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

Anton Cheremukhin, Mikhail Golosov, Sergei Guriev, Aleh Tsyvinski

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Abstract

We study growth and structural transformation of China in 1953-1978 in a two-sector neoclassical growth model with wedges. We find that the policy cycle of the left (Maoist) and right (pragmatist) policies is the principal driving force behind the behavior of the economy. We show distinct difference in the left and right policies in terms of economic performance and of the behavior of the wedges and construct direct quantitative evidence for the time series of the wedges. We propose a method to quantitatively decompose changes in economic variables in terms of the weighted changes in the wedges where the weights are the properly defined elasticities. Both the contemporaneous and the integral cross-effects of policies are quantitatively significant.

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1 Introduction

We study the Chinese economy from 1953, three years after the founding of the People's Republic of China to 1978, the start of the reform period, through the lens of a two-sector neoclassical growth model with wedges.[1] We show that economic growth and structural transformation during this period exhibited conspicuous fluctuations. We argue that these fluctuations can be explained by the shifts between the left-wing (Maoist) and right-wing (pragmatist) economic policies. These two policy modes are distinct in terms of the behavior of economic variables, wedges, and qualitative historical and direct quantitative empirical evidence. Thus, we uncover a pronounced policy cycle that drives the economic cycle and structural transformation. We further propose a new method connected to the variational approach to taxation that decomposes the effects of various policies.

Specifically, our model is a two-sector (agricultural and non-agricultural) neoclassical model with wedges building on Cole and Ohanian (2004), Chari, Kehoe, McGrattan (2007) and Cheremukhin et al (2016)[2]. There are three wedges. First, the intratemporal labor wedge is the cost of intersectoral reallocation of labor. Second, the intratemporal capital or investment wedge is the cost of intersectoral reallocation of capital. Third, the intertemporal capital wedge is the cost of reallocating capital across time. We further decompose the intersectoral labor wedge in three components: the consumption component (the ratio of the relative prices and the marginal rate of substitution), the production component (the ratio of the sectoral marginal products of labor relative to the sectoral wages), and the mobility component (the ratio of the sectoral wages). We also decompose the intersectoral capital wedge into its components.

We construct a comprehensive dataset that allows the application of the neoclassical model to study this period. We provide consistent data series for sectoral output, capital and labor, wages, deflators, and relative prices as well as defense spending and international trade variables. Using this dataset we then infer the wedges (and other variables such as sectoral TFPs) from the computed first order conditions of the model. Given the wedges, the neoclassical model matches the data exactly. We view the construction of the dataset that can be easily used for

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

[2] See Acemoglu (2008) and Herrendorf, Rogerson and Valentinyi (2014) for an overview of models of structural transformation. Caselli and Coleman (2001), Fernald and Neiman (2011), Restuccia, Yang and Zhu (2008), and Lagakos and Waugh (2013) consider models with sector-specific wedges.

computations of the neoclassical model and for inferring the wedges and their components for China as the first contribution of the paper.

We then provide detailed historical evidence for the existence of the policy cycle and classify the subperiods into the oscillations between the right and the left policies. In an influential study Eckstein (1977, p. 62-63) argued that "As one studies the evolution of economic policy in China between 1949 and 1975 one is struck by the shifts in development strategies, allocative priorities, the character of economic policies and the method of implementing economic programs. However, amidst these discontinuities there are very significant elements of continuity. Thus the tension between material incentives and ideological appeal has been the source of continuing policy conflict certainly from the early 1950s on. In actual fact, throughout the history of the People's Republic both elements have been present with cyclical changes occurring periodically in the relative importance of the first versus the second."[3] Our second contribution is showing that the right and left policies have distinct effects on the economy. First, there is significant difference in economic performance between the phases of the cycle. Under the right policies economy experienced faster growth (the growth rate of real GDP is 5.2 percent higher, of agricultural value added is 8.4 percent higher and of the non-agricultural value added is 3.2 percent higher) but slower structural transformation (-0.6 percentage point difference in the annual change in the share of the labor force in agriculture). Second, our calculations indicate the clear differences between the right and the left policies in terms of behavior of the wedges. Under the right policies, manufacturing and agricultural TFP grew, at 5.9 and 4.8 percent per year, respectively; the labor wedge increased at 7.6 percent, with the consumption component playing the most significant role (6.8 percent) and the production component moderately increasing (0.7 percent); the mobility component did not grow on average. The left policies are exactly the opposite: manufacturing and agricultural TFP fell, at -2.3 and -4.6 percent per year, respectively; the labor wedge fell at -10.9 percent, with the consumption component playing the most significant role (-10.7 percent) and the production component moderately decreasing (-1.5 percent); the mobility component increasing (1.2 percent). The results for the

[3]One of the most comprehensive books on China's economic development under Mao by Chu-yuan Cheng starts with the analysis of ideological background of Mao and views growth and economic development through the "Struggle between two lines" between the Maoists and the pragmatists (such as Zhou Enlai, Liu Shaoqi, Deng Xiaopin, and Sun Yefan) with the divergent views on "incentives and the path to modernization." The book concludes "Of all the factors affecting the Chinese economy, the primacy of ideology probably has had the most profound impact" (Cheng 1982, Chapter 2; p. 38, 51)

capital wedge are more nuanced. Both the labor and capital wedge have the same consumption component while the non-consumption of the capital wedge behaves similarly for both policies.

Our third contribution is to provide direct evidence that links the behavior of the wedges to the policy cycle of right and left policies. This is a challenging task and an important contribution of the paper as we are able to argue not only qualitatively using historical evidence but also find direct quantitative evidence for the wedges generated by the model. As many of the policies may potentially have different interpretation, our primary criteria for construction of such proxies are twofold: (1) there is direct comprehensive historical evidence for a policy and its effects are supported by a variety of sources; (2) wherever possible we find at least two different empirical proxies which are consistent with each other. Specifically, our construction of evidence is as follows. For the behavior of TFP, there is large literature with broad consensus and ample evidence on the distinction of the right and left policies. For the consumption component, historical evidence shows that the left policies were predominately focused on extracting resources from agriculture and on restricting the trade by peasants on the markets versus right policies which were focused on easing the burden on the agricultural sector. We use two direct estimates of the change in the degree of rationing and shortages to measure the consumption component of the wedge – a ratio of free market prices to state list prices of agricultural goods and the measure of unequal exchange between sectors. For the production component, historical evidence shows that the degree of state procurement of agricultural goods acting as an implicit tax on agricultural producers was one of the key determinants of left and right policies. We use two direct estimates for this implicit tax – data on gross procurement and the calculations of the implicit tax equivalent. For the mobility component, we use the ratio of sectoral wages to construct it, which is consistent with historical evidence. The non-consumption component of the capital wedge, the behavior of which is similar for both right and left policies, is consistent with the evidence that both right and left policies in terms of capital allocation prioritized the industrial sector. We construct a direct estimate of this wedge based on the data on state investment in agricultural infrastructure construction. The frequent shifts of priorities between the right and the left policies make it challenging to find an empirical proxy for policies determining the investment wedge. We, however, are able to construct two direct proxies for the behavior of this wedge based on the unpublished dissertation by Barry Naughton (1986) – the "general scarcity indicator", derived from a unique dataset for China,

and a measure of consumers' asset holdings reflecting the scarcity in consumer markets. These indicators track the investment wedge well and are consistent with the historical evidence that the investment cycle is driven by the interplay of the local and central authorities changing investment in response to scarcity or abundance of resources. Finally, we simulate our model using only the direct evidence and show that it closely matches the full accounting exercise with the wedges.

Our fourth contribution is to propose a method of quantitatively decomposing the behavior of the changes in economic variables into the weighted sum of changes in wedges and the proper elasticities. This method uses a tight connection of the business cycle accounting literature to the taxation literature. Specifically, we show that a marginal change in a wedge (or TFP) has both contemporaneous effects, measured with the contemporaneous elasticity, and the effects on all variables in other periods, measured with the respective cross-elasticities. The first important quantitative result is that although the contemporaneous elasticity, in most cases, is an order of magnitude larger than any individual cross-elasticity, the sum of the cross-elasticities is comparable to the contemporaneous elasticity. This implies that taking into account the cumulative cross-elasticities is crucial for understanding long-term effects of wedges and TFPs. Second, for the investment wedge, the contemporaneous elasticity is of the same order of magnitude as individual cross-elasticities, and much smaller than their sum. Thus, the integral effect of a change in the investment wedge accumulates over many periods both from the anticipation and capital accumulation effects of the change.

Finally, we use this methodology to measure the overall effects on the labor share and GDP from 1953 to 1978 from changes in wedges in specific subperiods associated with left and right policies. We find that the largest contributors to changes in the labor share (in order of decreasing importance) are the consumption component of the labor wedge, agricultural TFP, the investment wedge, the production component of the labor wedge, and manufacturing TFP. All of these factors show a pronounced asymmetry along the policy cycle. The most striking pattern is that TFPs and wedges pull the economy in opposite directions along the policy cycle. Right-wing policies increase TFP pulling people out of agriculture,[4] but also increase wedges pushing people back towards agriculture. Left-wing policies lower TFP thus slowing

[4]Note that an increase in either agricultural or non-agricultural TFP reduces the agricultural labor share by making agents more wealthy and eager to spread consumption into future periods by accumulating extra capital, which they can only produce if labor inputs are shifted towards the manufacturing sector.

the movement of workers out of agriculture, but decrease wedges which pushes people out of agriculture. However, the overall effects of wedges play a dominant role in determining the shifts in the composition of the labor force. The largest contributors to changes in GDP are manufacturing TFP, agricultural TFP, the investment wedge, and the consumption component of the labor wedge. Here the asymmetry along the policy cycle is the opposite. Right-wing policies improve TFP and boost GDP growth, but increased wedges slow down GDP growth. Left-wing policies slow down TFP and dampen GDP growth, but reductions in wedges speed it up. Overall changes in GDP are dominated by the effects of changes in TFP. We conclude with the full decomposition of changes in the agricultural labor share and GDP period-by-period into the effects of wedges and TFPs and a discussion of the advantage of the decomposition method we propose compared to the simple counterfactuals used in the literature. In short, our new methodology allows precise attribution of effects of period-by-period changes in wedges and TFPs, eliminates multiple-counting of effects which accumulate through state variables in long counterfactuals and resolves issues associated with the choice of terminal conditions.

We now turn to the connections and contributions to the literature. First, our findings regarding the policy cycle contribute to the literature on the political business cycle (e.g., Nordhaus (1975)). What is important and unique about the Chinese context is the finding that the difference between the right and left policies was so significant and that they fluctuate essentially at the normal business cycle frequency. If we compare this policy cycle to the experience of the developed economies, the changes in political power happen at similar frequencies but the differences in political and economic positions of the winners (for example, the democrats versus the republicans, the liberals versus the conservatives) and therefore the effects of those policies are much less pronounced. Second, our detailed construction of the quantitative proxies for the policies contributes more generally to the business cycle literature. A common criticism of this literature is that it is difficult to find the causes of the fluctuations. Here, we provide direct evidence of consistent fluctuations that stem from the large shifts in policy at the business cycle frequencies. Third, our paper contributes to the literature using wedge accounting for the analysis of growth and structural change – e.g., Cole and Ohanian (2004) or our previous work on transformation of Soviet Russia (Cheremukhin et al 2016)[5].

[5]It is also interesting to note why Soviet Union in contrast to China did not have such fluctuations. The primary reason is the difference in the origin of the Chinese and Bolshevik revolution. The Bolsheviks' power base was the "proletariat," (the industrial workers). The power base of the Chinese communists were peasants.

As our focus is rather on the shorter term fluctuations, we can no longer analyze a simple counterfactual exercise used in those papers of considering a once and for all change in policy (such as fixing some or all of the wedges).[6] Our decomposition method allows to comprehensively decompose the effects and observed changes in the economic variables over the short term fluctuation. Fourth, and related to the previous point, we also contribute to the business cycle accounting literature more directly (e.g., Chari, Kehoe and McGrattan (2007)). That literature in its essence is based on the taxation literature of implementing allocations with linear taxes. We show that our decomposition method is related to the variational approach to tax reforms (Golosov, Tsyvinski and Werquin (2014)) in terms of decomposing the effects into own and cross-elasticity, and the importance of the cumulated effects of the latter.[7] As in the work on the variational approach, the cross-elasticities and their cumulated effect play a significant quantitative role. Finally, one can view this paper as a modern analogue of the literature on the cycles in centrally-planned economies (e.g., Kornai 1992).

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

This is why Stalin was able to push with the policy (which in fact resembled the left policy in China) to break barriers - the policy that extracted resources from the peasants. In China, the policy cycle happened exactly because this was not possible. The left push lead to the threat of legitimacy with the peasants and resulted in the shift to the right policy that eased the pressure on agriculture.

[6] In fact, an analog of such simple counterfactual in this paper is presented in the last column of Tables 5 and 6. See a discussion of the limitations of such counterfactual exercise in Secton 6.3.

[7] See an extensive discussion in Section 6.

and Zhu (2008), Brandt and Zhu (2010) and Dekle and Vandenbroucke (2010, 2012), growth accounting by Young (2003) and Zhu (2012), the model of "growing like China" with the focus on financial frictions by Song, Storesletten, and Zilibotti (2011), a study of misallocation by Hsieh and Klenow (2010), analysis of factor wedges across space and sectors of Brandt, Tombe, and Zhu (2013) and Tombe and Zhu (2015), a model of transformation of the state-owned firms by Hsieh and Song (2015).

More broadly, our paper is related to such studies of structural transformation as Caselli and Coleman (2001), Kongsamut, Rebelo and Xie (2001), Stokey (2001), Ngai and Pissarides (2007), Hayashi and Prescott (2008), Acemoglu and Guerreri (2008), Buera and Kaboski (2009, 2012), Herrendorf, Rogerson and Valentinyi (2014). The main difference with this literature is that we find that the changes in the intersectoral labor wedges (and policies associated with them) play an important role in structural transformation. Also notable is a two-sector model of growth accounting with misallocation applied to Singapore by Fernald and Neiman (2010).

2 Model

We consider a two-sector (agricultural (A) and non-agricultural (M)) neoclassical model that we used to analyze Stalin's industrialization (Cheremukhin et al., 2016).

The preferences are given by:

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

where

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

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

Output in sector $i \in \{A, M\}$ is given by:

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

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

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

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

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

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

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

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

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

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

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

and

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

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

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

the intra-temporal capital allocation condition across sectors:

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

and the inter-temporal condition:

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

where $U_{i,t}$ is the marginal utility with respect to consumption of good i in period t.

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

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

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

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

$$\frac{U_{M,t}}{U_{A,t}} \frac{F^M_{K,t}}{F^A_{K,t}} = \underbrace{\frac{U_{M,t}/p_{M,t}}{U_{A,t}/p_{A,t}}}_{\text{consumption component}} \times \underbrace{\frac{p_{M,t}F^M_{K,t}}{p_{A,t}F^A_{K,t}}}_{\text{non-consumption component}} .$$

Note that the consumption component is common for the labor and capital wedges.

3 Policy cycle

In this section we describe and summarize the literature on the policy cycle in China in 1953-1978. Our primary goal is to determine the classification for the right-left cycle.

The literature on the policy cycle in communist China starts with the work of Skinner and Winckler (1969) who describe a model in which the society moves between the liberal phase with reliance on remuneration and the radical phase with reliance on exhortation and coercion. Perhaps the most influential view of the Chinese policy cycle is due to Alexander Eckstein (1977, p. 314-318): "the policy cycle revolves around [the regime's commitment to the Maoist vision of] resource mobilization–production nexus on the one hand, and the dichotomy between model Communist Man and Economic Man on the other. Consequently, the dilemma facing the regime is that precisely the kind of measures imposed to mobilize resources tend to (a) produce strong disincentive effects, and (b) lead to losses in productive efficiency." The policies of the mobilization phase "may take a variety of forms, depending on what period in Communist China's economic history we are considering". Yet their general features are: (1) designed to raise the level of extraction from the countryside; (2) curtail the scope of private industry and commerce; (3) "general lessening of reliance on material incentives in both agriculture and industry". These policies "tend to have strong disincentive effects ... aggravated by the fact that frequently, if not invariably, these policies are accompanied by the introduction of some new institutional forms ... [which are] in themselves disruptive". The cumulative negative effect on the economy "forces the regime to shift its policy mix" to the right policies broadly characterized as: (1) "easing the pressures on the peasantry, that is, more favorable prices, greater scope of the private plots, greater scope of the rural markets, and less control of labor allocation and mobilization"; (2) encouraging "capitalist tendencies" – increased reliance on material and financial incentives. Eckstein (1977, p. 42-43 and 46-48) summarizes that "policy differences ... revolve around two basic issues: the desired or feasible rate and character of economic growth and the role of the market or of centralized versus decentralized patters of decision making in allocating resources". Another evidence is "the ever present controversy best dramatized by the slogan that pits "Red" versus "Expert" where the group of "counselors of caution", "the planners, economists, and technocrats" were "locked in debate with the more political and radical elements identified with Mao" "at all the crucial policy turns, such as those

relating to collectivization, the Great Leap, the Agriculture First Policy, and the Cultural Revolution". Cheng (1982, p. 323-324 and Chapter 9-10 for a detailed analysis) summarizes "Generally speaking, periods of radical experimentation were succeeded by periods of retreat and adjustment ... economic policy changes in China have been closely tied to leadership changes".

Additionally, Nathan (1976, p.723-724) reviewing the literature argues that the research on policy cycle identifies the following general features of the left and right policies. "In agriculture, a rightist line involves a greater appeal to selfish, materialistic motives on the part of peasants in the form of free markets, private plots, piece-work rates, a greater flow of consumer goods to the countryside, decentralization of management to the team level, smaller state procurement from the harvest, and greater state investment in agriculture through fertilizer and mechanization ... Thus a right line in agriculture is connected to a right line in industry (balanced, planned investment and centralized management; greater technical sophistication; slower, more stable growth; reliance on material incentives to both workers and managers)". "A leftist line involves greater appeal to self-sacrificing mobilizational or ideological motives, and hence a reduction in the role of free markets and private plots, the politicization of remuneration systems, recentralization of decision-making to the brigade or commune level, higher state procurement, and reduced state subvention of fertilizer and mechanization ... Similarly, a left line in agriculture is associated with left lines in other policy areas: a more rapid but inefficient, decentralized growth of a less sophisticated industrial sector with greater worker participation in management and more reliance on ideological incentives; subordination of intellectuals and technicians to political cadres and the masses".[8]

We now turn to classification of periods into the right and left policies. While any such classification would imply some degree of choices to be made, our primary goal is to broadly fit the analysis of the historical literature.[9]

We follow Eckstein (1977) to classify the following major periods: the technocratic First Five Year Plan (1953-1957) as mostly the right strategy[10]; the Great Leap Forward (1958-1961)

[8] More broadly, see the debate of Nathan (1976) and Winckler (1976) on whether the policy oscillations have a general pattern or have to be viewed as separate historic episodes.

[9] One recent example of a similar undertaking is a book-length study of the cycles in Chinese foreign economic policy (Reardon 2015), the chronology of which is broadly consistent with ours.

[10] We omit the period of collectivization of 1955-1956 in this classification as it was rather mild and "limited the disorder and destruction of economic resources" (Teiwes 1987, p.111) as well as affecting primarily agriculture.

as the left strategy; the retrenchment and recovery period and the Agriculture First policy in the early 1960s (1962-1966)[11] as the right strategy.

We classify the period of 1967-1972 as the left policy. It is important to note that this period contained two different versions of the left policies. The first part, 1967-1968, the peak of the Cultural Revolution, is a period of radical left policies (see Eckstein (1977) and Riskin (1987, p. 186-187) for the discussion of the economic policy; Lardy (1983, p.46) marks 1967 as the beginning of production planning signifying the end of right policies with respect to agriculture). The second is the period of 1969-1972 when the military was tasked with restoring order in the country and rebuilding economy under Lin Biao that culminated in the attempted coup against Mao. A recently declassified analysis describes this second period as that of "radical ideologues and military leaders together controlling the implementation of economic policy" with the results "reminiscent of the policies that produced the Great Leap Forward, only this time presented in more reasoned and moderate vein" (CIA (1972), p. v-vi)[12].

We classify the period of 1973-1975 as the right policy. Deng Xiaopin "became the de facto premier" (Cheng (1982, p. 273)) between February 1973 and April 1976 and "possessed enormous power, second only to that of Mao; no longer was there any presumption that Deng would implement the policies of others" (Naughton (1993)).

We classify the period of the struggle for power 1976-1977 as left policy starting with the rule of the ultraleftist Gang of Four following Zhou Enlai's death in January 1976,[13] the rule of the leader of the "moderate left wing" Hua Guofeng (Cheng 1982, p. 47)[14] and ending with the restoration of Deng at the Third Plenum of the CCP Tenth Party Congress in July 1977 and with affirmation of the modernization program at the Fifth National People's Congress in

[11] See also Riskin (1987, p. 163-169) and Selden (1979, p.105 and Table 16, p.154-155)

[12] There is an issue in assigning the year of 1972 to the right or left policy. On the one hand, the rightist Zhou Enlai was in charge of the economy. However, as MacFarquhar (1991, p.342) notes "the premier was unable to liquidate the leftist positions because ... the radicals were still backed by Mao". Furthermore, Reardon (2015, p. 166-167) notes that the military control of the civilian economy continued to play an important role throughout 1972 and that the new development strategy was formulated only in 1973. Given these facts and our calculations of the wedges showing mostly leftist pattern of the wedges and the discussion of the next period, we assigned this transitionary year to the left policy.

[13] Naughton (2007, p. 77) argues that while the Gang of Four did not have control over the economy, the radicals were able to obstruct the rightist economic trends. See also Selden (1979, p. 144-45) for a description of a campaign to restrict bourgeois rights as the principal counter to the rightist modernization campaign.

[14] Ash, Howe, and Kueh (2003, p. 6) note that "between these events [the fall of Gang of Four] and the rehabilitation of Deng in 1978 [the policies of the Premier of China] Hua Guofeng ... were based more on Dazhai models of inspiration than any return of the use of material incentives. Even in the summer of 1978 these policies remained in full flight with talk of a new Leap Forward in the making." Also see Fontana (1982) for a detailed account of Hua Guofeng's political base and ideology.

February 1978.[15]

4 Data and Parametrization

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 1978.[16] One contribution of our paper is construction of the data for an application of a two-sector neoclassical model for this period.

4.1 Data sources and construction of the data

Our two main sources of data on China national accounts are the yearly "China Statistical Yearbooks" (CSY) and the "60 Years of New China" (60Y). Both sources are published by the Chinese National Bureau of Statistics (NBS). The second source aggregates data from previous publications for the years 1949-2009 and is also closely related with a book on pre-1996 statistics compiled by Hsueh and Li (1999), "China's national income 1952-1995" (HL). There is a broad consensus in the literature that while Chinese data is not perfect, the quality of it is reasonable.[17]

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

[15] Overall, our classification is broadly consistent with the textbook treatment of Naughton (2007) who 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-).

[16] The detailed data series until 2012 are provided in the working paper Cheremukhin et al. (2015).

[17] Perhaps the best overview of the data is by Carsten Holz in the leading Chinese studies journal China Quarterly (Holz 2003). He writes: "China's statistics are widely viewed as unreliable, with data falsification in order to meet economic growth targets increasingly the norm. This report examines some of the most recent criticism of statistics on China's industrial value-added and Gross Domestic Product, and shows this criticism to be unfounded as it is based on misunderstandings about the meaning and coverage of particular data". Holz cites the findings of a number of key Chinese economic data experts: "Dwight Perkins in 1966 concluded that falsification of disaggregated data is highly improbable; in the case of aggregated data, falsification might remain unnoticed in the short run, but not in the long run, and in the end it may not be in the interest of the leadership. Thomas Rawski in 1976 argued that "most foreign specialists now agree that statistical information published in Chinese sources provides a generally accurate and reliable foundation on which to base further investigations."

measure of nominal investment. We convert investment (as well as other components of GDP) from nominal to real values using the GDP deflator. This measure works well for the later part of the sample, but for the pre-1970 period it implies unrealistically low values for non-agricultural consumption, which is computed as the residual between value added, government, trade and investment.[18] To eliminate the influence of this issue on the level of the capital and labor wedges, we augment our estimates with data on non-agricultural consumption expenditure from CSY, Table 2.19. Data on non-agricultural consumption for the 1952-74 period is converted to 1978 yuan using the non-agricultural value added deflator, and investment is computed as the residual for the same period. We discuss alternative data sources and the reasons behind this choice in Section 2.3 of the online appendix.

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

We also use data from Holz (2006) to divide the aggregate capital stock into capital used in the agricultural and non-agricultural sectors. This sectoral division of capital stock is only available for 1978. For earlier years we use the data on sectoral investment from Chow (1993) to estimate the composition of capital stock by sector. We use net capital stock accumulation by sector from Table 5 on page 820 in Chow (1993), and then apply the perpetual inventory method to accumulate sectoral capital stock for 1953-1978. We allocate the total real capital stock in 1978 prices by sector using the relative proportions implied by Chow's data. We also constructed data on sectoral capital stock using provincial data and the results are consistent with our main series. Another alternative series is farm capital from Tang (1984) which we discuss together with provincial data in Section 1.8 of the online appendix.

For labor input, we use data on population, employment and its composition from the

[18]The standard assumption that all investment is produced using non-agricultural goods plays an important role when the non-agricultural sector is small.

two primary sources (60Y, CSY). We adjust the employment numbers prior to 1990 using the procedure proposed by Holz (2006), Appendix 13, page 236. The correction addresses the reclassification of employed workers that was made by the NBS in 1990.

For data on wages by sector we use average wages for staff and workers in the agricultural and non-agricultural sectors. The pre-1978 data come from CSY for year 1981. One issue with these data is that the wages of staff and workers may not be the same as labor remuneration for workers. Staff and workers are concentrated in non-agriculture, and to the extent that they are in agriculture, they are likely in state farms[19]. We address this concern by computing the ratio of labor remuneration in non-agriculture to agriculture from Bai and Qian (2010). We find that the ratio of two series behaves similarly for the overlapping time period (see Section 1 in the online appendix for more details).[20]

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

The data on defense spending comes from HL and CSY which joinly cover the 1952-1995 period and report nominal defense spending in yuan. We obtain an estimate of real defense spending in 1978 prices multiplying the share of defense in GDP by real GDP.

The main source for data on sectoral exports and imports is Fukao, Kiyota and Yue (2006). Fukao et al. report data on China's exports and imports by commodity at the SITC-R 2-digit level for 1952-1964 and for 1981, obtained from the "China's Long-Term International Trade Statistics" database. Using data from Fukao et al. (2006), we construct estimates of nominal exports and imports of agricultural and non-agricultural commodities. We then subtract imports from exports to obtain estimates of net exports by sector. We use the price deflators computed earlier to estimate real net exports by sector in 1978 prices. For the 1965-1978 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.

We convert real GDP per capita in 1978 prices to 1990 international dollars using Maddison's

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

[20] It is difficult to obtain data for a wider set of firms such as those located in rural areas for the pre-1978 period. Their omission could have an upward or downward bias. Our main results do not hinge on this bias as long as it does not change dramatically over time. What is ultimately important for our numerical exercise and main conclusions is the change in the ratio of wages in the two sectors over time. We find that the ratio of wages changed relatively little over the whole pre-reform period, and so the mobility component played a limited role in structural transformation. We think that inclusion of rural wages into the average would not change this conclusion.

estimate of 883 dollars of 1990 per person for the year 1973. We then apply real GDP growth rates (in constant 1978 prices) to construct real GDP per capita in international dollars for other years in the 1952-2012 period. This series may differ slightly from real GDP in international dollars reported by Maddison for other years, as relative prices changed. However, our index captures well the general patterns and the long-term growth rates.

4.2 Summary of the data

As shown in Figure 1, the Chinese economy in 1953-1978 grew rapidly, with a 3.6 percent average rate of growth of real GDP per capita. However, the economy did not experience structural transformation. In 1953, the primary occupation for 83 percent of the working-age Chinese population was agriculture. This fraction declined very slowly (with the exception of the brief period during the GLF when about 20 percent of the labor force temporarily moved from agriculture to manufacturing), remaining above 80 percent until 1970 and declining to 75 percent in 1977. The role of agriculture in GDP was also very important, with 68 percent of value added produced in agriculture in 1953, declining to only 30 percent in 1977 (with a similarly brief downward shift during the GLF). International trade was 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.

There is also significant difference between the right and left policy periods. The growth rate of real GDP is 5.2 percent higher under the right policies. The growth rate of agricultural value added is 8.4 percent higher and of the non-agricultural value added is 3.2 percent higher. There is a 0.6 percentage point difference in the change in the share of the labor force in agriculture. The growth rate of capital stock is higher under left policies by 11.3 percent.

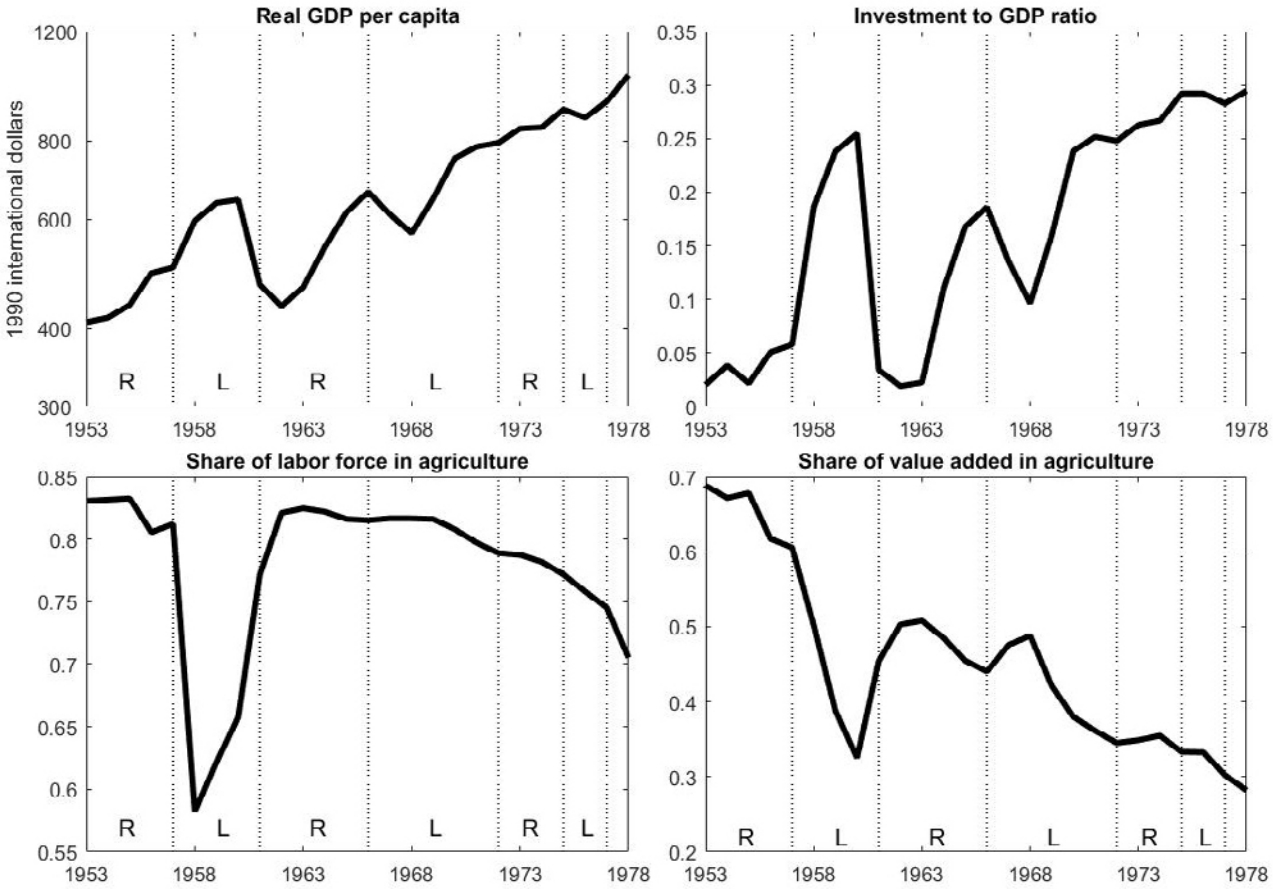

Figure 1: Macroeconomic indicators of People's Republic of China, 1953-78.

	Annual Growth Rate		
	1953-78	Right Policies	Left Policies
Real GDP	5.6	8.1	2.9
Agricultural value added	2.1	6.1	-2.3
Non-agricultural value added	9.0	10.5	7.3
Labor Force	2.5	2.6	2.4
Share of Labor Force in Agriculture (p.p)	-0.5	-0.2	-0.8
Capital Stock	10.7	5.2	16.5

Table 1: Changes in economic indicators, 1953-78.

4.3 Parametrization

For our baseline preference specification we chose a commonly used Stone-Geary specification which sets $\sigma = 1$. Parameter η measures the long run share of agricultural consumption

and we set it to 0.15. These parameters are consistent with the literature that used the two sector growth model to study growth and structural transformation in a variety of historical episodes[21].

We set the subsistence level to 54 yuan per capita per year in 1978 prices. We estimate this number using the purchase price of 0.172 yuan per kg of unhulled rice in 1957 (Swamy 1969, Table 5), convert it to 1978 prices using the state list price index (Zhang and Zhao 2000, Table 7) to arrive at the 215 kg of rice per year. This corresponds to the 1587 kcal average daily rural per capita energy intake, the lowest in 1952-1978 period (Ash 2006, Table 6). This subsistence level accounts for 53 percent of agricultural consumption per capita in 1953. We explore in an extensive online appendix, how our main results change in response to alternative calibrations of the subsistence parameter, as well as other parameters.

We choose the initial capital stock to match the observed level of capital in 1952. We set the shares of capital and labor in the non-agricultural sector to 0.3 and 0.7, respectively. We set the shares of capital and labor in the agricultural sector to 0.14 and 0.55, respectively. Our technology specification is close to Hayashi and Prescott (2008). The elasticities for the agricultural sector are also in line with estimates of Tang (1984), who uses the contributions of labor, capital and land at 0.5, 0.1 and 0.25, respectively, with the remaining share of 0.15 assigned to intermediate inputs.[22] 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). The discount factor β is set to 0.96 and depreciation δ is set to 0.05, consistent with annual frequency of the data. Finally, for χ_t, the paths of the both population and the labor force are assumed to change exogenously to match the data.

5 Wedges

In this section we pursue three goals. The first goal is to calculate the wedges and their components and show how they differ for right and left policies. The second goal is to provide comprehensive evidence for the economic policies consistent with the behavior of the wedges.

[21] See Caselli and Coleman (2001), Buera and Kaboski (2009, 2012), Hayashi and Prescott (2008), Herrendorf, Rogerson and Valentinyi (2014), Stokey (2001). The long run share η is also consistent with food expenditure shares in most developed countries.

[22] See p.89 and Appendix Table 9, p.228 in Tang (1984) for the discussion of the consistency of these input weights with a number of other countries.

	53-57	58-61	62-66	67-72	73-75	76-77	R	L	53-78
Manuf. TFP, X^M	7.7	-6.6	9.9	1.0	-0.8	-3.7	5.9	-2.3	2.0
Agric. TFP, X^A	4.0	-11.1	6.4	-0.9	3.0	-2.5	4.8	-4.6	0.3
Total labor wedge	-1.0	-22.2	23.2	-2.3	1.3	-14.4	7.6	-10.9	-1.3
Cons. component, τ^C	-3.7	-20.4	19.1	-3.1	3.9	-14.1	6.8	-10.7	-1.6
Prod. component,τ^P	-0.1	-6.4	4.0	1.0	0.9	0.6	0.7	-1.5	-0.3
Mobil. component, τ^M	2.8	4.5	0.2	-0.2	-3.5	-0.9	0.0	1.2	0.6
Total capital wedge	-11.4	-27.8	15.6	-3.6	-1.5	-15.4	1.7	-13.6	-5.7
non-cons. component, τ^R	-7.7	-7.4	-3.4	-0.5	-5.4	-1.3	-5.2	-3.0	-4.1
Investm. wedge, τ^K	1.9	0.9	-3.2	-0.8	0.9	-7.7	-0.0	-1.4	-0.7
GDP	7.4	-1.1	9.3	5.6	6.1	2.9	8.1	2.9	5.6
Labor share, p.p.	-0.5	-1.0	0.9	-0.4	-0.6	-1.3	-0.2	-0.8	-0.5
Ideology	R	L	R	L	R	L			

Table 2: Annual growth rates of wedges, TFPs and economic variables by subperiod, 1953-78

We are able to provide both the detailed historical account and the quantitative proxies for all wedges and their components. Third, we simulate the model using these quantitive proxies and find that the changes in the data that could be attributed to changes in wedges are well captured by the proxies.

5.1 Paths of wedges

We present the calculation of the total factor productivities in agriculture and non-agriculture, the components of the intersectoral labor wedge, the intersectoral capital wedge, and the investment wedge in Figure 2. Table 2 presents average growth rates of wedges and TFPs as well as the key economic variables for each subperiod. Figure 3 shows visually growth rates of wedges and TFPs by subperiods, where blue color indicates the improvements and red indicates worsening in the TFPs, wedges, or their components.[23] The color depth indicates the relative magnitude of changes.

These calculations indicate the clear differences between the right and the left policies. The periods of the right policies share the following common features. Manufacturing and agricultural TFP grew rapidly, at 5.9 and 4.8 percent per year, respectively. The labor wedge increased at 7.6 percent, with the consumption component playing the most significant role (6.8 percent) and the production component moderately increasing (0.7 percent). The mobility component did not grow on average. The left policies are exactly the opposite. Manufacturing

[23]The opposite signs of changes in mobility, capital and investment wedges are indicated by (-) in Figure 3.

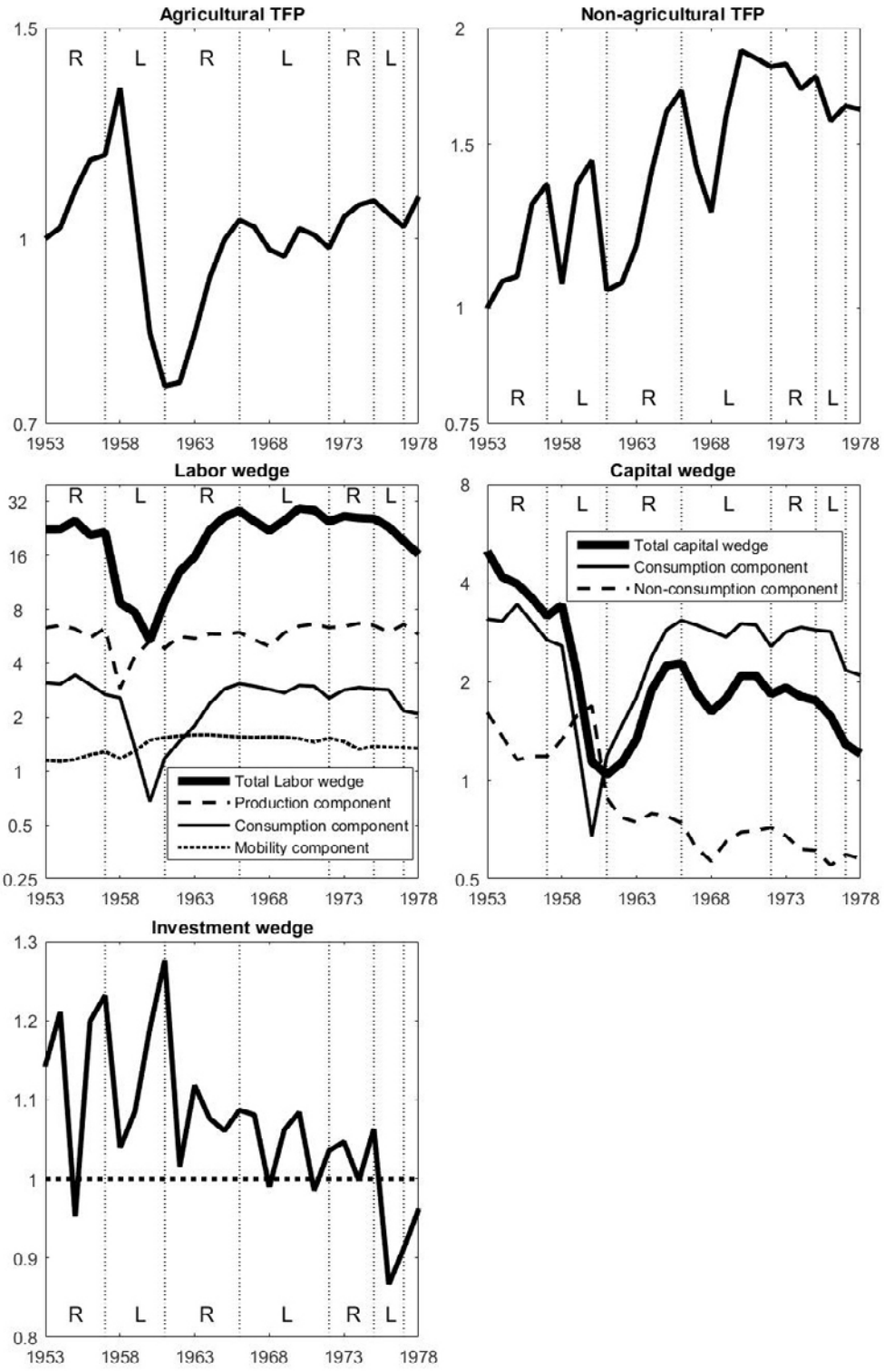

Figure 2: TFPs and wedges

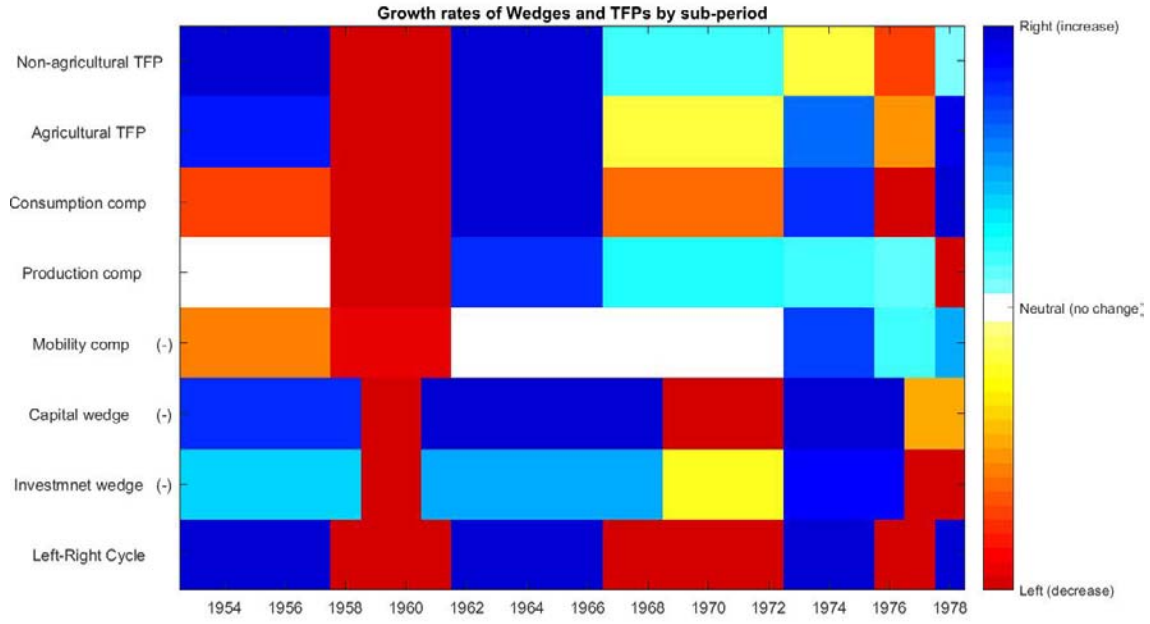

Figure 3: Growth rates of TFPs and wedges by subperiod and ideology for 1953-78

and agricultural TFP fell, at -2.3 and -4.6 percent per year, respectively. The labor wedge fell at -10.9 percent, with the consumption component playing the most significant role (-10.7 percent) and the production component moderately decreasing (-1.5 percent). The mobility component increased (1.2 percent).[24]

The results for the capital wedge are more nuanced. It is important to note that the capital wedge consists of two components. The first component, the same as in the labor wedge, is the consumption component the behavior of which changes dramatically between the right and the left policies as described above. The second component is the non-consumption component of the capital wedge. This component has an interesting pattern of behavior. For both the right and left policies, with the exception of the 1958-1960's peak of the Great Leap Forward, the non-consumption component of the capital wedge declines at 4.1 percent on average (-5.2 and -3.0 percent in periods of right and left policies respectively). In other words, the consumption component determines the primary difference between the right and the left policies with respect to allocation of capital across sectors, as shown in Figure 2.

The growth rates of the investment wedge presented in Table 2 are not a particularly useful

[24]If one excludes the Great Leap Forward, our qualitative results are essentially the same but the magnitudes are smaller.

measure for characterizing the investment wedge as it exhibits large fluctuations from year to year (see Figure 2). It may be more productive to look at average values by subperiod. The investment wedge was elevated, at 13 percent on average, during the FFYP and increased in excess of 20 percent during the GLF. The investment wedge declined to 6 percent on average in the recovery period, and to about 2.5 percent after the high tide of the Cultural Revolution passed. This suggests that right shifts in policy were generally associated with declines in the investment wedge, while left shifts were associated with increases. Note also, that for both the right and the left periods, while the TFPs and labor wedges were affected simultaneously, the capital and investment wedges were affected with a lag. Lagged growth rates shown in Figure 3 confirm the existence of a lagged effect of the policy cycle on the capital and investment wedges.

We have conducted two additional robustness checks for the policy cycle. First, we take the common factor of changes in TFPs and the labor wedge for the 1953-78 period. We associate high values of the common factor with right policies and low values with left policies. This method confirms the periods 1953-57, 61-66 and 73-75 as years when right ideology prevailed, while the periods 1958-61, 67-72 and 76-77 are periods when left-wing ideology took over. Second, we extend the common factor analysis to the post-1978 period. We find that starting with the 1973 party congress, the 5-year political cycle is almost perfectly correlated with the left-right wing policy swings. Each 5-year party congress cycle consists of a 2-3 year right-wing period of high TFP growth and little change to labor and capital wedges, followed by a 2-3 year period of slow TFP growth and fast decline in the labor and capital wedges. The investment wedge seems to move in a synchronized way with these right-left swings with a small lag. As we demonstrate in section 2.2 of the online appendix, this pattern of alternating left- and right-wing swings continued into the post-1978 period and became much more regular, with the timing of the swings associated very closely with party congresses.

5.2 Direct evidence

We now argue that the differences between the right and the left policies are consistent with the historical evidence discussed in Section 3 and provide additional, more detailed and specific evidence for the behavior of each wedge. Moreover, we are able to find quantitative proxies for each wedge. This is a difficult task and an important contribution of the paper as we are

able to argue not only qualitatively using historical evidence but also find direct evidence for the abstract wedges generated by the model. The discussion below emphasizes our choice of focusing on the policy cycle and grouping policies into the right and left policies rather than analyzing the individual policies. The main goal is to argue that the right and the left policies which may and do appear in several wedges simultaneously exhibit a clear, distinct pattern supported by historical and quantitative evidence. Our primary criterion for inclusion of such proxies is twofold: (1) there is direct comprehensive historical evidence for a policy and its effects supported by a variety of sources; (2) wherever possible there are two different empirical proxies which are consistent with each other.

We start with the more straightforward task of describing the policies consistent with different behavior of TFP under the right and left policies. Here, there is broad consensus in the literature and ample evidence. The decline in TFP during the periods of the left cycle is consistent with the centralization of decision-making, distorted incentives, and the overall disruptions caused by these policies. Examples of such policies include exceptional inefficiency of backyard steel furnaces (e.g., Eckstein, 1977, p. 124)[25] and poor management of agriculture under the commune system[26] during the Great Leap Forward, condemnations by the Maoists as class enemies of the managers who instituted incentives during the Cultural Revolution that lead to a "management debacle" and the calls for abolition of wage differentials during the period of the struggle for power (Cheng 1982, p. 270, p. 274). The increase in TFP during the periods of the right cycle is consistent with the decentralization, focus on incentives, and technocratic management of the economy of the right policies. Examples of such policies are the use of Soviet assistance in terms of transfer of advanced technology and advisors to help operate it during the First Five Year Plan (Lardy 1987a, p. 178; Eckstein 1977, p. 102; Naughton 2007, p. 66; Rawski, 1979, p. 51), decentralization of commune management that decreased the massively inefficient size of the production unit to that in 1955-56 (Eckstein, 1977 p. 60-

[25]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".

[26]Lin (1990) discusses a variety of hypotheses and presents a view emphasizing the role of incentives in the fall of productivity. See also Donnithorne (1987, Chapter 2) for the detailed description of the evolution of the communes. Considering the negative productivity impact of the communes Lardy (1987b, p. 370) argues that the most important factor was in the poor construction and design of the irrigation projects which reduced rather than raised yields (See also Cheng 1982, p. 267).

61) during the period of recovery from the Great Leap Forward, and material incentives as the "cornerstone" of economic policy (Cheng 1982, p. 270).[27]

The second main difference between the right and the left policies is in the behavior of the consumption component of the intersectoral wedges. Again, the historical evidence is straightforward. The left policies as we argued in Section 3 were predominantly focused on extracting resources from agriculture and on restricting the trade by peasants on the markets versus the right policies which were focused on easing the burden on the agricultural sector. We now turn to the more challenging task and present two types of direct evidence consistent with these policies. First, we construct a measure of a portion of the consumption component that can be accounted for by the change in shortages in the market for agricultural goods.[28] We use the data on the ratio of the market price of the agricultural goods as a percentage of the list (state mandated) price for 1952-1961 constructed by Sheng (1993b); for 1962-1978 we use China Trade and Price Statistics (1989)[29]. For the year where both of the series overlap, 1961, we take the data from Sheng (1993b) for consistency. We briefly summarize the data. The ratio of the prices is 1.32 in 1953, 1.33 in 1957, then increases to 4.13 in 1961, but falls back to 1.36 in 1964 and rises to 1.69 in 1978. The implied consumption wedge declines by a factor of 3 during the GLF, consistent with the actual decline in the consumption wedge, as shown in panel 1 of Figure 4. Broadly, this measure proxies the consumption component well with the exception of the delay in the start of the fall of the consumption in the beginning of the Great Leap Forward. The second method for providing evidence for the change in the degree of shortages is using the data from Niu et al. (Table 7 in Zhang and Zhao 2000). They construct an estimate of the difference between the state purchasing price and the "real value" of agricultural products[30]. Despite the fact that these estimates are based on the Marxist labor theory of value, a broad comparison of the trends is still useful. We compare the actual path of the consumption wedge and the two proxies in panel 1 of Figure 4. In particular, this

[27] A detailed chronological analysis of the individual policies is in the working paper version Cheremukhin, et al (2015).

[28] See also Huenemann (1966) and Imai (1994a) for a detailed account of rationing.

[29] This is a classic method to construct a proxy for shortages starting with Holzman (1960). See also a discussion in Lardy (1983 p. 111, p. 119-123) who advocates using this measure as an estimate of the terms of trade between agriculture and manufacturing.

[30] See an extensive discussion of the Chinese estimates of the degree of underpricing of the agricultural goods ("the value scissors" are contrasted to the "price scissors" which measure the terms of trade between the sectors) in Sheng (1993a, Chapters 2 and 5).

proxy performs particularly well in capturing the beginning and the depth of the fall during the Great Leap Forward. Summarizing, we conclude that these two measures jointly account for essentially all of the movements in the consumption wedge. We refer the reader to Section 3 of the online appendix for a sketch of the model for a consumption wedge, detailed calculations, and additional information.

We now turn to the production component of the labor wedge. We use two methods to proxy for this distortion. First, consider a simple model of an agricultural firm that has only labor as a factor of production and has to deliver a portion τ of the output to the state. The firm's objective is then given by $(1-\tau)\, p^A F^A(N^A) - w^A N^A$ and the first order condition is given by $\frac{p^A F_N^A}{w^A} = \frac{1}{1-\tau}$. Hence, τ is a standard tax on output: when it rises, agriculture becomes less attractive compared to manufacturing and the production component of the labor wedge decreases. The opposite happens if procurement increases. Lardy (1983, p. 18-20) argues that procurement of agricultural products by state was a major instrument of the "oscillation between indirect and direct planning have had major effect on the rate of growth and composition of aggregate farm output and the efficiency of resource allocation" and "periods of production planning coincide with the political swings to the left".[31] Similarly, Li and Yang (2005) show empirically that excessive procurement was second only to diversion of resources from agriculture in explaining the collapse of the agricultural output during the Great Leap Forward. Hence, we use state procurement of agricultural goods to proxy for the degree of such implicit tax. Specifically, we use data from Ash (2006, Table 3) and Li and Yang (2005, Table 1) to measure the distortion as one minus the ratio of gross procurement of grain to rural grain supply. As shown in panel 2 of Figure 4, the dramatic increase in procurement relative to grain supply during the Great Leap Forward (1957-61) explains most of the reduction in the production component of the labor wedge in that period, albeit with a slight lag. This measure also captures the broad pattern of the post-GLF behavior of the wedge but not the shorter term fluctuations. As the second method, we use the results from Imai (2000, Table 3) who measures price and wage distortions associated with implicit taxation of labor in the non-agricultural sector. Using his method, measuring the ratio of terms of trade under the

[31] See an extensive discussion in Lardy (1983b) on how procurement is a de facto implicit tax on agriculture, in Eckstein (1977, p. 51) that state agricultural trading companies earned large monopoly profits through imposing an implicit involuntary tax on the peasants, and the discussion of monopoly and monopsony power of the state trading companies in allowing to manipulate the terms of trade between agriculture and manufacturing and to extract resource from agriculture in Lardy (1983, p. 123-125)

assumption of zero implicit tax and the actual terms of trade is equivalent to measuring the production component of the labor wedge. This measure captures well the path of the production wedge in the 1964-78 period, explaining the drop and subsequent recovery during the high tide of the Cultural Revolution (1966-70).[32]

The mobility component of the labor wedge closely follows historical evidence. The increase in the mobility component during 1953-1957 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.[33] Describing the hukou policy during the Great Leap Forward, Chan and Zhang (1999) write how it closely parallels the political and economic priorities and is consistent with the increase of the mobility component during that period. Specifically, the measures to stop the "blind flows" of rural labour culminated in the promulgation of the set of hukou legislation by the National People's Congress in 1958 and that the disastrous Great Leap Forward and the famine helped the government set the full hukou system in place in 1960. The slower growth of the barrier is also consistent with the massive forced resettlement of urban population to the countryside. In 1961-62, about 30 million urbanites were moved to the countryside (Lardy 1987b, p. 387). Liu (2005) discusses hukou conversion process as a crucial aspect of rural–urban migration whereas recruitment by state-owned enterprises was the main channel for individuals in rural areas to obtain an urban hukou during the 1960s and 1970s. The policy of hukou conversion is consistent with the decline in the mobility component of the wedge, even though it likely accounts only for part of this decline. Wu (1994) also discusses the policy of sending about 18 million urban youth to villages during Cultural Revolution and their gradual recall back to the cities. This policy likely had a mixed impact on the mobility wedge – first an increase and then a decrease. Moreover, in 1971, the government, for the first time since the collapse of the Great Leap Forward, relaxed control over the increase in permanent positions in the urban/industrial sector. This policy is consistent with the decrease in the mobility wedge.[34]

[32]We also note that there is very little data on monopoly markups in the non-agricultural sector. The only direct evidence we are aware of is the study by Dong and Putterman (2000) who argue that monopsony in the pre-reform industry was a significant impediment to structural transformation. They calculate the difference between the marginal product of labor and wages, including welfare benefits and subsidies, in Chinese state industry and find that the mean gap was 169 percent and the median gap was 189 percent for 1952-1984.

[33]While the origins of the hukou system can be traced to 1951, Nolan and White (1984) argue that the measures to control migration started to be effective after 1955. See Cheng and Selden (1994) for a detailed account of the origins of this system and Chan and Zhang (1999) for a comprehensive history of the hukou system.

[34]Another potential force affecting the mobility component of the wedge is the return to schooling. For

As we described above, there is an important difference in behavior of the consumption and non-consumption component of the capital wedge. The behavior of the consumption component (which is the same for the labor wedge) is consistent with the voluminous literature on how the state used the policy of suppressing agricultural consumption to mobilize capital resources for industry and with the oscillations of the degree of such mobilization between the left and the right policies (see, for example, Ishikawa (1967) for the paper that started this literature, Chapter 3 "Prices and intersectoral resource transfers" in Lardy (1983), a book length treatment by Sheng (1993a), and references therein). We now turn to the non-consumption component of the capital wedge. The decline in this wedge is consistent with the fact that broadly both the right and the left policies in terms of capital allocation prioritized the industrial sector as, for example, the classification of the evolution of China's development strategies by Cheng (1982, Table 9.3) who ranks the sectoral priorities[35]. In 1952-1957 the intersectoral capital wedge decreased significantly. This is consistent with the main strategy of the First Five-Year Plan that placed the "overwhelming allocation of investment resources to industry" and production of capital goods (Lardy 1987a, p.158). 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. The decline in the non-consumption component of the capital wedge is consistent with the argument of Perkins (1991, p. 486) who concludes that the period of 1966-76 was very similar to the original 1950s vision of the First Five-Year Plan and Lardy (1983, p. 144) argues that this period was marked by "proportionally reduced agricultural investment, a decline in the volume of agricultural credit". An additional element was the development of the "Third Front", 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.[36] The Third Front was important even during the Cultural Revolution, but its rapid expansion phase was stopped by the Cultural Revolution. It is interesting to note the increase in the non-consumption component of the capital wedge during the Great Leap Forward. This can be

example, many of the left policies described in Section 5 explicitly discriminated against the well-educated workers and managers. We refer the reader to Fleisher and Wang (2005) who provide evidence for this period.

[35] Only during the Readjustment period of 1961-1965 agriculture received priority higher than industry, this consistent with the increasing overall capital wedge; in all other periods heavy industry ranked higher. At the same time, the "Agriculture First" strategy most significantly increased chemical fertilizer production, electricity allocation, and the production of small agricultural implements (Eckstein, 1977, p. 60) which can account for the decline of the non-consumption component of the capital wedge.

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

accounted for by the policy of "walking on two legs" which represented "a sharp break with the industrial policies of the First Five-Year Plan" in which the high capital intensity industry was developed alongside the small-scale, labor intensive plants such as backyard furnaces (Eckstein 1977, p. 124). We construct a proxy for this wedge using the data on state investment in agricultural infrastructure construction (Sheng (1993a, Table 6.4) and Zhang and Zhao (2000, Table 9)). Sheng (1993a, p. 120, p. 132) describes this variable as a "value indicator of capital construction" covering such directly related to agriculture projects as harnessing rivers, constructing water conservancy facilities, meteorological projects and capital construction in agricultural scientific research. Panel 4 of Figure 4 shows the path of agricultural infrastructure construction spending as a share of non-agricultural value added. To evaluate the effect of infrastructure spending on the non-consumption component of the capital wedge we need to compute the rate of return to capital in agriculture. To do this, we use the perpetual inventory method to construct a proxy for agricultural capital assuming that all the investment comes from infrastructure construction only. We then construct the rate of return to agricultural capital as the production elasticity times the ratio of value added to capital. The proxy for the capital wedge is then the ratio of returns to non-agricultural capital (fixed at its 1953 value) and the rate of return to agricultural capital coming from infrastructure spending. The resulting proxy for the non-consumption component of the capital wedge mimics the data remarkably well, as shown in panel 4 of Figure 4.

While the account of the shifts of priorities between the right and the left policies in terms of investment fits the behavior of the investment wedge in Section 3, the frequent changes in it make it challenging to find an empirical proxy for policies determining the investment wedge. The only direct evidence that we are aware of is the unpublished Ph.D. dissertation of Barry Naughton "Savings and investment in China: a macroeconomic analysis" (Naughton, 1986). In this work, he analyzes the theory of investment cycles in socialist economies and argues that the only factor that can quantitatively and empirically account for the "extreme investment instability" during this period is the interaction of the central and local governments. He provides evidence that China was unique among socialist economies as a large proportion of investment allocation was done by the local and provincial governments. The investment cycle is driven by the change in the bargaining position between the local governments who find it easier to push for high investment during the periods of abundance of consumer goods and the central

government who during the time of shortages limits the appetites of the local governments.[37] Furthermore, Naughton (1986) creates two indices that capture the degree of such shortages. The first index is based on the unique dataset, available only for China and not for any other centrally planned economies. After the leadership change in 1978, the Chinese economists were encouraged to criticize economic policy under Mao and as a part of this campaign the data on the difference between the supply of consumer goods and consumers' purchasing power and resulting shortages were released. We thus use the "general scarcity indicator" index from Table III-2, Column 4 in Naughton (1986).[38] The second index he constructs is based on the consumers' asset holding using income and saving data to measure excess money holdings of the population whereas the consumers choose to hold higher money balances as opposed to savings during the time of shortages consistent with the model of search for scarce consumer goods. We thus use the monetary shift index Table III-2, Column 4 in Naughton (1986). These indices show remarkable similarity when properly rescaled (Figure III-1). Summarizing, Naughton (1987) states that "The shortage index was the only time series found which predicted changes in investment: tests of agricultural production or procurement, energy supply, and foreign trade balance failed to provide any predictive power .... This test indicates that conditions on consumption goods markets have been a crucial determinant of investment fluctuations, either because planners allow investment to grow rapidly when supplies of consumption goods are abundant, or because emerging shortages in the consumption sector bring expansionary episodes to a halt." In panel 3 of Figure 4 we show that both of these measures track closely the behavior of the investment wedge.[39] Consistent with Naughton (1986), post 1973 this indicator loses its connection with the investment wedge.

5.3 The model with the proxies for the wedges

Now that we have largely constructed the paths of the wedges using only direct evidence, we analyze whether these direct proxies can explain the observed economic fluctuations. Alter-

[37] More broadly this model is related to the classical work by Kornai (1992) who argues that investment cycles are prevalent among socialist economies and are driven by capacity constraints.

[38] While both this indicator and the ratio of the free market prices relate to shortages they are different. The former measures the degree of the overall shortage and hence implicit forced savings – the component relevant to the intertemporal wedge. The latter measures the degree of relative shortage of agricultural to manufacturing goods.

[39] The timing of the investment cycles is also consistent with Imai (1994b) who studies a model similar to Naughton but in the context of repressed inflation.

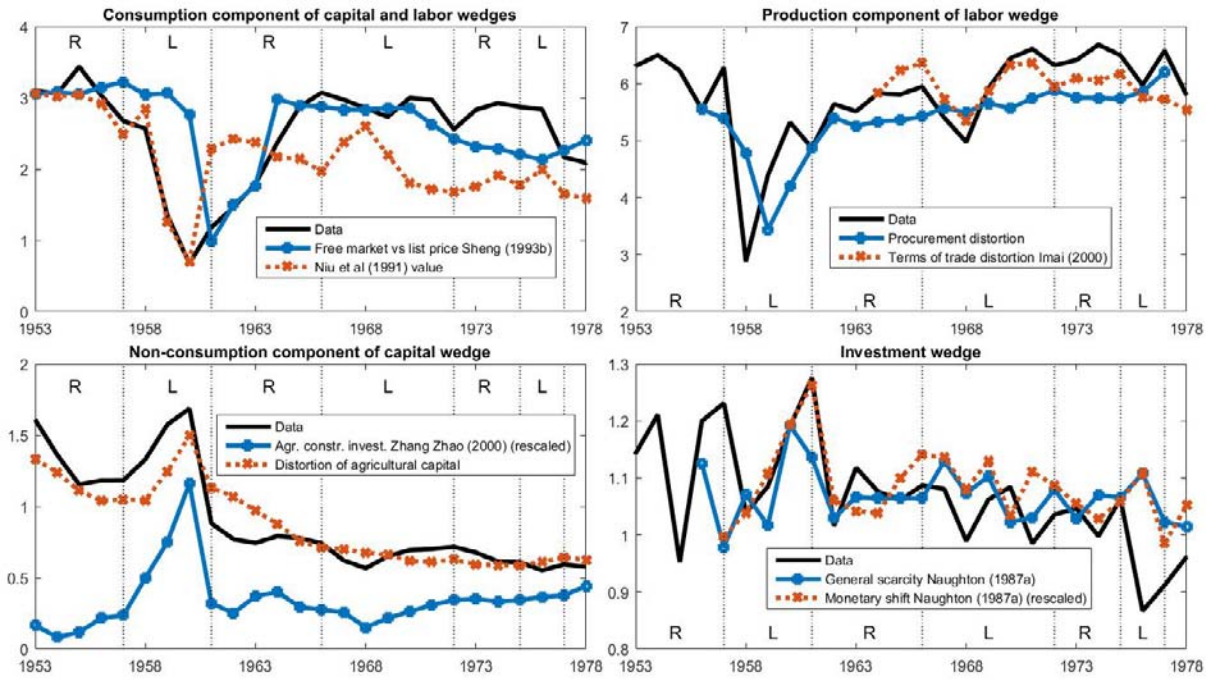

Figure 4: Direct evidence for wedges

natively, one can view this simulation as follows – that instead of determining the wedges as a part of the accounting exercise, we simulate the neoclassical growth model with the wedges calibrated to the time series of the direct evidence that we provided. With that goal in mind, we construct two counterfactuals. In the first counterfactual, we set all the wedges and TFPs to their median values over the 1953-78 period. As shown in Figure 5 ("trend wedges") China's economy would still fluctuate due to uneven growth in labor force and population. The second counterfactual replaces actual wedges by their proxies that we constructed from direct evidence in Section 5.2, and uses actual TFP. Figure 5 ("direct evidence") demonstrates that the wedge proxies capture remarkably well the economic effects of changes in wedges. Specifically, proxied changes in wedges account for all of the drop in the shares of labor and value added in agriculture during the Great Leap Forward and their gradual declines in the post-1970 period. Proxied changes in wedges also account for a substantial part of the build-up of investment and boosted GDP growth during the GLF and the post-1970 period. The model simulated using direct evidence reproduces basically all of the fluctuations with minor deviations during the

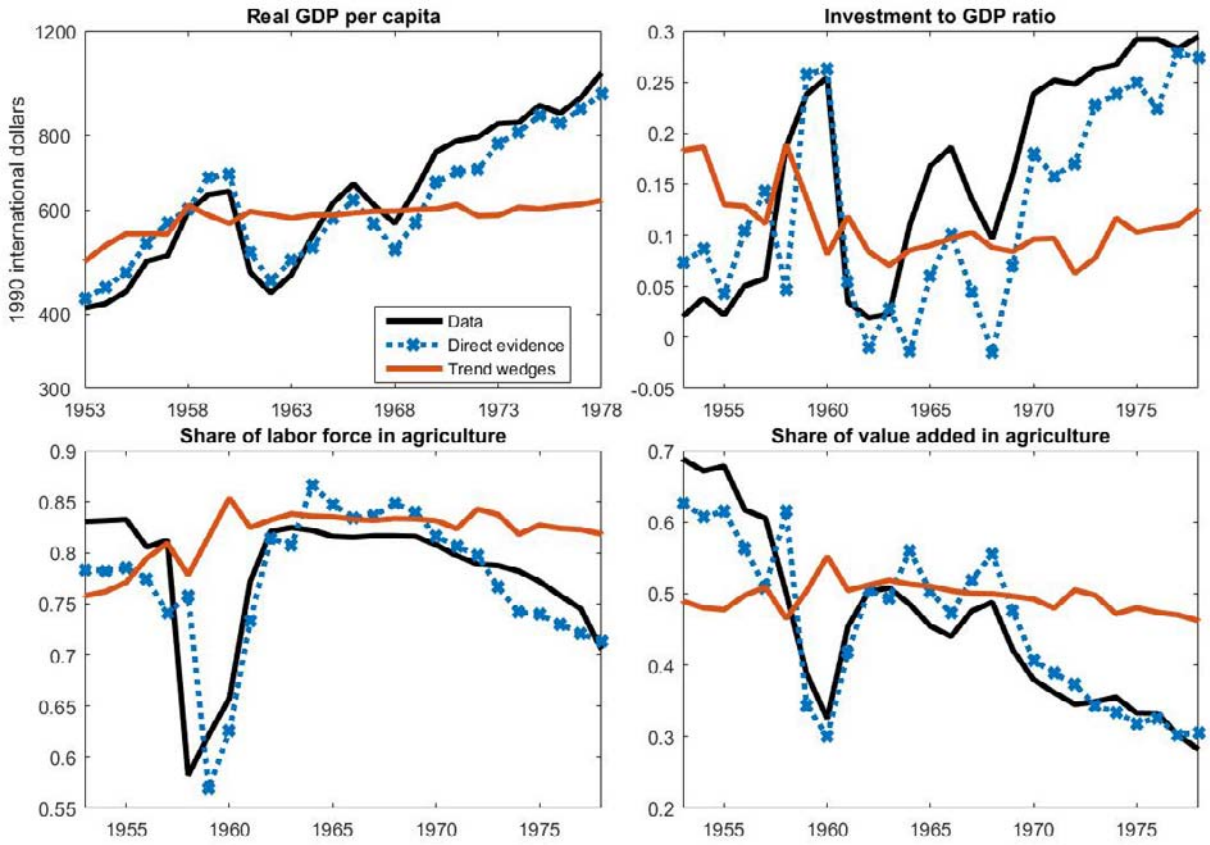

Figure 5: Counterfactual paths using direct evidence for wedges

high tide of the Cultural Revolution.[40]

6 Decomposing effects of policy

In this section we first describe methodology that relates a change in an economic variable to the change in the corresponding wedge in a specific period and decomposition of it using various elasticities. We explain how to compute the elasticities and show that the change in any variable over any time period can be decomposed into a weighted sum of wedge changes where the weights are contemporaneous and cross elasticities. We show that cross-elasticities play a quantitatively important role and are as important to accounting for the behavior of the data as the contemporaneous effects. Then we analyze the properties and the paths of elasticities, and combine them with the wedges to understand which changes in wedges had the biggest

[40]The correlations of the data and the counterfactuals using direct evidence are in the [+0.74,+0.93] range, while the correlations of the data with the trend counterfactuals are in the [-0.5,+0.3] range.

effects on China in 1953-78.

6.1 Elasticities and variational decomposition

Consider our benchmark economic model with wedges that exactly matches the data by construction. Denote the vector of endogenous state variables in period t by x_t and the vector of endogenous control variables by y_t. Denote the vector of exogenous wedges in period t by τ_t. The primitives of the model are initial x_0^* and a sequence of wedges $\{\tau_t\}_{t=1}^{\infty}$. The model is a sequence of equations

$$F\left(x_t, y_t, x_{t+1}, \tau_t\right) = 0 \text{ for all } t \tag{12}$$

that have data as a unique solution $\{x_{t+1}, y_t\}_{t=1}^{\infty}$. Let A be space of all $\mathbf{a} \equiv \{x_t, y_t, \tau_t\}_{t=1}^{\infty}$ that solve (12).

Take any $\mathbf{a}^* \in A$. We can apply variational analysis to this system by perturbing the values of exogenous variables and considering their effects on the whole solution to the system. For any $\mathbf{a} \in A$ we have, up to higher order terms,

$$\begin{aligned} &F_1\left(x_t^*, y_t^*, x_{t+1}^*, \tau_t^*\right)\left(x_t - x_t^*\right) + F_2\left(x_t^*, y_t^*, x_{t+1}^*, \tau_t^*\right)\left(x_{t+1} - x_{t+1}^*\right) \\ &+F_3\left(x_t^*, y_t^*, x_{t+1}^*, \tau_t^*\right)\left(y_t - y_t^*\right) + F_4\left(x_t^*, y_t^*, x_{t+1}^*, \tau_t^*\right)\left(\tau_t - \tau_t^*\right) = 0. \end{aligned}$$

This system can also be inverted to obtain, for all t,

$$z_s - z_s^* = \sum_{t=1}^{\infty} \epsilon_{\tau,t}^{z,s}\left(\tau_t - \tau_t^*\right) + \epsilon_{x,0}^{z,s}\left(x_0 - x_0^*\right), \tag{13}$$

where $z_s \in \{y_s, x_{s+1}\}$ and $\varepsilon_{\tau,t}^{z,s}, \varepsilon_{0,t}^{z,s}$ are all elasticities. In particular, $\epsilon_{\tau,t}^{z,s}$ is the elasticity of the economic variable z in period s to the wedge τ in period t. The last term captures the effect of the initial conditions.

The formula above can be used to derive a decomposition of changes in variables as a weighted change in wedges. Take $\mathbf{a} = \{x_t^*, y_t^*, \tau_t^*\}_{t=2}^{\infty}$. Clearly, $\mathbf{a} \in A$, therefore the formula above becomes:

$$z_{s+1}^* - z_s^* = \sum_{t=1}^{\infty} \epsilon_{\tau,t}^{z,s}\left(\tau_{t+1}^* - \tau_t^*\right) + \epsilon_{x,0}^{z,s}\left(x_1^* - x_0^*\right).$$

Recalling that variables and wedges are in vector form and more conveniently representing them in log form, we can rewrite this as an explicit sum over wedges:

$$\ln \frac{z_{s+1}}{z_s} = \sum_w \sum_{t=1}^{\infty} \epsilon_{w,t}^{z,s} \ln \frac{\tau_{w,t+1}}{\tau_{w,t}} + \epsilon_{x,0}^{z,s} \ln \frac{x_1}{x_0},$$

where w indexes wedges, and the elasticity $\epsilon_{w,t}^{z,s}$ measures the variational effect of a 1 percent change in the wedge τ_w in period t on the change in variable z in period s. In the case of a static model, i.e. if our model did not have inter-period linkages, the change in variable z between periods t and $t+1$ would be only affected by within-period changes in wedges. However, in our dynamic model there are inter-period linkages due to capital accumulation and intertemporal consumption smoothing which introduce these cross-period elasticities.

An additional technical issue is raised by the fact that data typically covers only a limited period of time from 1 to T, while the formula involves a sum for an infinite horizon. A simple solution is achieved by extending the period of interest forward to $\overline{T}$ large enough so that the effects of the distant future on the period of interest can be fully captured by a finite sum.[41] The variational decomposition is then described by:

$$\ln \frac{z_{s+1}}{z_s} = \sum_w \sum_{t=1}^{T-1} \epsilon_{w,t}^{z,s} \ln \frac{\tau_{w,t+1}}{\tau_{w,t}} + \sum_w \sum_{t=T}^{\overline{T}-1} \epsilon_{w,t}^{z,s} \ln \frac{\tau_{w,t+1}}{\tau_{w,t}} + \epsilon_{x,0}^{z,s} \ln \frac{x_1}{x_0}, \tag{14}$$

where the elements of the first term measure the contributions of the period-by-period changes in wedges to the change in economic variable z in period s, the second term measures the effect of "expectations" of the path after period T and the third term measures the impact of initial state x_0.

Our variational methodology not only shows the decomposition (14), but also provides a way of computing the weights and gives them an economic meaning. The elasticities introduced by equation (13) measure the percentage responses of economic variables to a 1 percent deviation of one wedge in one period from its baseline value. Thus, the elasticities can be computed by simple perturbation of the original non-linear system.[42] This method gives us a comprehensive tool to analyze the effects of a policy as the product of the corresponding change in a wedge and the elasticity of an economic variable to that change.

The first property of the decomposition is that both changes in wedges in the same period

[41] We extend the simulation using the actual data for China for 1978-2012. We have tried alternative extensions and they all give identical results.

[42] The elasticities can also be computed in a variety of other ways which helps uncover the economic intuition behind them, as we discuss at length for our specific model in section 4 of the online appendix.

and changes in wedges in other periods can have an effect on a variable in period s. We call the effect of a change in a wedge in period t on the economic variable in the same period t the *contemporaneous effect* of the wedge, and we refer to effects on other periods as *cross-effects*. We call the elasticities capturing the effects on the same period contemporaneous elasticities, while we refer to the rest of the elasticities as cross-elasticities.

The second property of the decomposition is that a change in a wedge in period t has effects on changes in the economic variable z in all periods, so those effects add up over time. Indeed, we can add up changes over time and then rearrange the formula as follows:

$$\ln \frac{z_T}{z_1} = \sum_w \sum_{t=1}^{T-1} \left(\sum_{s=1}^{T-1} \epsilon_{w,t}^{z,s} \right) \ln \frac{\tau_{w,t+1}}{\tau_{w,t}} + \sum_w \sum_{t=T}^{\overline{T}-1} \left(\sum_{s=1}^{T-1} \epsilon_{w,t}^{z,s} \right) \ln \frac{\tau_{w,t+1}}{\tau_{w,t}} + \left(\sum_{s=1}^{T-1} \epsilon_{x,0}^{z,s} \right) \ln \frac{x_1}{x_0},$$

where the term in the brackets describes the integral elasticity of economic variable z to the change in wedge τ_w in period t. It measures the total effect of a change in a wedge in period t on an economic variable in all periods from period 1 to period T. We can similarly define an integral elasticity for any subperiod.

Conceptually, our methodology emphasizes and extends the connection of the business cycle accounting literature to the taxation literature. The essence of the business cycle accounting literature as in Chari, Kehoe and McGrattan (2007) is that any allocation can be mapped into a prototype neoclassical growth model with wedges. In terms of the tax literature, this amounts to implementing a given allocation with a (linear) tax system (see, e.g., the review in Chari and Kehoe (1999)). The counterfactual exercises of Chari, Kehoe and McGrattan (2007), Cole and Ohanian (2004), Cheremukhin, et al (2016) amount in this context to once and for all changes in a given tax, whereas the wedge is fixed at the level of the starting period, and estimating the change in the path of the variables in the model.

What we do here, however, is related to another strand of taxation literature – the variational approach of Golosov, Tsyvinski and Werquin (2014). There, the goal is to consider a marginal change in a given tax and decompose the effects of this tax in terms of the change in the tax and the corresponding elasticities. The method described above also does the reverse of what the variational approach does – we consider a change in a given variable and decompose it into changes in the wedges in all periods and the corresponding elasticities.

6.2 Elasticities

In this section we compute three types of elasticities of two economic variables of interest: the agricultural labor share and GDP. First, the contemporaneous elasticity of an economic variable to wedge τ_w is the elasticity of the economic variable in period t with respect to change in the wedge in the same period t, $\epsilon_{w,t}^{z,t}$. Conceptually, this elasticity measures the contemporaneous effect of a 1-percent change in a wedge. Second, the cross-elasticity, $\epsilon_{w,t}^{z,s}$, is the elasticity that arises when we consider the effect of a change in the wedge in period t on some other period $s \neq t$. Conceptually, cross elasticities measure the effects of past or future changes in wedges. We show below that, in most cases, quantitatively each cross-elasticity is small compared with the contemporaneous elasticity but there are many of them, one for each period s. Therefore, we compute the sum of all cross-elasticities, compare this sum to the contemporaneous elasticity and argue that the cumulative effect of the cross elasticities is quantitatively as large as the contemporaneous elasticity. Finally, the integral elasticity is the sum of the contemporaneous elasticity and all cross-elasticities, $\sum_{s=1}^{T-1} \epsilon_{w,t}^{z,s}$. Conceptually, the integral elasticity measures the effect of an increase in the wedge in period t - on the change in the an economic variable z from period 1 to T (1953-78 in our case).

We compute elasticities of all economic variables to TFPs and wedges by re-computing the full path of the economy assuming a small deviation in TFP or wedge in one period t at a time. We plot first the contemporaneous and cross elasticities (for $s \in [t-5, t+5]$) of labor share and GDP to each TFP and wedge in the form of a heatmap in Figures 6 and 7.[43] On each heatmap, the vertical axis shows in which period t the change in wedge is considered, while the horizontal axis shows how many periods forwards or backwards from t the effect is measured. The vertical segment in the middle corresponding to the zero horizontal value shows the contemporaneous elasticity, while the rest of the vertical segments show cross-elasticities for a specific period in the future (positive values) or in the past (negative values). Values corresponding to the past show anticipated effects of the change in the wedge, while values corresponding to future values show effects of capital accumulation. The color of each point indicates the size of the elasticity, with shades of blue indicating positive values of elasticities and shades of red indicating negative values.

[43] The elasticities with respect to the production and mobility components of the labor wedge are identical since only their product plays a role in the model.

We find that the majority of the effects of wedges and TFPs are captured by the contemporaneous elasticity, while most cross-elasticities are an order of magnitude smaller in comparison. For instance, red and yellow colors for the contemporaneous elasticity of the labor share to non-agricultural TFP indicate a negative elasticity of -0.2 (i.e. a 1 percent increase in TFP translates into a 0.2 percentage point reduction in the labor share). Light blue values for the elasticity of labor share in preceding periods indicate a positive elasticity of +0.05 (i.e. a 1 percent increase in TFP in the current period will increase labor share in the preceding periods by 0.05 percentage points). The rest of the panels are interpreted in a similar way. The only exception is the investment wedge, where cross-elasticities (in the 0.05-0.1 range for preceding periods) are comparable to the contemporaneous elasticity (of roughly 0.15). Another notable pattern is the fact that for the labor share cross-elasticities for earlier periods are larger than for later periods, while for GDP the pattern is reversed. This finding suggests that anticipation of changes in wedges plays a non-negligible role for the labor share, while past changes in wedges (through capital accumulation) play an important role for GDP.

In the online appendix, we derive analytical expressions for the elasticities for a slightly simplified model that captures many of the key effects. Here, we describe the intuition for these elasticities. A positive agricultural TFP shock makes existing workers more productive. Labor is now more valuable in the manufacturing sector as the increase in productivity relaxes the subsistence requirement shifting labor towards the manufacturing sector. Hence, the contemporaneous effect on the agricultural labor share is negative (shown in red on panel 2 of Figure 6), e.g. a 1 percent increase in agricultural TFP translates into an approximately 0.3 percentage point contemporaneous decline in the labor share. However, consumers would like to spend some of the windfall due to increased productivity in both preceding and following periods. To achieve this, labor inputs are shifted even more towards the manufacturing sector in the period of the shock in order to increase investment at the time of the windfall. In all other periods, disinvesting takes place shifting labor inputs towards agriculture. Hence, the cross-elasticities are positive (shown in the same panel) and sum to about 0.1 percentage points. The effects on GDP are positive contemporaneously (shown in blue on panel 2 of Figure 7), and subsequently, but negative in anticipation of the shock (shown in yellow). E.g. a 1 percent increase in agricultural TFP increases GDP by 0.8 percent contemporaneously. Nevertheless, the sum of cross-elasticities is around 0.1. The effect of non-agricultural TFP on the labor share is similar

to that of agricultural TFP but smaller in magnitude (the contemporaneous elasticity is -0.2, shown in red on panel 1 of Figure 6). This is because an agricultural TFP shock relaxes the subsistence requirement while demand for manufacturing goods is homothetic. Notice that the increase in both agricultural and non-agricultural TFP reduces the agricultural labor share by making agents more wealthy and willing to spread this wealth into future periods by accumulating capital, which they can only produce by shifting labor inputs towards the manufacturing sector.

A positive shock to each component of the labor wedge creates a tax on manufacturing consumption and artificially lowers the relative prices of agricultural goods. A lower price makes agricultural goods a better bargain, shifts demand towards them, so both labor and capital inputs are reallocated towards the agricultural sector as supply follows demand. This explains the positive contemporaneous elasticity (shown in blue on panel 3), e.g. a 1 percent increase in the wedge increases the labor share by 0.25 percentage points. However, because of the increased tax, overall production and consumption drop. The negative cross-elasticities (shown in yellow on panel 3), which sum to roughly -0.1, capture the fact that consumers prefer to distribute the drop in consumption from the current period to future periods, which means building up capital in anticipation of the shock and disinvesting in the current and following periods.

A positive shock to the investment wedge makes capital transfer into the future more expensive. The consumers prefer to come into the taxed period with less capital and lower production since that reduces the stock to which the tax is applied. In the preceding periods investment is lower, in order to run down capital, so consumption is higher. In the periods that follow the tax, the consumers re-accumulate the capital stock that they had run down, but suffer from lower consumption. This path of consumption explains the negative effect on labor share from past investment wedge changes (shown in yellow on panel 5 of Figure 6), but positive effect of contemporaneous and future changes (shown in blue). A one percent increase in the wedge increases labor share by 0.15 percentage points contemporaneously.

We compare contemporaneous elasticities with sums of cross- elasticities (at all leads and lags) in Figure 8 for the labor share and Figure 9 for GDP. In each case, the dashed line shows the contemporaneous elasticity by year of wedge change, the dotted line shows the sum of cross-elasticities for the same wedge change, and the solid line shows the integral elasticity

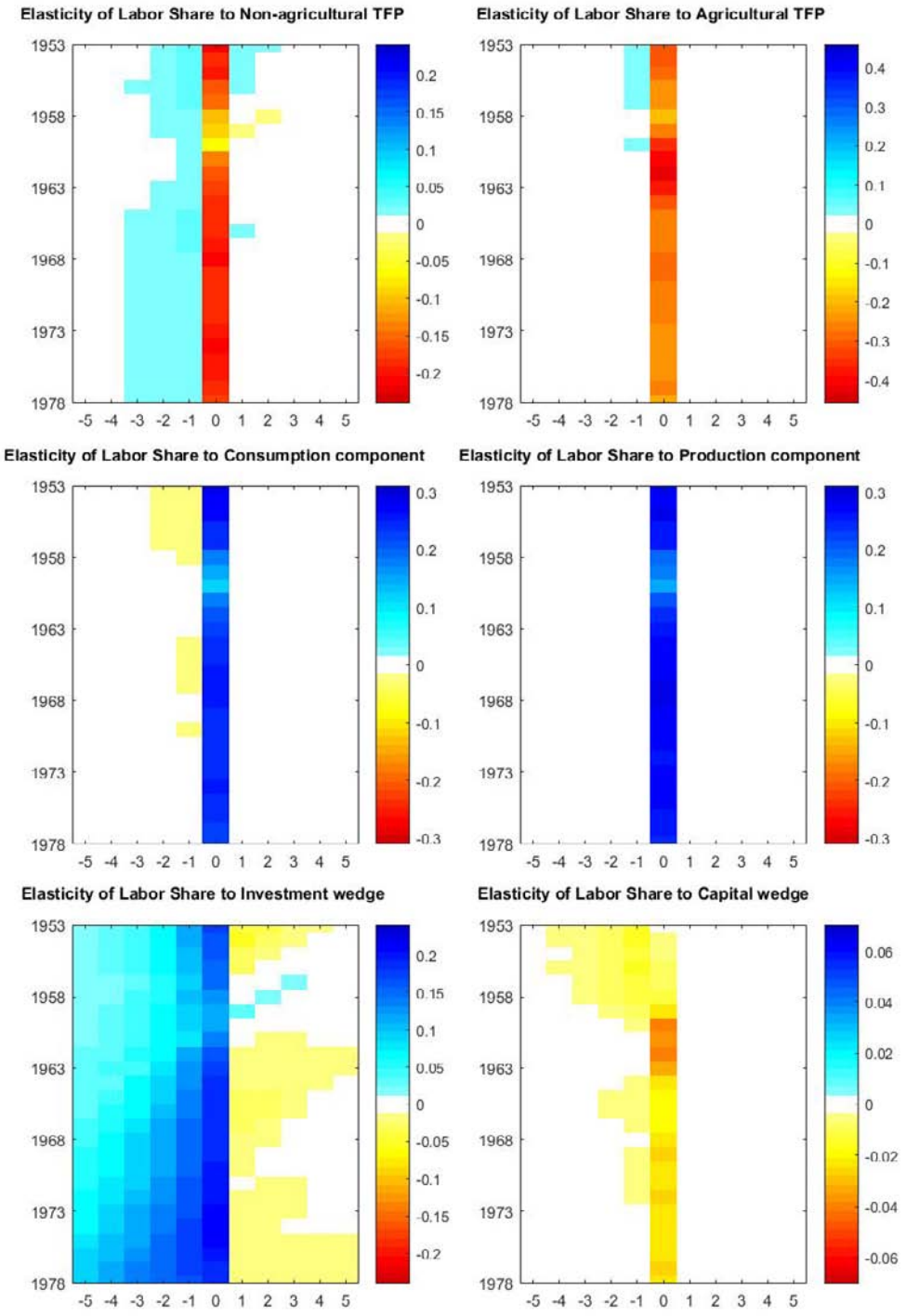

Figure 6: Elasticities of the labor share to wedges and TFPs

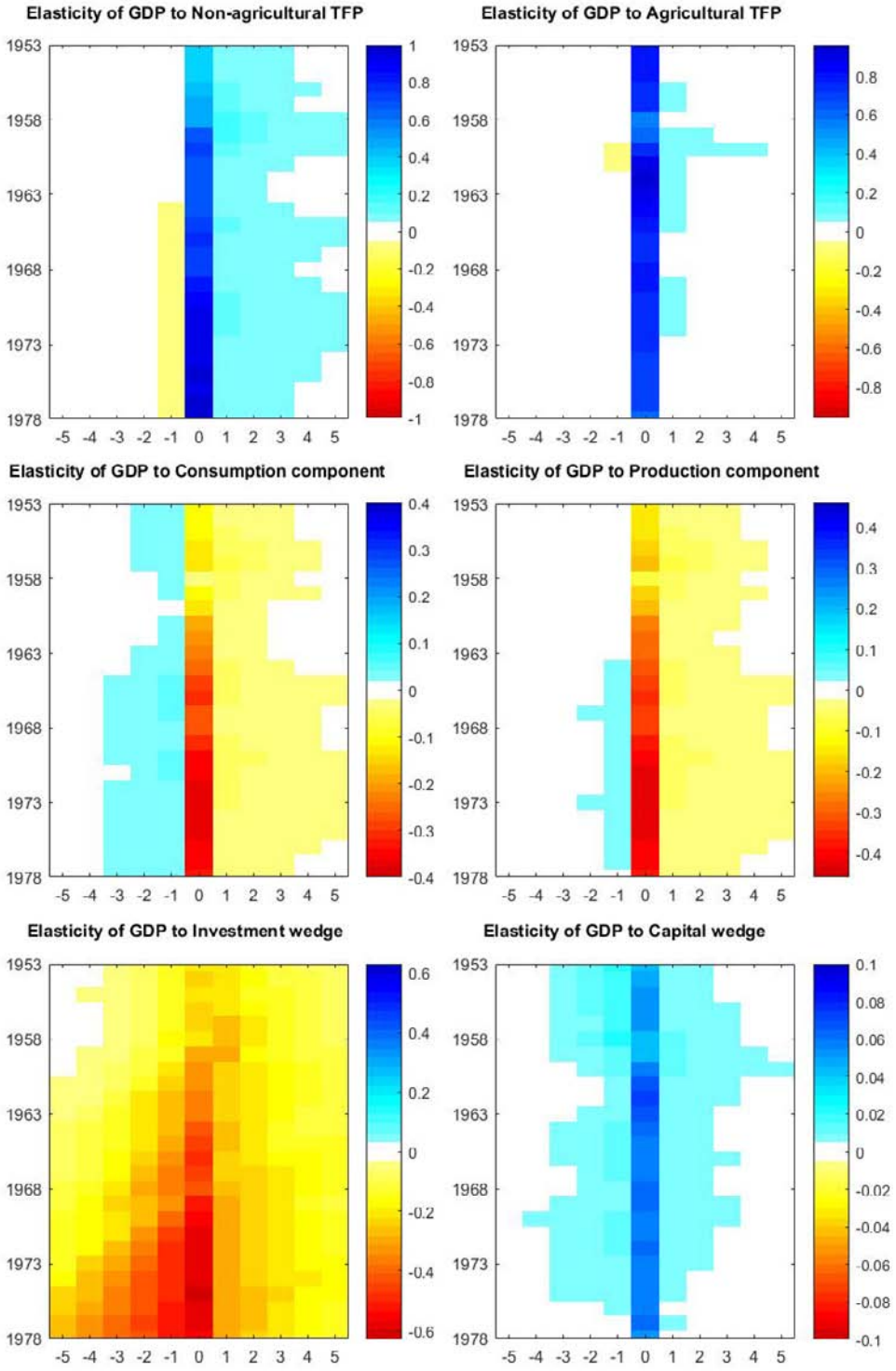

Figure 7: Elasticities of GDP to wedges and TFPs

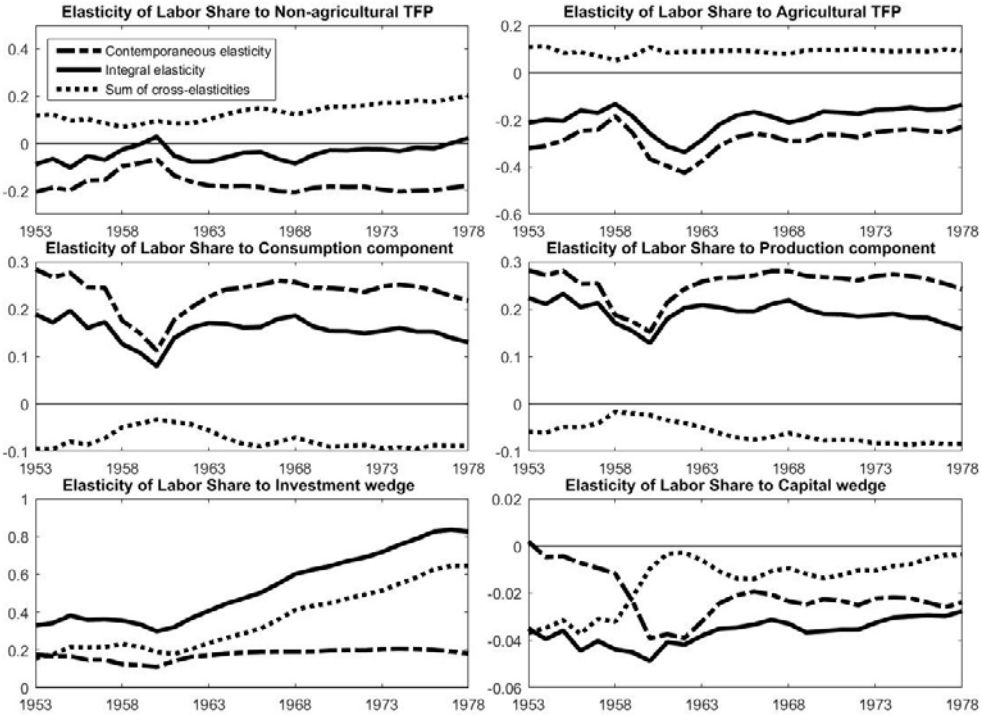

Figure 8: Elasticities of the labor share to wedges and TFPs

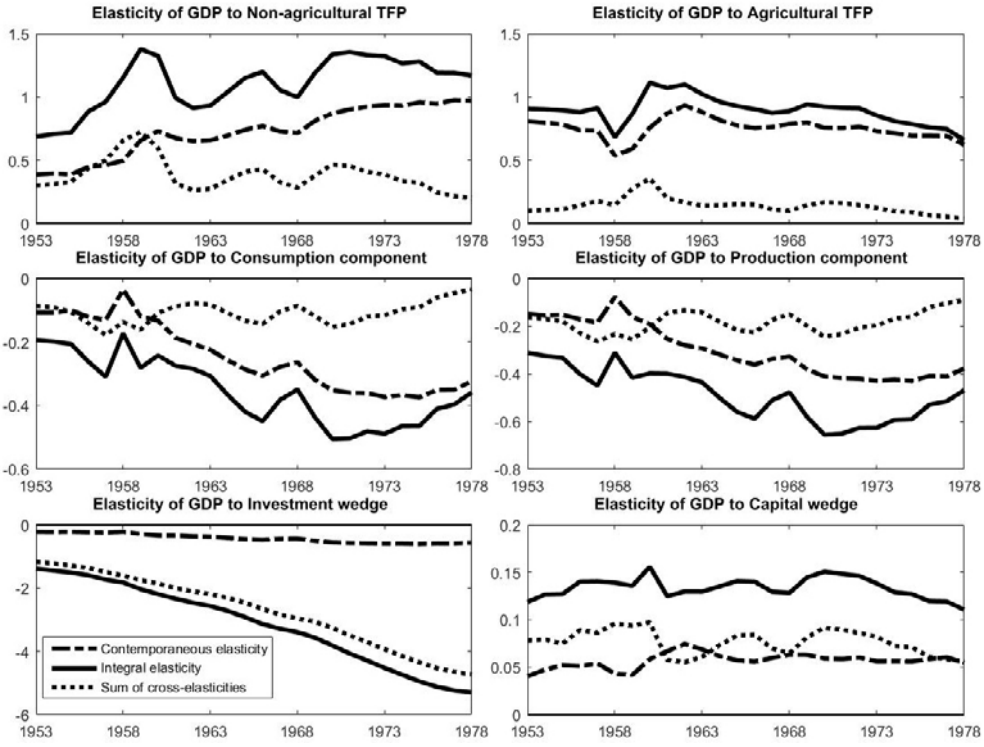

Figure 9: Elasticities of GDP to wedges and TFPs

computed as the sum of the other two lines. The integral elasticity captures the long-term effect of a permanent increase in a wedge in period t. The first important observation is that although the contemporaneous elasticity, in most cases, is an order of magnitude larger than any individual cross-elasticity, their sum is comparable to the contemporaneous elasticity. This implies that taking into account cross-elasticities is crucial for understanding long-term effects of wedges and TFPs. Note also that for the investment wedge, the contemporaneous elasticity is of the same order of magnitude as individual cross-elasticities, and much smaller than their sum. Thus, the integral effect of a change in the investment wedge accumulates over many periods both from anticipation and past effect of the change.

Another important observation is that most of the elasticities of the labor share are stable over time, fluctuating a little during the turbulent GLF period. This is because the two most important parameters explaining those elasticities are the current level of the labor share and the distance from the subsistence level (which controls the degree of non-homotheticity of preferences). When agricultural consumption approached subsistence in the early 1960s, the elasticities with respect to wedges and manufacturing TFP decreased dramatically, while the elasticities with respect to agricultural TFP increased. In addition, some of the elasticities of GDP show a well-pronounced trend. The main driver of this trend is the fact that as the economy slowly grows away from the subsistence level, the composition of GDP shifts from agricultural towards manufacturing production. This implies that the effectiveness of policies that move inputs towards the non-agricultural sector grows with the economy. Similarly, the effects of improvements in non-agricultural TFP grow and the effects of improvements in agricultural TFP shrink over time. In Section 5.3 of the online appendix we expand on this behavior and parameters driving the elasticities.

6.3 Effects of wedges on economic variables

In this subsection we consider the product of elasticities and wedges to identify which changes in which wedges had the largest effects. First, we measure the overall effects on the labor share and GDP from 1953 to 1978 from changes in wedges in specific subperiods associated with left and right policies. We compute those effects by multiplying period-by-period changes in wedges by the corresponding integral elasticities of labor share and GDP with respect to each wedge change. This exercise shows the effects of changes in a wedge in a specific subperiod on

the path of an economic variable over the whole pre-reform period. In Figures 10 and 11 we show heatmaps of effects of changes in wedges in each policy subperiod on the labor share and GDP over the whole pre-reform period. The horizontal axis shows years, the vertical axis shows wedges, and colors show increases (shade of blue) or decreases (shade of red) in each economic variable with the size of the effect indicated by color depth. The overall effects of wedges and TFPs on the labor share and GDP are also presented in Tables 3 and 4.

We find that the largest contributors to changes in the labor share (in order of importance) are the consumption component of the labor wedge, agricultural TFP, the investment wedge, the production component of the labor wedge, and manufacturing TFP. All of these factors show a pronounced asymmetry along the policy cycle. The pattern that is the most striking, is that TFPs and wedges pull the economy in opposite directions along the policy cycle. Right-wing policies increase TFP pulling people out of agriculture (see previous subsection), but also increase wedges pushing people back towards agriculture. Left-wing policies lower TFP thus slowing down the movement of workers out of agriculture, but decrease wedges which pushes people out of agriculture. However, the overall effects of wedges play a dominant role in determining the shifts in the composition of the labor force.

The largest contributors to changes in GDP are manufacturing TFP, agricultural TFP, the investment wedge, and the consumption component of the labor wedge. Here the asymmetry along the policy cycle is the opposite. Right-wing policies improve TFP and boost GDP growth, but increased wedges slow down GDP growth. Left-wing policies slow down TFP and thus dampen GDP growth, but reductions in wedges speed it up. Overall changes in GDP are dominated by the effects of changes in TFP.

While the previous exercise considered the effects of a wedge in a specific subperiod on an economic variable over the whole sample, our methodology allows us to also consider the effects of a wedge in all periods on the change in an economic variable in one period. We can compute this effect by adding up effects of changes in wedges in different periods multiplied by the cross-elasticities with respect to the economic variable in the period of interest. This exercise allows us to decompose period-by-period changes in the labor share and GDP and precisely attribute them to specific TFPs and wedges. This exercise adds significantly more detail compared with the results that we could have obtained if we computed a set of counterfactual exercises which shut down changes in one or several wedges and then averaged the

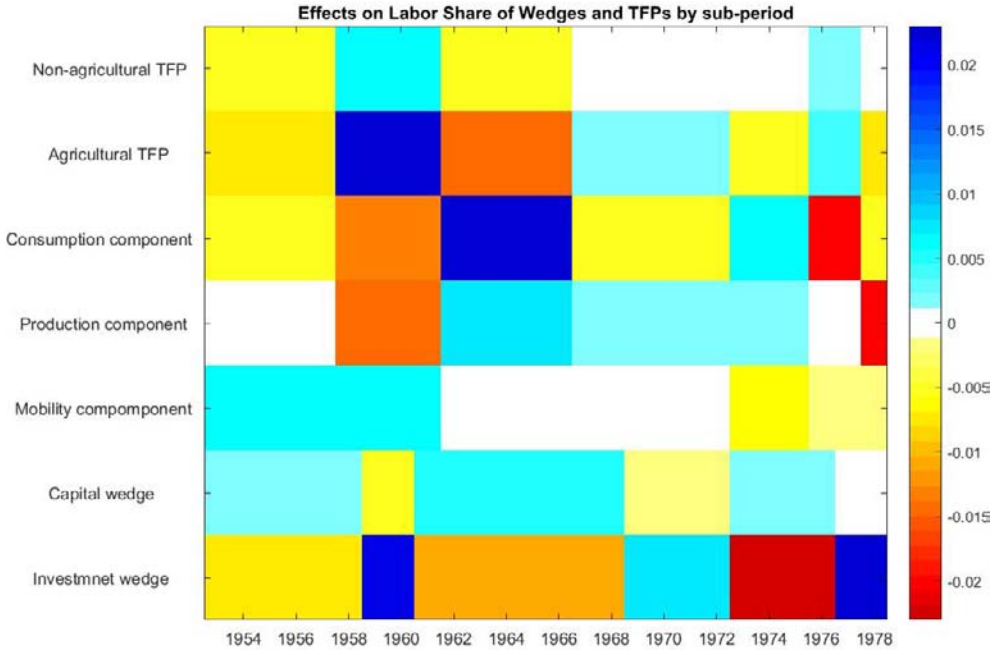

Figure 10: Effects on labor share of changes in TFPs and wedges by subperiod

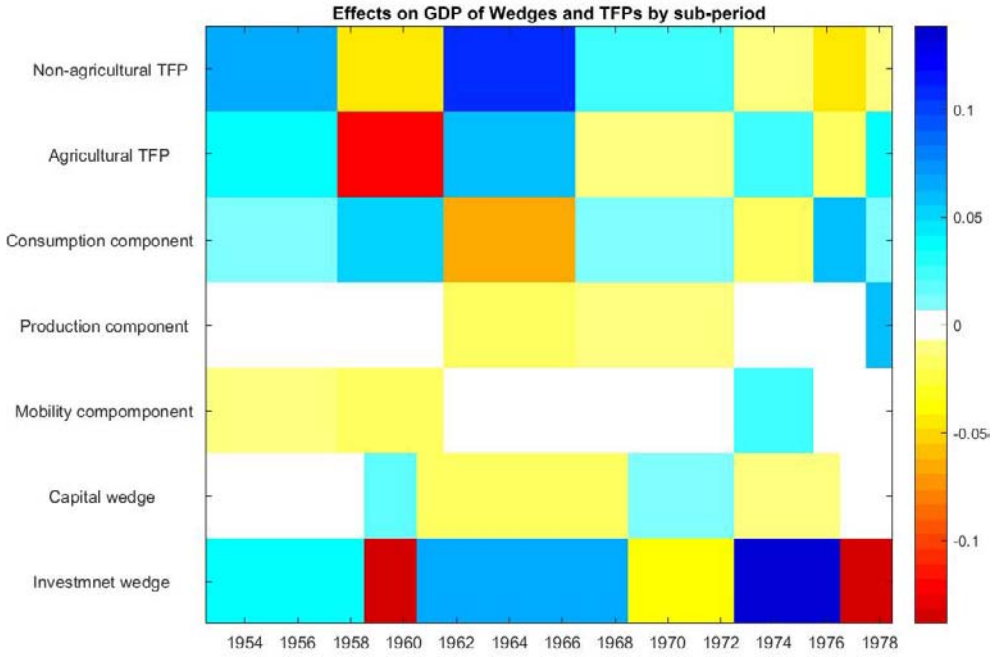

Figure 11: Effects on GDP of changes in TFPs and wedges by subperiod

	53-57	58-61	62-66	67-72	73-75	76-77	R	L
Manuf. TFP, X^M	-0.5	0.6	-0.6	0.1	0.0	0.1	-0.4	0.3
Agric. TFP, X^A	-0.8	3.0	-1.4	0.2	-0.5	0.4	-1.0	1.2
Total Labor wedge	0.0	-2.2	4.0	-0.4	0.1	-2.1	1.7	-1.3
Cons. comp.,τ^C	-0.5	-1.3	3.2	-0.5	0.6	-2.0	1.3	-1.0
Prod. comp.,τ^P	-0.1	-1.5	0.8	0.2	0.2	0.1	0.4	-0.4
Mobil. comp,τ^M	0.6	0.6	0.0	-0.0	-0.7	-0.2	0.0	0.1
Non-cons. comp. capital wedge,τ^R	0.3	0.3	0.1	0.0	0.2	0.0	0.2	0.1
Investm. wedge,τ^K	0.5	0.1	-1.1	-0.5	0.7	-6.3	-0.1	-1.3
Total	0.0	2.1	1.2	-0.5	1.0	-7.8	0.7	-0.8
Ideology	R	L	R	L	R	L		

Table 3: Integral effects on labor share of wedges and TFPs by subperiod, 1953-78

	53-57	58-61	62-66	67-72	73-75	76-77	R	L
Manuf. TFP, X^M	6.5	-4.7	10.5	2.2	-1.0	-4.4	6.3	-1.2
Agric. TFP, X^A	3.6	-12.2	6.2	-0.8	2.5	-1.9	4.4	-4.8
Total Labor wedge	0.0	3.6	-8.5	0.5	-0.3	5.8	-3.6	2.4
Cons. wedge,τ^C	1.3	5.0	-6.7	1.3	-1.9	5.6	-2.9	3.2
Prod. wedge,τ^P	-0.1	0.6	-1.8	-0.9	-0.6	-0.3	-0.9	-0.3
Mobil. wedge,τ^M	-1.1	-2.0	0.0	0.2	2.1	0.5	0.2	-0.5
Non-cons. comp. capital wedge,τ^R	-1.0	-0.8	-0.5	0.0	-0.7	-0.2	-0.7	-0.3
Investm. wedge,τ^K	-3.4	-3.6	7.7	2.7	-4.5	39.1	1.0	6.7
Total	7.5	-16.6	17.7	7.1	-3.1	39.6	9.1	4.6
Ideology	R	L	R	L	R	L		

Table 4: Integral effects on GDP of wedges and TFPs by subperiod, 1953-78

contributions. The difference is three-fold. First, the decomposition methodology that relies on counterfactual simulations finds contributions that do not necessarily add up to the actual change in the data. The reason for this is that a counterfactual simulation counts the effects of each wedge change multiple times through their effects on the state variables, e.g. capital, and this multi-counting accumulates differently over the length of each simulation. Our variational methodology avoids this problem by considering one-period deviations and results in contributions that add up precisely (up to the second order terms) to the actual change in the data. Second, our method allows us to compute the decompositions of period-by-period changes in each variable, as opposite to the decomposition of the total change over a long period of time. Third, our methodology explicitly takes into account the effects of expectations in the terminal period, while counterfactual exercises always require some choice to be made regarding the terminal conditions.

In Figure 12 we show the full period-by-period decomposition of changes in the agricultural

labor share and GDP into the effects of wedges and TFPs.[44] We find that changes in the production and consumption components of the labor wedge play a decisive role in explaining the variations in the labor share, far exceeding the effects of TFP and the investment wedge, which also contribute noticeably. The effects of the non-consumption component of the capital wedge, the mobility component of the labor wedge, demographics and expectations of future changes in wedges are limited. On the other hand, the changes in GDP are mostly driven by changes in manufacturing and agricultural TFP, and the investment wedge, while the effects of the consumption and production component of the labor wedge are more limited, contributing in special episodes such as the Great Leap Forward, the high tide of the Cultural Revolution and the power struggle.

Tables 5 and 6 add up the contributions by subperiods corresponding to the policy cycle. The columns add up and match closely the actual changes in the data. The rightmost column of each Table shows the accumulated total contributions of wedges and TFPs to the change in the agricultural labor share and GDP over the whole 1953-78 period. The rightmost column of each Table is similar to the result that could be obtained with the help of counterfactual simulations that shut down changes in one wedge at a time, but are much more precise as our new methodology does not need to average across simulations and does not depend on the choice of terminal conditions in those simulations.

We find that the policies that affected TFP and the components of the labor wedge during the Great Leap Forward and subsequent recovery play the largest role in explaining fluctuations in the labor share and GDP. We provided direct evidence and used it to reconstruct the key changes in wedges in Section 5.2. The variational decomposition also highlights the importance of the investment wedge, which has a large amount of period-by-period fluctuations, but also possesses a strong downward trend. The changes in the investment wedge accumulate gradually over time following this trend, which makes the contribution of the investment wedge very hard to detect when specific short episodes are considered separately. Our decomposition highlights the importance of the reduction in the investment wedge over the long term for the growth and structural transformation of China's economy in the pre-1978 period.

[44] We omit from the Figure the contributions of defense spending and trade as those are of tangential interest. We report them in Tables 5 and 6.

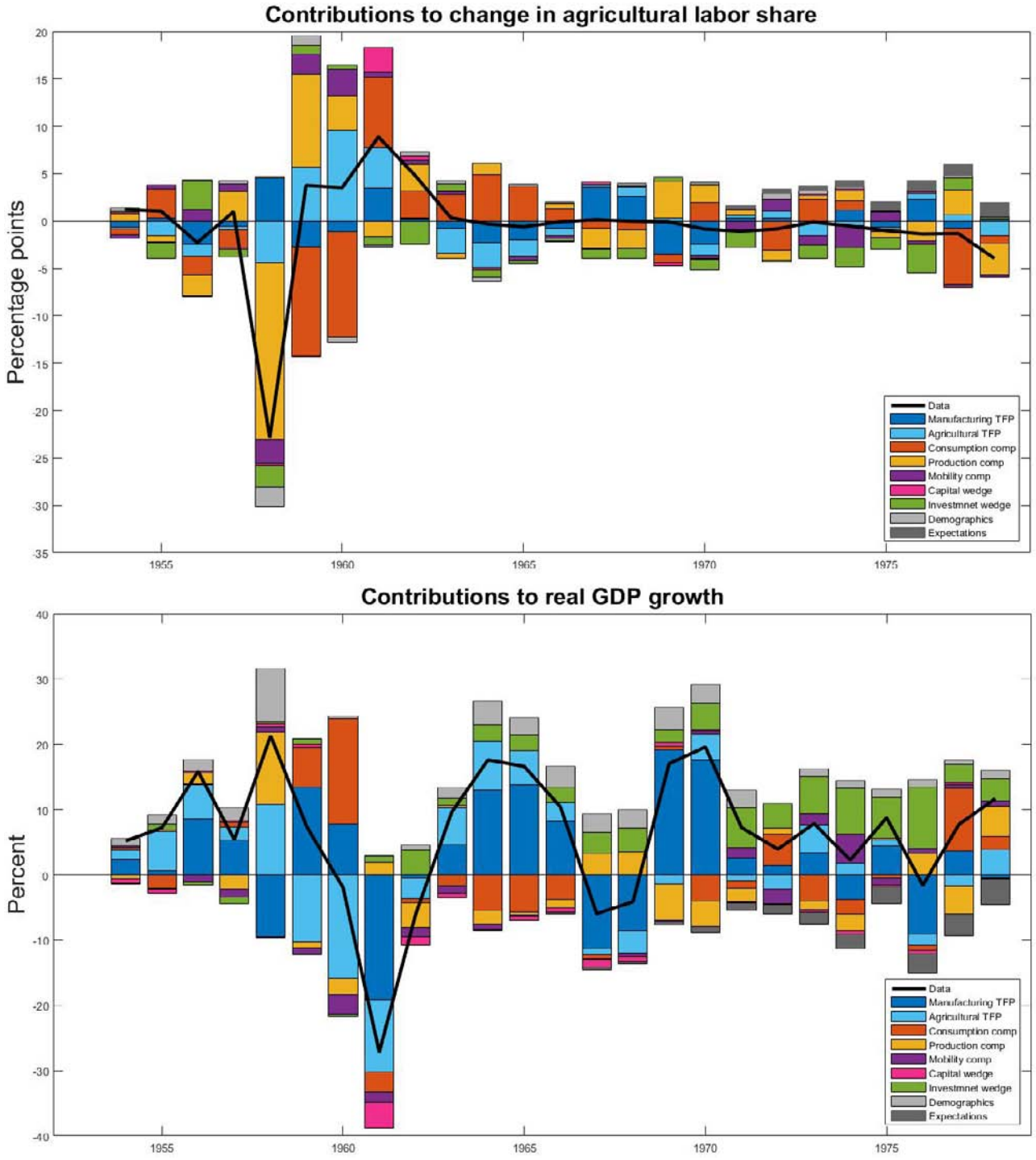

Figure 12: Decomposition of changes in labor share and GDP by year

	1953-57	1957-61	1961-66	1966-72	1972-75	1975-77	1953-78
Manuf. TFP, X^M	-3.3	3.4	-5.0	0.6	0.3	1.5	-2.6
Agric. TFP, X^A	-3.4	22.6	-7.2	1.5	-2.0	1.3	7.9
Cons. wedge,τ^C	-1.4	-21.5	16.0	-3.7	3.1	-6.1	-16.7
Prod. wedge,τ^P	1.0	-5.8	3.8	0.8	0.7	0.5	-2.7
Mobil. wedge,τ^M	2.1	4.7	0.1	0.0	-2.3	-0.4	3.6
Non-cons. comp. capital wedge,τ^R	-0.1	2.6	0.6	0.0	0.4	0.0	3.6
Investm wedge,τ^K	0.5	-1.4	-3.1	-4.6	-4.7	-1.8	-13.9
Defense	1.8	0.4	0.1	0.5	0.2	0.0	3.0
Labor force	-1.1	-1.2	-1.9	-2.6	-1.0	-0.6	-8.6
Population	1.9	-0.5	2.5	3.7	1.8	1.0	11.3
Agric. trade	0.3	-3.0	0.0	0.0	0.0	0.0	-2.7
Manuf. trade	-0.1	-0.4	0.1	0.0	0.1	0.0	-0.3
Expectations	0.0	0.1	0.2	1.6	2.1	2.2	7.9
Initial capital, K_{1953}	3.2	-0.1	0.1	0.1	0.0	0.0	3.1
Total	1.0	-6.9	4.6	-2.7	-1.7	-2.9	-12.5
Data change	-1.8	-4.1	4.4	-2.6	-1.7	-2.7	-11.9

Table 5: Wedge decomposition of changes in labor share, (percentage points), 1953-78

	1953-57	1957-61	1961-66	1966-72	1972-75	1975-77	1953-78
Manuf. TFP, X^M	16.4	-11.0	36.9	16.7	3.8	-6.0	56.4
Agric. TFP, X^A	14.2	-29.6	17.4	-5.3	6.9	-3.4	4.2
Cons. wedge,τ^C	-0.8	17.5	-17.7	-0.9	-7.0	8.4	1.4
Prod. wedge,τ^P	-0.9	9.0	-7.2	-4.1	-3.4	-1.1	-3.0
Mobil. wedge,τ^M	-2.0	-4.9	-3.7	-1.0	5.0	1.3	-4.8
Non-cons. comp. capital wedge,τ^R	-0.9	-2.8	-3.1	-1.1	-1.3	-0.3	-9.7
Investm wedge,τ^K	-0.9	1.5	12.1	22.5	18.3	11.7	68.6
Defense	-2.6	0.7	0.1	-1.6	-0.6	0.0	-4.0
Labor force	7.5	9.0	14.4	23.5	9.8	5.6	73.1
Population	-1.2	-0.4	-2.7	-9.2	-6.3	-3.8	-25.6
Agric. trade	-0.4	1.9	-0.9	-0.4	-0.1	0.0	0.0
Manuf. trade	0.1	0.8	-0.9	-0.3	-0.4	-0.1	-0.8
Expectations	0.0	-0.1	-0.8	-5.0	-6.6	-6.5	-23.0
Initial capital, K_{1953}	3.4	1.2	0.5	0.2	0.0	0.0	5.4
Total	32.0	-7.2	44.4	34.1	18.2	5.8	138.3
Data change	29.7	-4.5	46.6	33.8	18.2	5.7	140.5

Table 6: Wedge decomposition of changes in GDP, (log points), 1953-78

7 Sensitivity Analysis

We provide extensive robustness checks for all key parameters in Section 6 of the online appendix. We consider how our main findings are affected by changes in the parameters of the model, as well as alternative data sources that could be used for the analysis. To recap, our main findings are that 1) the largest contributors to changes in the labor share are the consumption component of the labor wedge, agricultural TFP, the investment wedge, the production component of the labor wedge, and manufacturing TFP; 2) the largest contributors to changes in GDP are manufacturing TFP, agricultural TFP, the investment wedge, and the consumption component of the labor wedge. 3) all of these factors show a pronounced asymmetry along the policy cycle, with TFPs and wedges pulling the economy in opposite directions along the policy cycle; 4) right-wing policies increase TFP and increase wedges on balance boosting GDP growth but pushing people towards agriculture; 5) left-wing policies lower TFP and decrease wedges on balance dampening GDP growth but pushing people out of agriculture. We find that all of these conclusions are robust to a wide variety of alternative assumptions and data sources that we briefly summarize below.

First, we consider alternative parameterizations. We start with setting the subsistence level to 70 yuan instead of the baseline value of 54 yuan, implying that the subsistence level is nearly reached in 1960, the year of the famine. This is the highest possible level of subsistence we can set without violating the assumptions of the model that consumption is always above subsistence.[45] We find that in this case, the major difference is during the Great Leap Forward and the recovery from it, with the contribution of agricultural TFP increasing and the contributions of the components of the labor wedge amplified to compensate for the larger effects of agricultural TFP. If we push the subsistence level to the opposite extreme by setting it to 0, the effects of agricultural TFP on the labor share are reduced to zero (consistent with the absence of static effects of TFP on the labor share when preferences are homothetic) and the effects of the components of the labor wedge are also reduced in absolute value to compensate for this. Overall, the effect of the subsistence parameter mainly affects the quantitative contribution of agricultural TFP without changing its qualitative behavior along the policy cycle.

[45] It is also worth noting that a representative-agent model like ours has its shortcomings, one of them being the fact that it does not capture well the welfare effects associated with redistribution, especially when some of the agents are close to subsistence.

Second, we consider the case of a constant-elasticity-of-substitution (CES) utility function, where the parameter σ is set to 0.5 instead of the baseline of 1. This change amplifies the contribution of the consumption component of the labor wedge with the main compensating factor being the amplified effect of the expected future consumption path, both on the labor share and on GDP. Overall, reduction in the CES parameter towards some of the estimates in the literature strengthens all of our main conclusions by amplifying the fluctuations in the consumption component of the labor wedge and their economic impact.

Third, we consider various changes in the production parameters, in particular the shares of capital in the production functions in both sectors. Increasing the share of capital in manufacturing production reduces the contribution of manufacturing TFP and amplifies the contribution of the investment wedge on GDP growth. Increasing the share of capital in agricultural production amplifies the contributions of TFP in both sectors, the non-consumption component of the capital wedge, and the investment wedge, while dampening the effect of the consumption component of the intersectoral wedges. All of these changes affect only the relative sizes of contributions of various wedges and TFPs without changing our main conclusions.

As a second exercise, we consider alternative data sources. We find that the effect of replacing our baseline series for relative prices by the relative prices advocated by Young (2003) quantitatively negligible, with only tiny changes in the contributions of the intratemporal components of wedges, fully compensating for each other. Also, we consider the effects of replacing Chow's sectoral capital series by data for farm capital from Tang (1984). This change increases observed manufacturing capital stock and thus has an overall effect similar to an increased share of capital in manufacturing production. These effects are noticeable, but do not change our main results or conclusions.

Finally, we consider an alternative methodology of treating investment and manufacturing consumption by taking gross fixed capital formation from the CSY as the primary source for overall investment and computing consumption of manufacturing goods as the residual. This change implies a much larger decline in the consumption component of the labor wedge and a much larger decline in the investment wedge in the pre-1960 period, which greatly amplifies the contributions of both wedges in that period, which nonetheless largely compensate each other. Such amplification is hard to believe given that it is inconsistent with directly available data on manufacturing consumption, which was the reason for our choices in the way we constructed

the data. However, even with this method, the main results regarding the effects of wedges and TFPs pulling in opposite directions, and varying in unison along the policy cycle remain intact.

8 Conclusions

In this paper we studied one of the largest development experiments in the 20th century – the transformation of Chinese economy under the communists from the time they took power to the beginning of the reform period in 1978. We showed that our analysis is useful not only for understanding this particular case study but also for providing insights into broader models of cyclical fluctuations. The pronounced political cycle in China, with its distinct right and left policies, with their tremendous differences, uncovers the politics-based fluctuations in policies and economic performance much more vividly than the more muted shifts in developed countries. In addition, we are able to describe not just abstract wedges arising in the business cycle accounting procedure but also provide detailed historical and, most importantly, quantitive evidence on the evolution of all significant policies. The analysis of the large and frequent fluctuations in policies leads us also to develop a novel quantitative decomposition of the changes in variables as an alternative to the usual counterfactual exercises. As the business cycle accounting literature is related to the Ramsey taxation literature, this decomposition relies on and is inspired by the tight connection to the modern theory of tax reform with its emphasis on the integral effects of changes in taxes.

More broadly, our analysis points to important continuity between the pre-1978 and post-1978 reforms period.[46] We see that many of the elements of the post-1978 reforms were already present during the periods of the right policies pre-1978. It is not surprising then that once firmly established in power, the right-wing "pragmatists" lead by Deng Xiaopin could fully implement their policies. In other words, the post-1978 rise of China has its origins in the pre-1978 policies.

[46] See the working paper version (Cheremukhin et al, 2015) for the detailed analysis of the post-1978 period.

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