a welfare service to a consumable commodity; (2) to change the system of distribution from in-kind and free to monetary and market-based; (3) to change the system of ownership and tenure from public to private; (4) to move from the subsidized minimum rent to the market rent.

An important recent paper provides a detailed empirical analysis of the impact of housing reform on consumption of housing and calculates the degree of misallocation prior to the reform (Wang 2011). The misallocation is estimated by comparing housing consumption (both size and amenities) for households living in subsidized units assigned by their state employers with households with similar characteristics living in private housing. The estimates of mismatch are equal to 15 percent less housing services than the households would have chosen in the private market. Furthermore, the system of state allocation of housing reduced the welfare of state-owned residents by 25 percent relative to a system in which instead of subsidized housing the households were able to freely choose the market housing.

The 1998 decision to further move from in-kind provision of housing by state companies to cash subsidies allowed to significantly increase house purchases from private developers. Deng et al. (2014) argue that it was "the turning point of China's housing reform" and the key strategic part of the overall economic reform, especially in the light of possible post-1997

[44]The discussion is based on the comprehensive survey of the reform by Wang and Murie (1996) unless noted otherwise.

[45]Prior to 1994, there were several experiments with the housing reform. The first nationwide experiment was started in 1980 with the total of about half a million square meters (about 10000 units) of housing available for sale. The experiment was formally abandoned in 1982 due to low demand. The second experiment in 1982-85 carried out pilot tests of sales of housing with about 10 million sq. m. (about 200000 units) sold. The third experiment in 1986-1988 in Yantai city in Shandong province offered the more comprehensive approach of adjusting the low rents, introducing housing subsidy, and promoting sales of the public sector housing. The National Housing Reform Plan was issued formally in February 1988 but was slow to get implemented at least until the update of the resolution in 1991. Yet, prior to the late 1993 Wang and Murie (1996) conclude that "the current situation is far from that aimed at in the reform plans". Wang (2011, 2012) and Deng et al. (2014) also argue that the major reform started in 1994. See also Iyer et al. (2013).

Asian crisis slowdown. By the early 2000s, the housing market was mostly deregulated. This is evidenced for example by the drastic reduction of the housing subsidies. Khan and Riskin (1998, 2005) provide evidence that housing subsidies reduced from 18 percent to 10 percent of disposable urban income in 1988-95 and from 10 percent to 2 percent in 1995-2002 (in real terms, the per capita housing subsidy declined in these years by 70 percent)[46]. Overall, the per capita floor space has increased to 24.97 meters in 2004 (Deng et al. 2014)[47] and the home ownership of 80 percent in China was among the highest in the world (Wang 2011).

Even after 2002, deregulation continued through softening of the hukou system which is quintessentially a housing ration as it serves as a barrier to a free housing market[48]. Effectively, urban households' consumption of services is subsidized through urban public good provision; at the same time there are no wedges in the consumption of food (either for urban or rural citizens). Therefore, a stricter hukou barrier translates into a higher price wedge[49]. As hukou continued to soften, the price wedge continued to decline. We also note an important recent paper by Garriga et al. (2014) who develop a model of how structural change affected the house and land prices in the cities, capturing 2/3 of the change in prices.

We now discuss additional indirect evidence that also is consistent with the decline in the consumption component of the wedge. First, the World Bank's Development Research Group "Estimates of wedges to Agricultural Incentives" estimates price wedges for 85 countries and for a number of those covers the periods of 1955-2011.[50] Anderson et al. (2008) provide a detailed description of the methodology of the project and use China as one of the main examples of application of this methodology. Their primary measure of wedges is the Consumer Tax Equivalent (CTE) calculated as the difference in the price that the consumers pay for a given food commodity and the international price at the border, taking into account the differences in

[46]It is also important to note that the housing subsidy was much more important than the price subsidy even in the beginning of the 1990s, further supporting our claim that housing reform was the main reason behind the reduction of the price wedge in the 1990s. The price subsidy on food and fuel in 1992 was only 4 percent of the urban disposable income (Yang and Zhou 1999); net non-housing subsidies declined to 1.25 percent in 1995 and to negligible 0.07 percent in 2002 (Khan and Riskin 2005).

[47]Of course, this increase in housing per capita reflects not only the removal of shortages but the overall growth in the economy and real incomes.

[48]It is interesting to note that the hukou system's restriction on housing may affect even the high income migrants. The governments of more than thirty big cities have implemented a policy of restricted transactions since 2011 that did not allow purchases of a new house without a local hukou (Song 2014).

[49]Wang and Zuo (1999) provide evidence that rural migrants not only pay much more but also receive inferior housing.

[50]The detailed description of the project including the database is available at www.worldbank.org/agwedges.

product quality. The implicit subsidy to agricultural goods was 42.6 percent in the beginning of the 1980s and reduced virtually to zero by 1995. The implicit tax on non-agricultural tradable goods declined steadily from 43 percent to about 4 percent in the early 2000s. While this relative terms of trade wedge also reflects the trade frictions and does not directly translate into the consumption component of the wedge, the behavior of this measure closely tracks the behavior of the consumption component of the wedge. Secondly, the decline in the consumption component is consistent with consumer revolution which started in the 1980s and drastically expanded the variety of goods and services available (Chai 1996, p. 274). Indeed, consider a model in which a consumer values a variety of agricultural and non-agricultural goods but the planner prohibits production of some goods. It is easy to show that an in increase in the share of the newly available non-agricultural goods reduces the consumption component of the wedge by reducing the relative measure of the unproduced goods. The third kind of evidence refers to the decline in the degree of unequal exchange between agriculture and manufacturing (see Sheng 1993a and Zhang and Zhao, 2000). Yan Ruizhen et al. (Table 5.2 in Sheng 1993a) estimate that the degree of uneven exchange decreased from 71.9 percent in 1978 to 15.4 in 1987. Niu et al. (Table 7 in Zhang and Zhao 2000) estimate that the percent by which state purchasing price is below "real value" for agricultural products decreased from 39 percent in 1981 to 29 percent in 1989.

7.3.3 Production component of the intersectoral labor wedge

Early work of Naughton (1992) argued that relaxation of state monopoly over industry is "a single simple interpretative framework [that] explains a great deal" about "a range of the complex changes that Chinese economy is undergoing" and that "The most crucial step in economic reform was the ending of the government monopoly over the economy, and especially over industrial production and investment." (Naughton 1996).

We first focus on studies that measure the markup in industry and its decline which provides direct evidence corresponding to the decline in the production component of the labor wedge. An influential paper by Li (1997) studies panel data on 789 state-owned enterprises between 1980 and 1989 and finds that the markup declined by 15 percent. Furthermore, he finds that industry's markup in 1980 is positively correlated with the growth of investment suggesting that the industries with higher initial profit margins experienced larger entry and expansion.

He also concludes that in 1989 monopoly power was still significant.[51] Bai and Qian (2010) compute labor shares of income and argue that the results of Li (1997) for 1978-1998 were due to the increase in market competition and the decline in the share of SOEs.[52] A related argument is provided by Dong and Putterman (2000) that state monopsony in industry was an important cause of slowness of structural change with respect to employment in the pre-reform period. Dong and Putterman (2002) study panel data for 967 Chinese SOEs in 1980-1990 and provide extensive direct evidence on the positive gap between the marginal product of labor and the full wages (including all forms of compensation) and the reasons behind the significant decline in this wedge. They find (Dong and Putterman 2002, Table III) that the mean gap across all industries decreased from 263 percent in 1980 to 139 percent in 1990. There is also evidence of significant dispersion in the misallocation and its decline across different industries. Among the lowest quartile, the gap decreased from 37 to 18 percent, while among the third quartile it decreased from 300 percent to 184 percent. Their analysis points to two statistically significant factors behind such decline. The most important reason is the increase in product market competition due to the decline in the share of SOEs. For example, the gap fell faster in the consumer goods sector than in the producer industry and in provinces where reforms were more rapid. The second factor, present in several years, is the increase in bonuses and performance pay that affected rent-sharing between enterprises and workers.[53]

We now turn to the indirect evidence that corresponds to the decline in non-agricultural monopoly power. Naughton (1992) provides evidence of a disproportionate reduction in profitability of sectors that in the beginning of the reforms had high profitability and those with low technological barriers to entry. He interprets this as evidence of a decline in monopoly rent due to entry and particularly the entry of non-state industry. Naughton (1992, Table 1) ranks industries by the reduction in profitability between 1980 and 1989. Among the sectors that experienced the largest such decline are light industrial sectors with initial high profitability and

[51] Another important finding is that growth in bonuses and improved market competition accounted for 49 percent of TFP growth. That is, reduction in the production component of the wedge and the monopoly power of the state owned enterprises also had the effect on TFP that we discussed in the previous section.

[52] They also find that for 1998-2005, the increase in monopoly power was one of the main reasons for the decrease in the labor share of income in industry. At the same time, they find an increase in the labor share of income in services. On the contrary Cao and Liu (2011) find that industry concentration decreased particularly fast for state owned enterprises in 1998-2007. Li, Liu and Wang (2012) in a model of China's state capitalism draw a distinction between the more competitive downstream industries and monopolized upstream industries dominated by SOEs.

[53] See also Dong and Putterman (1996) for the analysis of decline in monopoly power of rural TVEs.

low technological barriers to entry. For example, in textiles the profitability declined from 69 percent in 1980 to only 15.8 percent in 1989. Rubber products, culture and sport items, drinks and similar sectors experiences a decline in profitability of more than 20 percent.[54] At the same time, in 1989 a large number of sectors with significant monopoly power remained.[55] An alternative explanation to the decline in profitability of state owned enterprises is the increase in the share of labor compensation (Fan and Woo 1996, Sachs and Woo 2001). Either a reduction in monopoly power or an increase in the share of labor compensation led to the decline in the production component of the wedge. Holz (2002) provides a careful examination of the two hypotheses and argues that together they explain most of the variation in profitability. A recent OECD study (Conway et al. 2010) documents a significant increase in product market regulation and competition from 1998 to 2007. They report (Conway et al. 2010, Table 2) that out of 590 sectors in 1988, 88 were highly concentrated (15 percent) and 70 were concentrated (11 percent). In 2007, out of 521 sectors, 33 were highly concentrated (6 percent) and 36 were concentrated (7 percent). At the same time, they argue that in some sectors such as aviation, telecommunication and rare earth industry market competition might have recently decreased. Brandt et al. (2012) find significant pro-competitive effects of trade liberalization following the entrance of China to the WTO.

In the above discussion, we focus on evidence for the reduction in the non-agricultural monopoly wedge. Ideally, we would have liked to provide evidence on the relative evolution of the monopoly wedges in agriculture. However, there is lack of studies on the evolution of the monopoly wedge in agriculture (with the exception of Bai and Qian (2010) who compute the factor income shares in agriculture and non-agriculture but study the determinants only of the industrial income share).

Overall, our evidence on the decline in the production component of the wedge is consistent with the conclusions of the literature that the increase in competition was one of the key elements of the reforms. Hsu (1991, p.39) argues that one of the key goals of the reformist economists in China in the 1980s was to eliminate the inefficiency of the monopoly and that

[54] Naughton (1992) also extensively discusses the effect of the price reform, in particular in agriculture, on the decline in monopoly power in industry. For example, the largest reductions in profitability came from the industries producing consumer goods by processing agricultural products. Therefore, our discussion of the price reform is also relevant for the behavior of the production component of the wedge. In the appendix, we sketch a model in which the reduction in procurement affects the production component of the wedge.

[55] Ahuja (2012) computes a version of the Parente-Prescott model calibrated to China and finds significant gains to demonopolization.

"this new attitude toward market competition represents a fundamental change in the Chinese conception of the socialist enterprise".[56] Brandt and Rawski (2008) summarize in their preface to China's Great Economic Transformation: "In our view, reform has pushed China's economy toward extraordinarily high levels of competition. Despite pockets of monopoly and episodic local trade barriers, intense competition now pervades everyday economic life." (p. 14 and details in Chapters 15, 16, 19). Nicholas Lardy's "Markets over Mao" (Lardy 2014, p. 23-38) provides a comprehensive discussion of the dramatic decrease in the monopolization of the economy during the reforms with the exception of some service and energy sectors.

7.3.4 Mobility component of the labor wedge

There are two most important factors that are associated with the mobility component which we briefly describe here. On one hand, the hukou system was gradually reduced and labor mobility became much easier (see Song 2014 for a recent overview of the hukou system and its evolution) [57]. This is consistent with the mobility component of the wedge declining. On the other hand, the higher returns to skills tend to increase the gap between the agricultural and the non-agricultural wage. On balance, the increase in the skill premium due to human capital likely plays a dominant role at least starting from the 1990s. Zhang et al.. (2005) find a dramatic increase in the returns to education in urban China in the 1990s, with the rate of return to education increasing from 4.0 percent in 1988 to 10.2 percent in 2001.[58] This is also consistent with the evidence in Sicular et al. (2007) who studied the determinants of the rural-urban income gap in 1995 and 2002 household surveys and concluded that the contribution of location declined and the contribution of education was increasingly important. Cai et al. (2008, p. 183-186, 195-198) describe the developments of the Chinese labor market in the Reform era, summarize the literature and argue that education is the most important barrier to finding jobs off farm, and that the importance of this factor has significantly increased. They also describe several studies arguing for the importance of the increase in the skill premium

[56] This is in contrast with the pre-reform belief that socialism and competition are incompatible as the socialist enterprises engage in fraternal cooperation rather than in destroying the rivals (Hsu 1991, p. 39).

[57] At the same time, Chan and Buckingham (2008) argue that the reforms of the hukou system may be significantly overstated. Specifically, the cumulative effect of these reforms is to shift responsibility for hukou policies to local governments, which in many cases actually makes permanent migration of peasants to cities harder than before.

[58] Meng (2012) argues that returns to college and higher education decreased slightly post 2003 which may be related to the large influx of graduates due to the 1999 university expansion and an associated decline in quality.

and education premium. Moreover, they argue that the importance of hukou in affecting labor mobility significantly decreased over time.

7.4 Decomposing non-agricultural TFP growth with a three sector model

In this section, we extend our 2-sector model by dividing down the non-agricultural sector into 2 sub-sectors: state and non-state. We follow Brandt and Zhu (2010), Brandt, Hsieh, and Zhu (2008), and Dekle and Vandenbroucke (2012) and relegate the details to the appendix. We define two wedges in addition to those introduced in the 2-sector model. These two wedges correspond to the intratemporal wedges in capital and labor allocations between the state and non-state sectors within non-agriculture. The state and the non-state sectors have the same production functions. We also follow Brandt and Zhu (2010) assuming that the share of non-agricultural labor force allocated to the state sector is determined exogenously. When aggregated to two sectors (agricultural and non-agricultural) the three sector model generates identical results to the ones described above.

The three sector model allows us to further investigate the contributions of state and non-state non-agricultural TFP and the reduction of barriers for reallocation of labor from the state to the non-state sector.

Figure 8 presents the calculation of the post-1978 state and non-state non-agricultural sector TFPs. The annual growth rate of state TFP is equal to 2.4 percent which is remarkably close to 2.0 percent state sector growth post-GLF. The growth rate of non-state TFP is 13 percent per year, with TFP increasing by the factor of 10 compared with 1978.

Figure 9 presents the share of the labor force in the non-agricultural sector. The economy from 1978 to 2012 experienced a 45 percentage points reduction in this share.

Table 9 presents a decomposition of the contribution of non-agricultural TFP for the wedge accounting exercise of section 7.1. Two key factors affect the 5.8 percentage points non-agricultural TFP's contribution to GDP growth: private sector TFP growth is responsible for 3.4 percentage points and the reduction in the state sector is responsible for 1.5 percentage points. All four factors (private TFP growth, state TFP growth, labor reallocation, and capital reallocation) contribute to the change in the share of labor force in agriculture.

Table 10 presents a decomposition of the contribution of non-agricultural TFP for the exercise that evaluated the gains from reforms in section 7.1. Two key factors explaining the

3.0 percentage point contribution of non-agricultural TFP to GDP growth are private sector TFP growth (1.7 percentage points) and the reduction in the state sector (0.8 percentage points). All four factors contribute to the change in the share of labor force in agriculture.

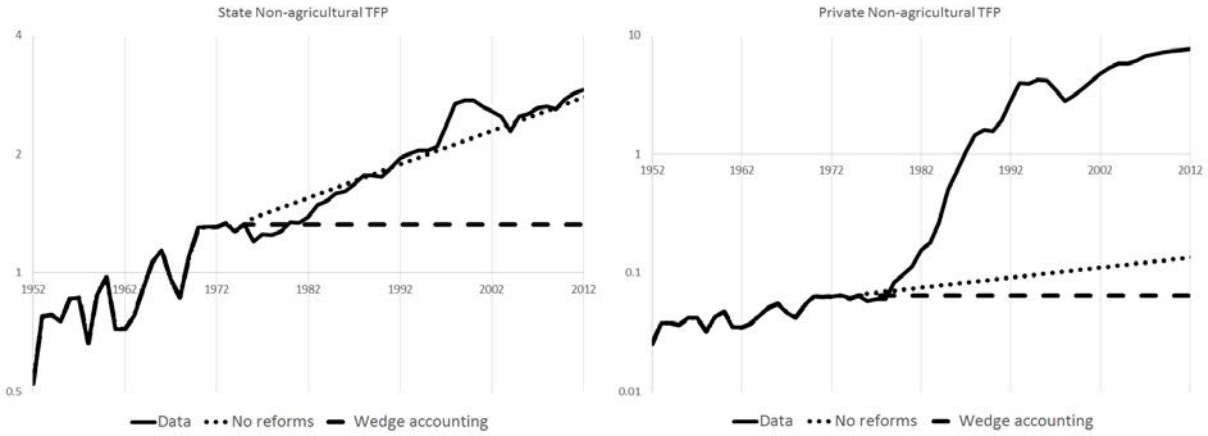

Figure 8: State and non-state sector TFP

Figure 9: Share of non-agricultural labor employed in the state sector

	Labor Share % lab. force	GDP % growth
Manufacturing TFP	-10.6	5.8
Private TFP	-3.4	3.4
State TFP	-3.0	0.6
Labor reallocation	-1.8	1.5
Capital reallocation	-2.4	0.3

Table 9: Wedge accounting 1978-2012: effects of the non-state sector

	Labor Share % lab. force	GDP % growth
Manufacturing TFP	-6.9	3.0
Private TFP	-2.1	1.7
State TFP	-1.7	0.3
Labor reallocation	-1.4	0.8
Capital reallocation	-1.7	0.2

Table 10: Effect of post-1978 reforms: contribution of the non-state sector

8 Robustness

We provide extensive robustness checks for all key parameters in the Appendix and summarize the results briefly here. First, we find that sizable changes in production function factor shares have only mild effects on the estimates. In particular, a substantial increase in the factor share of capital in the production function of the non-agricultural sector decreases the contributions of TFPs and increases the contribution of the mobility component of the intersectoral wedge. An increase in the factor share of labor implies a slightly bigger contribution of agricultural TFP while a decrease in the factor share of land implies a slightly smaller contribution of agricultural TFP to changes in the share of labor force in agriculture. While the effect of changes in these parameters on the results for the share of labor force in agriculture is small, the effect on results for GDP growth is negligible.

Second, a decrease in the degree of substitutability between agricultural and manufacturing goods makes economic outcomes more sensitive to developments in the agricultural sector, and, hence, attributes more of the changes in GDP and the share of labor force in agriculture to agricultural TFP and the consumption component of the intersectoral wedge. The contributions of other factors are diminished. Given that we deliberately chose a conservative value of the elasticity of substitution in our baseline calibration, less substitutability between goods ($\sigma = 0.8$ or lower values suggested by the literature) reinforces our main results.

Third, a lower subsistence level γ_A implies a smaller contribution of agricultural TFP and a larger contribution of the intersectoral wedges and the inverse is also true. Since we already set the subsistence level to a relatively high value in the baseline calibration, our main results represent a conservative estimate of the effects of intersectoral wedges. We find that for the highest level of $\gamma_A = 65$ that is close to the level of agricultural consumption per capita during

the famine period the contribution of the consumption component of the intersectoral labor wedge is reduced by about one third, and the contribution of agricultural TFP increases by one quarter. Conversely, setting a subsistence level lower than our baseline, increases the contribution of the consumption component of the intersectoral labor wedge and reduces the contribution of agricultural TFP. Other parameters essentially drop out of the expressions for changes in wedges and have no effect on the results. For more details and specifics we refer the reader to the appendix.

9 Projections for 2013-2050

In this brief and more speculative section we project the path of the Chinese economy until 2050. We consider two projections. The first is the continuation of the post-1978 trends which is the benchmark projection. The second is the imposition of the post-GLF (1966-1978) trends starting from 2013. This second projection can be viewed as a lower bound on future Chinese growth.

Specifically, we project the paths of sectoral TFPs and wedges and then simulate the model under the chosen paths of exogenous variables. We take the average trends for all wedges for two periods: 1966-78 and 1978-2012. The ratios of exports to value added by sector and the ratio of defense spending to GDP are assumed to stay constant at their average 2000-2012 levels. Population and labor force are assumed to grow 0.5 percent annually, which is on the lower end of rates observed over the 1978-2012 period. The components of the intersectoral wedges are assumed to keep changing at the same rate as in the corresponding periods. The intertemporal capital wedge is assumed to converge to its average 2000-2012 level from its 2012 level.

We assume that both agricultural and non-agricultural TFP continue growing initially at their average growth rates. However, at their current speed, TFP in both sectors may exceed the level of TFP in the USA by 2050. We thus assume that after Chinese TFP in either sector reaches the level of 70 percent of the US TFP, it slows down its growth and exponentially converges to US trend, as shown in Figure 10. These assumptions imply that non-agricultural TFP growth will slow down within the next 10 years, while agricultural TFP will keep growing at current rates until around 2030.

There are two key differences in the projections. The first is that TFP growth is faster

initially (until the convergence and the slowdown) in both sectors in the case of the post-1978 projection. The second is that in the case of projecting post-GLF trends, there is no decline in the production component of the intersectoral labor wedge.

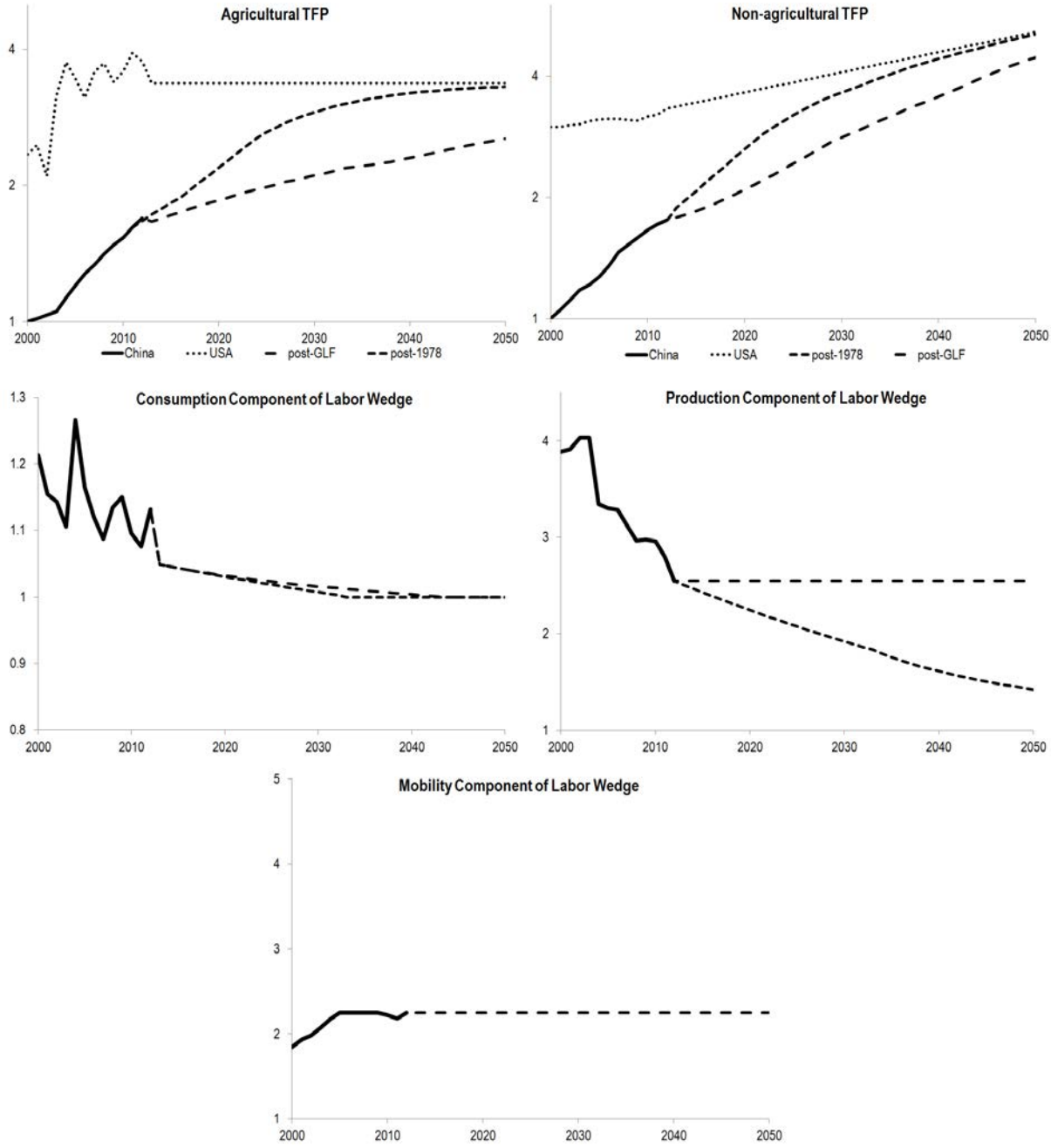

Figure 10: Actual and projected wedges in China in 2000-2050.

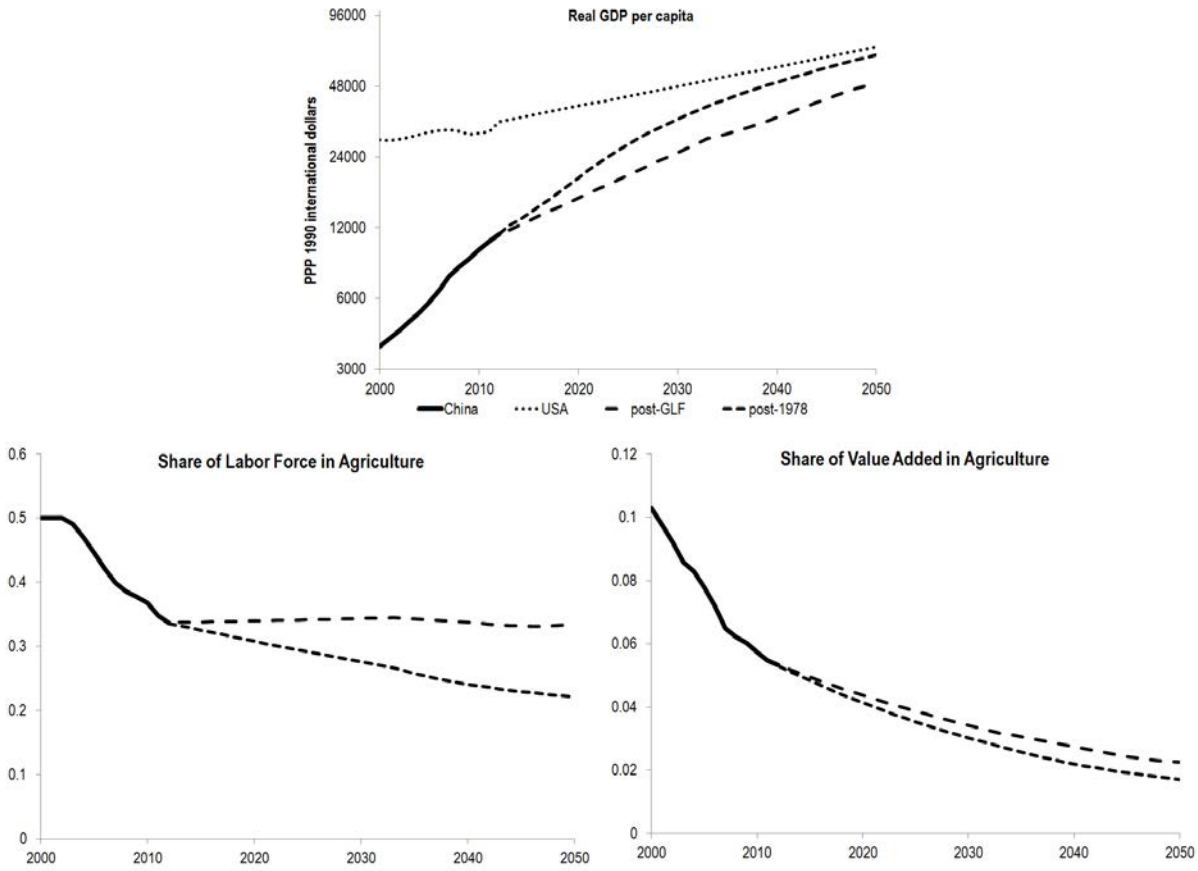

Figure 11: Actual and projected economic indicators in China in 2000-2050.

Figure 11 further describes the simulated path of the Chinese economy. Our post-1978 trend projection implies a stable share of investment in GDP at 40 percent. The movement of labor from agriculture to other sectors will continue, with the share of labor force in agriculture declining from 37 percent in 2010 to 28 percent in 2050. The share of value added by the agricultural sector will reach 2 percent in 2050 from 6 percent currently. The level of GDP per capita will approach that of the US by 2040 when China is likely to become a developed country. However, if the economy behaves similarly to what it did under the post-GFL trends, it would grow slower, and the movement of labor out of agriculture would stop.

We summarize the results of the wedge accounting decomposition for the simulated and projected economy for the period 1978-2050 in Table 11 for the benchmark case of continuation of the post-1978 reform trend. Figure 12 presents the same numbers on GDP growth decomposition in graphical form.

GDP, % growth	78-12	12-24	24-36	36-50
Manufacturing TFP	5.8	5.5	4.3	2.9
private TFP	3.4	4.7	3.5	2.1
state TFP	0.6	0.1	0.0	0.0
labor reallocation	1.5	0.8	0.8	0.8
capital reallocation	0.3	0.0	0.0	0.0
Agricultural TFP	0.8	0.2	0.1	0.0
Intersectoral wedges:	1.1	0.7	0.5	0.4
consumption	0.5	0.2	0.0	0.0
production	0.7	0.5	0.5	0.4
mobility	-0.2	0.0	0.0	0.0
capital	0.1	0.0	0.0	0.0
Demographics	1.3	0.4	0.3	0.3
Other	0.4	1.0	0.0	0.0
Total	9.4	7.8	5.2	3.6

Table 11: Wedge accounting and post-78 trend projection

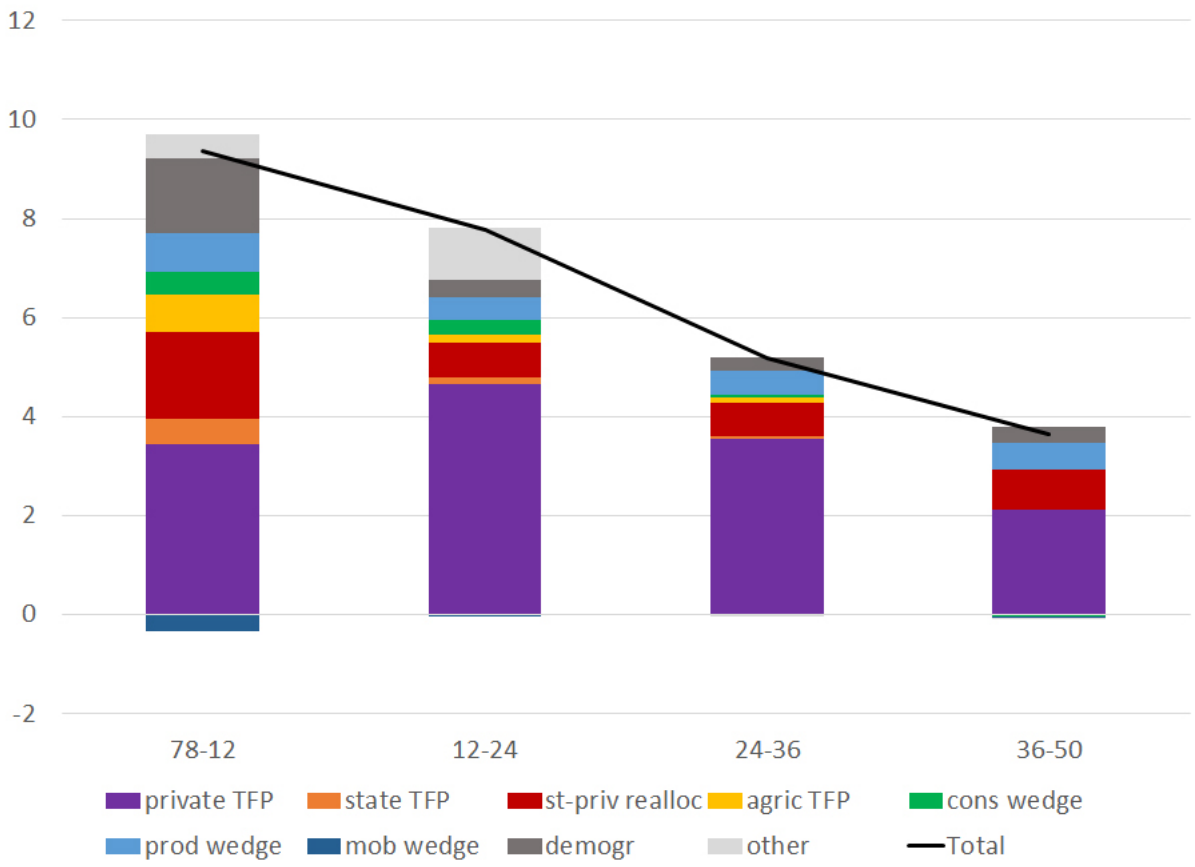

Figure 12: Actual and post-78 trend GDP growth.

The analysis of Figure 12 can be summarized as follows. As we argued, the key factors for 1978-2012 growth were: non-state, non-agricultural TFP growth and reallocation of labor from state to non-state non-agriculture; reduction of the wedges, most importantly, the consumption and the production wedges; and agricultural TFP growth. In the next three decades the key factors of growth are as follows. The growth in private non-agricultural TFP will continue to play a major role but its contribution diminishes as the economy approaches the technological frontier. Similarly, as the state sector diminishes, the relocation of labor from state firms plays a role smaller that during the 1978-2012 period. The reductions in intersectoral wedges and their components continue to play an important role. The contribution of the reduction in the production component of the intersectoral labor wedge is only slightly reduced compared with the 1978-2012 period. The reduction in the consumption component of the intersectoral labor wedge, however, is important only in the first decade of the projection as the level of this component is already quite low.

We conclude that China's economy can continue to grow at 7-8 percent per year for another 10 to 15 years. The reduction in wedges – the reallocation of labor from the state to the non-state, non-agricultural sector and the reduction in the production and consumption components of the intersectoral wedges – account for 1.5 percentage points of annual growth. Real GDP growth slows to around 4.5 percent by 2030 and to 3.6 percent in 2036-2050. Reallocation of labor from state to non-state firms and the decline in the production component of the wedge accounts for 1.2 percentage points in that period. In other words, as TFP growth slows, the relative contribution of the policies to reduce wedges in the economy rises from about 20 percent to 30 percent.

Finally, we summarize the results of the wedge accounting decomposition for the simulated and projected economy for the period 1978-2050 in Table 12 for the case of projecting post-GLF trends. Figure 13 presents the same numbers on GDP growth decomposition in graphical form.

The main difference in this scenario is a lower contribution to growth of manufacturing TFP up to 2036, and the lower contribution of the decrease in the production wedge. However, even in this case of growth slowdown, the economy is projected to grow at 4.5-5 percent until 2036.

GDP, % growth	78-12	12-24	24-36	36-50
Manufacturing TFP	5.8	4.1	4.1	3.5
Agricultural TFP	0.8	0.1	0.1	0.0
Intersectoral wedges:	1.1	0.1	0.0	0.0
consumption	0.5	0.1	0.0	0.0
production	0.7	0.0	0.0	0.0
mobility	-0.2	0.0	0.0	0.0
capital	0.1	0.0	0.0	0.0
Demographics	1.3	0.3	0.4	0.4
Other	0.4	0.4	0.0	0.0
Total	9.4	5.0	4.6	3.9

Table 12: Wedge Accounting and post-GLF trend Growth

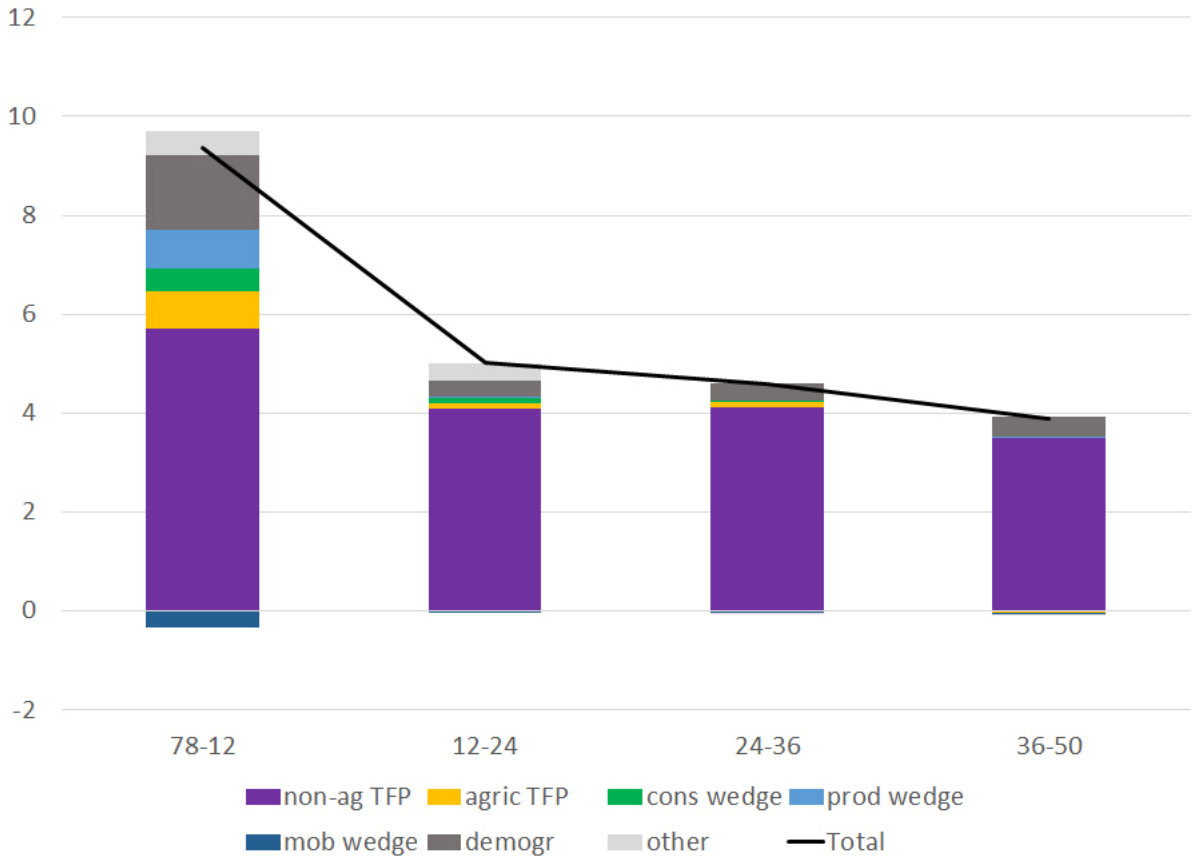

Figure 13: Actual and post-GLF trend GDP growth.

10 Conclusions

This paper provides a unified treatment of the 1953-2012 period of economic development of People's Republic of China. First, we find the importance of changes in the wedges and their components for growth and structural transformation. Second, our analysis of 1953-1978 serves as a key benchmark against which to compare the success of reforms in the post-1978 period. Third, we provide a careful analysis of the important changes in the economy of China in 1953-2012 and assess the key driving factors behind these changes. As such, the model is a useful lens through which to view different policies implemented during the time of a significant transformation of the country.

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12 Appendix

12.1 First order conditions for the 2-sector model

The full system of equations for the 2-sector model is given by:

$$Y_t^A = X_t^A \left(K_t^A\right)^{\alpha_{K,A}} \left(N_t^A\right)^{\alpha_{N,A}}, \tag{12}$$

$$Y_t^M = X_t^M \left(K_t^M\right)^{\alpha_{K,M}} \left(N_t^M\right)^{\alpha_{N,M}}, \tag{13}$$

$$N_t c_t^A + ex_t^A = Y_t^A, \tag{14}$$

$$N_t c_t^M + ex_t^M + K_{t+1} = Y_t^M \left(1 - g_t^M\right) + (1-\delta) K_t, \tag{15}$$

$$1 = \beta \frac{c_t^M}{c_{t+1}^M} \left(1 + \tau_t^I\right) \left(r_{t+1}^M + 1 - \delta\right), \tag{16}$$

$$\frac{\eta}{1-\eta} \frac{c_t^M}{c_t^A - \gamma^A} \frac{1}{p_{A,t}} \left(1 + \tau_t^C\right) = 1, \tag{17}$$

$$r_t^A = p_{A,t} \alpha_{K,A} \frac{Y_t^A}{K_t^A}, \tag{18}$$

$$r_t^M = \alpha_{K,M} \frac{Y_t^M}{K_t^M}, \tag{19}$$

$$w_t^M = \alpha_{N,M} \frac{Y_t^M}{N_t^M}, \tag{20}$$

$$w_t^A = p_{A,t} \alpha_{N,A} \frac{Y_t^A}{N_t^A} \left(1 + \tau_t^P\right), \tag{21}$$

$$\frac{w_{M,t}}{w_{A,t}} = \left(1 + \tau_t^M\right), \tag{22}$$

$$\frac{r_{M,t}}{r_{A,t}} = \left(1 + \tau_t^K\right), \tag{23}$$

$$N_t^A + N_t^M = \chi_t N_t, \tag{24}$$

$$K_t^A + K_t^M = K_t. \tag{25}$$

$$q_t ex_t^A + ex_t^M = 0. \tag{26}$$

$$ex_t^A = x_t Y_t^A \tag{27}$$

Given initial K_0, and a path for wedges (exogenous variables) $\{X_t^M, X_t^A, \tau_t^C, \tau_t^P, \tau_t^M, \tau_t^K, \tau_t^I, x_t, q_t, g_t^M, N_t, \chi_t\}_{t=0}^T$ the equilibrium is unique. Under the assumption of perfect foresight, this set of equations is invertible, so that for any set of data there is a unique set of exogenous variables that re-produce the dataset as an equilibrium of the model. Thus, our analysis is essentially an accounting procedure. This allows us to use counter-factual paths of wedges to compute the marginal contribution of each wedge to the deviations of data from undistorted allocations.

12.2 Three-sector model

We extend our 2-sector model by dividing the non-agricultural sector into 2 sub-sectors: state and non-state. We follow the route taken by Brandt and Zhu (2010) and Dekle and Vandenbroucke (2012). We only discuss the elements of the model that change when compared with the 2-sector model. We start with the frictionless benchmark.

There are three sectors in the economy, agricultural (A), state non-agricultural (S), non-state non-agricultural (N). Output in sector $i \in \{A, S, N\}$ is produced according to the Cobb-Douglas production function

$$Y_t^i = F_t^i\left(K_t^i, N_t^i\right) = X_t^i \left(K_t^i\right)^{\alpha_{K,i}} \left(N_t^i\right)^{\alpha_{N,i}}, \tag{28}$$

where X_t^i, K_t^i, and N_t^i are, respectively, total factor productivity, capital stock, and labor in sector i; $\alpha_{K,i}$ and $\alpha_{N,i}$ satisfy $\alpha_{K,i} + \alpha_{N,i} \leq 1$. We denote by $F_{K,t}^i$ and $F_{N,t}^i$ the derivatives of F_t^i with respect to K_t^i and N_t^i.

The S and N sectors produce the same non-agricultural good (M) which can be consumed, used to accumulate capital, for foreign trade or for government consumption. The feasibility condition for non-agricultural goods is:

$$N_t c_t^M + ex_t^M + G_t^M + I_t = Y_t^S + Y_t^N \equiv Y_t^M. \tag{29}$$

The capital is allocated to sectors according to

$$K_t^A + K_t^S + K_t^N = K_t. \tag{30}$$

The feasibility constraint for labor is

$$N_t^A + N_t^S + N_t^N = \chi_t N_t, \tag{31}$$

where χ_t is an exogenously given fraction of working age population.

Firms in sector i hire capital and labor to maximize profits

$$\Pi_t^i = \max_{\left\{K_t^i, N_t^i\right\}} p_t^i X_t^i \left(K_t^i\right)^{\alpha_{K,i}} \left(N_t^i\right)^{\alpha_{N,i}} - w_t^i N_t^i - r_t^i K_t^i,$$

where $p_t^N = p_t^S = 1$.

Maximization behavior of the firms implies that w_t^i and r_t^i are equal to the marginal product of capital and labor in sector i in each period.

We define two wedges in addition to those introduced in the 2-sector model. These two wedges correspond to the intratemporal distortions in capital and labor allocations between the state and non-state sectors within non-agriculture. Combining the first-order conditions of firms in the state and non-state sectors and assuming identical CRS production functions ($\alpha^{K,S} = \alpha^{K,N} \equiv \alpha^{K,M}$, $\alpha^{N,S} = \alpha^{N,N} \equiv \alpha^{N,M}$,$\alpha^{K,M} + \alpha^{N,M} = 1$), it follows that:

$$1 = \frac{X_t^N}{X_t^S} \left(\frac{w_t^N}{w_t^S}\right)^{\alpha^{N,M}} \left(\frac{r_t^N}{r_t^S}\right)^{\alpha^{K,M}}. \tag{32}$$

This result poses a problem to assuming exogenous processes for ratios of returns to labor and capital in the state and non-state sectors. If we make assumptions consistent with equation (32), then any allocation of labor and capital satisfies equilibrium conditions. If we make assumptions that violate equation (32), then labor and capital are allocated entirely to one of the two sectors. To eliminate multiplicity of equilibria and corner solutions, we follow the route taken by Brandt and Zhu (2010): by assuming that the share of non-agricultural labor force allocated to the state sector is determined exogenously:

$$\psi_t \equiv \frac{N_t^S}{N_t^S + N_t^M}. \tag{33}$$

The wedge governing capital reallocation is then defined in the standard way:

$$1 + \tau_{RS,t} \equiv \frac{F_{K,t}^N}{F_{K,t}^S} = \frac{r_t^N}{r_t^S}. \tag{34}$$

All the other wedges remain intact. We need to define some extra variables to compare the extended model with the 2-sector model. We define production of non-agricultural goods as the sum of production in the state and non-state sectors:

$$Y_t^S + Y_t^N \equiv Y_t^M \equiv X_t^M \left(K_t^N + K_t^S\right)^{\alpha^{K,M}} \left(N_t^N + N_t^S\right)^{\alpha^{N,M}} \tag{35}$$

$$X_t^M = \frac{\left(X_t^N\right)^{\frac{\alpha^{K,M}+\alpha^{N,M}}{\alpha^{N,M}}} (1-\psi_t)^{\alpha^{K,M}+\alpha^{N,M}} (1+\tau_{RS,t})^{\frac{\alpha^{K,M}}{\alpha^{N,M}}} + \left(X_t^S\right)^{\frac{\alpha^{K,M}+\alpha^{N,M}}{\alpha^{N,M}}} (\psi_t)^{\alpha^{K,M}+\alpha^{N,M}}}{\left(\left(X_t^N\right)^{\frac{1}{\alpha^{N,M}}} (1-\psi_t)(1+\tau_{RS,t})^{\frac{1}{\alpha^{N,M}}} + \left(X_t^S\right)^{\frac{1}{\alpha^{N,M}}} \psi_t\right)^{\alpha^{K,M}}} \tag{36}$$

The planner allocates capital in the following proportion:

$$\frac{\omega_t}{1-\omega_t} \equiv \frac{K_t^S}{K_t^N} = \frac{\psi_t}{1-\psi_t} \left(\frac{1}{(1+\tau_{RS,t})} \frac{X_t^S}{X_t^N}\right)^{\frac{1}{\alpha^{N,M}}}. \tag{37}$$

The wage differences between state and non-state sectors are determined as follows:

$$\frac{w_t^N}{w_t^S} = \left(\frac{X_t^S}{X_t^N}\right)^{\frac{1}{\alpha^{N,M}}} \left(\frac{1}{1+\tau_{RS,t}}\right)^{\frac{\alpha^{K,M}}{\alpha^{N,M}}}. \tag{38}$$

Changes in $\tau_{RS,t}$ affect the allocation of capital, and also the relative returns to both capital and labor. Changes in ψ_t determine the allocations of both capital and labor.

The returns to capital and labor in the non-agricultural sector are defined as:

$$r_t^M \equiv \frac{\alpha\left(Y_t^N + Y_t^S\right)}{K_t^M} = \omega_t w_t^S + (1-\omega_t) w_t^N, \tag{39}$$

$$w_t^M \equiv \frac{\beta\left(Y_t^N + Y_t^S\right)}{N_t^M} = \psi_t w_t^S + (1-\psi_t) w_t^N. \tag{40}$$

Our analysis remains an accounting procedure. Given initial K_0, competitive equilibrium allocations with wedges $\left\{X_t^N, X_t^S, X_t^A, \tau_t^C, \tau_t^P, \tau_t^M, \tau_t^K, \tau_t^I, x_t, q_t, g_t^M, N_t, \chi_t, \tau_{RS,t}, \psi_t\right\}_{t=0}^T$ match data exactly. This again allows to compute the marginal contribution of each wedge to the deviations of data from undistorted allocations.

12.3 Computational Details

The goal of the wedge accounting methodology we use in this paper is to quantify the contributions of changes in wedges towards changes in economic variables. Two economic variables of particular interest are real GDP and the share of labor force in agriculture. For our procedure to be an "accounting" procedure, we need to find two paths of wedges: the first (baseline)

path should account for the data exactly, and the second path should match some benchmark counterfactual against which to evaluate economic outcomes. We choose the benchmark counterfactiual to be one in which all economic variables are fixed at their initial values throughout the period of interest. Once we have paths of all economic variables in the data and in the benchmark counterfactual, we invert the system of equations (12-27) and use it to compute the corresponding paths of wedges.

Given this choice of the benchmark counterfactual, the difference between wedge paths by construction accounts for all of the changes in economic variables during the period of interest. Moreover, we can compute the effect of each wedge on an economic variable of interest (e.g. real GDP) by switching the path of just one wedge from its baseline path to its counterfactual path and simulating the model. Adding counterfactual wedge paths, one at a time, we can compute the effects of all the wedges on the variable of interest. A combination of these effects gives the desired wedge decomposition that accounts for the total change in the economic variable of interest. Thus, the name "wedge accounting".

However, there are several technical challenges that complicate the practical implementation of our accounting procedure.

First, economic agents are forward-looking and care about their consumption in the future. Thus, each simulation has an undefined terminal condition for expected consumption in period T+1, which has a major effect on the path of the model economy. To make meaningful comparisons between contributions of wedges, expectations of future consumption have to be somehow held "fixed" across simulations.

The way we choose to deal with this problem is to extend the period of interest and make projections of economic variables far into the future (up to 2050). Then we could construct the benchmark counterfactual in such a way that although there is no change in economic variables during the period of interest (e.g. 1978-2012), later on the economy could catch up to the baseline projected path (e.g. between 2020 and 2050). Similarly, for all intermediate simulations, with some wedges changing and others fixed, we assume that in the far future the economy reaches this same level for all economic variables of interest. Under this assumption, we can keep the terminal condition identical for all simulations and solve the problem outlined above.

Second, there is a complication implied by capital accumulation. Although most counter-

factual paths of wedges are constant paths equal to their initial values throughout the period of interest, some wedges (e.g. the investment wedge) require some movement to match the path of no change in economic variables, and their level may be very different from their initial value.

Finally, the model is highly non-linear, so that the sum of individual effects of wedges is not equal to the total change in an economic variable. There are several ways of dealing with this problem. One way, used in Cheremukhin et al. (2013), is to compute the Shapley values for contributions of each wedge. Shapley's procedure requires computing contributions for all possible orders in which wedges could be switched from the benchmark counterfactual to the baseline, and then averaging contributions across those orders. However, for this specific application (due to large changes in economic variables and a long period of interest) the Shapley method is not practical due to the difficulty in finding starting values for the shooting (simulation) algorithm from which it would converge to the solution. Instead, we choose to break down wedges into blocks (TFPs, intersectoral wedges, everything else), and compute the contribution of each block. Then we rescale the contributions of elements of each block to match the total contribution of the block. We attribute the residual (the difference between sum of block contributions, and total change in economic variables) to the "other" category in all of our results. We do this in order to isolate the intra-temporal wedges from the inter-temporal investment wedge and effects of expectations, which we also put into the "other" category when reporting results. Thus, the dynamic forward-looking nature of the exercise poses certain technical difficulties, which result in some uncertainty about the separate contributions of these various dynamic factors.

To sum up, our wedge accounting methodology consists of six steps.

1. Project the path of the economy into the future far enough for convergence between different combinations of wedges to take place.

2. Construct the benchmark counterfactual path of economic variables and its convergence to the projected path in the far future.

3. Compute the wedges for both the actual (and projected) path and the benchmark counterfactual.

4. Find starting values for the shooting algorithm which allows the simulation to reproduce both the actual (and projected) and the counterfactual paths exactly given the paths of wedges.

5. Compute effects of wedges by taking the baseline simulation and then removing variations

in one wedge at a time.

6. Compute effects of blocks of wedges by taking the baseline simulation and removing variations in a block of wedges at a time.

Combining the results from steps 5 and 6 and properly rescaling them to match block effects gives the results reported in our Tables. This procedure was done for various periods and counterfactuals for GDP and the share of labor force in agriculture. It is generally applicable to all variables of interest.

12.4 Sensitivity Analysis

In this section we consider the effects of alternative parameterizations of the model. The baseline values for the parameters are presented in Table 2. We consider the effects of changes in the key parameters: the production elasticities, the subsistence level and the elasticity of substitution between goods — on two of our main results: wedge accounting for 1978-2012 and the effect of reforms.

Tables 13-16 present the effects of parameter changes on the wedge accounting decomposition of GDP growth and the change in the share of labor force in agriculture from 1978 to 2012. Similarly, Tables 17-20 present the effects of parameter changes on the effect of post-1978 reforms on GDP growth and the change in the share of labor force in agriculture.

We summarize the main effects as follows. First, a decrease in the degree of substitutability between agricultural and manufacturing goods makes economic outcomes more sensitive to developments in the agricultural (subsistence) sector, and, hence, attributes more of the changes in GDP and the share of labor force in agriculture to agricultural TFP and the distortion to consumption, i.e. the consumption component of the intersectoral distortion. The contributions of other factors are diminished. Given that we deliberately chose a conservative value of the elasticity of substitution in our baseline calibration, less substitutability between goods (suggested by most micro estimates) only reinforces our main results.

Second, a substantial increase in the factor share of capital in the production function of the non-agricultural sector decreases the contributions of TFPs and increases the contribution of the mobility component of the intersectoral distortion. However, the overall effect of this change in parameters is small. Third, the effects of changes in the factor shares of labor and land in the agricultural production function are even smaller. An increase in the factor share

of labor implies a slightly bigger contribution of agricultural TFP while a decrease in the factor share of land implies a slightly smaller contribution of agricultural TFP to changes in the share of labor force in agriculture. The effects on contributions to GDP growth are negligible.

Fourth, the effects of changes in the subsistence level are more pronounced. A lower subsistence level implies a smaller contribution of agricultural TFP and a bigger contribution of intersectoral distortions. A higher subsistence level implies a larger contribution of agricultural TFP and a smaller contribution of intersectoral distortions. Note that we deliberately set the subsistence level to a relatively high value in the baseline calibration, so our baseline results represent a conservative estimate of the effects of intersectoral distortions. Note also that the level of $\gamma_A = 65$ is close to the highest possible level of subsistence which would match the level of agricultural consumption per capita during the famine of the Great Leap Forward. Thus, this exercise represents the lower bound on the contributions of intersectoral distortions on GDP and share of labor force in agriculture. Conversely, setting a subsistence level lower than our baseline, would only reinforce our main results.

Finally, we have redone the analysis using alternative price series using agricultural and industrial goods prices advocated by Young (2003).[59] For agricultural prices we used the General Purchasing Price Index for Farm Products and for industrial prices we used the Ex-Factory Price Index for Industrial Products, available from the CSY for various years. We find that the effect of using these alternative price series on our results is negligible.

	Baseline	$\alpha^{K,M} = 0.5$ $\alpha^{N,M} = 0.5$	$\alpha^{K,A} = 0.08$ $\alpha^{N,A} = 0.61$	$\alpha^{K,A} = 0.22$ $\alpha^{N,A} = 0.61$
Manufacturing TFP	5.8	5.4	5.7	5.7
Agricultural TFP	0.8	0.7	1.0	0.7
Intersector Wedges:	1.1	0.9	1.1	1.0
consumption	0.5	0.5	0.5	0.5
production	0.7	0.6	0.7	0.7
mobility	-0.2	-0.3	-0.2	-0.2
capital	0.1	0.0	0.1	0.1
Demographics	1.3	1.4	1.2	1.4
Other	0.4	1.1	0.5	0.6
Total	9.4	9.4	9.4	9.4

Table 13: Wedge accounting 1978-2012: Sensitivity of GDP growth

[59] Results are available upon request.

	Baseline	$\sigma = 0.8$	$\gamma_A = 27$	$\gamma_A = 65$
Manufacturing TFP	5.8	5.2	5.7	5.7
Agricultural TFP	0.8	1.1	0.4	1.0
Intersector Wedges:	1.1	1.2	1.6	0.8
consumption	0.5	0.6	0.9	0.3
production	0.7	0.7	0.9	0.6
mobility	-0.2	-0.2	-0.3	-0.2
capital	0.1	0.1	0.1	0.1
Demographics	1.3	1.2	1.1	1.3
Other	0.4	0.6	0.4	0.6
Total	9.4	9.4	9.4	9.4

Table 14: Wedge Accounting 1978-2012: Sensitivity of GDP growth

	Baseline	$\alpha^{K,M} = 0.5$ $\alpha^{N,M} = 0.5$	$\alpha^{K,A} = 0.08$ $\alpha^{N,A} = 0.61$	$\alpha^{K,A} = 0.22$ $\alpha^{N,A} = 0.61$
Manufacturing TFP	-10.6	-7.8	-9.8	-10.6
Agricultural TFP	-12.2	-11.0	-14.5	-9.0
Intersector Wedges:	-21.6	-19.6	-21.3	-21.4
consumption	-10.6	-10.4	-10.5	-10.5
production	-16.7	-15.8	-16.4	-16.6
mobility	6.7	7.2	6.6	6.7
capital	-1.0	-0.6	-1.0	-1.0
Demographics	2.9	0.3	3.8	2.0
Other	4.6	1.3	4.9	3.0
Total	-36.9	-36.9	-36.9	-36.9

Table 15: Wedge accounting 1978-2012: Sensitivity of Labor Share

	Baseline	$\sigma = 0.8$	$\gamma_A = 27$	$\gamma_A = 65$
Manufacturing TFP	-10.6	-0.7	-10.1	-10.5
Agricultural TFP	-12.2	-19.7	-5.8	-15.4
Intersector Wedges:	-21.6	-23.5	-32.4	-16.3
consumption	-10.6	-14.1	-19.4	-6.3
production	-16.7	-15.4	-19.4	-15.2
mobility	6.7	6.7	7.7	6.2
capital	-1.0	-0.8	-1.3	-0.9
Demographics	2.9	2.5	5.9	1.7
Other	4.6	4.4	5.5	3.5
Total	-36.9	-36.9	-36.9	-36.9

Table 16: Wedge accounting 1978-2012: Sensitivity of labor share

	Baseline	$\alpha^{K,M} = 0.5$ $\alpha^{N,M} = 0.5$	$\alpha^{K,A} = 0.08$ $\alpha^{N,A} = 0.61$	$\alpha^{K,A} = 0.22$ $\alpha^{N,A} = 0.61$
Manufacturing TFP	3.0	3.1	3.0	3.0
Agricultural TFP	0.3	0.1	0.3	0.2
Intersector Wedges:	1.0	0.7	0.9	1.0
consumption	0.2	0.2	0.2	0.3
production	0.6	0.6	0.6	0.6
mobility	-0.1	-0.2	0.0	0.0
capital	0.2	0.1	0.2	0.2
Other	0.0	0.0	0.0	0.0
Total	4.2	3.9	4.2	4.2

Table 17: No post-1978 reforms: Sensitivity of GDP growth

	Baseline	$\sigma = 0.8$	$\gamma_A = 27$	$\gamma_A = 65$
Manufacturing TFP	3.0	2.9	3.0	3.0
Agricultural TFP	0.3	0.4	0.2	0.3
Intersector Wedges:	1.0	1.1	1.0	1.1
consumption	0.2	0.3	0.2	0.3
production	0.6	0.5	0.6	0.6
mobility	-0.1	0.1	-0.1	0.0
capital	0.2	0.2	0.2	0.2
Other	0.0	0.0	0.0	0.0
Total	4.2	4.3	4.2	4.2

Table 18: No post-1978 reforms: Sensitivity of GDP growth

	Baseline	$\alpha^{K,M} = 0.5$ $\alpha^{N,M} = 0.5$	$\alpha^{K,A} = 0.08$ $\alpha^{N,A} = 0.61$	$\alpha^{K,A} = 0.22$ $\alpha^{N,A} = 0.61$
Manufacturing TFP	-6.9	-5.6	-6.9	-6.9
Agricultural TFP	-2.5	-2.3	-2.8	-2.4
Intersector Wedges:	-13.9	-11.7	-13.3	-14.3
consumption	-3.0	-2.6	-2.8	-3.2
production	-12.9	-15.2	-12.6	-13.0
mobility	4.0	7.1	3.9	4.0
capital	-2.0	-1.0	-1.9	-2.1
Other	-0.6	-0.5	-0.6	-0.5
Total	-23.9	-20.1	-23.6	-24.1

Table 19: No post-1978 reforms: Sensitivity of Labor Share

	Baseline	$\sigma = 0.8$	$\gamma_A = 27$	$\gamma_A = 65$
Manufacturing TFP	-6.9	-5.8	-6.2	-7.1
Agricultural TFP	-2.5	-3.5	-1.5	-3.0
Intersector Wedges:	-13.9	-12.6	-13.3	-16.7
consumption	-3.0	-2.4	-2.5	-5.1
production	-12.9	-9.4	-13.1	-13.7
mobility	4.0	1.6	4.1	4.2
capital	-2.0	-2.4	-1.9	-2.2
Other	-0.6	-0.5	-0.8	-0.5
Total	-23.9	-22.4	-21.8	-27.4

Table 20: No post-1978 reforms: Sensitivity of labor share