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

Anton Cheremukhin, Mikhail Golosov, Sergei Guriev, Aleh Tsyvinski

February 11, 2014

Abstract

This paper studies structural transformation of the Chinese economy since 1953 through a lens of a two-sector growth model. We compute sectoral TFPs and wedges in the capital, labor, and product markets. This is a simple accounting procedure — given the wedges, the model matches the data exactly. The first result is that the sectoral TFPs and, importantly, the reduction in labor barriers play the key role in determining welfare and the behavior of economic variables in both the 1953-1978 and the 1978-2011 period. The second result is that in 1953-78 China's development policies significantly outperformed those during Soviet industrialization under Stalin. However, if policies of the post-1978 period started earlier, this would lead to very large welfare gains. We also find that the Great Leap Forward was a short-lived policy shock with negative welfare gains only in one year but with an overall slightly positive aggregate impact. Our third result is to quantify the welfare gains and drivers of the economy post-1978. We show that while the post-1978 reforms were very successful, the continuation of the 1953-1978 policies with the exception of the Great Leap Forward would have delivered about a half of the post-1978 gains.

*Cheremukhin: Federal Reserve Bank of Dallas; Golosov: Princeton and NES; Guriev: NES and Sciences Po; Tsyvinski: Yale. We are indebted to Carsten Holz for providing us with several data series in this paper and for his many insightful discussions on Chinese statistics. We also thank Andrew Atkeson and Stephen Roach for their comments.

"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." (Fairbank and MacFarquhar 1987, p. xiii)

1 Introduction

We study the Chinese economy from 1952, three years after the founding of the People's Republic of China, through the lens of a two-sector neoclassical growth model. Our main focus and the main contribution of the paper is the analysis of the 1953-1978 period. This "pre-1978-reforms" 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. Second, the successful First Five-Year Plan (FFYP), the disastrous 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, Golosov, Guriev, and Tsyvinski (2013). On the other hand, the Chinese policies were quite distinct from their Soviet counterparts. We study a variety of questions using our model. What are the welfare costs of the Great Leap Forward, and what were the main contributing elements to the disaster? What if China implemented the Soviet industrialization policies either starting with the First-Five Year Plan in 1953, or with the Great Leap Forward in 1958? What if Deng's reforms were started not in 1978 but in 1953? Thirdly, the analysis of the 1953-1978 period is perhaps the most important benchmark against which the post-1978 growth should be measured. The main question here is: how would the Chinese economy develop if the policies of the 1953-1978 period continued? Relatedly, we provide a detailed analysis of the main factors behind the 1978-2011 economic performance.

Specifically, our model is a two-sector (agricultural and non-agricultural) neo-classical model with frictions building on Cole and Ohanian (2004), Chari, Kehoe, McGrattan (2007) and

Chermukhin, et. al. (2013). In such a model the growth of aggregate total factor productivity can come from either growth of TFP within each sector or from the reallocation of resources from a less productive agricultural sector to a significantly more productive non-agricultural sector.[1] This is why it is important to study the frictions (or "wedges") that slow down such reallocation 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 product market wedge (so called "price scissors") is the difference between producer and consumer prices of goods. The intertemporal capital wedge is the cost of reallocating capital across time. We construct a consistent dataset covering 1952-2011 that we use to infer the wedges (and other exogenous variables such as sectoral TFPs, government purchases, and international trade) from the computed first order conditions of the model. We want to emphasize that the determination of wedges is exclusively an accounting procedure. Given the wedges, the neoclassical model matches the data exactly. In other words, the wedges are not calibrated but are determined to exactly match the data. We provide an extensive discussion of the policies and historical evidence consistent with the wedges that we find.

The main focus of our paper is on the 1953-1978 period.[2] The first part of our analysis is to perform a welfare/growth-accounting exercise for the whole period of 1953-1978 to determine the main factors behind welfare changes and changes in other economic variables. We fix wedges at their initial values (1953) for the whole period of interest (1953-78) and simulate the economy. We then compare the simulated path with the actual historical path. We compute the difference between GDP per capita levels in the final period (1978) and in welfare discounted and summed over 1953-1978. Compared to the counterfactual, welfare increases by 45.5 percent[3] and GDP increases by 158.5 percent. The growth of non-agricultural TFP played the largest role (21.1 percent gains in welfare). The growth of agricultural TFP contributed 13.9 percent. The price

[1] In 1952, the agricultural sector employed 84% of the labor force but produced only 65% of GDP (see Figure 1). In other words, in terms of value added per worker, the non-agricultural sector was almost three times as productive as the agricultural one. In 1978, these numbers were, respectively 71%, 28% and the difference in labor productivity between the two sectors was 6 times. In 2008, the agricultural sector employed 40% of labor forces and produced only 5% of GDP, so the labor productivity difference was 13 times. In Section 4 we find what part of this striking difference is explained by differences in capital accummulation and what part is due to different levels and growth rates in TFP.

[2] Our analysis takes as an initial point the year of 1952 — 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.

[3] The welfare numbers are reported in consumption equivalents.

scissors (9.5 percent of welfare) played a role almost as important as the growth in agricultural TFP. Reduction in the labor barrier (the combined effect of the price scissors and the labor wedge) accounted for 8.3 percent of welfare.

The second part of our analysis is to assess the policies of the GLF, the FFYP, and the 1962-1978 phase.

We first simulate the economy assuming that the GLF did not happen. We linearly extrapolate TFP in both sectors, the price scissors wedge, the normalized capital and labor wedges between 1957 and 1964. We find that the overall effect of the GLF on the welfare of the consumer born in 1957 to be 2.6 percent of consumption, positive but not very large. The most important factor affecting welfare is the fall of the agricultural (-2.9 percent) and non-agricultural TFP (-6.2 percent) which together account for a 9.1 percent reduction in welfare. However, this fall was more than compensated by the increase in the price scissors (6.7 percent) and the decrease in the labor distortion (4.2 percent). In other words, the decrease in the labor barrier led to a 10.9 percent increase in welfare. The combined effect of this reduction in the normalized labor wedge thus balances the welfare costs of the fall in TFPs. The effects of government spending and international trade are small and act in opposite directions, essentially, canceling each other. The effect of the lower capital wedge is also small. The influence of the wedges and sectoral TFPs on other economic indicators (GDP per capita, labor share, capital) have the same general pattern as the effects described for welfare. It is also useful to look at the year by year changes in welfare compared to the counterfactual. Interestingly, the only year with a negative welfare effect of the GLF was 1960 (-3.9 percent). The behavior of the wedges is consistent with the extensive overview of the policies and the historical background that we provide. In summary, the Great Leap Forward was indeed "a brutal way"[4] to decrease the barriers and move resources from agriculture. However, the policies were so disruptive that led to a precipitous fall in sectoral TFPs. Despite large losses in productivity, the decrease in the labor barrier resulted in an overall positive welfare effect. Overall, the GLF was a very short episode of disruption to the economy with a negative welfare impact only in 1960[5].

[4]"A brutal way" to decrease the barriers is a phrase that Acemoglu and Robinson (2012) used assessing Stalin's industrialization.

[5]It is important to emphasize that the welfare losses that we find for policies during the Great Leap Forward are a lower bound. The representative consumer framework ignores the fact that different parts of population bore very different consequences of economic policies (for example, it was the rural population that mainly suffered famine). We also do not include the costs of political repressions. Taking these policies into account is

We then perform two counterfactual simulations to compare China's economic performance and policies with those in the Soviet Union under Stalin. In the first comparison with the Soviet Union, we start Stalin's policies in 1957 (1956 is thus 1928 of Stalin's policies) using the wedges calculated in Cheremukhin et. al (2013). 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 Stalin's peak of reforms (1932). This is done to isolate the GLF, and to highlight striking similarities as well as differences between the GLF and the most brutal phase of Stalin's collectivization. We find the overall effect on welfare of 3.9 percent of consumption. The most important factor affecting the difference in welfare is that the fall in non-agricultural TFP was less severe in China than in the Soviet economy. This yields 25.8 percent of welfare. During the Great Leap Forward, the fall in agricultural TFP was larger, however, accounting for -3.7 percent of welfare. Stalin's policies were more successful in breaking the labor barrier. The combined effect of the reduction in the normalized labor wedge was -17.8 percent. The smaller decrease in the labor distortion under GLF policies accounted for -16.7 percent. The effects of the price scissors were roughly comparable. The consequence of this is a 20.8 percent higher labor share in agriculture after the Great Leap Forward, largely accounted for by the combined effect of the higher normalized labor wedge (21.1 percent). The GDP per capita shows patterns similar to that of welfare. The persistent nature of labor reallocation in the Soviet Union led to a higher level of capital accumulated by 1975. We summarize the results as follows. If China followed Soviet industrialization and collectivization policies, the results in terms of welfare, GDP, and capital would have been worse than a combination of the Great Leap Forward and the retrenchment. The Great Leap Forward and Stalin's collectivization had similar effects on welfare at the peak of the campaigns. The quick reversal of the policies under the Great Leap Forward led to a significantly higher labor barrier in China but allowed to recover the losses in agricultural TFP. In contrast, Soviet collectivization policies implemented in China would have achieved a long-term reduction of the labor barrier at the cost of a long-term reduction of manufacturing TFP.

In the second comparison with the USSR, we contrast the combined effects of the FFYP and the GLF starting in 1953 to Stalin's collectivization and industrialization. This is done to compare the much milder initial collectivization period of the very successful First-Five Year

likely to significantly increase welfare losses.

Plan together with the Great Leap Forward to the much more brutal Soviet collectivization and industrialization. Specifically, we impose the changes in wedges and sectoral TFPs calculated in Cheremukhin, et. al (2013) for Stalin's 1928-1939 economy on our model of the Chinese economy from 1953. Our main finding is that Chinese policies in 1953-1964 led to significantly higher welfare (24.3 percent) compared to Stalin's policies in 1928-1939[6]. The difference in the effects of the GLF versus collectivization are very similar to the first comparison with the Soviet Union. However, China's First Five-Year Plan was indeed a very important success, especially, in its impact on non-agricultural TFP (and also, albeit smaller, impact on agricultural TFP). In summary of these two comparisons with the Soviet Union, China's economic policies outperformed those in USSR.

The third part of our analysis of 1953-1978 is to ask what if 1978 reforms started in 1953. Specifically, we compare the actual data for the Chinese economy to the simulated path of the Chinese economy with post-1978 policies. We impose trend changes in intersectoral wedges and sectoral TFPs of 1978-2012 on the 1953-1978 period. We find dramatically higher welfare, GDP per person, and capital in the simulated economy. In other words, if China started reforms earlier, the generation born in 1953 would have 28.6 percent higher welfare, 5.4 times higher capital, and 3.2 times higher GDP per capita by year 1978. By far, the most important factor affecting the difference in welfare is the difference in TFP growth. This yields a 30.7 percent increase in welfare. However, the impacts of the higher price scissors (-3.3 percent) and the lower labor wedge (1.1 percent) in the simulated economy are also noticeable.

In addition to our main focus on the 1953-1978 period, we study the 1978-2011 period through the lens of our model. We first perform a welfare/growth-accounting exercise for the 1978-2011 period. We fix wedges at their initial values (1978) for the whole period of interest (1978-2011) and simulate the economy. We then compare the simulated path with the actual historical path. Overall, compared to the counterfactual, welfare increases by 96.6 percent. The growth of non-agricultural TFP played by far the largest role (54.3 percent). The growth of agricultural TFP contributed 20.0 percent. The combined effect of the price scissors wedge (8.0

[6]One has to be careful with interpreting this comparison. By 1928, Soviet Russia recovered from the disruptions of the Civil War and also implemented a successful New Economic Policy Program (NEP). China, however, by 1953 might have still been in recovery from the Civil War. This may be one explanation for the fast TFP growth during the First Five Year Plan. Thus, we may overestimate the gains of our second comparison of China to USSR. However, the magnitude of the gain is large enough so that our main conclusion of the better performance of Chinese policies compared to Stalin's policies remains.

percent) and the labor wedge (15.6 percent) played a role almost as important as the growth in agricultural TFP. The rest of the wedges played a relatively minor role.

We then study what would happen if 1953-1978 policies continued after 1978. This is an important counterfactual as it provides a benchmark against which to measure the success of the post-1978 reforms. Specifically, we compare the actual data for the Chinese economy to the simulated Chinese economy with 1953-1978 policies continued. We preserve the simulation for the period 1952-1973, and impose the average trends in wedges and sectoral TFPs of 1953-1978 (excluding GLF) on the period 1974-2011. We find dramatically higher welfare, GDP, and capital in the actual economy than in the the hypothetical economy with extrapolated 1953-1978 policies. In other words, the actual China economy performed 46.4 percent better in welfare terms, accumulated 44 percent more capital, and had a 54.3 percent higher GDP per capita in the year 2000. The economy would also have a 17.6 percent lower labor share in agriculture. In short, the continuation of Mao's policies would have been disastrous compared to the actual path of the economy. The most important factor for welfare is the combined effect of the price scissors and the labor distortions — the normalized labor wedge yields a 19.5 percent welfare gain. The second most important factor is agricultural TFP growth with a welfare gain of 10.5 percent and non-agricultural TFP growth accounts for a 9.6 percent welfare gain. In other words, the reduction in the labor barrier is as important as TFP growth for welfare. Finally, the reduction of government purchases yields 4.7 percent of welfare.

Another way to summarize the measure of success of post-1978 reforms is as follows. Compared to the situation of no TFP growth and wedges fixed at 1978 level, the actual economy achieved a 96.6 percent increase in welfare — this is our growth/wedge accounting simulation. Compared to the continuation of 1953-1978 policies, the actual economy achieved a 46.4 percent welfare gain. That is, the continuation of 1953-1978 policies would have yielded about half of the post-1978 reform welfare gains.

We now briefly discuss the state of the literature on the topic. 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 Chinese economy from 1953 to 2011. We are aware of only one strand of papers dedicated to model-based macroeconomic analysis of the 1953-1978 period by Gregory Chow (1985, 1993, 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 Dekle and Vandenbroucke (2010, 2012), growth accounting by Young (2003), Brandt and Zhu (2010) and Zhu (2012), the model of "growing like China" with the focus on financial frictions by Song, Storesletten, and Zilibotti (2011), and a model of misallocation by Hsieh and Klenow (2010). More broadly, our paper is related to the studies of the the structural transformation as Stokey (2001), Buera and Kaboski (2009, 2012), Caselli and Coleman (2001), and Hayashi and Prescott (2008).

The paper is organized as follows. Section 2 develops the model and defines the wedges. Section 3 describes the data and calibration. Section 4 calculates and describes the wedges and provides an extensive overview of the policies and historical background consistent with the wedges. Section 5 contains all the counterfactual simulations. Section 8 concludes.

2 Main Idea and Theoretical Framework

2.1 Model

We consider a standard two-sector neo-classical general equilibrium model in discrete time, similar to the one we used to analyze Stalin's industrialization (Cheremukhin et al., 2013).

There is an economy populated by N_t identical individuals. There are two sectors in the economy, agricultural (A) and non-agricultural (M). In each period, t, output in sector $i \in \{A, M\}$ is produced according to the Cobb-Douglas production function

$$Y_t^i = F_t^i\left(K_t^i, N_t^i\right) = A_t^i\left(K_t^i\right)^{\alpha_{K,i}}\left(N_t^i\right)^{\alpha_{N,i}}, \tag{1}$$

where A_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.

Each individual maximizes discounted utility of consumption:

$$\sum_{t=0}^{\infty} \beta^t U\left(c_t^A, c_t^M\right), \tag{2}$$

where

$$U\left(c_t^A, c_t^M\right) = \eta \log\left(c_t^A - \gamma^A\right) + (1-\eta)\log c_t^M,$$

c_t^A is consumption of agricultural goods and c_t^M is consumption of non-agricultural goods.[7] The subsistence consumption level of agricultural goods is denoted by $\gamma^A \geq 0$. The discount factor is $\beta \in (0,1)$. We use notation $U_{c,t}^i$ to denote the derivative of U in period t with respect to the consumption good $i \in \{A, M\}$.

Population growth is exogenous. The total population in period t is denoted by N_t. The fraction of total labor allocated to agricultural and non-agricultural sector in period t are denoted, respectively, by $N_t^A + N_t^M$. Each working individual is endowed with one unit of labor services which he supplies inelastically. The share of working age population χ_t is exogenous. Therefore, the feasibility constraint for labor is

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

We assume that the new capital I_t can be produced only in the non-agricultural sector. Capital can be used in any sector. Aggregate capital in period t is denoted by K_t. Capital allocated in period t to agricultural and non-agricultural sector is denoted, respectively, by K_t^A and K_t^M. The law of motion for aggregate capital is given by

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

where δ is the depreciation rate. The capital is allocated to sectors according to

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

We assume that there exists an exogenous sequence of government consumption of non-agricultural goods, G_t^M. Let ex_t^A and ex_t^M denote net exports of agricultural and non-agricultural goods in period t. Let q_t be exogenous terms of trade for those goods.

The feasibility conditions in the two sectors are

$$N_t c_t^A + ex_t^A = Y_t^A, \tag{6}$$

[7] In the model, we use terms "non-agriculture" and "manufacturing" interchangeably. While construction and services played a very important role in China's industrialization, in this paper we focus on a two-sector model and aggregate all non-agricultural production into one sector. In the data, c_t^M corresponds to the private consumption of all non-agricultural goods and services.

and

$$N_t c_t^M + ex_t^M + G_t^M + I_t = Y_t^M. \tag{7}$$

Throughout the paper we assume that the trade balance is zero in all periods, so that the net exports satisfy

$$q_t ex_t^A + ex_t^M = 0. \tag{8}$$

Given exogenous parameters and initial conditions (K), equations (2)-(8) provide a complete description of our model.

2.2 First order conditions without frictions

We now characterize a standard social planner's problem. The optimality conditions are as follows:

the intratemporal capital allocation condition across sectors is

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

the intratemporal labor allocation condition is

$$1 = \frac{U_{c,t}^M}{U_{c,t}^A} \frac{F_{N,t}^M}{F_{N,t}^A}, \tag{10}$$

and the intertemporal (Euler) condition is

$$1 = \left(1 + F_{K,t+1}^M - \delta\right) \beta \frac{U_{c,t+1}^M}{U_{c,t}^M}. \tag{11}$$

The solution to this social planner's problem coincides with the decentralized competitive equilibrium. We omit the formal definition of the competitive equilibrium as it is standard. In the competitive equilibrium, all agents pool their income and maximize their utility (2) subject to a budget constraint in each period

$$\begin{aligned} &p_t^A N_t c_t^A + N_t c_t^M + K_{t+1}^A + K_{t+1}^M = \\ &= w_t^A N_t^A + w_t^M N_t^M + \left(1 + r_t^A - \delta\right) K_t^A + \left(1 + r_t^M - \delta\right) K_t^M + \Pi_t^M + \Pi_t^A - T_t, \end{aligned}$$

where w_t^i, r_t^i, Π_t^i are, respectively, the wage, the rate of return on capital, and the profit in sector i; p_t^A is the price of agricultural goods in terms of non-agricultural goods; and T_t is the lump sum taxes.

Firms in sector i hire capital and labor to maximize profits

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

where $p_t^M = 1$.

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. Maximization behavior of workers and owners of capital implies that w_t^i and r_t^i are equalized across sectors. Maximization of utility by consumers implies that

$$1 = \frac{U_{c,t}^A}{p_{A,t} U_{c,t}^M}, \tag{12}$$

We show that data rejects the implications of this frictionless competitive equilibrium.

2.3 Wedges accounting

The Chinese economy since 1950 had a large number of institutional frictions and government policies that distorted decisions of households and firms. In order to map these frictions and policies into distortions, we use the methodology developed by Cole and Ohanian (2004) and Chari, Kehoe and McGrattan (2007) and applied in our paper to USSR (Cheremuknin, et. al. 2013).

Specifically, we define four wedges, each equal to deviations in the right hand side of equations (9), (10), (11), and (12) from 1. The first three wedges correspond to the intratemporal distortions in capital and labor allocations between sectors and to the intertemporal distortion. The fourth wedge is related to one of the main policies used by communist planners — price scissors. This policy introduces a wedge between the relative prices that a producer of agricultural goods faces, and the prices that consumers of agricultural goods pay. Specifically, if producer of agricultural goods faces a price $p_{A,t}$ and a consumer faces a price $\tilde{p}_{A,t}$, then the *price scissors* wedge, $1 + \tau_{C,t}$, is given by $1 + \tau_{C,t} = \tilde{p}_{A,t}/p_{A,t} = \frac{U_{c,t}^A}{p_{A,t} U_{c,t}^M}$. Thus, using additional data on the producer relative prices (for the first three wedges), we define four wedges, $\tau_{R,t}, \tau_{W,t}, \tau_{C,t}$

and $\tau_{K,t+1}$ as follows

$$
\begin{aligned}
1+\tau_{R,t} &\equiv \frac{F^M_{K,t}}{p_{A,t}F^A_{K,t}} = \frac{r^M_t}{r^A_t}, \\
1+\tau_{W,t} &= \frac{F^M_{N,t}}{p_{A,t}F^A_{N,t}} = \frac{w^M_t}{w^A_t}, \\
1+\tau_{C,t} &= \frac{U^A_{c,t}}{p_{A,t}U^M_{c,t}}, \\
1+\tau_{K,t+1} &= \left(1+F^M_{K,t+1}-\delta\right)\frac{\beta U^M_{c,t+1}}{U^M_{c,t}}.
\end{aligned} \tag{13}
$$

Note that the intratemporal distortions for capital and labor implied by the right hand side of expressions (9) and (10) are given by $1+\tilde{\tau}_{R,t} = (1+\tau_{R,t})/(1+\tau_{C,t})$ and $1+\tilde{\tau}_{W,t} = (1+\tau_{W,t})/(1+\tau_{C,t})$. These *normalized* wedges (as well as the intertemporal wedge) do not require knowledge of the prices.

The normalized intratemporal labor wedge, for example, implies that reduction in misallocation of labor between agriculture and manufacturing can be achieved either by reducing the wedge $\tau_{W,t}$, which is determined by the ratio of the wages paid in the two sectors and in many models is often related to the size of barriers to labor mobility or by increasing $\tau_{C,t}$, which measures distortions between consumer and producer prices. This distinction helps us to evaluate the effect of different policies.

Finally, one can also think of $\left\{A^M_t, A^A_t, ex^i_t, G^M_t\right\}_{t=0}^T$ as wedges. These variables are exogenous to the equilibrium and — as the wedges above — depend on the policies and institutional frictions.

We want to emphasize that our analysis is essentially an accounting procedure. Given initial K_0, we find such $\left\{A^M_t, A^A_t, \tau_{R,t}, \tau_{W,t}, \tau_{C,t}, \tau_{K,t}, ex^i_t, G^M_t\right\}_{t=0}^T$ that the competitive general equilibrium allocations with wedges $\left\{A^M_t, A^A_t, \tau_{R,t}, \tau_{W,t}, \tau_{C,t}, \tau_{K,t}, ex^i_t, G^M_t\right\}_{t=0}^T$ match data exactly. This allows to compute the marginal contribution of each wedge to the deviations of data from undistorted allocations and carry out quantitative analysis of various counterfactuals.

3 Data and calibration

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 2011. Most importantly, it details the

sectoral variables including defense spending, capital series and international trade. To our knowledge, this construction of the data for this period for an application of a two-sector neoclassical model is new.

3.1 Data sources and construction of the data

The main source of data on value added for the 1952-78 period is 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 from HL 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 source allows 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. HL is also our source for gross fixed capital formation in current prices which serves as our measure of nominal investment. We convert it to real investment using the GDP deflator.

The second source of data on value added for the period of 1978-2011 is the China Statistical Yearbook (2012) (CSY) provided to us by Carsten Holz. We apply the same method to the data from the CSY to estimate real value added by sector, real aggregate investment and the relative price of agricultural and non-agricultural goods.

We use Holz (2006), Tables 19 and 20 on pages 159-161, as our main source for 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 (computed from CSY and HL) 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 varies between 3 and 5 percent.

We also use data from Holz (2006) to break down the whole capital stock into capital used in the agricultural and non-agricultural sectors. This sectoral division of capital stock is only available for 1978-2011. 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. As initial values we use the value from the same table for non-agricultural capital, and the value of 450 for agricultural capital. We then break down by sector the total real capital stock in 1978 prices computed earlier using the relative proportions implied by Chow's data.

We use data on the labor force and its composition also from Holz (2006), Table 14 in the appendix on page 238. We extrapolate it for the period 2003-2011 assuming a constant rate of exit from the agricultural sector. We use data on population from the Palgrave International Historical Statistics database and extrapolate values for the 2003-2011 period in the same way.

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 1983-2011 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) (FKY). FKY 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 FKY, 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 2001-2011 period we extrapolate these ratios using trends from 1995-2000.

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 1952-2011 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.

3.2 Summary of the data

Figures 1 and 2 show aggregate and sectoral, agricultural and non-agricultural, data for China for 1952-2011. We subdivide the discussion of this period into two subperiods: pre- and post-1978 reforms.

China 1952-1977

The Chinese economy in 1952-1977 grew rather rapidly, with a 3.9 percent average rate of growth of real GDP per capita. However, the economy did not experience structural transformation from agriculture. The primary occupation for 83 percent of the working-age Chinese population was agriculture in 1952, and this fraction declined very slowly (with the exception of the brief period during the GLF when about 20 percent of the labor force was temporarily moved from agriculture to manufacturing), staying above 80 percent until 1970 and declining to 75 percent in 1977. The role of agriculture in the economy was also very important, with about 65 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 1978-2011

In 1978-2011 growth in real GDP per capita sped up 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 dropped from 75 percent in 1977 to 40 percent in 2011. The share of value added produced in the agricultural sector fell from 30 percent to 5 percent respectively. Defense expenditures dropped abruptly from 6 percent of GDP to 1.5 percent of GDP in the late 1980s. The relative prices of non-agricultural goods show a dramatic 40-percent appreciation in the 5 years following the reforms, and then continued appreciating at approximately the same pace as in the pre-reform period.

Figure 2 shows agricultural and non-agricultural per capita value added in 1978 prices,

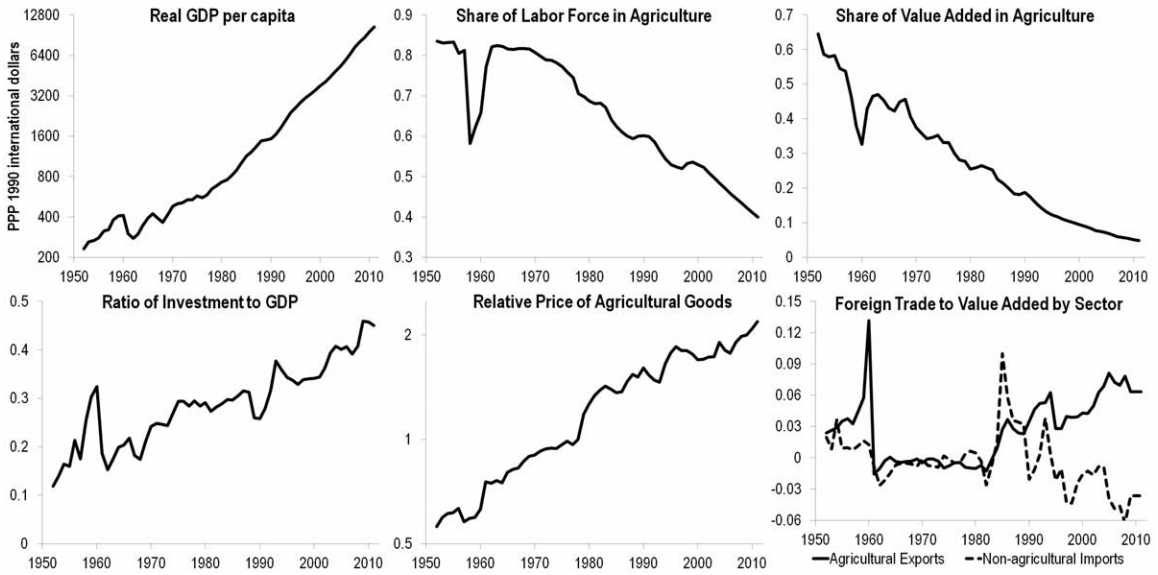

Figure 1: Macroeconomic indicators of the People's Republic of China, 1952-2011.

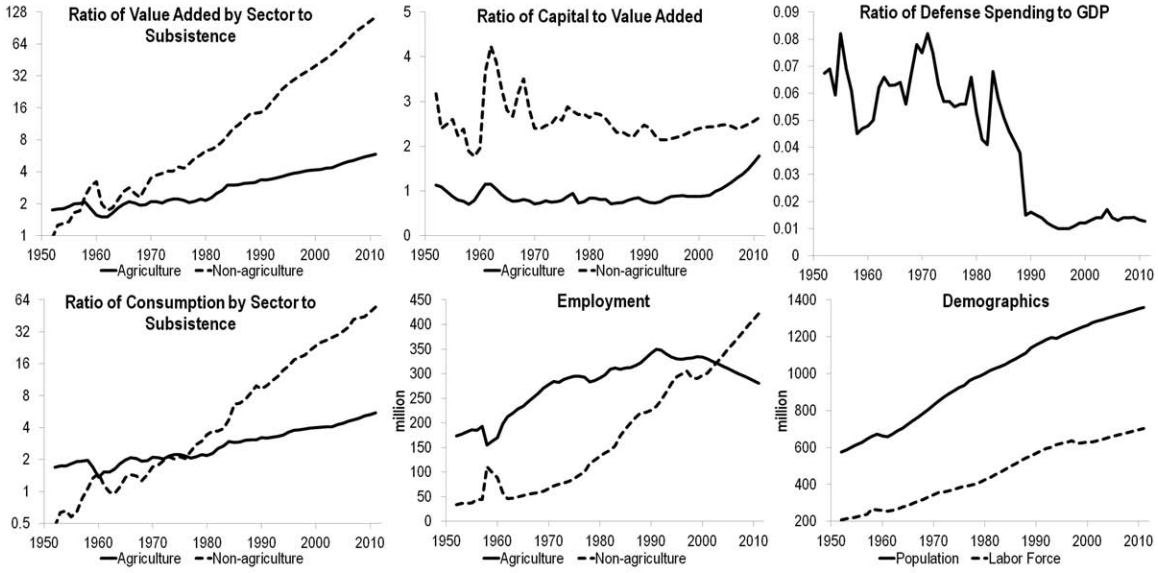

Figure 2: Macroeconomic indicators of People's Republic of China, 1952-2011.

capital stock, and government expenditures. Non-agricultural value added shows remarkable growth throughout both periods, growing at 8.7 and 10.3 percent, respectively. Agricultural value added grew much slower, at 2.8 percent prior to reforms, and 4.1 percent afterwards. The ratios of sectoral capital stock to sectoral GDP remain roughly stable over the whole period.

3.3 Calibration

To calibrate the model we need to choose values of eight parameters and the initial value of capital stock. The five technology parameters include the elasticities of production functions in the agricultural and manufacturing sectors with regard to capital and labor, $(\alpha_{Ki}, \alpha_{Ni})$, and the depreciation rate, δ. Three preference parameters include the discount factor, β, the asymptotic agricultural consumption share, η, and the subsistence level in agriculture, γ^A.

The depreciation rate is set to $\delta = 0.05$, and the discount factor is set to $\beta = 0.96$. The asymptotic consumption shares of agricultural and non-agricultural goods are set to $\eta = 0.15$ and $1 - \eta = 0.85$, correspondingly.[8] We assume that all intermediate goods used in the production of manufactured goods represent labor. We set the corresponding factor shares for the manufacturing sector to $\alpha_{K,M} = 0.3$ and $\alpha_{N,M} = 0.7$. Instead, we assume that all intermediate goods used in the production of agricultural goods represent land. We set the remaining capital and labor shares to $\alpha_{K,A} = 0.14$ and $\alpha_{N,A} = 0.55$ (thus assuming that land's elasticity is 1-0.14-0.55=0.31). The values for these parameters are also in the range of values adopted by Caselli and Coleman (2001) and Stokey (2001) and calibrated using direct estimates for the U.S. and the U.K.[9]

The elasticities for the agricultural sector are also in line with estimates of Tang (1982), who has 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. However, there is a large variation in estimates of factor shares in Chinese agriculture in the literature, neatly summarized by Wen (1993, Table 9, page 27). We check the robustness of our results to these alternative estimates of factor shares in an online appendix.

[8] Parameter η only enters as a constant in one first-order condition and determines the scale of the price scissors wedge, $\tau_{C,t}$. By the same token, since the relative price of agricultural to manufacturing goods is measured in the data as an index, the scale of the price scissors wedge, $\tau_{C,t}$, means little, so we normalize it to be zero in 1952.

[9] Caselli and Coleman (2001) use the values $\alpha_{K,M} = 0.6$, $\alpha_{N,M} = 0.34$, $\alpha_{K,A} = 0.21$ and $\alpha_{N,A} = 0.6$. Stokey calibrates $\alpha_{K,M} = 0.5$, $\alpha_{N,M} = 0.5$, $\alpha_{K,A} = 0.17$ and $\alpha_{N,A} = 0.38$.

We choose the initial capital stock to match the observed level of capital in 1952. We do not have data needed to directly determine the subsistence parameter, γ^A. We set the subsistence level to 56 yuan per capita per year in 1978 prices. This subsistence level accounts for 66 percent of agricultural consumption per capita in 1952. If we set it higher than 79 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. Finally, for χ_t, the path of the fraction of labor force in the population is pinned down by the data.

We provide extensive robustness checks for all key parameters in the online appendix.

4 Wedges and policies

We now proceed with the calibrated model to compute wedges using equations (13). Figure 3 shows wedges for China with solid lines and their average level (or trends, for the case of TFPs) with dashed lines. In this figure, we draw the trends for the pre-reform (1953-1978) and for the post-reform (post-1978) periods. This division is consistent with the common historical view and with the related evidence for the structural break in 1978.

In the remaining part of the section, we give a more nuanced division in sub-periods. Before starting the analysis of the wedges, 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-). Cambridge History of China (MacFarquhar and Fairbank 1987, Perkins 1991) considers the periodisation 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. Selden (1979, p.153) provides an exceptionally useful summary of the main stages in China's development

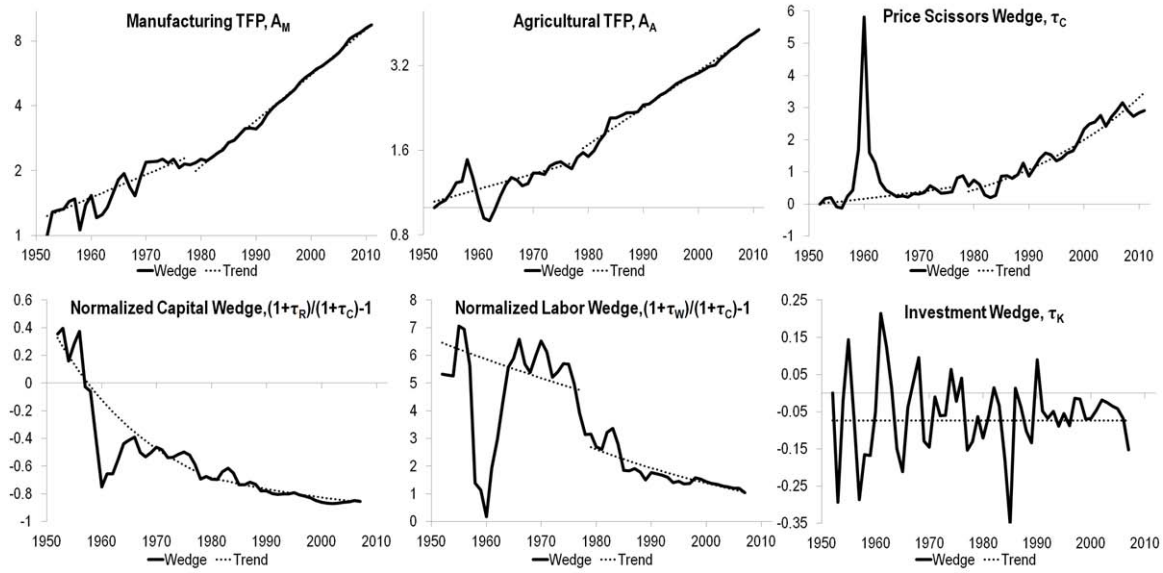

Figure 3: China: Wedges

priorities.

In what follows, we consider a periodization into the First Five-Year Plan (1952-57), Great Leap Forward (1958-62), the period of 1962-78, and the post-reform period of 1978 onward. We stop at 2011 and do not discuss the reforms proposed in the Third Plenum in November 2013.

4.1 Initial conditions

We begin with briefly discussing the initial conditions and decisions and strategies chosen in 1949-52. The creation of the People's Republic of China in 1949 was a turning point in Chinese history. After the World War II and the Civil War, the Communist party consolidated power and embarked on a comprehensive political, economic and social transformation. Following the Soviet experience, the Chinese communists planned to turn a backward agrarian economy into a modern industrial power through collectivization of agriculture, expropriation of "agricultural surplus", and a massive top-down industrial investment.

The initial conditions in China 1950 were different from those in the Soviet Union. Imperial Russia was behind its Western counterparts, yet, it had been growing for several decades before the World War I. Stalin inherited a relatively developed industry and urbanized population. The Chinese economy before 1950 was a stagnating agrarian one. It had not experienced

growth; moreover, its very institutions were built to preserve the status quo rather than to promote growth. "The Confucian political economy ... was that of an agrarian empire and was directed above all to the maintenance of social stability through the guarantee of minimal standards of survival and the amelioration of unacceptable inequalities." (Richardson, 1999, p. 85). Lin (2012, p. 32-34) also argues that the tradition of the Chinese bureaucratic state was to reject the modern (or Western) approach to innovation thus creating a bias for the status quo. The second important distinction was land scarcity. While in Russia, especially after the World War I and the Civil War of 1917-22, labor was relatively scarce compared to land, in China, the combination of centuries of stagnation and of rapid population growth[10] resulted in relative labor abundance and land scarcity.

Despite the difference in the initial conditions, the Communist Party immediately announced a program that was very similar to the Soviet model (see Lin, 2012, p. 75, Spence, 2013, p. 461 on the Common Program for China announced at the People's Political Consultative Conference convened by Mao Zedong in September 1949). An ambitious plan was created for rural reform through rent reduction and land redistribution based on the Soviet model; and the work centered on the rehabilitation and development of the heavy industry.

By 1952, the communist government completed the initial post-war recovery: inflation had been brought under control, output in both industry and agriculture surpassed the highest pre-war levels. (Naughton, 2007, p. 64, Richardson, 1999, p. 103). At the very same time, the government completed a massive redistribution of land from rich to poor households: about 43 percent of China's cultivated land was redistributed to about 60 percent of the rural population (Teiwes, p. 87). This redistribution was brutal: according to Spence (2013, p. 463), one landlord family in six had a member killed during the land reform; a total of about 1 million people who died. The redistribution to the poor also included massive investment in public health (Perkins 1975, p. 127).

By 1952, the government also introduced systematic collection of economic data (Richardson, 1999, p. 25, Rawski, 1979, p.15, Perkins, 1975, p. 116).

[10]The population of China increased from 30 million in 1800 to 600 million in 1950 (Richardson, 1995, p. 2).

4.2 Wedges in 1952-1957 (First Five-Year Plan)

The period of 1952-57 was that of the First Five-Year Plan, "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[11]. China's planners – who learned from the USSR and who also understood that agriculture was much more important for China – never tried to sacrifice agriculture as badly (Perkins 1975, p. 143). China proceeded with collectivization much more gradually.[12] There was no single-minded focus on the expropriation of the agricultural surplus. The rich peasants were restricted but not liquidated. (Teiwes, p. 110). This made China's First Five Year Plan much more successful than its Soviet counterpart (Lardy, p. 155).

We now turn to Figure 3 to document the behavior of the wedges and to provide the historical background that is consistent with the wedges.

Sectoral TFPs grew significantly. Average annual TFP growth was 4.3 percent between 1952 and 1957 in agriculture, and by 7.8 percent in non-agriculture.

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

[11] As evidenced, for example, in Mao's famous 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 Soviet development strategy (Selden 1979, p. 315-322).

[12] Mao was always "walking on two legs", he was a Marxist but also wanted to adopt it to Chinese tradition (Schram, p. 1, p. 42-43).

[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).

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 very 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 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 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 Communist Party. Agriculture was also viewed as an important source of raw materials for the industry. Overall, the process of collectivization in China was able to "limit the disorder and destruction of economic resources that marked the Soviet comparing" (Teiwes 1987, p.141). We return to this issue in a more detailed comparison with Stalin's industrialization in Section 5.1.3. 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 labor productivity, decreased the travel time between plots, and allowed the use of mechanization (Spence 2013, p. 491)

[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).

The capital wedge decreased significantly. This is consistent with the main strategy of the First Five-Year Plan that placed the overwhelming priority in allocation of investment resources to industry and production of capital goods. 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.[15]

There is a slight increase in the price scissors wedge starting in 1957. The First Five-Year Plan laid the foundation of the government procurement at artificially low prices[16] but certainly was much more gradual and not to the extent of the Great Leap Forward or Stalin's collectivization. The magnitude of the increase in the price scissors is not surprising given the relative mildness of the policies compared to the increase during the Great Leap Forward or during Stalin's collectivization.

There is an increase in the normalized labor wedge starting 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. The origins of the system can be be traced back 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.[17] Additionally, Rawski (1979, p. 67 and footnote 34) provides evidence for the wage scissors which in our model are equivalent to the price scissor wedge. The wages of the industrial sector were set higher (order of 2:1) than in the country side exacerbating the rural-

[15] 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).

[16] See, e.g., a detailed description in Eckstein (1977, p. 78 and p. 117) and Naughton (2007, p. 80).

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

urban divide. This resulted in rising inequality and was one of the reasons for the 1957 policy turn – instead of fixing the problems with large-scale industrialization, Mao decided to pursue the small-scale industrial firms and decentralization (Perkins, 1973, p. 227).

In this and other subsections, we do not to focus on the the investment wedge. The primary reason is that the investment wedge exhibits large short term fluctuations. This is consistent with the large and frequent policy changes regarding investment but would necessitate a much finer periodization of the economy, essentially, year by year.

4.3 Wedges in 1958-1962 (Great Leap Forward)

We now discuss the behavior of the wedges and sectoral TFPs during the Great Leap Forward in Figure 3 and the policies and historical background consistent with these wedges. We also use the calculation of the wedges and the connection of wedges to policies to argue in Section 5.1.3 that the GLF was even more drastic in some dimensions than Stalin's Big Push.

The collectivization of agriculture was completed already by 1956: 98 percent of farm households were members of cooperatives or collective farms (Naughton, 2007, p. 67). At the very same time, it was clear that the cooperatives failed — because of the lack of incentives to exert effort and poor management and coordination (Naughton, 2007, p. 237, Spence, 2013, p. 509). The worrisome developments in agriculture resulted in a retrenchment. The Eighth Party Congress (September 1956) discussed economic moderation; the earlier policies were criticized as a "reckless advance". Mao encouraged open debate and praised blooming of the "Hundred Flowers". However, already in 1957 Mao understood that freer debate may be politically costly and changed his mind. He launched the "Anti-Rightist Campaign" that targeted non-party intellectuals who had spoken out during the "Hundred Flowers". About 800 000 were removed from their jobs, condemned and sent to labor camps (Naughton, 2007, 69). Instead, Mao suggested to address the problem of falling agricultural output through a Great Leap Forward. Instead of cooperatives (which included about 50 households), GLF introduced communes (thousands of households). The communes would be used to mobilize resources for construction, provide social services, and develop rural small-scale industries. Within the communes, all material incentives were abolished. "These communes attempted to practice full communism" (Rawski, 1979, p. 76.).

The reported results of 1958 were very positive. Partially, it was due to an exceptionally

good harvest, 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 (notorious "backyard furnaces"). At the same time, the complete destruction of incentives as well as poor harvests had a dramatic negative effect on agricultural output. "In 1959, grain output declined by 15 percent, in 1960 by another 15 percent, and in 1961 on par with 1960." (Lin, 2012, p. 88). The number of hogs in 1961 after private agricultural activity had been virtually eliminated was only 52 percent of the 1957 peak." (Perkins, 1991, p. 483). The combination of high plans (and therefore procurement quota) and low output resulted in a great famine which cost about 30 million lives (Meng et al., 2013).

We find that TFP in agriculture fell by 50 percent from its peak in 1958 to the trough in 1962. TFP in manufacturing fell in 1958 by 33 percent and again in 1961 by 23 percent.

Several factors affected TFP in both manufacturing and agriculture in the first years of GLF: rejection of material incentives, monetary rewards, bonuses in the industry, curtailment of free markets in the countryside and the productive private farming plots – all of which worsened incentives (Naughton 2007, p. 69; Lardy 1987b, p. 365).

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.[18] 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 construction and design of the irrigation projects which reduced rather than raised yields. The unusually bad weather in 1960 also had serious adverse effects on the yields.[19] Li and Yang (2005) argue that the most important causal factors in the collapse of agricultural output between 1958 and 1961 are: (1) the diversion of resources from agriculture,

[18] Lin (1990) discusses a variety of hypotheses and presents a view emphasizing the role of incentives in the fall of productivity.

[19] 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)

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; (3) bad weather contributing 12.9 percent to the collapse.

The fall in productivity was reversed only after 1962. Following the agricultural crisis, the state undertook the "Agriculture first" strategy. This strategy included reopening of private plots (Lardy 1987b, p. 389), decentralization of commune management that essentially decreased the size of the production unit to that in 1955-56, and a greater reliance on material incentives (Eckstein, 1977 p. 60-61).

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 extremely inefficient (e.g., Ekstein, 1977, p. 124).[20] Third, the Sino-Soviet split led to the departure of 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 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 price scissors wedge dramatically increased by a factor of 4.7 from 1958 to reach its peak in 1960, before falling to the pre-GLF level in 1964. 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 2006, Table 1). 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 1962, procurement was drastically reduced (Lardy 1987b, p. 388).

The normalized labor wedge dramatically decreased by 82 percent from 1957 to 1960 and then shot back up returning to its 1957 level in 1964. It is not surprising that this was accompa-

[20]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, 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".

nied by an unprecedented increase in the agricultural labor force.[21] The reversal of the wedge is 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).

The normalized capital wedge decreased dramatically to the trough in 1960 and then started its gradual 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)[22]. 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 agricultural TFP in those years.[23]

4.4 Wedges 1962-1978

The period of 1962-1966 was a period of recovery from the disaster of the Great Leap Forward which we already started to discuss in the previous section. 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.). Material incentives were reintroduced. 20 million workers were sent back from cities to the countryside. Mao recognized that "backyard furnaces" were a 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). 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.

[21] In 1958, the number of workers state non-agricultural units rose by almost 21 million, an increase of 85 percent compared with 1957. The peak level of employment in state units was 50.44 million at the end of 1960, more than double the number in 1957 (Lardy 1987b, p. 369)

[22] 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, p.), Lardy (1987b, p. 367) gives detailed statistics on the preponderance of investment allocation to the medium and large-scale industrial plants.

[23] For example, special allocations of materials to produce small implements 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).

Agricultural TFP grew by 42 percent from the low of 1962 to the peak of 1966, but was still 14 percent below the peak of 1958. The price scissors wedge continued to decrease to reach its trough in 1966. Both the increase in agricultural TFP and the decrease in the price scissors wedge are 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. Both the growth of manufacturing TFP and the rapidly increased capital wedge are consistent with the arguments that the period of readjustment did not mean that fundamentally the growth strategy shifted to prioritize 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)[24]. The rapid increas in the capital wedge 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.[25] 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 labor 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).

The next subperiod (1967-69) is that of the peak of the Cultural Revolution.[26] Despite the events of the Cultural Revolution being of exceptional importance 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

[24]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).

[25]See Naughton 1974 for a detailed discussion of the industrial policies under the Third Front.

[26]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) .

TFPs reached or exceeded the peak of 1966 already in 1969. The behavior of other wedges was also rather uneventful. 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 (1997, 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, from the Daqing oil fields.

The period of 1970-1978 despite the power struggles, death of Mao, purges, had a relatively minor impact on the economy and the wedges. Overall, this is consistent with 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 and that the early changes to the strategy started happening only in 1977. Naughton (1997, 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 (decentralized decision making, simultaneous rural and urban industry development, especially, "Five Small Industries" that served agriculture, and criticism of the economic incentives). The period of 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 who decreased the prioritization of the Third Front.

4.5 Wedges 1978-2011

After Mao's death in 1976, Deng Xiaopin rose to power and eventually managed to become a "paramount leader" of China. In December 1978, at the Third Plenum of the Central Committee

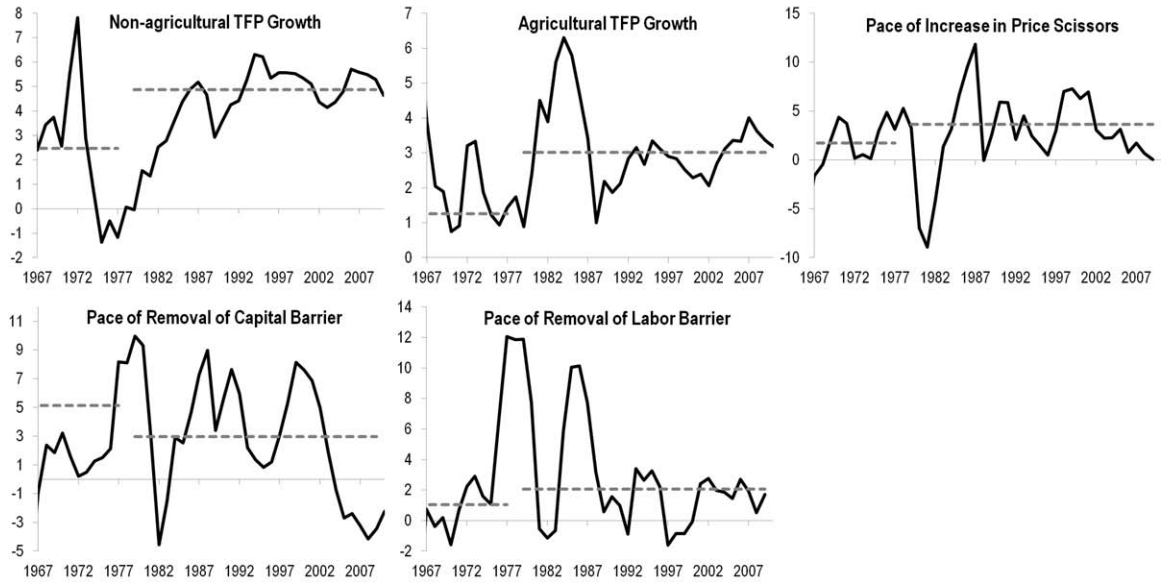

Figure 4: Percentage Changes in Wedges and Sectoral TFPs (5-year moving averages)

Deng consolidated his power and launched the course of reforms.

The dynamics of productivity growth and intersectoral wedges in 1978-2011 are very different from those in 1952-78. As shown in Figure 3, after 1978 in both the agricultural and the manufacturing sector there is a substantial acceleration in the total factor productivity growth, and there is a large fall in the normalized labor wedge. The normalized capital wedge continues to decline slowly as before 1978. The investment wedge remains very volatile, with the average value somewhat lower than prior to 1978. It is also useful to refer to Figure 3 which shows 5-year moving averages in percentage changes in wedges and sectoral TFPs.

We first discuss the changes in growth rates of TFP. Trend TFP growth before 1978 was 1.3 percent per year in agriculture and 2.5 percent per year in the non-agricultural sector. After 1978, these growth rates increased to 3.0 percent and 4.9 percent, respectively. This acceleration of productivity growth was however uneven across time and across sectors. As shown in Figure 4, in 1978-85, TFP in agriculture grew faster than non-agricultural TFP. After 1985 agricultural TFP growth slowed down and was outpaced by the growth of non-agricultural TFP.

In particular, in 1978-85 the growth in *agricultural TFP* was 4.7% per year, while in 1985-2011 it decreased to 2.8 percent per year. The fast growth of agricultural productivity in 1978-85

is consistent with several explanations. First, these productivity gains can be attributed to 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 bottom up. Also 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 Plenary Session 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).

The empirical studies of the effect of these reforms (Lin, 1988, McMillan, Walley, 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, Walley, and Zhu (1989) and Lin (1992) 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.[27]

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

[27]The immediate impact of the reform may seem implasible. 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 should therefore be ascribed to 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). It is also important that reform announcements changed expectations and therefore incentives so quickly due to Deng's personal credibility.

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 (Brandt and Zhou, 2001). 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).[28] 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).

In contrast with agricultural productivity, in 1978-85 the growth of *non-agricultural TFP* was relatively slow (3.5 percent per year) — although higher than in 1952-78 (2.8 percent per year). Only after 1985 non-agricultural TFP growth accelerated to 5.0 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.[29] 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. 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

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

[29] 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).

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 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 1985-2011 (5 percent per year on average).

First, 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 (Cai 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, 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).[30] 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.

The dynamics of the *price scissors* wedge also reflects the shift of the focus from agricultural reforms before 1985 to reforms of the non-agricultural sector after 1985. The price scissors declined from 48 percent in 1978 to about 33 percent in 1984. This is consistent with the substantial increase in agricultural prices and the permission to sell above-quota agricultural products at market prices described above. However, price scissors were not completely eliminated. This is consistent with the detailed analysis of agricultural prices by Lardy (1983) who argues that the government was also concerned about price stability and was still trying to use price scissors as a major instrument for intersectoral reallocation.

After 1985, price scissors followed an upward trend (increasing to 200 percent by year

[30]The benefits of privatization are also consistent with macroeconomic studies of three-sector models of Chinese economy. Brandt, Hsieh, Zhu (2008) and Brandt, Tombe, Zhu (2008), Dekle and Vandenbroucke (2012) compare aggregate productivity growth in the state and non-state sectors and argue that the productivity growth in the non-state sector as well as the reallocation of resources from state to non-state sector were key drivers of the aggregate economic growth in China. The efficiency of the private sector is also a cornerstone of the model in Song et al. (2011). In our model, we do not differentiate between private and state-owned non-agricultural firms; so in our calibrations, the growth of the more efficient non-state sector is tantamount to the faster TFP growth in the non-agricultural sector as a whole.

2000).[31] One important explanation for this reversal is the change in reform priorities from the agricultural to the non-agricultural sector in the late 1980s that we discussed above. The other factor that contributed to the dynamics of the price scissors was the subsidization of urban consumption. These subsidies explain why farmers faced different, less favorable, relative prices than urban consumers. The subsidies (funded by the government and by urban firms) included food price subsidies, welfare benefits, housing, heating, healthcare and transportation subsidies and were quite sizable. For example, Yang and Zhou (1999, Table 2, p. 111) estimate them at 19 percent of disposable income of urban households being non-pecuniary in 1992. Yang (2007) shows that in 1986-92 these subsidies were always greater than 25 percent the budget of an urban household. Also, these subsidies and other investments in urban amenities were an important part of the government budget. As of 1992, price subsidies were about 10 percent of total government expenditures, with "other urban expenditures" being about 15 percent. (Yang, 2007, Table 9). These subsidies were available to permanent urban workers (the so-called "non-agricultural population", fei nongye renkou, Lardy, 1984) which included non-agricultural workers in rural areas but excluded temporary urban workers (the peasants who came to the city to get a temporary job). Even though the hukou system was relaxed in the mid-1990s so the peasants could come to the cities, they would still not be able to enjoy public services in the cities such as education, medical insurance, housing, and pensions available to the permanent urban residents (Li, 2012).

The *labor wedge* τ_W immediately went down at the beginning of the reforms from 800 percent before 1978 to 430 percent in 1985. After 1985 the labor wedge τ_W increased, reaching its 1978 level in 2000 and staying constant in the 2000s.

Given the non-transparency of urban subsidies and public goods, and therefore of the effective relative prices, it is more important to analyze the dynamics of the *normalized labor wedge* $(1+\tau_W)/(1+\tau_C)-1$. As argued in Section 2.3, it does not depend on prices and price scissors and captures the ratio of marginal productivities of agricultural and non-agricultural workers normalized by the ratio of consumers' marginal utilities of their respective products.

The normalized labor wedge went down from 500 percent to 300 percent right after the start

[31] Lin and Yu (2008) find that price scissors were mostly stable during the period. However, their definition of price scissors is different from ours. While we define price scissors as the gap between the relative prices and the ratio of marginal utilities, Lin and Yu simply look at the relative prices of agricultural and manufacturing goods.

of the reforms and continued to decline throughout the period, reaching 200 percent by 1985 and 100 percent by 2011. The fact that the normalized labor wedge decreased substantially in the 1978-2011 era (including a dramatic fall at the very beginning of the reforms) is consistent with the conscious policy of softening the barriers to labor mobility. In 1984 the government allowed peasants to register even if they work in non-agricultural firms in the rural areas or small towns (Cai et al., 2008, p. 172).[32] In 1988, China moved to issuing national identity cards that made it easier for migrants to register as temporary workers in cities. Also, over time the development of urban markets for housing, healthcare and education allowed at least the highest-paid migrants to obtain public goods without having the hukou status, thus, partially moderating the effect of the hukou system that remained in place (Cai et al., 2008, p. 197).

While it did decrease substantially after 1978-85, the labor wedge remained high. This is consistent with the fact that many institutional barriers to reallocation of labor remain in place. In particular, while the household responsibility system did give the land-use rights to households, it did not transfer the ownership of land. The households could not sell land. If the farmers moved to the city, they would have to give up the land to the state (Yang, 1997, Yang, 2007). This resulted in split family labor supply decisions where one member of the household would seek a non-agricultural job and the other one would have to stay back in the farm sector. The other important barrier to mobility was the continuation of the hukou system. While it was relaxed and the temporary rural-urban migration was allowed, temporary workers still did not get the same access to public goods and welfare benefits as permanent urban residents (Wang and Zuo, 1999). Moreover, the migrants face labor market discrimination and receive substantially lower wages than permanent urban residents (Meng, 2012).

For the sake of brevity we do not discuss the other wedges in detail. The *capital reallocation wedge* also decreased from the average of 0 percent in 1952-78 to -50 percent after 1978. The *normalized capital wedge* was declining throughout the whole 1978-2011 period reaching -80 percent in the end of the period. This is consistent with the fact that the government funded massive infrastructure projects and increased the subsidies to the urban sector thus promoting

[32]The rural nonagricultural labor force, which should not include permanent migrants to urban areas, increased from 28 million in 1978 to 188 million in 2005 (Cai et al., 2008). For example, in 1978-92 rural non-agricultural employment tripled while urban labor increased by 50 percent and rural agricultural employment only grew by 25 percent (Yang and Zhou, 1999, Table 6). Essentially, in those years, more than half of jobs added in rural areas were in non-agricultural sector. As the cost of reallocation from agricultural to non-agricultural sector in the rural areas is much lower than those of the proper rural-urban migration (that involves a geographical mobility), it is not surprising that we find a substantial decrease in the normalized labor wedge.

the reallocation of capital to non-agricultural industries. The *intertemporal wedge* slightly improved on average (from -5.5 percent before 1978 to -6.5 percent) but remained highly volatile. However, the volatility was lower post 1978 (6 percent) than before 1978 (12 percent).

5 Counterfactuals

We divide the discussion in this section into two parts: 1953-1978 and 1978-2011.

5.1 Analyzing the economy in 1953-1978

First, we perform a welfare/growth accounting exercise for the whole period to determine the main factors behind welfare changes and behind the behavior of economic variables. Second, we analyze the Great Leap Forward. Third, we analyze what would happen if China followed Soviet industrialization policies. Finally, we analyze what would happen if post-1978 reforms started in 1953.

5.1.1 Wedge Accounting 1953-1978

We first perform a welfare/growth accounting exercise for the period of 1953-1978. We fix the wedges at their initial values (1953) for the whole period of interest (1953-1978) and simulate the economy. We then compare the simulated path with the actual historical path. We compute the difference between GDP per capita levels[33] in the final period (1978) and in welfare discounted and summed over 1953-1978. The contributions of wedges and TFP are computed by adding wedges subsequently one by one and computing the relative changes in GDP and welfare at each step.

Table 1 summarizes the results. Overall, compared to the counterfactual, welfare increases by 45.5 percent and GDP increases by 158.5 percent. The growth of non-agricultural TFP played the largest role (21.1 percent of welfare). The growth of agricultural TFP contributed 13.9 percent. The price scissors wedge (9.5 percent of welfare) played a role almost as important as the growth in agricultural TFP. The reduction in the labor barrier (the combined effect of the price scissors and the labor wedge) accounted for a 8.3 percent welfare gain. A sizable role was played by a decrease in defense spending (4.6 percent). The rest of the wedges played a

[33] We also keep the total population and the labor force fixed.

	Welfare 1953-1978 % cons.	GDP 1978 % change
Price Scissors, τ^C	9.5	13.3
Labor Distortion, τ^L	-1.2	-4.5
Capital Distortion, τ^R	0.2	-21.5
Defense Spending, g_M	4.6	-4.6
Non-ag. TFP, A^M	21.1	68.9
Agricult. TFP, A^A	13.9	66.7
Trade	1.0	6.7
Intertemporal wedge, τ^K	-3.7	33.3
Total	45.5	158.5

Table 1: Wedge accounting 1953-1978

relatively minor role for welfare.[34] This decomposition is consistent with the historical evidence presented in Sections 4.2, 4.3, 4.4.

For GDP per capita, the contribution of the wedges is similar to that of welfare but the impacts of the intratemporal and intertemporal capital wedges are more pronounced. Real GDP per capita grew by a factor of 2.6 due to changes in wedges from 1953 to 1978, which gives an average growth rate of 3.8 percent. 1.6 percent of that growth is accounted for by TFP growth in the non-agricultural sector while 1.3 percent is accounted for by TFP growth in the agricultural sector. The remaining 0.5 percent can be attributed to reallocation of factors of production between sectors and across time.

5.1.2 The Role of the Great Leap Forward

In this section, we simulate the behavior of the economy assuming that the Great Leap Forward did not happen. Figure 5 plots the behavior of the actual and simulated wedges and sectoral TFPs. We linearly extrapolate TFP in both sectors, the price scissor wedge, the normalized capital and labor wedges between 1957 and 1964. We also linearly extrapolate the shares of export of agricultural goods and imports of non-agricultural goods in respective value added between 1957 and 1970, as the effect on trade was apparently somewhat more prolonged than on other wedges.

[34] Since the investment wedge changes frequently and significantly without a particular trend, we do not have a good benchmark for the behavior of this wedge. The simulation above assumes that the labor wedge is equal to zero. Thus we measure the contribution of the actual wedge versus the zero wedge for welfare and GDP per capita. We also computed another benchmark where we assume that intertemporal wedge is equal to the average of the period 1953-1978 (-5.5 percent). The welfare results change insignificantly, while the impact on GDP is somewhat higher.

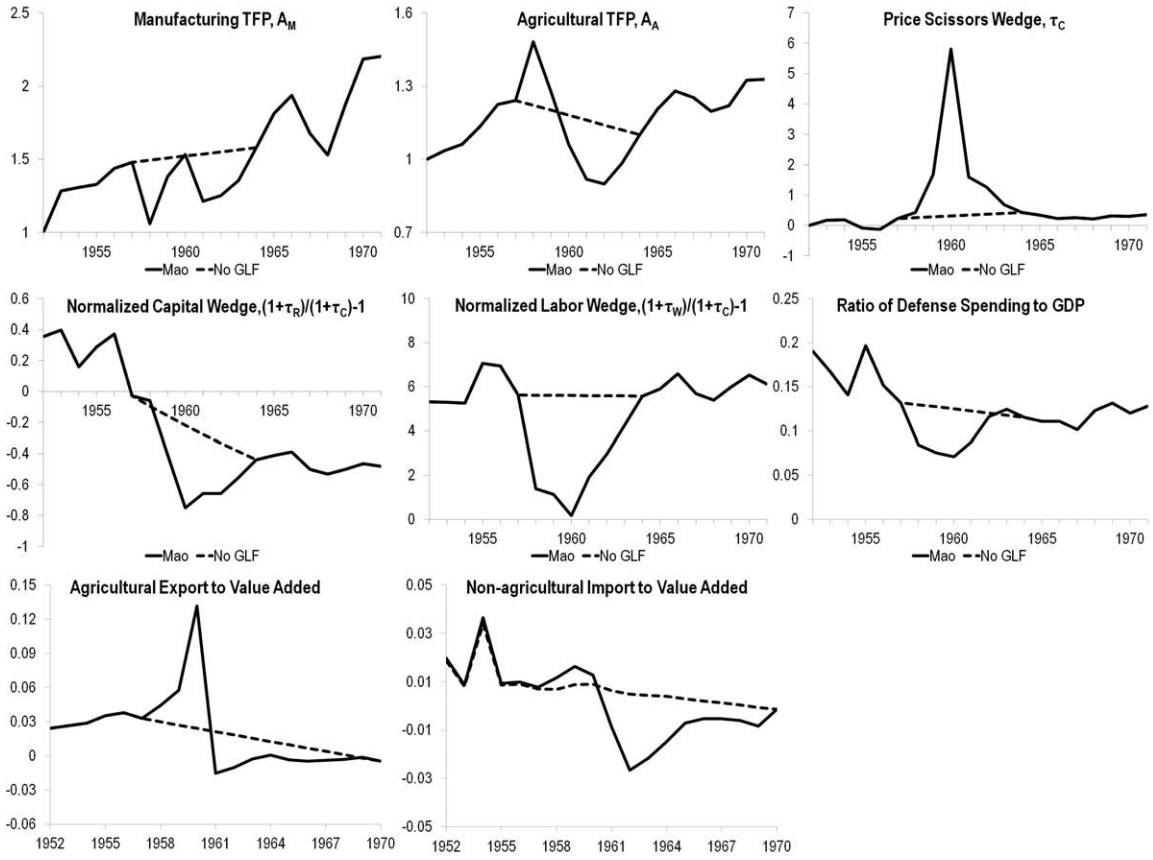

Figure 5: No GLF: Wedges and Sectoral TFPs

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 is no jump in the price scissors and the decrease in the labor distortion (normalized and non-normalized). There is no sharp decline in defense spending. There is no expansion of agricultural exports or the corresponding import of industrial equipment.

Figure 6 plots the behavior of actual and simulated real GDP, labor and value added composition, sectoral consumption and capital stock. Fluctuations in most of the variables are dampened in the absence of the GLF. In particular, the labor share remains stable around 85 percent, consumption of agricultural goods drop much less than it did during the famine, at the expense of a somewhat lower path of non-agricultural consumption. The path of capital to value added ratio remains stable, indicating no push for fast industrialization in the absence of GLF.

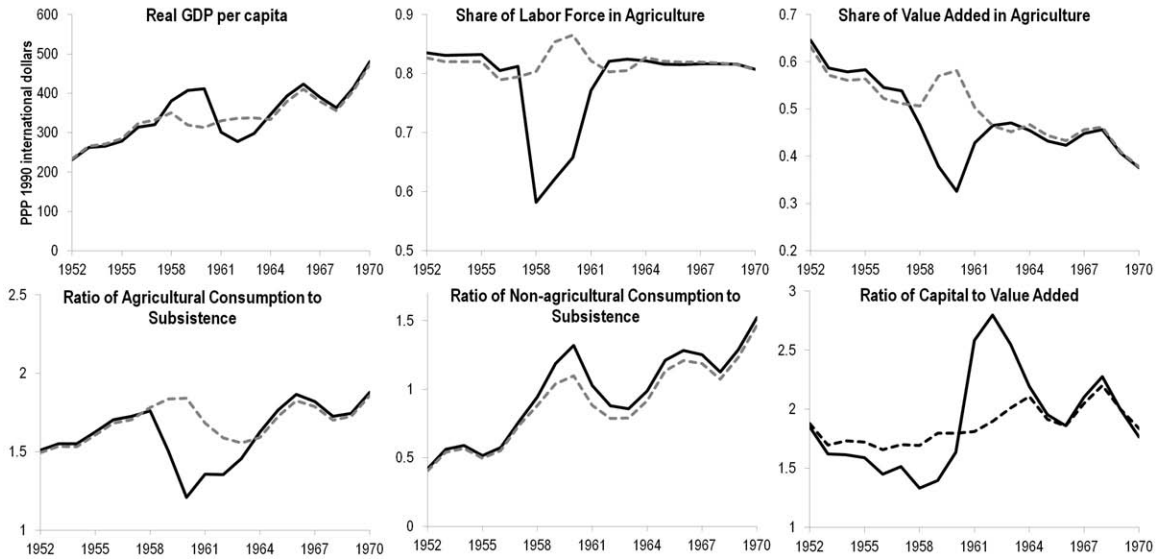

Figure 6: No GLF: Economic Indicators

	Welfare % cons.	Labor Share % lab. force	Capital % change	GDP % change
Price Scissors, τ^C	6.7	-13.3	26.1	14.5
Labor Distortion, τ^L	4.2	-8.7	12.7	8.3
Capital Distortion, τ^R	0.8	-1.1	1.2	0.7
Defense Spending, g_M	0.9	0.4	2.2	0.0
Non-ag. TFP, A^M	-6.2	2.3	-22.3	-14.7
Agricult. TFP, A^A	-2.9	0.8	-8.1	-6.5
Trade	-1.0	1.5	-1.6	-0.5
Total	2.6	-18.1	10.2	1.8

Table 2: Great Leap Forward: Effect on Welfare and Contribution of Wedges

	1958	1959	1960	1961	1962	1963	1964	1965
Price Scissors, τ^C	3.8	1.7	-2.7	8.4	9.5	12.0	12.8	11.7
Labor Distortion, τ^L	0.5	4.8	4.7	4.9	5.3	4.9	5.1	4.7
Capital Distortion, τ^R	0.3	1.5	2.1	0.7	0.2	0.1	0.4	0.4
Defense Spending, g_M	1.2	1.2	0.9	1.0	0.8	0.8	0.8	0.7
Non-ag. TFP, A^M	-3.8	-6.2	-4.9	-5.0	-6.3	-7.9	-9.1	-8.4
Agricult. TFP, A^A	3.3	1.1	-2.4	-6.1	-7.4	-6.2	-3.8	-3.5
Trade	-0.6	-1.0	-1.7	-0.9	-0.8	-0.8	-0.8	-0.7
Total	4.6	3.0	-3.9	2.9	1.4	1.4	5.5	4.9

Table 3: Great Leap Forward: Effect on Welfare and Contribution of Wedges by Year

Table 2 shows the aggregate effects on welfare and other economic indicators, as well as a decomposition of aggregate effects into the contributions of individual wedges. We consider the effects on: 1) welfare of the representative consumer born in 1957; 2) the average effect on the labor share over the period 1958-61; 3) the effect on capital accumulated by 1965; and 4) the average effect on GDP over the period 1958-65.

Our main findings for welfare are as follows. We find that the overall effect of GLF of 2.6 percent of consumption was positive but not very large. The most important factor affecting welfare is the fall of the agricultural (-2.9 percent) and non-agricultural TFP (-6.2 percent) which together account for -9.1 percent reduction in welfare. However, this fall was more than compensated by the increase in the price scissors (6.7 percent) and the decrease in the labor distortion (4.2 percent). In other words, the decrease in the labor barrier led to a 10.9 percent increase in welfare. The combined effect of this reduction in the normalized labor wedge thus balances the welfare costs of the fall in TFPs. The effects of defense and trade are small and are in the opposite directions, essentially, canceling each other. The effect of the lower capital wedge is also small.

The influence of the wedges and sectoral TFPs on other economic indicators (GDP, labor share, capital) have the same general pattern as the effects described for welfare. For instance, the labor share in manufacturing increases by 18.1 percent over the 1958-1961 period. Most of this increase is accounted for by the decline in the intersectoral barrier to labor movement and by the spike in price scissors when food was requisitioned at artificially low prices. The effects of the fall in the agricultural TFP are twofold. First, the decrease in agricultural TFP brings consumption of agricultural goods closer to subsistence and makes agriculture more attractive to workers. Second, the decrease in non-agricultural TFP makes the agricultural sector relatively more attractive.

The effect on capital is large and positive due to the movement, albeit temporary, of a large fraction of the labor force from the agricultural sector to the non-agricultural sector, which increased the investment rate and, hence, resulted in more capital accumulated over the whole 8-year period.

It is also useful to look at the year-by-year decomposition of the effects on welfare of different wedges which we present in Table 3. Interestingly, the only year in which the welfare effect of the GLF was negative was 1960 (-3.9 percent of consumption).

In summary, the Great Leap Forward was indeed "a brutal way" to decrease the barriers and move resources from agriculture. However, the policies were so disruptive that lead to a precipitous fall of sectoral TFPs. Despite large losses in productivity, the decrease in a labor barrier resulted in an overall positive welfare effect. Overall, the GLF was a very short episode of the disruption of the economy with the negative welfare impact only in 1960.

5.1.3 Comparison with Collectivization in the USSR

The conclusion of the previous section 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 two counterfactual simulations. First, we start Stalin's policies in 1957 (1956 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 highlight striking similarities as well as differences between the GLF and the most brutal phase of Stalin's collectivization. This comparison highlights Mao's way of transforming agriculture that was even more radical than Stalin's (see discussion in Section 4.3).[35] Second, we impose Stalin's policies starting in 1953. This is done, to compare the much milder initial collectivization period of the First-Five Year Plan together with the Great Leap Forward to the much more brutal Soviet collectivization and industrialization.

Comparing the effects of the GLF with Stalin's Collectivization. Since Stalin's wedges and some policies during collectivization (Cheremukhin, et. al. 2013) are similar to Chinese wedges during the Great Leap Forward, we choose the timing 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 1956-1967 has the same innovations to wedges and sectoral TFP as that of Stalin. After 1967, the economy returns to the same growth rates

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

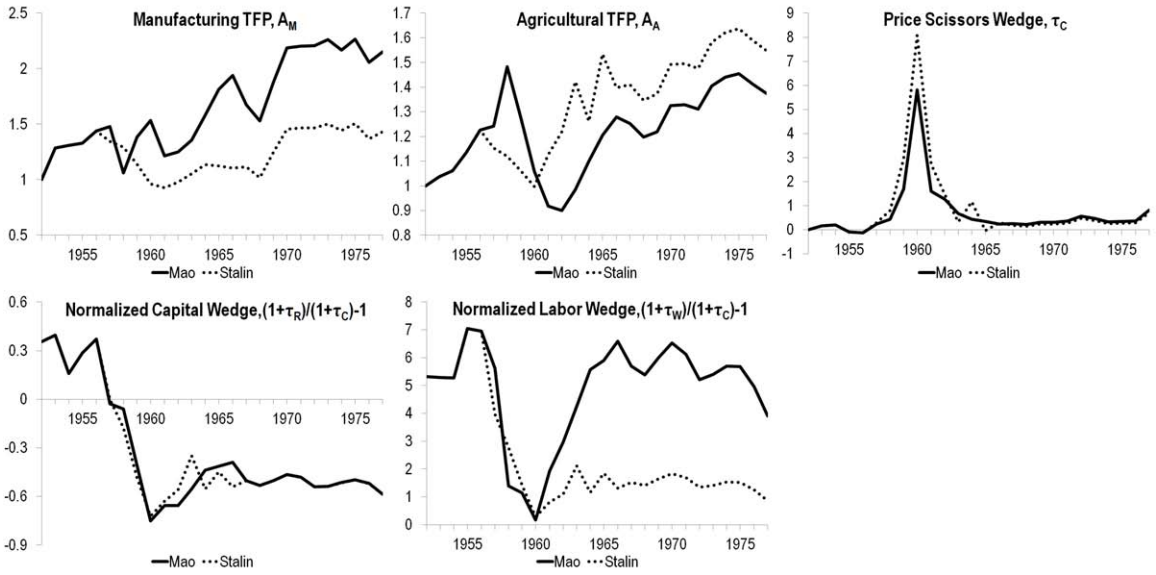

Figure 7: Soviet Collectivization vs GLF: Wedges

of wedges and the sectoral TFPs as in the baseline model.

Figure 7 plots both actual Chinese wedges and the simulated economy with Stalin's wedges. There are remarkable similarities between these economies and some important differences. First, both the price scissors and the change in the normalized labor wedge are almost identical. The normalized labor and capital wedges are virtually identical as well. The similarities are consistent with our discussion in Section 4.3 and with Cheremukhin, et. al. (2013) that the primary goals of both Chinese and Soviet economic policies were to move people from agriculture to industry. Second, the policies both in China and Soviet Russia led to a collapse of TFP. The fall of agricultural TFP from the peak to trough was 19 percent in Soviet Russia versus 40 percent in China. This is consistent with the more radical way of transforming agriculture in China during the Great Leap Forward that we discussed in Section 4.3. The fall of non-agricultural TFP from the peak to trough was 36 percent in Soviet Russia versus 28 percent in China. Third, and most importantly, the Great Leap Forward was much shorter lasting than Stalin's policies.

We summarize the behavior of the wedges and sectoral TFPs as follows. The size of the changes in the wedges at the peak of the reforms were similar in China and USSR. The normalized labor wedge in China returned to the original high level promptly but was permanently reduced in USSR. China had a more severe and slightly more protracted collapse of agricultural

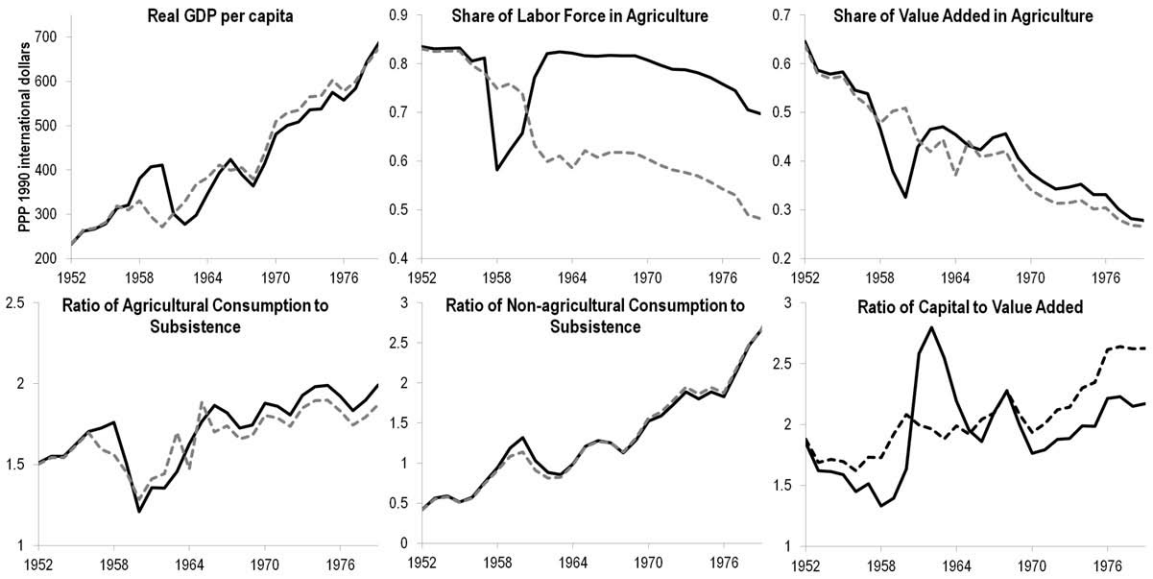

Figure 8: Soviet Collectivization vs GLF: Economic Indicators

TFP than USSR. The collapse of non-agricultural TFP was larger in China but was quickly reversed; while in the USSR, the TFP in non-agriculture took much longer to recover.

Figure 8 plots the key variables for the simulated and actual economy. The most important issues to notice are that the simulated Chinese economy with Stalin's policies would have achieved a much larger structural transformation with a significantly higher share of labor force in non-agriculture (40 percent) compared to (20 percent) in the actual economy. As noted earlier, the size of the changes in wedges in China during the GLF is essentially identical to that under Stalin in Soviet Union's First Five-Year Plan, but the changes to the labor barrier were largely reversed in China, and not reversed in Soviet Russia. Similarly, the differences in TFP (higher in agriculture, lower in manufacturing) persist in the USSR, but not in China. However, these large shifts of factors of production have a very limited effect on the paths of production and consumption, as they follow similar paths in China and USSR.

Table 4 shows the aggregate effects on the economic indicators and welfare as well as contributions of individual wedges. Our main findings for welfare are as follows. We find the overall effect of 3.9 percent of consumption. The most important factor affecting the difference in welfare is that the fall in non-agricultural TFP was less severe in the Soviet economy. This yields 25.8 percent of welfare. During the Great Leap Forward, the fall in the agricultural TFP was larger, however, accounting for -3.7 percent of welfare. Stalin's policies were more

	Welfare % cons.	Labor Share % lab. force	Capital % change	GDP % change
Price Scissors, τ^C	-1.1	-1.0	0.0	-1.7
Labor Distortion, τ^L	-16.7	21.1	-47.7	-13.1
Capital Distortion, τ^R	-0.5	-0.2	0.5	-0.2
Non-ag. TFP, A^M	25.8	-2.1	43.5	22.4
Agricult. TFP, A^A	-3.7	2.9	-8.8	-8.5
Total	3.9	20.8	-12.2	-1.1

Table 4: Soviet Collectivization vs GLF: Welfare and Contribution of Wedges

successful in breaking the labor barrier. The combined effect of the reduction in the normalized labor wedge was -17.8 percent. The smaller decrease in the labor distortion under GLF policies accounted for -16.7 percent. The effects of the price scissors were roughly comparable. The consequence of this is a 20.8 percent higher labor share in agriculture after the Great Leap Forward, largely accounted by the combined effect of the higher normalized labor wedge (21.1 percent). The GDP and capital numbers show patterns similar to that of welfare, which was higher than in the USSR due to higher TFP but lower due to a higher labor barrier. The persistent nature of labor reallocation in the Soviet Union lead to a higher level of capital accumulated by 1975.

We summarize the results as follows. If China followed Soviet industrialization and collectivization policies the results in terms of welfare, GDP, and capital would have been worse than a combination of the Great Leap Forward and the post-1962 retrenchment. The Great Leap Forward and Stalin's collectivization had similar effects on welfare at the peak of the campaigns. The quick reversal of the policies under the Great Leap Forward led to a significantly higher labor barrier in China but coincided with the recovery of the losses in agricultural TFP. In contrast, Soviet collectivization would have achieved a long-term reduction in the labor barrier at a cost of a long-term reduction in manufacturing TFP.

Comparing the effects of the FFYP and GLF with Stalin's Collectivization. We now turn to a slightly more comprehensive view of China's development strategy — comparing the combined effects of the FFYP and the GLF starting in 1953 to Stalin's collectivization.

The first First Five-Year Plan was modeled on that of the Soviet Union but still remained rather distinct (see, e.g., "Part 1: Emulating Soviet Model" in MacFarquhar and Fairbank 1987 and Chapter 2 "Development Strategies and Policies in Contemporary China" in Eckstein 1977).

We briefly expand our discussion in Section 4.2 to focus on the differences between the policies in China and USSR from 1953. The process of collectivization during the First Five-Year Plan was a "gradual, stage-by-stage process, rather than the sudden and chaotic pattern of the Soviet Union". CCP avoided during the FFYP, the "single minded focus on extracting agricultural surplus" (Teiwes 1987, p.141). Nolan (1976) in an insightful study compares the main features of collectivization in China and the Soviet Union and argues for three key differences: (1) the core explanation was the rural origin of the CCP reflecting the different way in which the revolution happened; (2) the Chinese village was less polarized than in the Soviet Union limiting the scope of expropriation; (3) the low level of agricultural output per capita forced China to the more positive approach of trying to raise production and incomes as well as surplus extraction. Nolan (1976, p. 194-195) concludes that "the process of collectivization was carried through in fundamentally different ways in China and the Soviet Union, and with sharply contrasting results. The disastrous losses sustained to the means of production in agriculture in Russia during collectivization had a direct and lasting negative impact on agricultural output; the losses sustained by China were of an altogether smaller magnitude."[36]

Specifically, we start with initial values of agricultural and non-agricultural TFP and three intersectoral wedges in 1952. We impose the wedges and sectoral TFPs calculated in Cheremukhin, et. al (2013) for Stalin's 1928-1939 economy on our model of the Chinese economy. 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 1953-1964 has the same innovations to wedges and sectoral TFP as that of USSR. After 1964, the economy returns to the same growth rates of wedges and sectoral TFPs as in the baseline model.

Figure 9 plots both actual Chinese wedges and the simulated economy with Stalin's wedges. Figure 10 plots the key variables for the simulated and actual economy. Table 5 shows the aggregate effects on the economic indicators and welfare as well as contributions of individual wedges. Our main finding is that Chinese policies in 1953-1964 lead to significantly higher

[36]To provide one example, Nolan (1976, Table 3 and 4) gives a number of comparative estimates on the losses in live animals and grain output. Forced collectivization in Russia lead to the widespread slaughter of the draft animals that severely affected the amount of horsepower available in agriculture. The total amount of horsepower available was not recovered until late 1930s, even counting the tractors. In contrast, in China in 1955-56 during the height of the campaign of collectivization there was only a small reduction in the stock of draft animals (Lardy 1987b, p. 157; Cheremukhin et. al 2013).

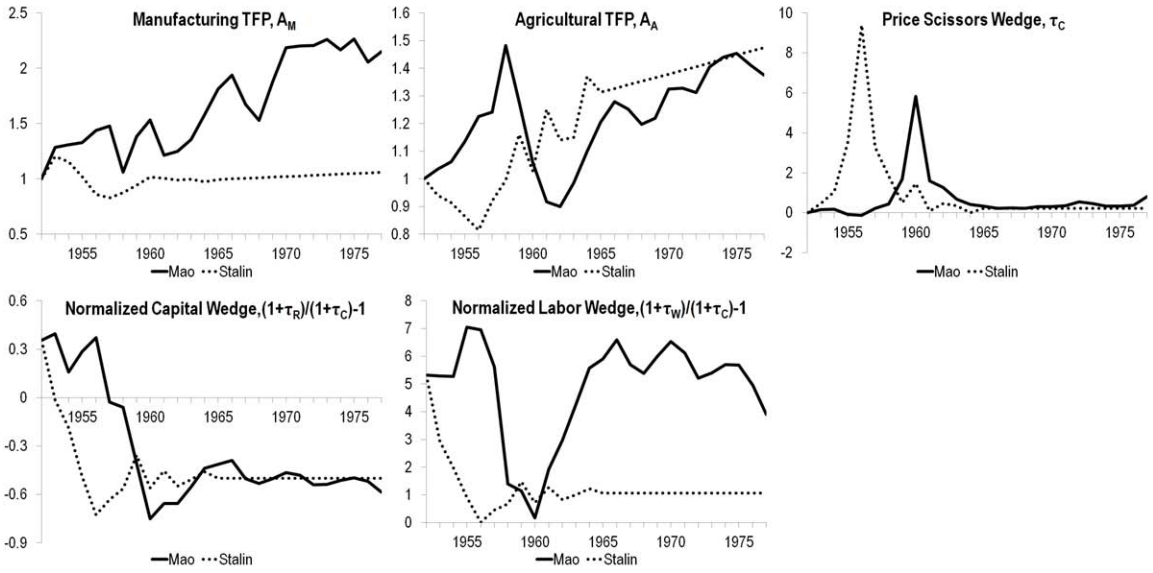

Figure 9: Soviet Collectivization vs FFYP and GLF: Wedges

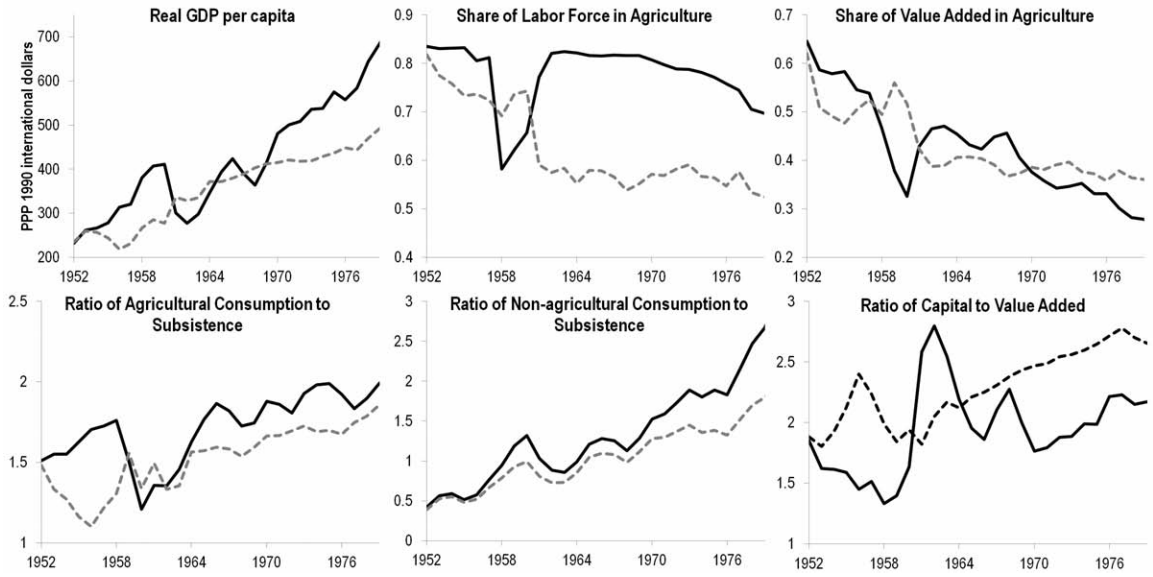

Figure 10: Soviet Collectivization vs FFYP and GLF: Economic Indicators

	Welfare % cons.	Labor Share % lab. force	Capital % change	GDP % change
Price Scissors, τ^C	-3.4	-1.1	-5.1	-4.8
Labor Distortion, τ^L	-26.2	25.7	-46.5	-13.6
Capital Distortion, τ^R	1.5	-0.3	1.6	1.2
Non-ag. TFP, A^M	48.5	-2.3	56.9	24.4
Agricult. TFP, A^A	3.8	1.7	-1.1	3.1
Total	24.3	23.6	-5.8	10.4

Table 5: Soviet Collectivization vs FFYP and GLF: Welfare and Contribution of Wedges

welfare (24.3 percent) compared to Stalin policies in 1928-1939. The difference in the effects of the GLF versus collectivization are very similar to Section 5.1.3. However, China's First Five-Year Plan was indeed a very important success, especially, in the difference in non-agricultural TFP (and also, albeit smaller, difference in agricultural TFP).

5.1.4 Market Reforms Starting in 1953

We now turn to another counterfactual: what if post-1978 reforms started in 1953.

Specifically, we compare the actual data for the Chinese economy to the simulated Chinese economy with post-1978 policies. We impose trend changes in intersectoral wedges and sectoral TFPs of 1978-2012 on the period of 1953-1978. For 1978-2011 we keep the same changes to wedges and sectoral TFPs as calculated in Section 5.

First, note from Figure 3 that, in terms of the wedges and the sectoral TFPs, the first 5 years of post-1978 reforms are very similar to those under the First Five-Year Plan.

Figure 11 plots both the actual Chinese wedges and those in simulated economy with post-1978 policies. First, we turn to sectoral TFPs. In the simulated economy, the growth of sectoral TFPs is higher than in the actual economy. The average manufacturing TFP growth is 4.5 percent in the simulated economy versus 2.6 percent in the actual economy in 1953-1977. The average agricultural TFP growth is 3.2 percent in the simulated economy versus 1.5 percent in the actual economy in 1953-1978. Importantly, simulated TFP does not have dramatic fluctuations, especially, the drops of the sectoral TFPs and labor and capital wedges, and spikes in price scissors during the Great Leap Forward. Second, the average wedges differ. The average normalized labor wedge declined from 5.3 in 1953 to 2.6 in the simulated economy versus 3.9 in the actual economy in 1977. The average normalized capital wedge declined from

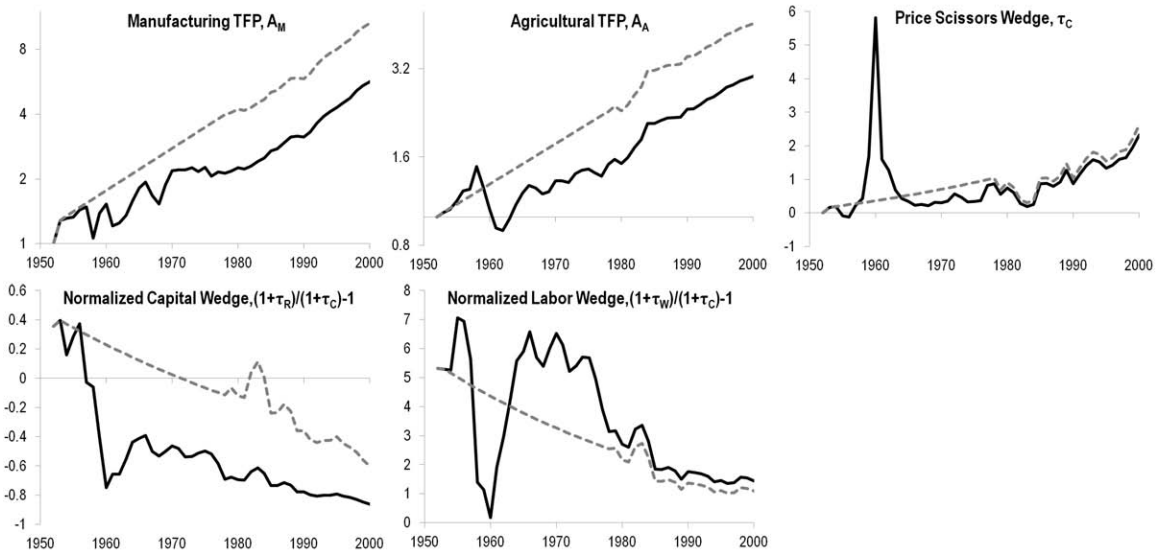

Figure 11: Market Reforms in 1953: Wedges and Sectoral TFPs

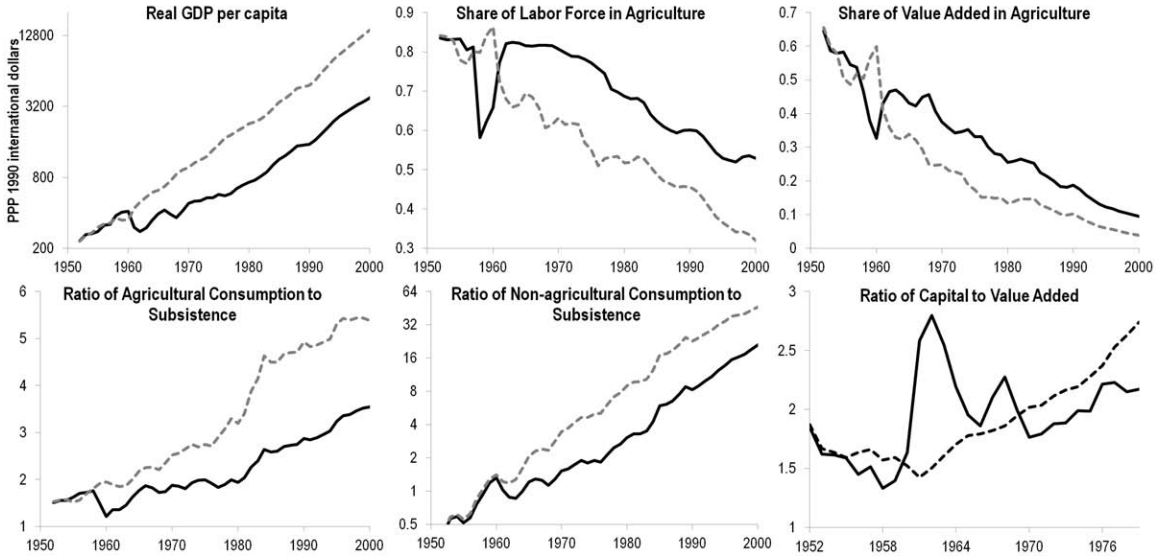

Figure 12: Market Reforms in 1953: Economic Indicators

	Welfare % cons.	Labor Share % lab. force	Capital % change	GDP % change
Price Scissors, τ^C	-3.3	-6.1	146	54
Labor Distortion, τ^L	1.1	-4.6	110	43
Capital Distortion, τ^R	0.2	-3.5	56	25
Non-ag. TFP, A^M	21.2	-6.3	172	160
Agricult. TFP, A^A	9.5	-11.5	59	42
Total	28.6	-31.9	542	324

Table 6: Market Reforms in 1953: Welfare and Contribution of Wedges in 1953-1978

0.4 in 1953 to -0.1 in the simulated economy versus -0.6 in the actual economy in 1977.

Figure 12 plots the key variables for the simulated and actual economy. The most important issues to notice are that GDP, consumption, and capital are very similar until 1957 and significantly higher in the simulated economy after 1957. The labor share in agriculture and the share of value added in agriculture are significantly lower.

Table 6 shows the aggregate effects on the economic indicators and welfare as well as contributions of individual wedges. Specifically, this table reports welfare gains for the period 1953-1978 and the contribution of wedges to the labor share, capital, and GDP in 1978. We find dramatically higher welfare, GDP, and capital in the simulated economy. In other words, if China started reforms earlier, its generation 1953 would have 28.6 percent higher welfare, it would have 5.4 times higher capital, and 3.2 times higher GDP by year 1978. By far the most important factor affecting the difference in welfare is the difference in TFP. This yields 30.7 percent increase in welfare. However, the impacts of the higher price scissors wedge (-3.3 percent) and the lower labor wedge (1.1 percent) in the simulated economy are also noticeable.[37]

5.2 Post-1978 Reforms

We conduct two experiments in this section. We first perform a welfare/growth accounting exercise for the period of 1978-2011. Second, we continue Mao's policies in the post-1978 period to provide a benchmark against which to measure the success of the reforms.

[37] We also considered another exercise for robustness. As it does not to be the case that the economy would sustain this high level of TFP growth for additional 25 years (i.e., grow at 1978-2011 rate for the whole period of 1952-1978), we assume that TFP growth was the same as in 1978-2011 during 1953-1978 but then slowed down to the average of 1952-1978 (excluding the years of the Great Leap Forward). The results for welfare in 1953-1978 are not significantly different.

	Welfare 1978-2011 % cons.	GDP per capita 2011 % change
Price Scissors, τ^C	8.0	14.1
Labor Distortion, τ^L	7.6	14.4
Capital Distortion, τ^R	-2.0	-1.0
Defense Spending, g_M	2.5	3.1
Non-ag. TFP, A^M	54.3	381.2
Agricult. TFP, A^A	20.0	168.8
Trade	-2.1	-3.1
Intertemporal wedge, τ^K	8.3	6.4
Total	96.6	584.0

Table 7: Wedge Accounting 1978-2011

5.2.1 Wedge Accounting 1978-2011

We first perform a welfare/growth accounting exercise for the period of 1978-2011. We fix wedges at their initial values (1978) for the whole period of interest (1978-2011) and simulate the economy. We then compare the simulated path with the actual historical path. We compute the difference between GDP per capita levels in the final period (2011) and in welfare discounted and summed over 1978-2011. The contributions of wedges and TFP are computed by adding wedges subsequently one by one and computing the relative changes in GDP and welfare at each step.

Table 7 summarizes the results. Overall, compared to the counterfactual, the welfare increases by 96.6 percent. The growth of non-agricultural TFP played by far the largest role (54.3 percent). The growth of agricultural TFP contributed 20.0 percent. The combined effect of the price scissors wedge (8.0 percent) and the labor wedge (7.6 percent), that is, the reduction in the labor barrier (15.6 percent) played a role almost as important as the growth in agricultural TFP.[38] The rest of the wedges played a relatively minor role for welfare. This decomposition is consistent with the historical evidence presented in Section 4.5.

For GDP, the ranking of the contributions of the wedges is similar to that on the welfare but the effects of TFP growth are more pronounced. Real GDP per capita due to changes in wedges and sectoral TFPs grew by a factor of 6.84, which gives an average growth rate of 5.8 percent; 3.8 percent of that growth is accounted for by TFP growth in the non-agricultural sector while

[38] As in the wedge accounting simulation for the pre-reform period, here we also assume that the in the simulated economy the intertemporal wedge is equal to zero.

1.6 percent is accounted for by TFP growth in the agricultural sector. The remaining 0.4 percent can be attributed to reforms which broke the barriers to labor and capital reallocation.

5.2.2 China Without Market Reforms

In this section, we consider the counterfactual which is the opposite of that in Section 5.1.4: what if 1953-1978 policies continued after 1978. This is an important counterfactual as it provides a key benchmark against which to measure the success of the post-1978 reforms.

Specifically, we compare the actual data for the Chinese economy to the simulated Chinese economy with 1953-1978 policies continued. We preserve the wedges for the period 1952-1973, and impose the average trends in wedges and sectoral TFPs of 1953-1978 (excluding GLF) on the period 1974-2011 (there is a brief 1974-77 transition period towards trend to eliminate large jumps towards the trend line). Figure 13 plots both actual Chinese wedges and the simulated economy with 1953-1978 policies extended after 1978; Figure 14 plots the main economic indicators.

Table 8 shows the aggregate effects on the economic indicators (their average level in year 2000) and welfare of generation 1978, as well as contributions of individual wedges. Specifically, this table shows the difference of the actual over the simulated economy.

We find dramatically higher welfare, GDP, and capital in the actual economy. In other words, the actual China economy performed 46.4 percent better in welfare terms, accumulated 44 percent more capital, and had a 54.3 percent higher GDP in the year 2000. The economy would also have a 17.6 percent lower labor share in agriculture. In short, the continuation of 1953-1978 policies would have been achieved significantly lower welfare compared to the actual path of the economy. The most important factor for welfare is the combined effect of the price scissors and the labor distortions – the normalized labor wedge yields a 19.5 percent welfare gain. The second most important factor is agricultural TFP growth with a welfare gain of 10.5 percent and non-agricultural TFP growth accounts for a 9.6 percent gain. In other words, the reduction in the labor barrier is as important as the growth of TFP for welfare. Finally, the reduction of government purchases yields a 4.7 percent welfare gain.

Another way to summarize the measure of success of post-1978 reforms is as follows. Compared to the situation of no TFP growth and wedges fixed at their 1978 levels, the actual economy achieved a 96.6 percent increase in welfare — this is our growth/wedge accounting

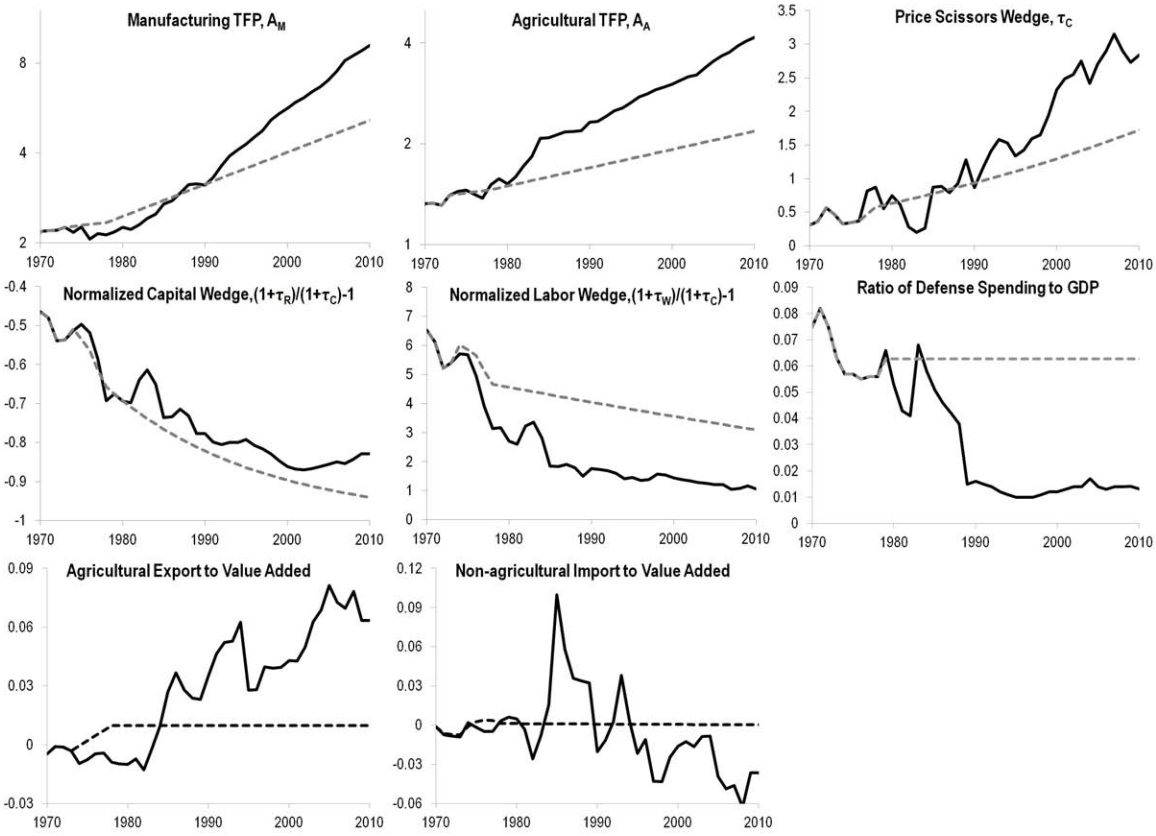

Figure 13: No Market Reforms in 1978: Wedges and Sectoral TFPs

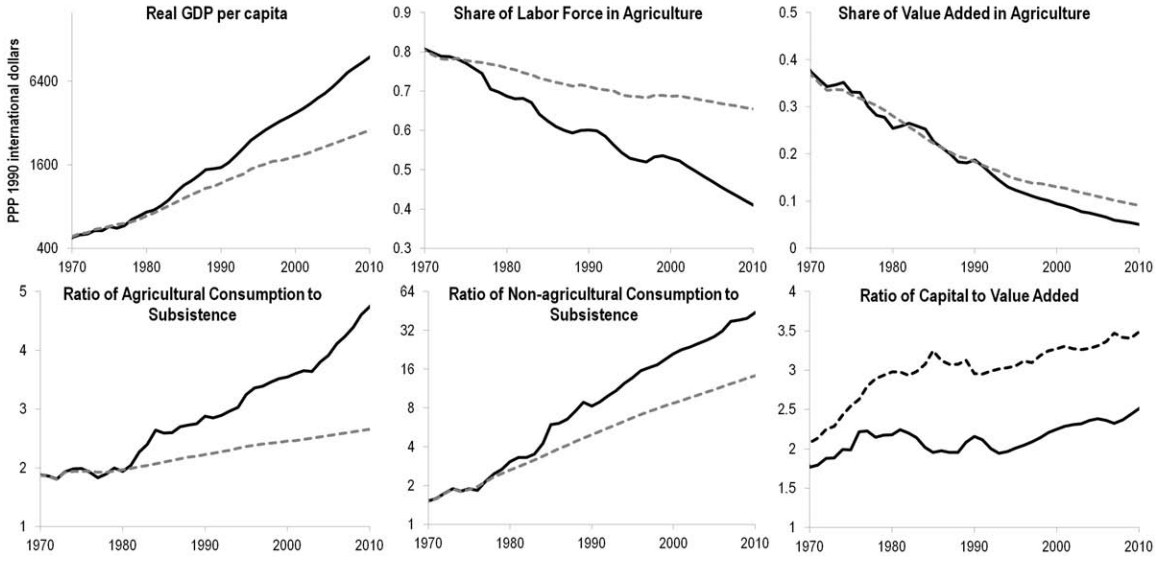

Figure 14: No Market Reforms in 1978: Economic Indicators

	Welfare % cons.	Labor Share % lab. force	Capital % change	GDP % change
Price Scissors, τ^K	2.7	-1.7	6.9	2.7
Price Scissors, τ^C	4.4	-4.5	-5.2	2.2
Labor Distortion, τ^L	15.1	-5.9	16.8	9.2
Capital Distortion, τ^R	1.0	-2.6	6.0	3.5
Government, g^M	4.7	1.6	1.9	-1.1
Non-ag. TFP, A^M	9.6	0.9	3.1	23.7
Agricult. TFP, A^A	10.5	-5.0	8.6	11.9
Trade	-1.6	-0.5	6.0	2.2
Total	46.4	-17.6	44.0	54.3

Table 8: No Market Reforms in 1978: Welfare and Contribution of Wedges

simulation. Compared to the continuation of 1953-1978 policies, the actual economy achieved a 46.4 percent welfare gain. That is, the continuation of 1953-1978 policies would have yielded about half of the post-1978 reform welfare gains.

6 Projections for 2012-2050

In this section we project the path of the Chinese economy until 2050. 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 the period 2000-2011. These trends are largely continuations of the trends (or absence of such) for the 1978-2011 period, with two notable exceptions. The price scissors wedge and the normalized intersector capital wedge stabilized during the past decade. Given the already substantial degree of the rural-urban divide and the current high level of distortion in the allocation of capital across sectors, it is unlikely that a further substantial increase in the price scissors or a further substantial decline in the normalized capital wedge will take place in the future. Thus, we assume that these two wedges remain at their average 2000-2011 values.

Similarly but consistent with earlier trends, 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 2000-2011 levels. Population and labor force are assumed to continue growing at the same rates as in 2000-2011. The normalized intersector labor wedge is assumed to keep declining at the same rate as in the 2000-2011 period. The intertemporal capital wedge is assumed to converge to its average 2000-2011 level from its 2011 level.

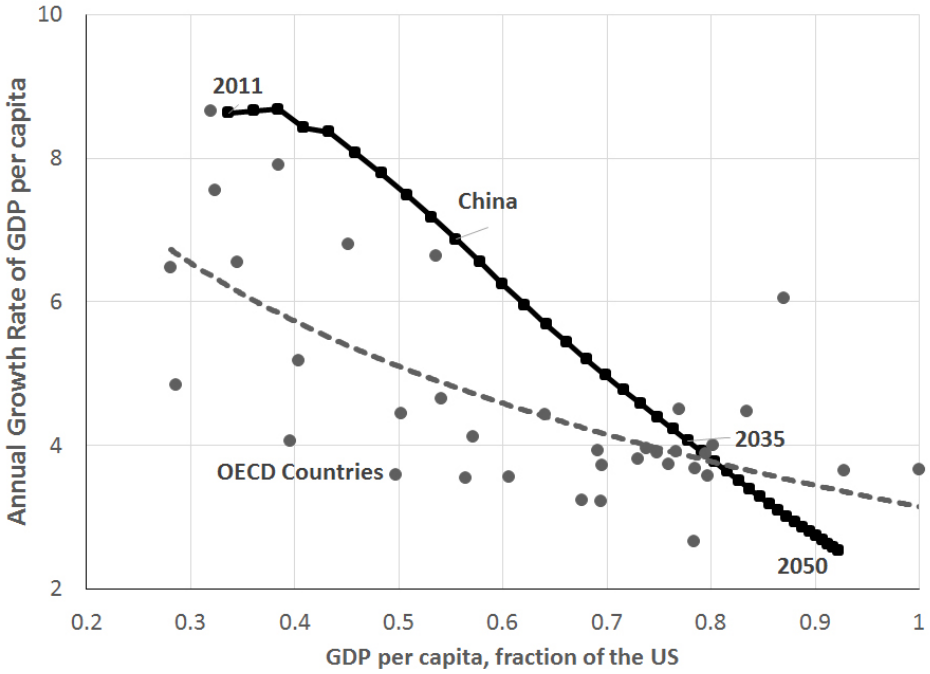

Figure 15: Convergence path of China in 2011-2050.

We assume that both agricultural and non-agricultural TFP continue growing intitially at their average 2000-2011 growth rates. However, at their current speed, TFP in both sectors is bound to exceed by orders of magnitude 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 16. 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. These projections are consistent with the large literature on growth convergence, which documents that the closer a country is to the frontiere, the slower its growth rate. Figure 15 shows the empirical relationship between the level of GDP per capita relative to the US in 2006 and the growth rate in GDP per capita in the preceding 20 years for OECD countries. The same Figure shows the projected path of China implied by our model.

Figure 17 further describes the simulated path of the Chinese economy. Our 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 labor share in agriculture declining from 40

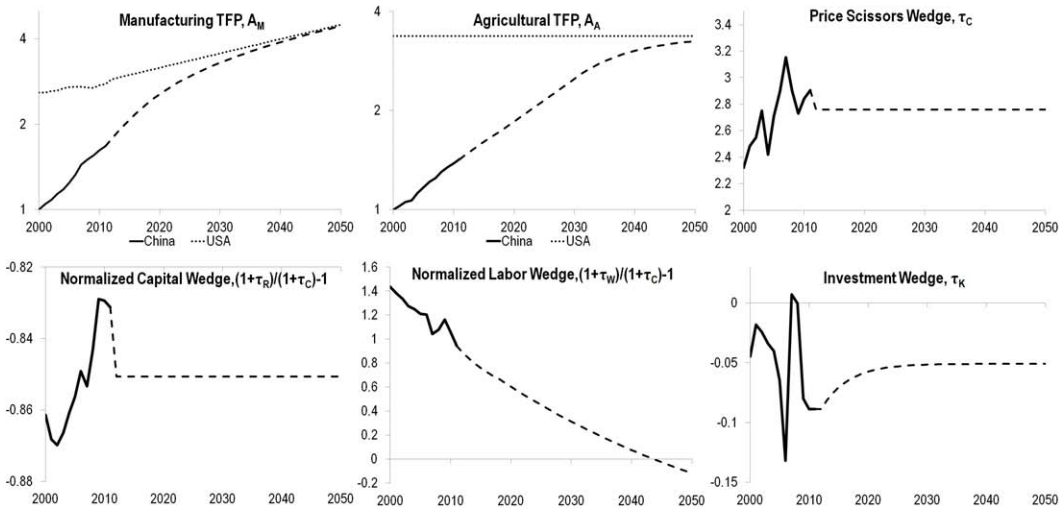

Figure 16: Actual and projected wedges in China in 2000-2050.

percent in 2010 to 25 percent in 2050. The share of value added by the agricultural sector will reach 2 percent in 2050 from 5 percent currently. The level of GDP per capita will approach that of the US by 2040, when China will likely be considered a developed country.

7 Wedge and Growth Accounting

This section further decomposes the sources of growth and relates our results to the growth accounting literature.

We perform the following decomposition exercise to explore the sources of GDP growth implied by our model. As described in sections 5.1.1 and 5.2.1, we fix wedges at their initial values and compute the path of the economy with all wedges fixed. Then we add the actual paths of wedges in sequence, and compute at each step the contribution of the added wedge as the difference between the paths of the economy with and without the wedge. This allows us to decompose the GDP growth rate for each subperiod of interest into the effects of individual wedges. We summarize our findings for 1953-1978 and 1978-2011 in Tables 9 and 10 respectively. Each period is divided into sub-periods to have a better understanding of the changes in the contributions of wedges to economic growth. Table 11 shows a decomposition for our projections to 2050, which is further divided into three subperiods. As an example, consider the period 1953-1978 in the last column of Table 9. GDP growth is 5.6 percent per year over that period. The contribution of the demographic changes is 1.6 percent, of intersectoral wedges is -0.3

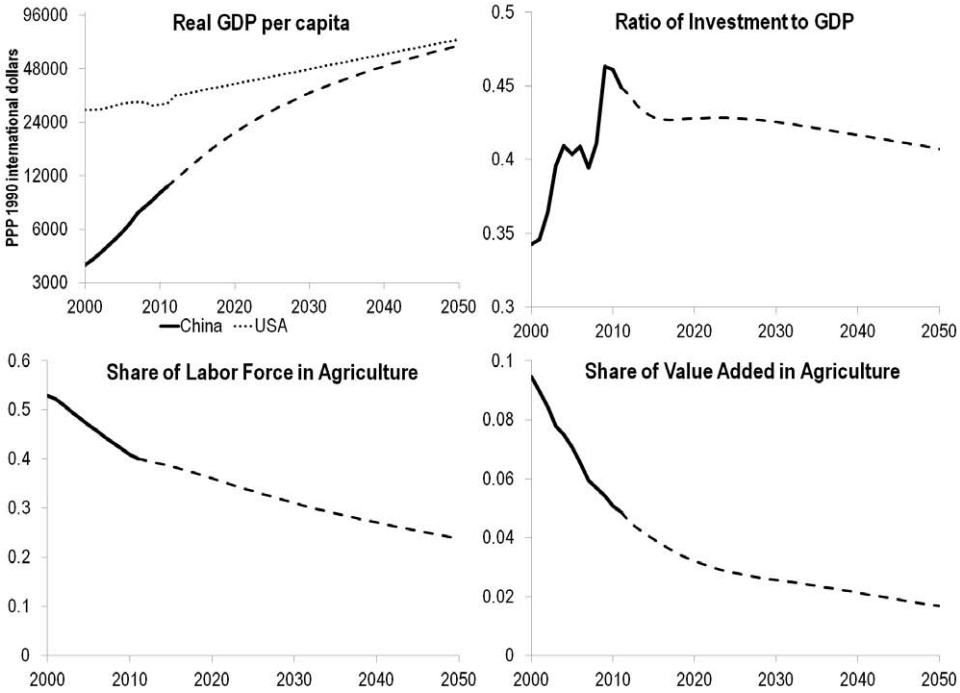

Figure 17: Actual and projected economic indicators in China in 2000-2050.

	53-58	58-65	65-78	1953-78
Demographics, N, POP	1.6	2.3	1.2	1.6
Intersectoral wedges, τ^C, τ^L, τ^R	-2.4	0.0	0.1	-0.3
Non-agricultural TFP, A^M	1.1	1.5	2.2	1.8
Agricultural TFP, A^A	4.2	-0.6	1.7	1.4
Intertemporal wedge, τ^K	2.8	0.8	0.9	1.2
Total	7.4	4.0	6.1	5.6

Table 9: Wedge accounting for GDP: 1953-1978

percent, of non-agricultural TFP is 1.8 percent, of agricultural TFP is 1.4 percent, and of the intertemporal wedge is 1.2 percent. That is, for example, if agricultural TFP growth were 0 percent, then GDP growth would have been lower by 1.4 percent.

As we already provided a detailed discussion for the 1953-1978 and 1978-2011 periods in the previous sections, we now briefly discuss the sources of GDP growth for our projections for 2011-2050 to further the discussion of Section 6 and to specially highlight the importance of labor reallocation. Note that since we assume that in the projections all the wedges except for the intrasectoral labor wedge are constant, we only present the results for that changing wedge. GDP growth slows down from 8.6 percent per year in 2011-2020 to 5.9 percent in

	78-89	89-00	00-11	1978-2011
Demographics, N, POP	2.8	1.7	1.1	1.9
Intersectoral wedges, τ^C, τ^L, τ^R	2.0	0.1	1.0	1.0
Non-agricultural TFP, A^M	2.8	6.7	7.6	5.7
Agricultural TFP, A^A	1.6	0.7	0.0	0.8
Intertemporal wedge, τ^K	-0.1	0.1	0.2	0.1
Total	9.1	9.4	9.9	9.4

Table 10: Wedge accounting for GDP: 1978-2011

	11-20	20-30	30-50	2011-50
Demographics, N, POP	0.5	0.3	0.5	0.4
Labor Reallocation, τ^L	0.7	0.7	0.8	0.8
Non-agricultural TFP, A^M	7.0	4.5	2.5	4.0
Agricultural TFP, A^A	0.4	0.4	0.0	0.2
Total	8.6	5.9	3.8	5.5

Table 11: Wedge accounting for projected GDP growth: 2011-2050

2020-2030 to 3.8 percent in 2030-2050. Overall, growth in GDP is 5.5 percent in the period of 2011-2050. The most important factor, not surprisingly, is the growth in non-agricultural TFP. Given our assumption that upon reaching 70 percent of US TFP in that sector non-agricultural TFP starts converging to the US trend, the impact and the average magnitude of that factor declines over time. The declining labor wedge and reallocation of labor from agriculture to non-agriculture is the second most important factor delivering 0.7-0.8 percent of GDP growth. With the decline in the magnitude of the contribution of non-agricultural TFP, labor reallocation contributes a quarter of 2030-2050 growth. Agricultural TFP plays a relatively minor role until 2030 contributing 0.4 percent to GDP growth until 2030 and 0 percent after that.

Figures 18 and 19 further illustrate our findings.

We now turn to the comparison with the standard growth accounting approach and further decompose the growth rate of factors of production (capital and labor), as well as aggregate TFP, into the effects of wedges. We compute aggregate TFP as the residual from a CRS Cobb-Douglas production function with the labor share equal to 0.4. This assumption is commonly used in the literature that accounts for Chinese growth (see among others Chow and Li (2002), Hu and Khan (1997), Young (2003)). Using another popular assumption of 0.5 (see e.g. Wang and Yao (2003), Brandt, Hsieh and Zhu (2008), Zhu (2012)) would slightly increase the contribution of aggregate TFP and reduce the contribution of capital. Our results are described in

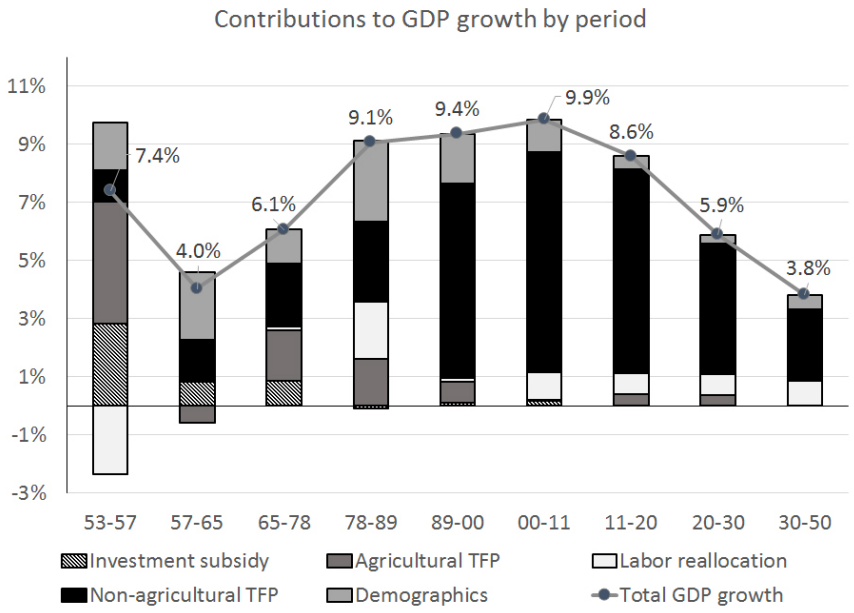

Figure 18: Contributions to GDP growth by period: 1953-2050.

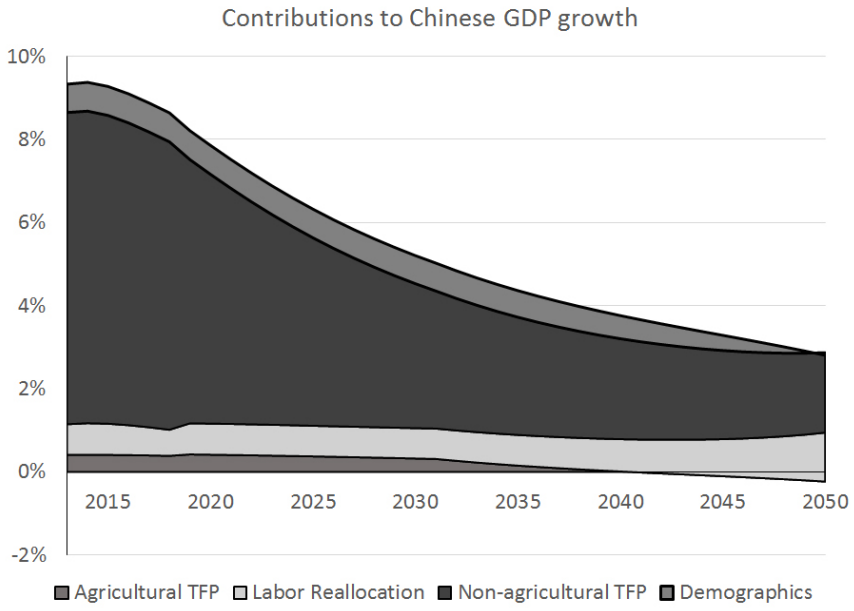

Figure 19: Contributions to projected GDP growth: 2011-2050.

Tables 12, 13 and 14.

As an example, consider Table 12. First, note that the wedge decompositions of GDP growth in Tables 9-11 are the same as in Tables 12-14. We now turn to the difference between the growth and wedge accounting approaches in Table 12. The growth accounting procedure attributes (the last row of the table): 4.1 percent of GDP growth to capital, 1.0 percent to labor, and 0.6 percent to the residual (the growth of aggregate TFP). Consider now how the 0.6 percent contribution of the residual (aggregate TFP) in turn is driven by the wedges and the sectoral TFPs: -0.5 percent is due to demographic change, 0.7 percent is due to changes in the intersectoral wedges, 1.0 percent is due to non-agricutural TFP, 1.0 percent is due to agricultural TFP, and -1.7 percent is due to the intertemporal wedge. In this example, the effects of the wedges do not cancel and the contribution of growth of aggregate TFP in the growth accounting exercise is not equal to the contributions of the aggricultural and non-agricultural TFP in the wedge accounting exercise. Similarly, in 1978-2011, the contribution of aggregate TFP in the growth accounting exercise is 2.7 percent while the contribution of the sum of the agricultural and non-agricultural TFP in the wedge accounting exercise is 3.4 percent and the contribution of the combined effect of other wedges is -0.7 percent. In the projection for 2011-2050, the contribution of aggregate TFP in the growth accounting exercise is 1.0 percent while the contribution of the sum of agricultural and non-agricultural TFP in the wedge accounting exercise is 1.1 percent and the contribution of the labor wedge is 0.3 percent. In other words, the growth accounting exercise attributes to the residual (the aggregate TFP) also some of the effects of changes in wedges.

An even more interesting comparison of the growth and the wedge accounting is in the effects of capital. There is a conceptual difference in the growth and wedge accounting exercises. In the growth accounting exercise, there is no difference between the exogenous and endogenous variables. Capital and labor are measured in the data, and the aggregate TFP is a residual to exactly match the growth of GDP. In the wedge accounting exercise, the situation is different. The changes in the wedges and the sectoral TFPs (and demographics) drive the changes in capital, labor, and GDP. Consider, for example, the contribution of capital (4.1 percent) in the growth accounting exercise for period 1953-1978 (last row of Table 9). Compare this with the wedge accounting exercise (first column of Table 9). Recall that the way the wedge accounting exercise is conducted is that the data is compared with the model economy in which

	Capital	Labor	Aggregate TFP	GDP
Demographics, N, POP	1.1	1.0	-0.5	1.6
Intersectoral wedges, τ^C, τ^L, τ^R	-1.0	0.0	0.7	-0.3
Non-agricultural TFP, A^M	0.8	0.0	1.0	1.8
Agricultural TFP, A^A	0.3	0.0	1.0	1.4
Intertemporal wedge, τ^K	2.8	0.0	-1.7	1.2
Total	4.1	1.0	0.6	5.6

Table 12: Decomposition of growth accounting: 1953-78

	Capital	Labor	Aggregate TFP	GDP
Demographics, N, POP	1.2	0.7	0.0	1.9
Intersectoral wedges, τ^C, τ^L, τ^R	0.7	0.0	0.4	1.0
Non-agricultural TFP, A^M	2.4	0.0	3.3	5.7
Agricultural TFP, A^A	0.7	0.0	0.1	0.8
Intertemporal wedge, τ^K	1.0	0.0	-1.0	0.1
Total	6.0	0.7	2.7	9.4

Table 13: Decomposition of growth accounting: 1978-2011

individual factors are set to zero. For example, -1.0 percent contribution of the intersectoral wedge is the difference in the GDP in the data and the model with the intersectoral wedge set to zero. Therefore, 4.1 percent change in capital in the growth accounting exercise is driven by demographic factors (1.1 percent), the intersectoral wedges (-1.0 percent), changes in the non-agricultural TFP (0.8 percent), changes in agricultural TFP (0.3 percent) and changes in the intertemporal wedge (2.8 percent).

The calculations in the tables above show that in a multi-sector economy the standard growth-accounting methodology, attributes the effects of policies regarding inter-sector reallocation of resources partially to aggregate TFP and partially to capital accumulation. For instance, out of 0.8 percent of future growth in Chinese GDP that comes purely from the continued removal of the labor barrier, 0.3 percent would be attributed to aggregate TFP growth,

	Capital	Labor	Aggregate TFP	GDP
Demographics, N, POP	0.6	0.3	-0.4	0.4
Intersectoral wedges, τ^C, τ^L, τ^R	0.5	0.0	0.3	0.8
Non-agricultural TFP, A^M	3.1	0.0	0.9	4.0
Agricultural TFP, A^A	0.0	0.0	0.2	0.2
Total	4.1	0.3	1.0	5.5

Table 14: Decomposition of growth accounting: 2011-50

and 0.5 percent to additional capital accumulation by the growth accounting exercise.

8 Conclusions

This paper provides a unified treatment of the 1953-2011 period of economic development of People's Republic of China. Our main interest is in the 1953-1978 period of dramatic changes in the economy of the country. We also study 1978-2011 on its own and compare it to a continuation of pre-reform policies.

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