A Model of China's State Capitalism*

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Abstract

This paper documents a hallmark feature of China's state capitalism as the state controlling the economy in a vertical economic structure: State-owned enterprises (SOEs) monopolize key industries and markets in the upstream, whereas the downstream industries are largely open to private competition. We develop a theoretical model to show that this unique vertical structure, when combined with openness and labor abundance, is critical in explaining two puzzling facts about China's economy: (1) the SOEs have outperformed the private firms in the past decade while the opposite was true in the 1990s; (2) the labor income share in total GDP is persistently low and declining, contradicting the predictions in the standard growth and trade models. Our paper highlights how the vertical structure leads to the upstream SOEs benefiting disproportionally more than the downstream private firms from the international trade by taking advantage of the abundant domestic labor. Sustainability of such a growth model and the SOE reforms are discussed.

Key Words: State Capitalism; China Economy; Growth and Development; SOEs; Structural Change; International Trade; Partial Reform

JEL Classifications: E2, F4, O1, P2

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1 Introduction

Major emerging economies all practice some forms of state capitalism, which generally refers to that the state controls an important share of the economy while the private sectors are still largely operating in the free market. The last decade has witnessed the rapid economic growth of these economies (especially BRIC).[1] The case in point is China, whose GDP rank rose from world number six in 2000 all the way to world number two in 2011. At the same time, the number of Chinese firms in the club of Fortune Global 500 swelled by five folds from 12 to 57, only next to the US and Japan. In particular, almost all of these large Chinese firms are state-owned enterprises (SOEs) and the SOEs as a whole account for more than 80% of China's total stock market value. By contrast, the major industrialized economies operate under the so-called liberal capitalism, where the role of government is far more limited and the SOEs are not nearly as important. With the backdrop of the 2008 world financial crisis, state capitalism seems to be gaining popularity as a favorable alternative to liberal capitalism. In this paper, we will develop a formal theory of China's state capitalism by mainly focusing on the SOEs and will argue that state capitalism is actually an important root of economic distortions that ultimately undermine the growth sustainability.

More specifically, we document the following often-ignored fact about China's economy: The SOEs have outperformed the private firms on average in terms of profitability since the last decade while the opposite was true in the 1990s, although the GDP growth rates were stably high during the whole period.. Interestingly, the drastic increase in SOEs' profitability has been accompanied by the rapid rise in China's export, especially after entering WTO in 2001. This may appear counter-intuitive as standard theory predicts that the SOEs are less efficient than the private firms and that the increased competition due to trade liberalization would hurt the less efficient firms. We also highlight the related puzzling fact that the labor income share in total GDP has been persistently declining in China since 1990, contradicting the commonly observed constancy (known as one of the Kaldor facts in standard growth theory) and also intrinsically conflicting the factor price equalization theorem for a labor-abundant country as predicted by the Heckerscher-Ohlin trade theory.

To resolve these two puzzles, we propose a theory that highlights an important yet insufficiently-

[1] The Economist magazine published a special issue on state capitalism on January 21, 2012.

emphasized aspect of China's state capitalism, that is, the state grants SOEs unchallenged monopolies in most of the upstream industries and key markets while leaving downstream industries mostly open to intensive competition among private enterprises. For example, the manufacturing sector, which is one of the downstream industries and main source of commodity trade, now becomes one of the most liberalized sectors with the lowest shares of state investment. By stark contrast, upstream industries and the key markets such as Petroleum and Natural Gases, Electricity and Power, Banks, Transport, Storage and Post, and Information Transmission are still highly monopolized by the SOEs. This vertical structure and how this pattern emerged will be documented in details.

This vertical structure, together with trade openness and labor abundance, can explain the two afore-mentioned puzzling facts. Here is the key intuition for understanding the first fact: The initial deregulation reform and trade liberalization in the downstream industries in the 1990s led to the bankruptcies and gradual exits of the downstream SOEs, replaced by the more competitive private firms which followed China's comparative advantage in its abundant labor. The dynamism in the downstream capitalism drove the growth of the aggregate economy while the SOEs as a whole were hurt by the trade openness and outperformed on average by the private firms. However, by 2001, most low-efficiency SOEs in the downstream industries had already been weeded out in most downstream industries while the upstream industries are still monopolized by the remaining SOEs. Therefore, the enhanced trade liberalization (especially the entry to WTO in 2001) results in further expansion of the downstream private firms, which in turn leads to more demand for the intermediate goods, factors, and services that are monopolized by the SOEs in those upstream industries. As a consequence, those remaining SOEs flourish disproportionately more than the private firms in the competitive downstream. At this stage, international trade benefits instead of hurting the SOEs. Without international trade, the SOEs would not leave the downstream industries so fast in the first stage, and the downstream private firms, hence the upstream SOEs, would not expand that much either.

Labor abundance is also important. Without this, wage would go up immediately after the downstream industries expands due to international trade. Then the room for the monopoly pricing on the intermediate goods charged by the upstream SOEs would become smaller as international trade imposes a constraint on the pricing of the downstream goods. It means that the upstream SOEs would not be that profitable for so long. More accurately, we will highlight the dual feature

in China's labor market, namely, there exists a large labor pool in the non-industrial sector while the industrial sector expands by absorbing more capital and demanding more capital in this process of industrialization and urbanization. This explains the second puzzling fact that the labor income share in total GDP is low and persistently declining. Before industrialization and urbanization finish, the large pool of surplus labor in the non-industrial sector keeps the wage and hence the total wage income low, while the capital income (both in terms of rental prices and profits) and hence total GDP increases largely due to more external demand after trade liberalization. As a result, the labor income share in total GDP is low and has been decreasing over this period. This dual labor market feature also accounts for why the wage-rental ratio decreases in a labor-abundant country after international trade, opposite to the factor price equalization result in the standard H-O trade model.

To understand more precisely how the theoretical model works, imagine a model economy where there are two types of firms: SOEs, which monopolize in the upstream industries, and the privately-owned enterprises (POEs hereafter), which are engaged in perfect competition in the downstream industries. We first consider the situation where the downstream industries have already been fully occupied by the private firms. Upstream firms (SOEs) use labor and capital to produce the intermediate good (or services), and downstream firms (POEs) use labor, capital, and the intermediate good to produce the differentiated goods, interpreted as manufacturing goods. There is also a numeraire good, interpreted as some non-manufacturing good or service, which can be produced by labor only. Consumption goods include the differentiated manufacturing goods and the numeraire good, while only the manufacturing goods can be used for capital accumulation. There are two social groups in the economy: the elite class and the grass root class. All the agents are identical within their own social groups, and only the elite class controls the upstream SOEs and the members share the monopoly profits equally. Labor is assumed abundant to capture China's structure of the dual economy between the industrialized sector and the non-industrialized sectors.

In order to illustrate the role of vertical structure, openness, and dual labor market most clearly, we will present four different cases sequentially. Each time we will add one more mechanism. We start with the simplest case: a static autarky. We analytically derive the market equilibrium for this economy featured by the vertical industrial structure, two different market structures, two different types of ownership, and two different social groups. In particular, we characterize the

static properties of the profit of the upstream SOEs, the labor income share in total GDP, and the income inequality between those two social groups.

Then we move to a two-period dynamic autarky model, which allows us to analyze the endogenous investment and saving decisions and the dynamics of SOE profits, labor income share, and income inequality. When comparing this new equilibrium with that in static autarky, we show that the newly added demand of private investment will raise the aggregate domestic demand for the downstream output, which in turn leads to a larger profit of the SOEs that monopolized the upstream industries. This also causes the labor income share in total GDP to decline further as both the capital income and the profit increases while the labor income remains constant due to the large labor pool in the numeraire sector. The income inequality between the two social groups is also widened further. In addition, we show that the extent of the internal imbalances will become strictly worse as the monopoly power of the SOEs (measured by the size of the price markup they can charge) increases. In other words, the stronger the state capitalism, the more serious the internal imbalances.

Next we consider the third case – a static model with free trade between two countries: Home and Foreign. Home country is identical to that in the static autarky model while the Foreign country is a free private market economy without SOEs. Assume that the Foreign country has Ricardian comparative advantage in the non-munufacturing sector (the numeraire good). Thus international trade will boost the aggregate demand for the manufacturing goods (downstream goods) produced by the Home country due to the extra foreign demand. However, the upstream industry is not open to trade and still monopolized by the SOEs. Therefore, trade openness in the downstream industries leads to a higher profit of the SOEs in the upstream industry and a higher return rate to capital. This means that the labor income share in total GDP becomes smaller than the autarky case and the income inequality between the two social groups is also worse. Recall that the surplus labor in the numeraire sector, together with the Samuelson-Stolper trade effect, prevents the wage from going up in the Home country. Comparative statics show that a stronger state-capitalism will lead to more severe internal imbalances up to the extent that the markup pricing is not too high to undermine the comparative advantage in Home country's manufacturing sectors in the international market.

The fourth case extends the third one into a two-period two-country dynamic open economy with international trade, but international borrowing or factor movement across borders is prohibited. In other words, we rule out external trade imbalances by construction. In this simplest dynamic trade framework with the state-capitalism in Home country, we analyze the domestic investment and saving decisions as well as the dynamics of the internal imbalances. Now the domestic investment in country Home is not only needed to serve the future domestic consumption of the manufacturing goods, but also the future exports to the foreign country. This not only drives up the investment and the GDP economic growth rate when compared with the dynamic autarky model, but also exacerbates the internal imbalances even further. However, like argued before, the international competition in the downstream industries will indirectly discipline the monopoly pricing for the non-traded intermediate goods, which have important implications on the domestic economy.

The above four cases try to capture or illustrate what has happened in the past decade, and we still need to formalize how the vertical structure gradually emerged in the1990s. This part is modelled by introducing the coexistence of the SOEs and private firms in the downstream industries. Deregulation and the trade liberalization in the downstream industries have two effects. First, at the intensive margin, the profits of the inefficient downstream SOEs are driven down by the increased competition, which tends to lower the average profitability of the SOEs. Second, at the extensive margin, inefficient SOEs gradually exit from the downstream industries, which tends to increase the average profitability of the SOEs. Since the remaining SOEs monopolize the upstream industries that benefit from the flourishing downstream tradeable sectors (thanks to the cheap labor conditional on its productivity), eventually the profitability of SOEs exceeds that of the private firms after the vertical structure has developed to certain extent.

According to our framework, wage will eventually increase after all the surplus labor is absorbed away from the numeraire sector, which tends to squeeze the margin of the markup pricing by the upstream SOEs. So is this growth mode with state capitalism sustainable? What if the productivity of the upstream SOEs does not increase fast enough? What happens to the internal and external imbalances if the external demand declines? Why do the upstream monopolist SOEs sometimes subsidize the downstream industries instead of charging a positive markup pricing? We briefly discuss these issues within this framework as well.

The paper is structured as follows. Section 2 highlights the contribution of this paper in the context of the pertinent literature. Section 3 provides a detailed documentation on the related facts. Section 4 presents the model with different cases. Section 5 briefly discusses several further implications and possible extensions of this framework with state capitalism. The last section concludes.

2 Related Literature

To our best knowledge, our paper is the first to document systematic evidence and provide a theoretical framework to study the vertical economic structure featured in China's state capitalism and its macroeconomic implications. Our work contributes to several strands of literature in growth and development as well as institutions and reforms.

Firstly, our paper is most closely related to the economic growth literature on resource allocation across different firms, especially in the context of China's economic development and growth. Song, Storesletten and Zilibotti (2011) argue that China's high growth is driven by the resource (especially capital) reallocation within the manufacturing sector from the low-productivity SOEs to the high-productivity private firms. Their model, like in Hsieh and Klenow (2009), focuses on the horizontal competition between SOEs and POEs in the same industry (or substituting industries), which implies that SOEs and private firms cannot both expand, or equivalently, the aggregate economic growth cannot coexist with that the low-efficient SOEs persistently outperforming POEs. In contrast, our paper highlights the importance of the vertical economic structure in which SOEs and POEs mainly operate in different and complementary industries. Therefore our framework can explain why the SOEs have outperformed the POEs in China in the past ten years while the private sectors and the aggregate economy have continued to grow fast. At the same time, our model can also explain the opposite case observed in the 1990s, which Song, Storesletten and Zilibotti (2011) seem to focus on.[2] Brandt, Tombe and Zhu (2010) document the factor market misallocation (mainly capital and labor) both within and across provinces in China and also quantitatively

[2] Lin (2009) attributed China's high GDP growth to the resource reallocation from the overly capital-intensive industries to the labor-intensive industries which are more consistent with China's Heckscher–Ohlin comparative advantage. Since the overly capital intensive industries work against China's comparative advantage and had to reply on government support, they were dominated by SOEs, whereas private firms could survive in the labor-intensive industries even facing international competition. Thus, his paper would suggest that the profitability of

decompose the aggregate TFP loss into the across-province distortion and the within-province distortion between state and non-state sectors. They find a "V" –shaped pattern of distortion: it first decreased during 1985 and 1997 and then increased in the last decade. Our paper provides a theoretical explanation to their findings: the distortion between state and non-state sectors declined as the SOEs gradually exited from the downstream industries during 1985-1997, and increased again in the last decade because the remaining SOEs monopolize the upstream industries and benefit disproportionately more from the trade liberalization than the downstream private sectors.

Secondly, our paper also provides a theoretical explanation for why the labor income share in China's total GDP is persistently low and declining over the past decade, which is first documented by Bai and Qian (2009a). This phenomenon is puzzling not only because it starkly deviates from the standard Kaldor fact (constant labor income share in GDP over time) in growth models, but also because it appears to run against the factor price equalization result in the standard H-O trade theory. The key reason is the dual labor market (i.e., sufficiently large labor supply in the non-industrial sector) a la Lewis (1957). This ensures that wage (hence total wage income) not increase despite the trade-induced expansion in the downstream industries. At the same time, international trade helps prevent the return to capital from decreasing too fast, similar to Ventura (1997), and also boosts the profit of the SOEs in the upstream industries via the enlarged demand for the downstream manufacturing goods. Thus the total capital income goes up after trade liberalization. This leads to a persistently low and declining labor income share in total GDP.

Thirdly, our paper contributes to the literature studying institutions related to SOEs. The classical microeconomic analysis offers important insights to explain why state-owned enterprises can hardly be efficient and why an SOE-dominant economy can hardly achieve high and sustainable economic growth (e.g., Stiglitz (1991), Shleifer and Vishny (1994)). Two important reasons for low efficiency of SOEs are agency problems and multiple tasks issues of SOE managers.[3] In this paper, we study an important type of state capitalism based on China's experience. We document that

SOEs should become monotonically worse after trade openness as they defy China's comparative advantage, similar to Song et al. (2011). However, as is discussed earlier, this contradicts what we observe in the last decade. Our paper highlights the role of the vertical economic structure in explaining this.

[3]Specifically, the state as the 'abstract' principtal needs to use a chain of delegtion to have a 'physical' manager to run the firm (so incentives become a problem) and the manager, who is typically a politican, faces mutiple tasks rather than pursues economic efficiency.

China's SOE prosperity co-exists with China's high economic growth, which seems to contradict the key predictions of the classic theory. However, our theory argues that the high profitability of China's SOEs is not the cause of the country's aggregate economic success, on the contrary, it is the mere consequence of the distorting monopoly surplus extraction from the dynamic downstream sectors that operate under 'capitalism': economic deregulation, private ownership, competition in both domestic and foreign markets. In addition, our analysis suggests that, without institutional reforms, the upstream SOEs would eventually strangle the expansion of the downstream private sectors and therefore undermine the growth sustainability of the aggregate economy.

Lastly, our model also sheds some new light on the effect of partial and gradual institutional reforms in the economic transition literature. While Lau, Qian, and Roland (2000) empathizes how the gradual dual track reform in China was successful as a Pareto-improving process, Murphy, Shliefer and Vishny (1992) emphasize more on the economic distortions created in this process (also see Bruno (1992)). Our paper documents and theorizes a concrete example of partial (gradual) reform on SOEs in China, that is, only the downstream industries are liberalized while the upstream continues to be monopolized by the SOEs. We show how this partial deregulation together with trade liberalization has led to disproportionate growth in the SOEs and POEs at different stages and why this incompleteness in SOE reforms undermines the growth sustainability of the whole economy. From the macro growth point of view, we provide a new concrete theoretical mechanism to show how economic growth can be derived from the sequential removal (reform) of newly binding barriers or growth bottlenecks (see Parente and Prescott, 2002; Rodrik, 2005). We show that economic expansion can be first achieved by partial deregulation (allowing the entry of POEs into the downstream industries) and trade liberalization, and the binding growth bottleneck also endogenously changes over time. For example, the low productivity and monopoly power of the SOEs in the upstream industries become the binding obstacle for further growth only when the wage starts to increase after the surplus labor in the non-industrial sector is fully absorbed by industrialization, while no free entry of private firms into the downstream industry and economic closeness were main growth obstacles in the early stage.

3 Institutional background and empirical evidence

3.1 A brief chronicle of China's economic reforms

1978-1992 China started its 'reform and openness' policy in 1978, giving up the unique orthodoxy of 'planned economy'. From then, China began its market economy experiments in selected regions and some economic sectors. In this period, China was largely a mixed or two-track economy, with some elements of planning and others of market economy.

1992-1998 After Deng Xiaoping's southern tour in 1992, China accelerated its reform process toward a full-fledged market economy. Since 1992, China has not only drastically increased the openness to international trade and FDI, but also significantly lowered the barrier of entry to domestic private enterprises. In particular, the free market competition was first introduced in the downstream industries and gradually became dominant. This was a hard period for China's SOEs because of the enhanced market competition, although the GDP growth soared. In year 1998, two thirds of SOEs suffered losses and the aggregate profit of SOEs in the country was only 21.37 billion RMB (contrasting the profit of over1000 billion RMB ten years later in 2008). To make things worse, a large number of money-losing SOEs continued to operate by relying on the huge subsidues from the state, often via state-owned banks and other upstream SOEs, partly because the state wanted to keep the unemployment rate low. This lowered the aggregate profit of the SOEs even further.

1998-2000 Facing the severe situation of SOEs, the state began a so-called 'three-year battle' targeting to turn around SOEs' situations within three years between 1998 and 2000. The key strategy of the state is 'zhua da fang xiao', i.e., restructuring and consolidating large enterprises while relaxing control over small ones. Indeed, by 2002, the number of SOEs was significantly reduced. More importantly, SOEs gradually retreated from more competitive sectors, notably, the tradable goods sectors, while they focused themselves on the upstream industries.[4] Indeed, before 1998, the majority of SOEs were in the downstream industries; those firms were losing money, due to competitions from private and foreign firms, and often had to rely on the state's subsidy to keep operation. After the state decided to restructure, sell out, or close these firms in 1998-2000, the

[4] This is a 'learning-by-doing ' process. The state gradually realized that SOEs were not capable to compete with private and foreign firms in the tradable goods sectors.

overall average profitability of SOEs immediately experienced a jump despite the Aisan financial crisis.

2001 China entered WTO in 2001, a milestone for China's openness policy. This tremendously facilitated China's integration to the world trade system, which led to the fast expansion of tradable sectors due to China's comparative advantage in abundant labor forces.

2002-2007 This period is the main focus of this paper. During the period, SOEs have largely retreated from the downstream industries while still controling the key upstream industries with great monopoly power.

3.2 Empirical evidence

While anecdote evidence exists on the evolution of the imbalances and state capitalism in China, relatively limited systematic evidence is available. We fill this gap in this section. We first show the largely simultaneous sharp increase in current account surplus and the profitability of SOEs relative to POEs. We then present evidence on the vertical structure of China's state capitalism in the last decade. Finally, we document the declining labor income as a percentage of China's national income and the declining consumption as a percentage of China's GDP, as well as the importance of investment and export to China's GDP growth.

The first empirical fact that we document is the largely simultaneous sharp increase in current account surplus and the profitability of SOEs relative to private-owned enterprises (POEs hereafter). Figure 1 presents the time-series of aggregate profitability of SOEs versus POEs between 1998 and 2010, as well as the current account surplus of China. There has been a drastic increase in aggregate profitability of SOEs since the late 1990, which happened largely in sync with the rise in current account surplus.

Insert Figure 1 Here

Following the timeline, China's current account surplus is mostly between 0% and 2% of GDP from the early 1990s to early 2000s. SOEs underperformed POEs since the early 1990s and had some big drops in their profitability between 1994 and 1996. SOEs experienced the sharpest increase in

profitability between 1998 and 2000, catching up and surpassing the profitability of POEs, which is likely due to the state's explicit strategy of "zhua da fang xiao" in this period. The state probably started implementing this strategy by letting go the most money losing SOEs in this period.

After the initial sharp increase in profitability, SOEs experienced a steady increase in profitability between 2000 and 2007. This steady increase in profitability is consistent with the state continuing its retreat from the downstream competitive industries, while also consolidating SOEs in upstream industries. The vertical structure, coupled with the monopoly positions of SOEs and the positive external demand shock evident in the sharp increase in current account surplus, is likely one reason for the steady increase in profitability.

In 2008, the profitability of SOEs experienced a significant pullback, which occurred largely in sync with the drop in the current account surplus. While our model's focus is on Chinese economy before the Great Financial Crisis of 2008-2009, the sudden pullback is consistent with our argument that upstream SOEs use their monopoly power to extract rents from the value created by downstream POEs through supplying factor inputs to the downstream POEs. As a result, the SOEs are disproportionally exposed to the volatility of external demand. Even though we see that current account surplus only dropped significantly in 2009, actual order volume from abroad likely lags the actual export volume.

Further corroboration Figure 1, Figures 2a and 2b present the total profit of industrial enterprises scaled by the number of enterprises and employees, respectively. They show the results separately for SOEs and the rest of enterprises. The profitability of SOEs far outstrips that of the other enterprises according to these two measures.

Insert Figures 2a and 2b Here

Figure 3 examines the profitability issue from yet another angle. It shows that the presence of SOEs in low margin sectors has drastically declined, especially around 2003, whereas their presence in high margin sectors stabilized at a high level.

Insert Figure 3 Here

Figure 4 reports on the 57 Chinese companies in the 2011 list of Fortune Global 500. We report their names, rank, revenues, headquarter city, and affiliated industry. The Three of the largest 10 Fortune global 500 are from China. Almost all are SOEs. In fact, one interesting observation is that 41 of the 57 companies are headquartered in Beijing, the political capital of China, whereas only four companies are headquartered in Shanghai, the financial center of China and the Chinese city with the second largest number of Fortune Global 500. These Chinese Companies are mostly from upstream industries such as power generation, oil and energy, materials, and telecom. In fact, these few industries represent 29 of the 47 non-financial related companies on the list.

Insert Table 1 (Figure 4) Here

The second empirical fact that we document is the vertical structure created by China's state capitalism through SOEs' gradual retreat from the downstream industries while maintaining their presence in the upstream industries.[5] Figure 5 shows the shares of SOEs in investments on fixed assets across all sectors. We classify the sectors that we perceive as upstream and downstream on the left and middle parts of the figure, respectively. We classify the sectors that we perceive as undetermined on the right part of the figure.[6] One of the most striking feature of the figure is that the manufacturing sector, which is the main source of export goods and arguably the main concern of China's trading partners (e.g., the U.S.), has become among the least state investment shares.

Insert Figure 5 Here

Figure 6 shows the shares of SOEs in gross industrial output for industrial subsectors. We classify the sectors that we perceive as upstream and downstream on the left and right parts of the figure, respectively. We determine upstream and downstream sectors in the same way as in Figure 5. We present the upstream and downstream sectors only and present these sectors along with undetermined sectors in Appendix. In Figure 6a, we present the level of SOEs' shares, whereas in Figure 6b we present the scaled shares using the level in 2005 as 100. In Figures 7-9, we show the

[5] This is likely a "learning-by-doing" process as the state gradually realized that SOEs were not capable to compete with private and foreign firms in the tradable goods sectors.

[6] The three coauthors first classify the sectors individually and then include the sectors as upstream or downstream only if all three coauthors unanimously classify sectors accordingly.

share of SOEs in industrial revenue, industrial taxes and other charges, and industrial value added for industrial subsectors, respectively, using the same approach as in Figure 6.

Insert Figures 6-9 Here

All of Figures 6-9 show that SOEs continue to dominate the upstream sectors, whereas they have retreated aggressively from downstream sectors. This is the case even if we adjust in Figures 6b-9b for the lower level of SOE presences in downstream sectors from the start of our sample period in 1995. The last empirical fact that we document is that labor income share in total GDP has been persistently declining in recent years. Figure 10 shows the shares of labor compensation in China's national income from which the proportion of labor income has been persistently declining. This pattern runs contrast with the balanced growth of so-called Kaldor (1963) facts. It is striking also because China is well known as a relatively labor-intensive economy.

Insert Figure 10 Here

Figure 11 decomposes China's GDP into consumption, investment, net exports and government spending. During 2001-08, net exports and investment accounted for about 50% of China's economy, up from 40% in the 1990s. This is much larger than the 2001-08 average of the G7 (16%), Euro area (30%), or the rest of Aisa (35%). The growing share of net exports and investment also suggests that these two components contribute to a greater share of GDP growth over time.

Insert Figure 11 Here

4 The model

4.1 Static Autarky

Consider a closed economy H, which is populated by a continuum of agents with the measure equal to unity. There are two types of firms: state-owned firms and private firms. The state-owned firms are controlled by an elite class with measure equal to $\theta \in (0, 1)$. Each agent in the elite class shares

the profits of the state-owned firms equally and they work cooperatively. The rest agents (with measure$1-\theta$) are the grass root.

Preference. All the agents in this economy have the same utility function

$$u(c)=\frac{\left[c_0+\int_0^1 \log c(i)di\right]^{1-\sigma}-1}{1-\sigma}, \tag{1}$$

where c is a consumption vector composed of numeraire good c_0 and a continuum of differentiated goods $c(i)$ for $i\in[0,1]$. It is required that $c_0\geq 0$.[In other words, $u(c)=-\infty$ when $c_0<0$].

Technologies. All the technologies are constant returns to scales. In particular, one unit of labor produces one unit of good 0. To produce any differentiated good $i\in[0,1]$, it requires capital k, labor l, and intermediate good m. The production functions for all these differentiated goods are Cobb-Douglas and symmetric:

$$F_i(k,l,m)=Ak^{\alpha}l^{\beta}m^{1-\alpha-\beta},\forall i\in[0,1], \tag{2}$$

where $\alpha>0,\beta>0,\alpha+\beta<1$. If good i is produced in a state-owned firm, TFP $A=A_s$; if it is produced in a private firm, $A=A_p$. For standard reasons, we assume $A_p>A_s$.

The intermediate good m is monopolized by a state-owned firm with the following technology

$$F_m(k,l)=A_m k^{\gamma}l^{1-\gamma}, \tag{3}$$

where $\gamma\in(0,1)$.

Endowment. Each agent, elite or grass root, is endowment with L units of time (labor) and K units of capital. L is sufficiently large, which will be more precisely defined soon. The profits of all the state-owned enterprises are equally shared by the elite class. All the private firms are owned by the grass root.

Let ϕ denote the exogenous fraction of the varieties of final differentiated goods that only the state-owned enterprises are allowed to produce. If private firms are allowed to compete with the state-owned firms on the same ground, then $\phi=0$. Let W and R denote the wage and rental price of capital. Let p_0 denote the price good 0, and let $p(i)$ denote the market price that a consumer faces for good $i\in[0,1]$. Let p_m denote the price of intermediate good m. All the factor markets and the private sectors are perfectly competitive. Thus $p_0=W$. Let I_e and I_g denote the total

income of a representative agent in the elite class and in the grass root, respectively. Thus the total income of the elite class is given by

$$\theta I_e = \theta \left[WL + RK \right] + \Pi_m + \phi \pi_s,$$

where Π_m is the total profit of the state-owned firm that produces intermediate good m and π_s denote the profit of each variety of the final differentiated good that is monopolized by a state-owned firm. Similarly, the total income of the grass root is given by

$$(1-\theta) I_g = (1-\theta) \left[WL + RK \right] + (1-\phi) \pi_p,$$

where π_p denotes the profit of a private firm that produces some variety of final differentiated good. For a household with the total income $I \in \{I_e, I_g\}$, she maximizes the utility function (1) subject to the following budget constraint

$$W c_0 + \int_0^1 p(i) c(i) di \leq I.$$

The equilibrium demand for the consumption goods for each household is given by

$$c_0^d = \frac{I - W}{W}; \; c^d(i) = \frac{W}{p(i)} \text{ for any } i \in [0,1].$$

Therefore the aggregate demand is as follows:

$$\begin{aligned} D_0 &= \frac{\left[WL + RK \right] + \Pi_m + \phi \pi_s + (1-\phi) \pi_p}{W} - 1; \\ D(i) &= \frac{W}{p(i)}, \text{ for any } i \in [0,1]. \end{aligned}$$

The unit cost of intermediate good m is $\frac{R^\gamma W^{1-\gamma}}{A_m \gamma^\gamma (1-\gamma)^{1-\gamma}}$. The unit cost of any variety i is $\frac{R^\alpha W^\beta {p_m}^{1-\alpha-\beta}}{A \alpha^\alpha \beta^\beta (1-\alpha-\beta)^{1-\alpha-\beta}}$, where $A = A_p$ or A_s, depending on whether that variety is produced by a private firm or a state-owned firm. Suppose there is free entry to any sector that allows for private ownership, then $\pi_p = 0$ and the equilibrium price is equal to the unit cost:

$$p(i) = \frac{R^\alpha W^\beta {p_m}^{1-\alpha-\beta}}{A_p \alpha^\alpha \beta^\beta \left(1-\alpha-\beta\right)^{1-\alpha-\beta}},$$

for any i produced by a private firm. Next we mainly characterize the simple case in which all the state-owned firms have already exited from the downstream industries ($\phi = 0$)

By Shephard Lemma, to produce one unit of good i, it requires $\frac{\partial p(i)}{\partial W}$ units of labor, $\frac{\partial p(i)}{\partial R}$ units of capital, and $\frac{\partial p(i)}{\partial p_m}$ units of intermediate good. Therefore the aggregate demand for intermediate good m is

$$\int_0^1 D(i)\frac{\partial p(i)}{\partial p_m}di = \frac{(1-\alpha-\beta)W}{p_m}$$

The monopolist of the intermediate good m tries to maximize its profit but also faces an upper bound of the price for the intermediate good, denoted by $\widehat{p}_m$:

$$\Pi_m = \max_{p_m \leq \widehat{p}_m} \frac{(1-\alpha-\beta)W}{p_m}\left[p_m - \frac{R^{\gamma}W^{1-\gamma}}{A_m\gamma^{\gamma}(1-\gamma)^{1-\gamma}}\right] \tag{4}$$

So the equilibrium price $p_m = \widehat{p}_m$.

The capital market clearing condition is

$$K = \underbrace{\frac{(1-\alpha-\beta)W}{\widehat{p}_m}\frac{R^{\gamma-1}W^{1-\gamma}}{A_m\gamma^{\gamma-1}(1-\gamma)^{1-\gamma}}}_{\text{by producer of intermediate good } m} + \underbrace{\frac{\alpha W}{R}}_{\text{by private producers}}, \tag{5}$$

which uniquely determines $R = R(K, W, \widehat{p}_m, A_m)$ with the following properties:

$$\frac{\partial R}{\partial K} < 0; \frac{\partial R}{\partial A_m} < 0; \frac{\partial R}{\partial \widehat{p}_m} < 0; \frac{\partial (RK)}{\partial K} < 0 \tag{6}$$

The intuition is that straightforward. An increase in total supply of capital lowers the rental price of capital. A higher TFP in the upstream production or a higher price upper limit for the intermediate good implies a higher price markup, and hence the demand for capital is depressed and the rental price of capital becomes smaller. In addition, an increase in the capital stock will decrease the aggregate return to capital for facing an exogenous price upper limit $\widehat{p}_m$. This is because when the capital stock becomes larger, not only the rental price of capital falls but also the price markup becomes larger, which tends to lower the demand and hence of the rental price of capital even further.

(4) can be rewritten as $\Pi_m = \left(1-\alpha-\beta+\frac{\alpha}{\gamma}\right)W - \frac{R(K,W,\widehat{p}_m,A_m)K}{\gamma}$, which, by revoking (6), implies

$$\frac{\partial \Pi_m}{\partial K} > 0; \frac{\partial \Pi_m}{\partial A_m} > 0; \frac{\partial \Pi_m}{\partial \widehat{p}_m} > 0.$$

The labor income share in the total GDP, denoted by θ_L, is

$$\begin{aligned}\theta_L^{sa} &\equiv \frac{WL}{WL+RK+\Pi_m} \\ &= \frac{L}{L-(1-\gamma)\frac{(1-\alpha-\beta)}{\mu}+(1-\beta)},\end{aligned}$$

where we define the price markup

$$\mu \equiv \frac{\widehat{p}_m}{\frac{R^\gamma W^{1-\gamma}}{A_m \gamma^\gamma (1-\gamma)^{1-\gamma}}} > 1. \tag{7}$$

Clearly we have

$$\frac{\partial \theta_L}{\partial \mu} < 0; \frac{\partial \theta_L}{\partial L} > 0; \frac{\partial \theta_L}{\partial \alpha} < 0; \frac{\partial \theta_L}{\partial \beta} > 0.$$

In particular, $\frac{\partial \theta_L}{\partial \mu} < 0$ says that the higher the markup for the state monopoly, the lower the labor income share. By definition of μ and (6), using the chain's rule, we have

$$\frac{\partial \theta_L}{\partial A_m} = \frac{\partial \theta_L}{\partial \mu}\frac{\partial \mu}{\partial A_m} < 0; \frac{\partial \theta_L}{\partial \widehat{p}_m} < 0; \frac{\partial \theta_L}{\partial K} < 0.$$

To derive the income inequality between the representative households in the two social groups, observe that

$$\frac{I_e}{I_g} = 1 + \frac{(1-\alpha-\beta)\left[\frac{\mu-1}{\mu}\right]}{\theta\left(L+\frac{(1-\alpha-\beta)\gamma}{\mu}+\alpha\right)},$$

which decreases with the population fraction of elite θ and labor endowment L, increases with monopoly markup μ, and decreases with α, β, and γ.

For future references, (4) can be rewritten as

$$\Pi_m = (1-\alpha-\beta)\, W\left[\frac{\mu-1}{\mu}\right], \tag{8}$$

and (5) can be rewritten as:

$$K = \left[\frac{(1-\alpha-\beta)\,\gamma}{\mu}+\alpha\right]\frac{W}{R} \tag{9}$$

(9) indicates that the wage-rental ratio increases with the price markup. The intuition is that a larger markup will depress the capital demand from the upstream state monopolist and therefore lower the rental price of capital relative to the wage. If capital is not required in the production of upstream good ($\gamma = 0$), then $\frac{W}{R}$ is not affected by the price markup μ.

4.2 Dynamic Autarky

Consider a two-period model with the following utility function

$$u(c_1) + \eta u(c_2) \tag{10}$$

where c_1 and c_2 denote the consumption vectors for period 1 and period 2, respectively, and η is the time discount factor. All the goods are perishable except for capital. The technology to produce capital good is given by

$$G(x) = \int_0^1 \log x(i) di, \tag{11}$$

where G is the production function for capital goods and x is an input vector composed of a continuum of differentiated inputs $x(i)$ for $i \in [0,1]$. The technology to produce $x(i)$ is given by (2) for each variety $i \in [0,1]$. Capital goods cannot be used for consumption.

Each household has a class identity $j \in \{e, g\}$, where e and g denote elite class and grass root class, respectively. A representative household with class identity j has the following intertemporal budget constraint:

$$W_1 c_{0,1}^j + \int_0^1 p_1(i) c_1^j(i) di + \frac{W_2 c_{0,2}^j + \int_0^1 p_2(i) c_2^j(i) di}{\widetilde{R}} + \int_0^1 p_1(i) x^j(i) di \leq I_1^j + \frac{I_2^j}{\widetilde{R}},$$

where subscripts 1 and 2 denote period 1 and period 2, respectively, superscript j denotes the class identity, $\widetilde{R}$ is the gross interest rate. The incomes are given by

$$I_1^j = \begin{cases} W_1 L + R_1 K_0 + \frac{\Pi_{m,1}}{\theta}, & \text{when} \quad j = e \\ W_1 L + R_1 K_0, & \text{when} \quad j = g \end{cases},$$

$$I_2^j = \begin{cases} W_2 L + R_2 \left[(1-\delta) K_0 + \int_0^1 \log x^e(i) di \right] + \frac{\Pi_{m,2}}{\theta}, & \text{when} \quad j = e \\ W_2 L + R_2 \left[(1-\delta) K_0 + \int_0^1 \log x^g(i) di \right], & \text{when} \quad j = g \end{cases}.$$

Thus the capital accumulation function for the whole economy is

$$K_2 = (1-\delta) K_0 + \theta \int_0^1 \log x^e(i) di + (1-\theta) \int_0^1 \log x^g(i) di,$$

where δ is the depreciation rate.

The dynamic optimization of a grass root representative household yields

$$c_1^g(i) = \frac{W_1}{p_1(i)};\ c_2^g(i) = \frac{W_2}{p_2(i)}; \frac{R_2}{\widetilde{R}} = x^g(i)p_1(i), \forall i \in [0,1] \tag{12}$$

and the Eular equation is

$$\begin{aligned} & \eta\widetilde{R}\left[L + \frac{R_2\left[(1-\delta)K_0 + \int \log \frac{R_2}{\widetilde{R}p_1(i)}di\right] - W_2}{W_2} + \int \log \frac{W_2}{p_2(i)}di\right]^{-\sigma} \\ = & \frac{W_2}{W_1}\left[\frac{W_1L + R_1K_0 - \frac{R_2}{\widetilde{R}} - W_1}{W_1} + \int \log \frac{W_1}{p_1(i)}di\right]^{-\sigma}. \end{aligned} \tag{13}$$

We normalize $\frac{W_2}{W_1} = 1$ from now on.

The budget constraint implies

$$\begin{aligned} & W_1L + R_1K_0 + \frac{W_2L + R_2\left[(1-\delta)K_0 + \int \log x^g(i)di\right]}{\widetilde{R}} \\ = & W_1c_{0,1}^g + \int p_1(i)\left[c_1^g(i) + x^g(i)\right]di + \frac{W_2c_{0,2}^g + \int p_2(i)c_2^g(i)di}{\widetilde{R}} \end{aligned}$$

Similarly, from the optimization problem of an Elite representative household we obtain

$$c_1^e(i) = \frac{W_1}{p_1(i)};\ c_2^e(i) = \frac{W_2}{p_2(i)}; \frac{R_2}{\widetilde{R}} = x^e(i)p_1(i), \forall i \in [0,1] \tag{14}$$

and

$$\frac{\eta\left[L + \frac{R_2\left[(1-\delta)K_0 + \log\frac{R_2}{Rp_1(i)}\right] + \left[\frac{(1-\alpha-\beta)}{\theta}\frac{\mu_2-1}{\mu_2} - 1\right]W_2}{W_2} + \int \log \frac{W_2}{p_2(i)}di\right]^{-\sigma}}{\left[\frac{W_1L + R_1K_0 + \left[\frac{(1-\alpha-\beta)}{\theta}\frac{\mu_1-1}{\mu_1} - 1\right]\left(\frac{R_2}{\widetilde{R}} + W_1\right)}{W_1} + \int \log \frac{W_1}{p_1(i)}di\right]^{-\sigma}} = \frac{W_2}{\widetilde{R}W_1}, \tag{15}$$

where we have already substituted out the profits $\Pi_{m,1}$ and $\Pi_{m,2}$. Notice that

$$\begin{aligned} \Pi_{m,1} &= \max_{p_{m,1} \leq \widehat{p}_{m,1}} \int_0^1 \left[\theta\left[c_1^e(i) + x^e(i)\right] + (1-\theta)\left[c_1^g(i) + x^g(i)\right]\right]\frac{\partial p_1(i)}{\partial p_{m,1}}di\left[p_{m,1} - \frac{R_1^\gamma W_1^{1-\gamma}}{A_{m,1}\gamma^\gamma(1-\gamma)^{1-\gamma}}\right] \\ &= (1-\alpha-\beta)\left[W_1 + \frac{R_2}{\widetilde{R}}\right]\frac{\mu_1 - 1}{\mu_1}, \end{aligned}$$

where μ_1 denotes the price-cost ratio (markup) in period 1 ($\mu_1 \geq 1$) and the second equality comes from (12) and (14) together with

$$p_t(i) = \frac{R_t^\alpha W_t^\beta {p_{m,t}}^{1-\alpha-\beta}}{A_{p,t}\alpha^\alpha\beta^\beta(1-\alpha-\beta)^{1-\alpha-\beta}},\ t \in \{1,2\}.$$

Similarly, the profit in the second period is given by

$$\Pi_{m,2} = (1-\alpha-\beta)\, W_2 \frac{\mu_2 - 1}{\mu_2},$$

where μ_2 denotes the price-cost ratio (markup) in period 2 ($\mu_2 \geq 1$).

Capital market clears in period 1:

$$\begin{aligned} K_0 &= \underbrace{\frac{(1-\alpha-\beta)\left(W_1 + \frac{R_2}{\widetilde{R}}\right)}{\widehat{p}_{m,1}} \frac{R_1^{\gamma-1} W_1^{1-\gamma}}{A_{m,1}\gamma^{\gamma-1}(1-\gamma)^{1-\gamma}}}_{\text{by producer of intermediate good } m} \\ &+ \underbrace{\frac{\alpha\left[W_1 + \frac{R_2}{\widetilde{R}}\right]}{R_1}}_{\text{by private producers}} \end{aligned} \tag{16}$$

or equivalently

$$K_0 = \frac{\left[W_1 + \frac{R_2}{\widetilde{R}}\right]}{R_1}\left[\frac{(1-\alpha-\beta)\,\gamma}{\mu_1} + \alpha\right] \tag{17}$$

Capital market clears in period 2:

$$\begin{aligned} & (1-\delta)K_0 + \int \log \frac{R_2}{\widetilde{R} p_1(i)} di \\ = & \underbrace{\frac{(1-\alpha-\beta)\, W_2}{\widehat{p}_{m,2}} \frac{R_2^{\gamma-1} W_2^{1-\gamma}}{A_{m,2}\gamma^{\gamma-1}(1-\gamma)^{1-\gamma}}}_{\text{by producer of intermediate good } m} \\ & + \underbrace{\frac{\alpha W_2}{R_2}}_{\text{by private producers}} \end{aligned} \tag{18}$$

or equivalently

$$(1-\delta)K_0 + \int \log \frac{R_2}{\widetilde{R} p_1(i)} di = \left[\frac{(1-\alpha-\beta)\,\gamma}{\mu_2} + \alpha\right]\frac{W_2}{R_2}. \tag{19}$$

(17) implies $\frac{R_2}{\widetilde{R}} = \frac{R_1 K_0}{\frac{(1-\alpha-\beta)\gamma}{\mu_1} + \alpha} - W_1$. Notice (13) and (15) imply the following relationship between the rental wage ratios in the two periods:

$$\frac{R_2}{W_2} = \frac{1}{\eta}\left(\frac{R_1 K_0}{W_1\left[\frac{(1-\alpha-\beta)\gamma}{\mu_1} + \alpha\right]} - 1\right)\left[\frac{\frac{\mu_1 - 1}{\mu_1}}{\frac{\mu_2 - 1}{\mu_2}\left[\frac{(1-\alpha-\beta)\gamma}{\mu_1} + \alpha\right]}\right]^{\sigma}\left(\frac{R_1}{W_1}K_0\right)^{\sigma} \tag{20}$$

Combining (19) with (**??**) yields

$$
\begin{aligned}
&(1-\delta)K_0 + \log A_{p,1}\alpha^{\alpha}\beta^{\beta}\left(1-\alpha-\beta\right)^{1-\alpha-\beta} + (1-\alpha-\beta)\log\left(\frac{A_{m,1}\gamma^{\gamma}\left(1-\gamma\right)^{1-\gamma}}{\mu_1}\right) \\
&+\log\left[\frac{R_1K_0}{W_1\left[\frac{(1-\alpha-\beta)\gamma}{\mu_1}+\alpha\right]}-1\right] - \left[\alpha+\gamma\left(1-\alpha-\beta\right)\right]\log\left(\frac{R_1}{W_1}\right) \\
= \quad & \frac{\eta\left[\frac{(1-\alpha-\beta)\gamma}{\mu_2}+\alpha\right]}{\left[\frac{R_1K_0}{W_1\left[\frac{(1-\alpha-\beta)\gamma}{\mu_1}+\alpha\right]}-1\right]}\left[\frac{\frac{\mu_2-1}{\mu_2}\left(\frac{(1-\alpha-\beta)\gamma}{\mu_1}+\alpha\right)}{\frac{\mu_1-1}{\mu_1}}\right]^{-\sigma}\left(\frac{R_1K_0}{W_1}\right)^{\sigma} \qquad (21)
\end{aligned}
$$

It can be shown that the right hand side of (21) is strictly decreasing in $\frac{R_1}{W_1}$ (suppose $\sigma < 1$) while the left hand side is strictly increasing in $\frac{R_1}{W_1}$. Therefore $\frac{R_1}{W_1}$ can be uniquely determined. In addition, we have the following properties.

$$
\begin{aligned}
\frac{\partial}{\partial K_0}\left(\frac{R_1}{W_1}\right) &< 0; \frac{\partial}{\partial A_{m,1}}\left(\frac{R_1}{W_1}\right) < 0; \frac{\partial}{\partial A_{p,1}}\left(\frac{R_1}{W_1}\right) < 0; \\
\frac{\partial}{\partial \delta}\left(\frac{R_1}{W_1}\right) &> 0; \frac{\partial}{\partial \eta}\left(\frac{R_1}{W_1}\right) > 0; \frac{\partial}{\partial L}\left(\frac{R_1}{W_1}\right) = 0
\end{aligned}
$$

The intuition is the following. When initial capital stock is larger, the rental-wage ratio in the first period is smaller due to the larger capital supply. When holding the price markup fixed, a higher TFP in the upstream monopolist or a higher TFP in the downstream industry tends to lower the demand for capital and therefore depresses the rental-wage ratio in the first period. A larger depreciation rate implies a smaller net intertemporal supply of capital and hence a higher rental-wage ratio. A more patient household tends to invest more for the future and hence raises the demand for capital resulting in a higher rental-wage ratio. The quasi-linear utility function plus a sufficiently large supply of labor large L naturally implies that the labor supply does not affect wage and hence has no impact on the rental-wage ratio. Interestingly, (21) also implies that $\frac{\partial}{\partial \mu_2}\left(\frac{R_1}{W_1}\right) < 0$. A larger markup in the second period implies a lower capital demand in that period and hence a higher capital supply for the first period, reducing the rental-wage ratio in the first period. In addition, we have $\frac{\partial}{\partial K_0}\left(\frac{R_1}{W_1}K_0\right) < 0$.Thus (20) implies

$$
\begin{aligned}
\frac{\partial}{\partial K_0}\left(\frac{R_2}{W_2}\right) &< 0; \frac{\partial}{\partial A_{m,1}}\left(\frac{R_2}{W_2}\right) < 0; \frac{\partial}{\partial A_{p,1}}\left(\frac{R_2}{W_2}\right) < 0; \\
\frac{\partial}{\partial \delta}\left(\frac{R_2}{W_2}\right) &> 0; \frac{\partial}{\partial L}\left(\frac{R_2}{W_2}\right) = 0; \frac{\partial}{\partial \mu_2}\left(\frac{R_2}{W_2}\right) < 0 \ .
\end{aligned}
$$

We can calculate the labor income share in the first period

$$\theta_{L,1} = \frac{L}{L + \frac{R_1}{W_1} K_0 \left[1 + \left[\frac{(1-\alpha-\beta)}{\frac{(1-\alpha-\beta)\gamma}{\mu_1}+\alpha}\right] \frac{\mu_1 - 1}{\mu_1}\right]}.$$

By revoking the properties of $\frac{R_1}{W_1}$, we obtain

$$\frac{\partial \theta_{L,1}}{\partial K_0} > 0; \frac{\partial \theta_{L,1}}{\partial L} > 0; \frac{\partial \theta_{L,1}}{\partial A_{m,1}} > 0; \frac{\partial \theta_{L,1}}{\partial A_{p,1}} > 0; \frac{\partial \theta_{L,1}}{\partial \delta} < 0; \frac{\partial \theta_{L,1}}{\partial \eta} < 0$$

For the second period, $\theta_{L,2} = \frac{L}{L + \frac{(1-\alpha-\beta)(\gamma+\mu_2-1)}{\mu_2}+\alpha}$ and therefore

$$\frac{\partial \theta_{L,2}}{\partial L} > 0; \frac{\partial \theta_{L,2}}{\partial \alpha} < 0; \frac{\partial \theta_{L,2}}{\partial \beta} > 0; \frac{\partial \theta_{L,2}}{\partial \gamma} < 0; \frac{\partial \theta_{L,2}}{\partial \mu_2} < 0.$$

Since the total investment is $\frac{R_2}{\widetilde{R}}$, thus the saving rate in period 1 is

$$s^{da} = \frac{\frac{R_1 K_0}{W_1} - \left[\frac{(1-\alpha-\beta)\gamma}{\mu_1} + \alpha\right]}{\left[\frac{(1-\alpha-\beta)\gamma}{\mu_1} + \alpha\right] L + \frac{R_1}{W_1} K_0 \left[\frac{(1-\alpha-\beta)\gamma}{\mu_1} + \alpha + (1-\alpha-\beta)\frac{\mu_1 - 1}{\mu_1}\right]},$$

which is increasing in $\frac{R_1 K_0}{W_1}$, implying

$$\frac{\partial s}{\partial L} < 0; \frac{\partial s}{\partial K_0} < 0; \frac{\partial s}{\partial \eta} > 0; \frac{\partial s}{\partial A_{p,1}} < 0; \frac{\partial s}{\partial A_{m,1}} < 0; \frac{\partial s}{\partial \delta} > 0; \frac{\partial s}{\partial \mu_2} < 0$$

In particular, when $\gamma = 0$, we have $\frac{\partial}{\partial \mu_1}\left(\frac{R_1}{W_1}\right) > 0$ and $s^{da} = \frac{\frac{R_1 K_0}{W_1} - \alpha}{\alpha L + \frac{R_1}{W_1} K_0 \left[\alpha + (1-\alpha-\beta)\frac{\mu_1 - 1}{\mu_1}\right]}$.

4.3 Static Open Economy

Now consider a world with two countries, home (H) and foreign (F). The home country is identical to the economy specified in Section 3. Country F is populated with a continuum of identical households with measure equal to unity . We use star to denote the variables for country F. Each household is endowed with L^* units of labor and has the same utility function as in country H:

$$u(c^*) = \frac{\left[c_0^* + \int_0^1 \log c^*(i) di\right]^{1-\sigma} - 1}{1-\sigma},$$

where $c_0^* \geq 0$.

All the firms are private in country F and have free access to the following production technology

$$F_i^*(l) = l, \tag{22}$$

for any variety $i \in [0,1]$. However, firms in country H have no access to this technology. The technology for the numeraire good (good 0) is also constant return to scale with one unit of foreign labor producing A^* units of numeraire good. Therefore in the autarky equilibrium, $p_0^* = \frac{W^*}{A^*}$ and $p^*(i) = W^*$,for any $i \in [0,1]$. Assume $L^* < \frac{1}{A^*}$ so in the autarky equilibrium $c_0^* = 0$.

Now the two countries are allowed to have free trade. Define

$$\begin{aligned}\Phi \equiv\ & A_p \alpha^\alpha \beta^\beta (1-\alpha-\beta)^{1-\alpha-\beta} \left(\frac{K}{\left[(1-\alpha-\beta)\frac{\gamma}{\mu} + \alpha \right]} \right)^{\alpha+\gamma(1-\alpha-\beta)} \\ & \cdot \left(\frac{A_m \gamma^\gamma (1-\gamma)^{1-\gamma}}{\mu} \right)^{1-\alpha-\beta}\end{aligned}$$

Assume the following condition holds

$$\Phi \geq \frac{[1 + A^* L^*]^{\alpha+\gamma(1-\alpha-\beta)}}{A^*}, \tag{23}$$

which is the necessary and sufficient condition for country F to have comparative advantage in the numeraire goods. Hence country F specializes in numeraire good and imports all the final goods from country H. Assume labor endowment is sufficiently large:

$$L \geq \left[(1-\alpha)\left(\frac{1-\gamma}{\mu}\right) + \beta \frac{\gamma+\mu-1}{\mu} \right] [1 + A^* L^*], \tag{24}$$

which ensures the home country also produces the numeraire good. So country H produces both numeraire goods and differentiated goods and only exports differentiated goods.

In the trade equilibrium, the consumption in country H is given by

$$\begin{aligned} c_0^e &= L + \left[(1-\alpha-\beta)\frac{\gamma + \frac{\mu-1}{\theta}}{\mu} + \alpha \right] [1 + A^* L^*] - 1 \\ c_0^g &= L + \left[(1-\alpha-\beta)\frac{\gamma}{\mu} + \alpha \right] [1 + A^* L^*] - 1 \\ c^j(i) &= \frac{\Phi}{[1 + A^* L^*]^{\alpha+\gamma(1-\alpha-\beta)}}, \forall i \in [0,1], \forall j \in \{e, g\} \end{aligned}$$

Aggregate consumption of numeraire goods in country H is

$$C_0 = L + \left[(1-\alpha-\beta)\frac{\gamma+\mu-1}{\mu} + \alpha \right] [1 + A^* L^*] - 1$$

and the GDP (per capita) in country H is

$$I = \left[L + \left[(1-\alpha-\beta)\frac{\gamma+\mu-1}{\mu} + \alpha \right] [1 + A^* L^*] \right] W$$

The total monopolist profit in the upstream industry is

$$\Pi_m = (1-\alpha-\beta)[1 + A^* L^*] \frac{\mu-1}{\mu} W.$$

The rental price of capital in country H is

$$R = \frac{\left[(1-\alpha-\beta)\frac{\gamma}{\mu} + \alpha \right] (1 + A^* L^*)}{K} W.$$

The equilibrium world price is

$$\begin{aligned} p(i) &= p^*(i) = \frac{[1 + A^* L^*]^{\alpha+\gamma(1-\alpha-\beta)} W}{\Phi}, \forall i \in [0,1] \\ p_0 &= p_0^* = W \\ W^* &= A^* W. \end{aligned}$$

The labor income share in GDP is

$$\theta_L^{so} = \frac{L}{L + \left[(1-\alpha-\beta)\frac{\gamma+\mu-1}{\mu} + \alpha \right] [1 + A^* L^*]},$$

which is smaller than that in the static autarky θ_L^{sa}. This is because international trade increases the profit for the upstream monopoly and also increases the capital return. θ_L^{so} also decreases in the foreign productivity A^* and foreign labor endowment L^*. The income inequality between the representative households from the two social groups is

$$\begin{aligned} \frac{I^e}{I^g} &= \frac{WL + RK + \frac{\Pi_m}{\theta}}{WL + RK} \\ &= 1 + \frac{(1-\alpha-\beta)[1 + A^* L^*]\frac{\mu-1}{\mu}}{\theta \left(L + \left[(1-\alpha-\beta)\frac{\gamma}{\mu} + \alpha \right] [1 + A^* L^*] \right)}, \end{aligned}$$

which increases in $A^* L^*$ and is larger than that in the static autarky.

For completeness, the total (or individual) consumption in country F is given by $c_0^* = 0$ and $c^*(i) = \frac{\Phi}{[1+A^* L^*]^{\alpha+\gamma(1-\alpha-\beta)}} A^* L^*$.The total GDP is $I^* = L^* W^* = L^* A^* W$.

4.4 Dynamic Open Economy With Balanced Trade

Now consider a two-period open economy model. Country H is identical to that described in the Section 4. Country F is identical to that in Section 5 except that now there are two periods. Households in country F have the same preference as in country H:

$$U(c_1^*, c_2^*) = u(c_1^*) + \eta u(c_2^*)$$

where c_1^* and c_2^* denote the consumption vectors for period 1 and period 2, respectively. Country F has access to all the technologies described in Section 5. The technology to produce capital good is given by (11) in Section 4 and it is public knowledge to both countries. In addition, country F has *exclusive* access to the following technology of planting Lucas trees. One unit of seed in period one can generate one Lucas tree in period 2, and each tree yields fruits that are the same as the numeraire good. More precisely,

$$F_{fruit}(Q_{seed}) = \xi Q_{seed}.$$

To plant Lucas trees, seeds have to be produced or purchased first. Seeds are produced by combining all the differentiated good $i \in [0, 1]$ with the following technology

$$Q_{seed} = F_{seed}(y) = \int_0^1 \log y(i) di$$

where y is a vector of input $y(i)$ with $i \in [0, 1]$. And the input $y(i)$ can be produced either with the technology in country H as described by (2) or with the technology in country F as described by (22) for any $i \in [0, 1]$.

The two countries can have free trade in consumption goods in both periods, but no international borrowing or factor movement is allowed, so trade has to be balanced in both periods. In the equilibrium, country F specializes in numeraire goods in both periods and exchanges numeraire goods for differentiated goods in both periods. Part of the imported differentiated goods in period one is used for consumption and the rest is used as seeds to plant Lucas trees. In period 2, country F uses the fruits from the Lucas trees and the numeraire goods produced by labor to exchange for the differentiated goods from country H and consumes all of them. On the other hand, country H produces both numeraire goods and the differentiated goods in period one but only exports

part of the differentiated goods in that period. The rest of the differentiated goods is used for self consumption and domestic investment in capital goods. In period 2, country H produces both numeraire goods and differentiated goods but only exports the differentiated goods.

First of all, we know that in the trade equilibrium

$$p_{0,t} = p^*_{0,t} = W_t = \frac{W^*_t}{A^*_t} \text{ for } t \in \{1, 2\}.$$

Again, we normalize $W_1 = W_2$.

We will restrict the parameters such that country F will consume no numeraire goods in both periods in the equilibrium ($c^*_{0,1} = c^*_{0,2} = 0$). Now consider a representative household in country F. The budget constraint is

$$\begin{aligned} \int_0^1 p_1(i)c^*_1(i)di + \int_0^1 p_1(i)y(i)di &\leq W^*_1 L^* \\ \int_0^1 p_2(i)c^*_2(i)di &\leq W_2\xi\left(\int_0^1 \log y(i)di\right) + W_2 A^*_2 L^* \end{aligned}$$

Therefore

$$c^*_1(i) = \frac{W^*_1 L^*}{p_1(i)} - y(i); c^*_2(i) = \frac{W_2\xi\left(\int_0^1 \log y(i)di\right) + W_2 A^*_2 L^*}{p_2(i)} \text{ for } \forall i \in [0, 1]$$

Substituting the above equations back into the utility function, we have, for any $j \in [0, 1]$, the first order condition with respect to $y(j)$:

$$\eta\left[\int_0^1 \log \frac{W_2\xi\int_0^1 \log y(i)di + W_2 A^*_2 L^*}{p_2(i)} di\right]^{-\sigma} \frac{W_2\xi}{p_2(j)} \frac{\left[\frac{W^*_1 L^*}{p_1(j)} - y(j)\right]}{y(j)} = \left[\int_0^1 \log\left[\frac{W^*_1 L^*}{p_1(i)} - y(i)\right] di\right]^{-\sigma}. \tag{25}$$

Symmetry implies

$$\eta\left[\frac{\log \frac{W_2\left(\xi \log y(j) + A^*_2 L^*\right)}{p_2(j)}}{\log\left[\frac{W^*_1 L^*}{p_1(j)} - y(j)\right]}\right]^{-\sigma} = \frac{p_2(j)y(j)}{W_2\xi\left[\frac{W^*_1 L^*}{p_1(j)} - y(j)\right]},$$

which can uniquely determine $y(j)$ because the lhs is strictly decreasing in $y(j)$ while the rhs is strictly increasing in it. Clearly, we have

$$\frac{\partial y(j)}{\partial \eta} > 0; \frac{\partial y(j)}{\partial \frac{p_2(j)}{W_2}} < 0; \frac{\partial y(j)}{\partial A_2^*} < 0; \frac{\partial y(j)}{\partial \frac{W_1^*}{p_1(j)}} > 0.$$

In addition, (25) implies that the implicit interest rate in country F is $\widetilde{R}^* = \frac{W_2 \xi}{p_2(j)} \frac{\left[\frac{W_1^* L^*}{p_1(j)} - y(j)\right]}{y(j)}$. Now consider country H. A representative household with class identity j has the following intertemporal budget constraint:

$$W_1 c_{0,1}^j + \int_0^1 p_1(i) c_1^j(i) di + \frac{W_2 c_{0,2}^j + \int_0^1 p_2(i) c_2^j(i) di}{\widetilde{R}} + \int_0^1 p_1(i) x^j(i) di \leq I_1^j + \frac{I_2^j}{\widetilde{R}},$$

where subscripts 1 and 2 denote period 1 and period 2, respectively, superscript j denotes the class identity, $\widetilde{R}$ is the gross interest rate. The incomes are given by

$$I_1^j = \begin{cases} W_1 L + R_1 K_0 + \frac{\Pi_{m,1}}{\theta}, & \text{when} \quad j = e \\ W_1 L + R_1 K_0, & \text{when} \quad j = g \end{cases},$$

$$I_2^j = \begin{cases} W_2 L + R_2 \left[(1-\delta) K_0 + \int_0^1 \log x^e(i) di \right] + \frac{\Pi_{m,2}}{\theta}, & \text{when} \quad j = e \\ W_2 L + R_2 \left[(1-\delta) K_0 + \int_0^1 \log x^g(i) di \right], & \text{when} \quad j = g \end{cases}.$$

The dynamic optimization of a grass root representative household yields

$$c_1^g(i) = \frac{W_1}{p_1(i)}; \; c_2^g(i) = \frac{W_2}{p_2(i)}; \frac{R_2}{\widetilde{R}} = x^g(i) p_1(i), \forall i \in [0,1]$$

and the Eular equation

$$\eta \widetilde{R} \left[L + \frac{R_2 \left[(1-\delta) K_0 + \int \log \frac{R_2}{\widetilde{R} p_1(i)} di \right] - W_2}{W_2} + \int \log \frac{W_2}{p_2(i)} di \right]^{-\sigma} \tag{26}$$

$$= \frac{W_2}{W_1} \left[\frac{W_1 L + R_1 K_0 - \frac{R_2}{\widetilde{R}} - W_1}{W_1} + \int \log \frac{W_1}{p_1(i)} di \right]^{-\sigma}.$$

Similarly, from the optimization problem of an Elite representative household we obtain

$$c_1^e(i) = \frac{W_1}{p_1(i)}; \; c_2^e(i) = \frac{W_2}{p_2(i)}; \frac{R_2}{\widetilde{R}} = x^e(i) p_1(i), \forall i \in [0,1]$$

and

$$\eta\left[L+\frac{R_2\left[(1-\delta)K_0+\log\frac{R_2}{\widetilde{R}p_1(i)}\right]+\left[(1-\alpha-\beta)\left[1+\xi\int_0^1\log y(i)di+A_2^*L^*\right]\frac{\mu_2-1}{\mu_2}-1\right]W_2}{W_2}+\int\log\frac{W_2}{p_2(i)}di\right]^{-\sigma}$$
$$\frac{}{\left[\frac{W_1L+R_1K_0+(1-\alpha-\beta)\left(W_1+\frac{R_2}{\widetilde{R}}+W_1A_1^*L^*\right)\frac{\mu_1-1}{\mu_1}-W_1-\frac{R_2}{\widetilde{R}}}{W_1}+\int\log\frac{W_1}{p_1(i)}di\right]^{-\sigma}}=\frac{W_2}{\widetilde{R}W_1},\tag{27}$$

where we have already substituted out the profits $\Pi_{m,1}^{do}$ and $\Pi_{m,2}^{do}$.

$$\begin{aligned}\Pi_{m,1}^{do} &= \max_{p_{m,1}\leq\widehat{p}_{m,1}}\int_0^1\left[\theta\left[c_1^e(i)+x^e(i)\right]+(1-\theta)\left[c_1^g(i)+x^g(i)\right]+\frac{W_1^*L^*}{p_1(i)}\right]\frac{\partial p_1(i)}{\partial p_{m,1}}di\left[p_{m,1}-\frac{R_1^\gamma W_1^{1-\gamma}}{A_{m,1}\gamma^\gamma(1-\gamma)^{1-\gamma}}\right]\\ &= (1-\alpha-\beta)\left[W_1+\frac{R_2}{\widetilde{R}}+W_1^*L^*\right]\frac{\mu_1-1}{\mu_1},\end{aligned}$$

Capital market clears in period 1:

$$K_0=\frac{\left[W_1+\frac{R_2}{\widetilde{R}}+W_1^*L^*\right]}{R_1}\left[\frac{(1-\alpha-\beta)\gamma}{\mu_1}+\alpha\right]\tag{28}$$

In period 2,

$$\Pi_{m,2}^{do}=(1-\alpha-\beta)\left[W_2+W_2\xi\left(\int_0^1\log y(i)di\right)+W_2A_2^*L^*\right]\frac{\mu_2-1}{\mu_2},$$

Capital market clears in period 2:

$$(1-\delta)K_0+\int\log\frac{R_2}{\widetilde{R}p_1(i)}di=\frac{\left[\frac{(1-\alpha-\beta)\gamma}{\mu_2}+\alpha\right]\left[W_2+W_2\xi\left(\int_0^1\log y(i)di\right)+W_2A_2^*L^*\right]}{R_2}\tag{29}$$

(28) and (29) jointly imply

$$\begin{aligned}&(1-\delta)K_0+\log\left[\frac{R_1K_0}{W_1\left[\frac{(1-\alpha-\beta)\gamma}{\mu_1}+\alpha\right]}-(1+A_1^*L^*)\right]+\left[\alpha+\gamma(1-\alpha-\beta)\right]\log\frac{W_1}{R_1}\\ &+\log A_{p,1}\alpha^\alpha\beta^\beta(1-\alpha-\beta)^{1-\alpha-\beta}\left(\frac{A_{m,1}\gamma^\gamma(1-\gamma)^{1-\gamma}}{\mu_1}\right)^{1-\alpha-\beta}\\ =\;&\left[\frac{(1-\alpha-\beta)\gamma}{\mu_2}+\alpha\right]\left[1+\xi\left(\int_0^1\log y(i)di\right)+A_2^*L^*\right]\frac{W_2}{R_2}\end{aligned}$$

(26) and (27) imply

$$\frac{R_2}{W_2} = \frac{\left(\frac{R_1K_0}{W_1\left[\frac{(1-\alpha-\beta)\gamma}{\mu_1}+\alpha\right]} - 1 - A_1^*L^*\right)\left[1+\xi\int_0^1 \log y(i)di + A_2^*L^*\right]^{\sigma}}{\eta\left(\frac{R_1K_0}{W_1}\right)^{\sigma}} \left[\frac{\frac{\mu_2-1}{\mu_2}\left(\frac{(1-\alpha-\beta)\gamma}{\mu_1}+\alpha\right)}{\frac{\mu_1-1}{\mu_1}}\right]^{\sigma} \tag{30}$$

therefore

$$\begin{aligned}
&(1-\delta)K_0 + \log\left[\frac{R_1K_0}{W_1\left[\frac{(1-\alpha-\beta)\gamma}{\mu_1}+\alpha\right]} - (1+A_1^*L^*)\right] - \left[\alpha+\gamma\left(1-\alpha-\beta\right)\right]\log\left(\frac{R_1}{W_1}\right) \\
&+ \log A_{p,1}\alpha^{\alpha}\beta^{\beta}\left(1-\alpha-\beta\right)^{1-\alpha-\beta}\left(\frac{A_{m,1}\gamma^{\gamma}\left(1-\gamma\right)^{1-\gamma}}{\mu_1}\right)^{1-\alpha-\beta} \\
= &\left[\frac{\left(1-\alpha-\beta\right)\gamma}{\mu_2}+\alpha\right]\left[1+\xi\int_0^1 \log y(i)di + A_2^*L^*\right]^{1-\sigma} \\
&\cdot\frac{\eta\left(\frac{R_1K_0}{W_1}\right)^{\sigma}}{\left(\frac{R_1K_0}{W_1\left[\frac{(1-\alpha-\beta)\gamma}{\mu_1}+\alpha\right]} - 1 - A_1^*L^*\right)\left[\frac{\frac{\mu_2-1}{\mu_2}\left(\frac{(1-\alpha-\beta)\gamma}{\mu_1}+\alpha\right)}{\frac{\mu_1-1}{\mu_1}}\right]^{\sigma}}
\end{aligned}$$

which uniquely determines $\frac{R_1}{W_1}$ because the lhs is strictly increasing in $\frac{R_1}{W_1}$ while the rhs is strictly decreasing in it when holding $y(i)$ fixed (or when $\xi = 0$) .

In addition, we have the following properties.

$$\begin{aligned}
\frac{\partial}{\partial K_0}\left(\frac{R_1}{W_1}\right) &< 0; \frac{\partial}{\partial A_{m,1}}\left(\frac{R_1}{W_1}\right) < 0; \frac{\partial}{\partial A_{p,1}}\left(\frac{R_1}{W_1}\right) < 0; \frac{\partial}{\partial \delta}\left(\frac{R_1}{W_1}\right) > 0; \\
\frac{\partial}{\partial \eta}\left(\frac{R_1}{W_1}\right) &> 0; \frac{\partial}{\partial L}\left(\frac{R_1}{W_1}\right) = 0; \frac{\partial}{\partial \mu_2}\left(\frac{R_1}{W_1}\right) < 0; \frac{\partial}{\partial K_0}\left(\frac{R_1}{W_1}K_0\right) < 0.
\end{aligned}$$

The intuition is similar to that in Section 4. Moreover,

$$\frac{\partial}{\partial A_1^*}\left(\frac{R_1}{W_1}\right) > 0; \frac{\partial}{\partial A_2^*}\left(\frac{R_1}{W_1}\right) > 0; \frac{\partial}{\partial L^*}\left(\frac{R_1}{W_1}\right) > 0, \frac{\partial}{\partial \xi}\left(\frac{R_1}{W_1}\right) > 0$$

which are due to that the import demand for the differentiated goods hence the demand for capital increases when the foreign TFP increases or foreign labor endowment increases or when the Lucas tree becomes more productive.

Thus (30) implies, when holding $y(i)$ fixed.

$$\begin{aligned}\frac{\partial}{\partial K_0}\left(\frac{R_2}{W_2}\right) &< 0; \frac{\partial}{\partial A_{m,1}}\left(\frac{R_2}{W_2}\right)<0; \frac{\partial}{\partial A_{p,1}}\left(\frac{R_2}{W_2}\right)<0; \frac{\partial}{\partial \delta}\left(\frac{R_2}{W_2}\right)>0; \frac{\partial}{\partial L}\left(\frac{R_2}{W_2}\right)=0;\\ \cdot\frac{\partial}{\partial A_2^*}\left(\frac{R_2}{W_2}\right) &> 0; \frac{\partial}{\partial \xi}\left(\frac{R_2}{W_2}\right)>0\end{aligned}$$

We can calculate the labor income share in country H in the first period

$$\theta_{L,1}^{do}=\frac{L}{L+\frac{R_1}{W_1}K_0\left[1+\left[\frac{(1-\alpha-\beta)}{\frac{(1-\alpha-\beta)\gamma}{\mu_1}+\alpha}\right]\frac{\mu_1-1}{\mu_1}\right]}$$

$$\begin{aligned}\Pi &= (1-\alpha-\beta)\left[W_1+\frac{R_2}{\widetilde{R}}+W_1^*L^*\right]\frac{\mu_1-1}{\mu_1}\\ &= \frac{(1-\alpha-\beta)\frac{\mu_1-1}{\mu_1}R_1K_0}{\left[\frac{(1-\alpha-\beta)\gamma}{\mu_1}+\alpha\right]}\\ K_0 &= \frac{\left[W_1+\frac{R_2}{\widetilde{R}}+W_1^*L^*\right]}{R_1}\left[\frac{(1-\alpha-\beta)\gamma}{\mu_1}+\alpha\right]\end{aligned}$$

By revoking the properties of $\frac{R_1}{W_1}$, we obtain

$$\begin{aligned}\frac{\partial\theta_{L,1}^{do}}{\partial K_0} &> 0; \frac{\partial\theta_{L,1}^{do}}{\partial L}>0; \frac{\partial\theta_{L,1}^{do}}{\partial A_{m,1}}>0; \frac{\partial\theta_{L,1}^{do}}{\partial A_{p,1}}>0; \frac{\partial\theta_{L,1}^{do}}{\partial \delta}<0; \frac{\partial\theta_{L,1}^{do}}{\partial \eta}<0\\ \frac{\partial\theta_{L,1}^{do}}{\partial A_1^*} &< 0; \frac{\partial\theta_{L,1}^{do}}{\partial A_2^*}<0; \frac{\partial\theta_{L,1}^{do}}{\partial L^*}<0, \frac{\partial\theta_{L,1}^{do}}{\partial \xi}<0\end{aligned}$$

For the second period,

$$\theta_{L,2}^{do}=\frac{L}{L+\left[\alpha+(1-\alpha-\beta)\frac{\mu_2-1+\gamma}{\mu_2}\right]\left[1+\xi\int_0^1\log y(i)di+A_2^*L^*\right]},$$

which is smaller than that in dynamic autarky ($\theta_{L,2}^{da}$) because the second-period total output of country F $\xi\int_0^1\log y(i)di+A_2^*L^*>0$. Clearly,

$$\frac{\partial\theta_{L,2}^{do}}{\partial L}>0; \frac{\partial\theta_{L,2}^{do}}{\partial\alpha}<0; \frac{\partial\theta_{L,2}^{do}}{\partial\beta}>0; \frac{\partial\theta_{L,2}^{do}}{\partial\gamma}<0; \frac{\partial\theta_{L,2}^{do}}{\partial\mu_2}<0; \frac{\partial\theta_{L,2}^{do}}{\partial\left(A_2^*L^*\right)}<0.$$

The saving rate of country H in period 1 is

$$\begin{aligned} s^{do} &= \frac{\frac{R_2}{\widetilde{R}}}{W_1 L + R_1 K_0 + \Pi_{m,1}} \\ &= \frac{\frac{R_1 K_0}{W_1} - (1 + A_1^* L^*) \left[\frac{(1-\alpha-\beta)\gamma}{\mu_1} + \alpha\right]}{\left[\frac{(1-\alpha-\beta)\gamma}{\mu_1} + \alpha\right] L + \frac{R_1}{W_1} K_0 \left[\frac{(1-\alpha-\beta)\gamma}{\mu_1} + \alpha + (1-\alpha-\beta)\frac{\mu_1 - 1}{\mu_1}\right]} \end{aligned}$$

which, by revoking the properties of $\frac{R_1 K_0}{W_1}$, implies

$$\begin{aligned} \frac{\partial s^{do}}{\partial L} &< 0; \frac{\partial s^{do}}{\partial K_0} < 0; \frac{\partial s^{do}}{\partial \eta} > 0; \frac{\partial s^{do}}{\partial A_{p,1}} < 0; \frac{\partial s^{do}}{\partial A_{m,1}} < 0; \frac{\partial s^{do}}{\partial \delta} > 0 \\ \frac{\partial s^{do}}{\partial \mu_2} &< 0; \frac{\partial s^{do}}{\partial A_2^*} > 0; \frac{\partial s^{do}}{\partial \xi} > 0 \end{aligned}$$

4.5 Dynamic Open Economy With International Borrowing

Now we relax the assumption of balanced trade for each period and allows for international borrowing (hence trade imbalance) in the environment otherwise identical to the previous section. In particular, a representative household in country F is allowed to issue debt D^*, which can be only purchased by the domestic households in country F or by the government (elite class) of country H. Grass roots households in country H are not allowed to purchase the debt from country F. The gross return rate of this debt is endogenous and denoted by ψ. Thus the aggregate import demand for each variety j is $\frac{D^* + W_1^* L^*}{p(j)}$ and the aggregate demand for any final good $j \in [0,1]$ produced in country H now becomes $\frac{W_1 + D^* + W_1^* L^*}{p(j)}$. Since all the final goods are now produced by private firms in country H, we have

$$\begin{aligned} \Pi_{m,1} &= \max_{p_{m,1} \leq \widehat{p}_{m,1}} \int_0^1 \left[D_1(i) + \frac{D^* + W_1^* L^*}{p_1(i)} + \frac{R_2}{\widetilde{R} p_1(i)}\right] \frac{\partial p_1(i)}{\partial p_{m,1}} di \left[p_{m,1} - \frac{R_1^\gamma W_1^{1-\gamma}}{A_{m,1}\gamma^\gamma (1-\gamma)^{1-\gamma}}\right] \\ &= (1-\alpha-\beta)\left[W_1 + D^* + W_1^* L^* + \frac{R_2}{\widetilde{R}}\right]\frac{\mu_1 - 1}{\mu_1} \end{aligned}$$

Similarly

$$\begin{aligned} \Pi_{m,2} &= \max_{p_{m,2} \leq \widehat{p}_{m,2}} \int_0^1 \left[D_2(i) + c_2^*(i)\right] \frac{\partial p_2(i)}{\partial p_{m,2}} di \left[p_{m,2} - \frac{R_2^\gamma W_2^{1-\gamma}}{A_{m,2}\gamma^\gamma (1-\gamma)^{1-\gamma}}\right] \\ &= (1-\alpha-\beta)\left[W_2 + I_2^* - \psi D^*\right]\frac{\mu_2 - 1}{\mu_2}, \end{aligned}$$

where period-2 income of country F is $I_2^* = W_2\xi \int_0^1 \log y(i)di + W_2 A_2^* L^*$.Capital market clears in period 1:

$$K_0 = \left[\frac{\gamma(1-\alpha-\beta)}{\mu_1} + \alpha\right]\left[\frac{W_1 + D^* + W_1^* L^*}{R_1} + \frac{R_2}{R_1\widetilde{R}}\right] \tag{31}$$

Capital market clears in period 2:thus

$$K_2 = (1-\delta)K_0 + \log\frac{R_2}{p_1(i)\widetilde{R}} = \frac{\left[\frac{(1-\alpha-\beta)\gamma}{\mu_2} + \alpha\right][W_2 + I_2^* - \psi D^*]}{R_2}. \tag{32}$$

Now consider a representative household in country F. The budget constraint is

$$\begin{aligned}\int_0^1 p_1(i)c_1^*(i)di + \int_0^1 p_1(i)y(i)di &\leq D^* + W_1^* L^* \\ \int_0^1 p_2(i)c_2^*(i)di + \psi D^* &\leq I_2^* = W_2\xi\int_0^1 \log y(i)di + W_2 A_2^* L^*\end{aligned}$$

They imply $c_1^*(i) + y(i) = \frac{D^* + W_1^* L^*}{p_1(i)}$. The intertemporal budget constraint is

$$\int_0^1 p_2(i)c_2^*(i)di + \psi\left[\int_0^1 p_1(i)c_1^*(i)di + \int_0^1 p_1(i)y(i)di - W_1^* L^*\right] = W_2\xi\int_0^1 \log y(i)di + W_2 A_2^* L^* \tag{33}$$

In the equilibrium, we have

$$\begin{aligned}\frac{W_2\xi}{\psi p_1(i)} &= y(i) \\ \frac{\left[\int_0^1 \log c_1^*(i)di\right]^{-\sigma}}{\left[\int_0^1 \log c_2^*(i)di\right]^{-\sigma}} &= \eta\psi\frac{p_1(i)c_1^*(i)}{p_2(i)c_2^*(i)}\end{aligned}$$

No arbitrage condition implies $\psi = \widetilde{R} = \widetilde{R}^*$, therefore

$$D^* = \frac{W_2\xi\log y(i) + W_2 A_2^* L^* - W_1^* L^* + p_1(i)y(i)}{1+\psi}.$$

and

$$c_2^*(i) = \left[\frac{p_2(i)}{p_1(i)}\right]^{\frac{1}{(\eta\psi)^{-\frac{1}{\sigma}}-1}}; c_1^*(i) = \left[\frac{p_2(i)}{p_1(i)}\right]^{\frac{(\eta\psi)^{-\frac{1}{\sigma}}}{(\eta\psi)^{-\frac{1}{\sigma}}-1}}.$$

We can calculate the labor income share in country H in the first period $\theta_{L,1}^{dob} = \frac{L}{L+\frac{R_1}{W_1}K_0\left[1+\frac{(1-\alpha-\beta)}{\frac{\gamma(1-\alpha-\beta)}{\mu_1}+\alpha}\frac{\mu_1-1}{\mu_1}\right]}$.

For the second period,

$$\theta_{L,2}^{dob} = \frac{L}{L+\left[\alpha+(1-\alpha-\beta)\frac{\mu_2-1+\gamma}{\mu_2}\right]\left[1+\frac{p_2(i)}{W_2}\left[\frac{p_2(i)}{p_1(i)}\right]^{\frac{1}{(\eta\psi)^{-\frac{1}{\sigma}}-1}}\right]}.$$

4.6 A summary of the model

The model developed in Section 7 can simultaneously generate the following macroeconomic phenomena observed in China recently: [1] the high profitability of the SOEs, [2] low labor income share in total GDP, [3] China's high dependence on investment and export , as well as [4] the external imbalance in the sense that China has run large trade surplus with its trade partner. The model highlights three key features that we think are fundamentally important to result in such macroeconomic performance.

The first feature, which we highlight most, is the vertical structure in the sense that China's state-owned enterprises have firmly monopolized the upstream industries , which provide intermediate goods and services (often non-tradeables) to the downstream industries, which are essentially privatized and allow for domestic and foreign competition. This makes the relationship between state-owned and non-state-owned firms become complementary instead of directly competing with each other. The economic expansion in the downstream industries due to the capitalism (market-oriented liberalization and privatization) directly increases the demand for the upstream inputs and services hence the monopoly rent of the SOEs.

The second important feature is the openness, which enables the separation between domestic production and domestic demand. A comparison between static autarky (Section 2) and static trade (Section 4) makes it clear that the trade openness increases the total demand for the downstream industrial output and therefore indirectly leads to a higher profit of the upstream SOEs. At the same time, the domestic private consumption can still maintain a relatively low level. On the other hand, a comparison between dynamic Autarky (Section 4) and Dynamic Trade with Borrowing (Section 7) makes it clear that financial globalization (with international borrowing allowed) is a necessary condition to generate the external imbalance (large trade surplus of China). Another two

necessary conditions that help drive the external imbalance is China's comparative advantage in the manufacturing sector due to the cheap labor and the high return rate to the oversea investment *relative* to the domestic investment. This can be partly justified by the low efficiency in China's financial institutions rather than the high oversea return rate in the absolute level. Another factor that helps amplify this external imbalance is the relatively low private consumption demand for the domestically produced manufacturing goods because of the relatively low income level and high price due to the upstream monopoly pricing.

The third important feature is the dual economy with a large labor supply in the non-industrial sectors, which manages to keep the wage low and hence the final goods internationally competitive despite of the large demand for labor in the industrialization. Consequently, the labor income share in GDP is relatively low as the capital income and profits both go up due to the expansion and prosperity of the downstream industries and upstream SOE monopolies. If the labor pool is small, then the expansion of the downstream industries will immediately increase the wage and squeeze the magnitude of the price markup charged by the upstream SOE monopolists in order to make the final goods competitive in the international market. That would lead to the labor income share relatively because the SOE profit shrinks and the labor income goes up.

In addition, a comparison between the static autarky and dynamic autarky makes it clear that future investment in the capital goods will depress the labor income share even further because of the increased demand for capital and the induced increase in the SOE profits, the latter of which is also what we want to explain. In short, with the existence of the three key modelling features, domestic investment, international trade, and foreign investment are all mutually reenforcing the four macro economic consequences listed previously, among which we want to highlight [1] and [2] most.

5 Further Discussions

In this section, we make several simple extensions to the main model and illustrate why this framework is useful in helping us understand a wide array of macroeconomic phenomena in reality.

5.1 Why SOE Profits First Decline At the Early Stage of Reform and Openness

The models characterized earlier are designed to capture what happened after the year 2000, when the privatization and reform in the downstream industries were almost completed. So the fraction of SOEs in the downstream industries ϕ is set to zero. However, at the early stage of reform and openness (during the 1980s and 1990s), the average profitability of SOEs relative to that of non state-owned enterprises actually declined. This is mainly because all the firms were state-owned at the beginning of the reform in the late 1970s ($\phi = 1$). So when more and more private firms, domestic or foreign, were allowed to compete with the SOEs in the downstream industries, those SOEs were naturally outperformed and hence lost money, which required even more subsidies from the government or the other state-owned enterprises to maintain the operation. This drove down the *average* profitability of the SOEs even though some of the upstream SOEs were still making positive monopoly profits. The formalization of this idea is provided in the Appendix.

Note that economic openness enhanced the market competition in the downstream tradable sectors and thus precipitated the exit or privatization of the SOEs from the downstream industries. Therefore during this period, SOEs were on average performing poorly although the country as a whole grew rapidly, partly due to the better capital allocation from the low-productivity SOEs to the high-productivity private firms, as formalized in Song *et al* (2011). In other words, trade openness helped the upstream SOEs (especially in the non -radeable sectors) but harmed the downstream SOEs (mainly tradeable sectors).

5.2 Role of Government

To highlight the key mechanisms in the simplest way, our benchmark models have abstracted away many other important roles played by the government such as providing export-promoted subsidies to the downstream firms, collecting tax revenues, and making public investment. In the reality many SOEs in the upstream industries have indeed earned huge profits for the reasons our models have illustrated, including China's telecommunication tycoons (China Mobile), China's Oversea Transportation Company, Post Office, State-owned Construction Companies, *etc.* Nevertheless, we also observe that some other upstream SOEs such as the State-Owned Banks actually subsidize the downstream firms instead of charging a markup. This opposite phenomenon, however, can be easily explained within our framework by simply introducing the tax and subsidy instruments into

our benchmark model. The logic is that government subsidies to the downstream private firms in the tradable sectors help increase the export and the expansion of the whole "capitalist" private sectors in the downstream, which in turn contribute more tax revenues to the government and also absorbed more labor from the numeraire good (rural) sector to the industrial sector (downstream industries). The increase in tax revenues and total GDP strongly dominate the subsidy cost, which can explain why the "government" is so rich in China and at the same time the private sectors remain dynamic and internationally competitive. Again, vertical structure, openness, and large labor supply are still the key. Without trade openness (and privatization reform), it would be hard to explain why the SOEs were now doing much better than before the economic reform , although SOEs also monopolized the upstream industries and there was even a larger pool of cheap labor. Without abundant labor, the downstream industries could not maintain the cost competitiveness in the tradable sectors for such a long time while tolerating the large markup price charged by the upstream monopolist SOEs, the whole economy would not be that dynamic and prosperous, the upstream SOEs could not make so much profit, and the government would be unable to collect so much tax revenue. Without the vertical structure or the trade openness, the SOEs and private firms would be competing in a zero-sum game, unable to explain why both the private sectors and many SOEs become unprecedentedly successful and profitable in China.

5.3 Sustainability of Such Growth Mechanism

Should we expect that the macroeconomic consequences of the state capitalism characterized in this models can sustain forever? The answer is unambiguously negative according to the logic of our models. This is because, as the downstream sectors keep expanding, the labor force in the numeraire sector will eventually be absorbed out by the industrialized sectors, after which the wage will increaseed and it will squeeze the price markup charged by the upstream SOEs in order to make the final goods internationally competitive. It implies that the upstream SOEs are unlikely to increase their profits forever unless they can improve their productivity sufficiently fast or be privatized, otherwise the external demand (export) has to fall as the price advantage gradually erodes away. The trade imbalance also triggers the policy responses of China's trade partner to reduce their imports. Consequently, the export share in total GDP will decline, therefore China will have to rely more on the domestic private consumption to maintain fast growth, for which the endogenous internal imbalance (the low labor income share in total GDP) may backfire and

become a major obstacle via the unequal purchasing power distribution.

6 Conclusion

In this paper, we document a vertical structure featured in China's state capitalism, namely, SOEs monopolize key industries and markets in the upstream, whereas downstream industries are largely left to intense competition among private enterprises. We construct mathematical models to show that this unique vertical structure, when combined with openness and labor abundance, is critical in explaining two puzzling facts in the last decade: (1) the unprecedentedly high profitability of SOEs and (2) the persistently low and declining labor income share in China's total GDP. Our framework also helps explain China's high dependence on investment and export.

We highlight how the vertical structure leads to the upstream SOEs flourishing disproportionally more than the downstream private firms in the globalization process by taking advantage of the abundant domestic labor forces, exacerbating China's internal imbalances.We also explain why this theoretical framework may be useful in sharpening our understanding on the potential vulnerability of this mode of economic development. In a globalization age like today, we believe that a deep understanding of this type of state capitalism (vertical structure) is of fundamental importance to China and the world economy at large.

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Mathematical Appendix

6.1 When SOEs Also Exist in Downstream Industries ($\phi > 0$)

The aggregate demand for good 0 is

$$\begin{aligned} D_0 &= \frac{[WL + RK] + \Pi_m + \phi\pi_s + (1-\phi)\pi_p}{W} - 1 \\ &= \frac{[WL + RK] + (1-\alpha-\beta)\, W\left[1 - \frac{R^\gamma W^{1-\gamma}}{\widehat{p}_m A_m \gamma^\gamma (1-\gamma)^{1-\gamma}}\right] + \phi\pi_s}{W} - 1 \end{aligned}$$

With the government policy support for the state-owned firms that produce the differentiated final goods,

$$\pi_s = 0$$

and

$$\theta I_e = \theta\left[WL + RK\right] + \Pi_m - \phi\tau \frac{W}{\widehat{p}} \frac{\left[(1-\tau)\, R\right]^{\alpha-1} W^\beta {p_m}^{1-\alpha-\beta}}{A_s \alpha^{\alpha-1} \beta^\beta \left(1-\alpha-\beta\right)^{1-\alpha-\beta}}$$

so

$$D_0 = \frac{[WL + RK] + (1-\alpha-\beta)\, W\left[1 - \frac{R^\gamma W^{1-\gamma}}{\widehat{p}_m A_m \gamma^\gamma (1-\gamma)^{1-\gamma}}\right] - \frac{\alpha\phi\tau}{(1-\tau)R} W}{W} - 1,$$

and L is sufficiently large such that $D_0 > 0$.

For any variety j produced by a single state-owned firm (called firm j), the firm will take all the other prices as given and maximize its profit by choosing price $p(j)$, and $p(j) \leq \widehat{p}$, where $\widehat{p}$ is an exogenous upper bound. This upper bound may be either due to the political considerations (for example, in China the ticket price for the state-owned railways is subject to an upper bound, or consider an open economy with $\widehat{p}$ interpreted as the after-tariff import price of the same variety).

$$\begin{aligned} \pi_s &= \max_{p(j) \leq \widehat{p}} D(j) \left[p(j) - \frac{R^\alpha W^\beta {p_m}^{1-\alpha-\beta}}{A_s \alpha^\alpha \beta^\beta \left(1-\alpha-\beta\right)^{1-\alpha-\beta}}\right] \\ &= \max_{p(j) \leq \widehat{p}} \frac{W}{p(j)} \left[p(j) - \frac{R^\alpha W^\beta {p_m}^{1-\alpha-\beta}}{A_s \alpha^\alpha \beta^\beta \left(1-\alpha-\beta\right)^{1-\alpha-\beta}}\right]. \end{aligned}$$

Thus, conditional on that the firm operates, the optimal price is

$$p(j) = \widehat{p},$$

for any j that is produced by the state-owned enterprises and $j \in [0,1]$. In particular,

$$\pi_s = W\left[1 - \frac{R^{\alpha}W^{\beta}{p_m}^{1-\alpha-\beta}}{\widehat{p}A_s\alpha^{\alpha}\beta^{\beta}\left(1-\alpha-\beta\right)^{1-\alpha-\beta}}\right] < 0,$$

when

$$\widehat{p} < \frac{R^{\alpha}W^{\beta}{p_m}^{1-\alpha-\beta}}{A_s\alpha^{\alpha}\beta^{\beta}\left(1-\alpha-\beta\right)^{1-\alpha-\beta}}.$$

The state-owned firm still operates even when the profit is negative because the government wants those products to be produced by the state-owned enterprises.

By Shephard Lemma, to produce one unit of good i, it requires $\frac{\partial p(i)}{\partial W}$ units of labor, $\frac{\partial p(i)}{\partial R}$ units of capital, and $\frac{\partial p(i)}{\partial p_m}$ units of intermediate good. Therefore the aggregate demand for intermediate good m is

$$\int_0^1 D(i)\frac{\partial p(i)}{\partial p_m}di = \frac{\left(1-\phi\right)\left(1-\alpha-\beta\right)W}{p_m} + \phi\frac{W}{\widehat{p}}\frac{R^{\alpha}W^{\beta}{p_m}^{-\alpha-\beta}}{A_s\alpha^{\alpha}\beta^{\beta}\left(1-\alpha-\beta\right)^{-\alpha-\beta}}$$

The monopolist of the intermediate good m tries to maximize its profit but it also faces an upper bound of the price for the intermediate good, denoted by $\widehat{p}_m$. In other words, it solves the following problem

$$\begin{aligned}\Pi_m &= \max_{p_m \le \widehat{p}_m} \int_0^1 D(i)\frac{\partial p(i)}{\partial p_m}di\left[p_m - \frac{R^{\gamma}W^{1-\gamma}}{A_m\gamma^{\gamma}\left(1-\gamma\right)^{1-\gamma}}\right] \\ &= \max_{p_m \le \widehat{p}_m}\left[\frac{\left(1-\phi\right)\left(1-\alpha-\beta\right)W}{p_m} + \phi\frac{W}{\widehat{p}}\frac{R^{\alpha}W^{\beta}{p_m}^{-\alpha-\beta}}{A_s\alpha^{\alpha}\beta^{\beta}\left(1-\alpha-\beta\right)^{-\alpha-\beta}}\right]\left[p_m - \frac{R^{\gamma}W^{1-\gamma}}{A_m\gamma^{\gamma}\left(1-\gamma\right)^{1-\gamma}}\right]\end{aligned}$$

Since the goal function is a strictly increasing function of p_m, the equilibrium price $p_m = \widehat{p}_m$ and

$$\Pi_m = \left[\frac{\left(1-\phi\right)\left(1-\alpha-\beta\right)W}{\widehat{p}_m} + \phi\frac{W}{\widehat{p}}\frac{R^{\alpha}W^{\beta}{\widehat{p}_m}^{-\alpha-\beta}}{A_s\alpha^{\alpha}\beta^{\beta}\left(1-\alpha-\beta\right)^{-\alpha-\beta}}\right]\left[\widehat{p}_m - \frac{R^{\gamma}W^{1-\gamma}}{A_m\gamma^{\gamma}\left(1-\gamma\right)^{1-\gamma}}\right].$$

The capital market clearing condition implies

$$\begin{aligned}K &= \underbrace{\left[\frac{\left(1-\phi\right)\left(1-\alpha-\beta\right)W}{\widehat{p}_m} + \phi\frac{W}{\widehat{p}}\frac{R^{\alpha}W^{\beta}{\widehat{p}_m}^{-\alpha-\beta}}{A_s\alpha^{\alpha}\beta^{\beta}\left(1-\alpha-\beta\right)^{-\alpha-\beta}}\right]\frac{R^{\gamma-1}W^{1-\gamma}}{A_m\gamma^{\gamma-1}\left(1-\gamma\right)^{1-\gamma}}}_{\text{by producer of intermediate good } m} \\ &+ \underbrace{\phi\frac{W}{\widehat{p}}\frac{R^{\alpha-1}W^{\beta}{\widehat{p}_m}^{1-\alpha-\beta}}{A_s\alpha^{\alpha-1}\beta^{\beta}\left(1-\alpha-\beta\right)^{1-\alpha-\beta}}}_{\text{by state-owned producers of differentiated goods}} \\ &+ \underbrace{\left(1-\phi\right)\frac{\alpha W}{R}}_{\text{by private producers}}\end{aligned}$$

Assume $\gamma < 1-\alpha$. So the right hand side of the above equation is a strictly decreasing function of R, hence it can be uniquely determined

$$R = R(K, W, \widehat{p}_m, \widehat{p}, \phi, A_m, A_s).$$

It can be shown that

$$\frac{\partial R}{\partial K} < 0; \frac{\partial R}{\partial W} > 0; \frac{\partial R}{\partial \widehat{p}} < 0; \frac{\partial R}{\partial \phi} > 0; \frac{\partial R}{\partial A_m} < 0; \frac{\partial R}{\partial A_s} < 0.$$

In addition,

$$\frac{\partial R}{\partial \widehat{p}_m} \begin{cases} > 0, & \text{when} \quad \widehat{p}_m > \widehat{p}_m^{**} \\ = 0, & \text{when} \quad \widehat{p}_m = \widehat{p}_m^{**} \\ < 0, & \text{when} \quad \widehat{p}_m < \widehat{p}_m^{**} \end{cases},$$

where $\widehat{p}_m^{**}$ is the uniquely determined by the following equation

$$\phi \frac{W}{\widehat{p}} \frac{R^{\alpha} W^{\beta} \widehat{p}_m^{**1-\alpha-\beta}}{A_s \alpha^{\alpha} \beta^{\beta} (1-\alpha-\beta)^{-\alpha-\beta}} = \frac{(1-\phi)(1-\alpha-\beta) W \frac{\gamma R^{\gamma} W^{1-\gamma}}{\widehat{p}_m^{**} A_m \gamma^{\gamma} (1-\gamma)^{1-\gamma}}}{\alpha - (\alpha+\beta) \frac{\gamma R^{\gamma} W^{1-\gamma}}{\widehat{p}_m^{**} A_m \gamma^{\gamma} (1-\gamma)^{1-\gamma}}}.$$

Observe that $\widehat{p}_m^{**} > \frac{(\alpha+\beta)\gamma R^{\gamma} W^{1-\gamma}}{\alpha A_m \gamma^{\gamma} (1-\gamma)^{1-\gamma}}$.

The aggregate demand for good 0 is

$$\begin{aligned} D_0 &= \frac{[WL + RK] + \Pi_m + \phi \pi_s + (1-\phi)\pi_p}{W} - 1 \\ &= L - \left[(1-\phi) + \phi \frac{1}{\widehat{p}} \frac{R^{\alpha} W^{\beta} \widehat{p}_m{}^{1-\alpha-\beta}}{A_s \alpha^{\alpha} \beta^{\beta} (1-\alpha-\beta)^{1-\alpha-\beta}} \right] \left[\frac{(1-\alpha-\beta) R^{\gamma} W^{1-\gamma}}{\widehat{p}_m A_m \gamma^{\gamma} (1-\gamma)^{-\gamma}} + \beta \right] \end{aligned}$$

Assume L is sufficiently large such that $D_0 > 0$.

To fully compensate the loss of those state-owned firms, the government provides capital subsidies τ such that

$$\widehat{p} = \frac{[(1-\tau) R]^{\alpha} W^{\beta} p_m{}^{1-\alpha-\beta}}{A_s \alpha^{\alpha} \beta^{\beta} (1-\alpha-\beta)^{1-\alpha-\beta}}. \tag{34}$$

Thus $\pi_s = 0$ when receiving the policy support. By the Shephard Lemma, the total subsidy provided by the government to each of such state-owned firm is

$$T(j) = \tau \frac{W}{\widehat{p}} \frac{[(1-\tau) R]^{\alpha-1} W^{\beta} p_m{}^{1-\alpha-\beta}}{A_s \alpha^{\alpha-1} \beta^{\beta} (1-\alpha-\beta)^{1-\alpha-\beta}}.$$

By Shephard Lemma, to produce one unit of good i, it requires $\frac{\partial p(i)}{\partial W}$ units of labor, $\frac{\partial p(i)}{\partial R}$ units of capital, and $\frac{\partial p(i)}{\partial p_m}$ units of intermediate good. Therefore the aggregate demand for intermediate good m is

$$\begin{aligned}\int_0^1 D(i)\frac{\partial p(i)}{\partial p_m}di &= \frac{(1-\phi)(1-\alpha-\beta)W}{p_m} + \phi\frac{W}{\widehat{p}}\frac{[(1-\tau)R]^{\alpha}W^{\beta}{p_m}^{-\alpha-\beta}}{A_s\alpha^{\alpha}\beta^{\beta}(1-\alpha-\beta)^{-\alpha-\beta}} \\ &= \frac{(1-\phi)(1-\alpha-\beta)W}{p_m} + \phi\frac{(1-\alpha-\beta)W}{p_m} \\ &= \frac{(1-\alpha-\beta)W}{p_m}.\end{aligned}$$

The monopolist of the intermediate good m tries to maximize its profit but it also faces an upper bound of the price for the intermediate good, denoted by $\widehat{p}_m$. In other words, it solves the following problem

$$\Pi_m = \max_{p_m \leq \widehat{p}_m} \frac{(1-\alpha-\beta)W}{p_m}\left[p_m - \frac{R^{\gamma}W^{1-\gamma}}{A_m\gamma^{\gamma}(1-\gamma)^{1-\gamma}}\right],$$

which implies that the equilibrium price $p_m = \widehat{p}_m$ and

$$\Pi_m = (1-\alpha-\beta)W\left[1 - \frac{R^{\gamma}W^{1-\gamma}}{\widehat{p}_m A_m\gamma^{\gamma}(1-\gamma)^{1-\gamma}}\right].$$

The capital market clearing condition is given by

$$\begin{aligned}K &= \underbrace{\frac{(1-\alpha-\beta)W}{\widehat{p}_m}\frac{R^{\gamma-1}W^{1-\gamma}}{A_m\gamma^{\gamma-1}(1-\gamma)^{1-\gamma}}}_{\text{by producer of intermediate good } m} + \underbrace{\phi\frac{\alpha W}{(1-\tau)R}}_{\text{by state-owned producers of differentiated goods}} \\ &\quad + \underbrace{(1-\phi)\frac{\alpha W}{R}}_{\text{by private producers}}\end{aligned}$$

(34) implies

$$\widehat{p} = \frac{[(1-\tau)R]^{\alpha}W^{\beta}{\widehat{p}_m}^{1-\alpha-\beta}}{A_s\alpha^{\alpha}\beta^{\beta}(1-\alpha-\beta)^{1-\alpha-\beta}},$$

which implies

$$\left[\frac{A_s\alpha^{\alpha}\beta^{\beta}(1-\alpha-\beta)^{1-\alpha-\beta}\widehat{p}}{W^{\beta}{\widehat{p}_m}^{1-\alpha-\beta}}\right]^{\frac{1}{\alpha}} = (1-\tau)R$$

$$K = \underbrace{\frac{(1-\alpha-\beta)W}{\widehat{p}_m}\frac{R^{\gamma-1}W^{1-\gamma}}{A_m\gamma^{\gamma-1}(1-\gamma)^{1-\gamma}}}_{\text{by producer of intermediate good } m} + \underbrace{\phi\frac{\alpha\left(\frac{W}{\widehat{p}_m}\right)^{\frac{\alpha+\beta}{\alpha}}}{\left[A_s\alpha^{\alpha}\beta^{\beta}(1-\alpha-\beta)^{1-\alpha-\beta}\frac{\widehat{p}}{\widehat{p}_m}\right]^{\frac{1}{\alpha}}}}_{\text{by state-owned producers of differentiated goods}}$$

$$+ \underbrace{(1-\phi)\frac{\alpha W}{R}}_{\text{by private producers}}$$

The above equation can uniquely determine $\frac{W}{R}$ as a function of K, $\frac{W}{\widehat{p}_m}$, $\frac{\widehat{p}}{\widehat{p}_m}$,$A_m$, A_s, and ϕ.

The government revenue is

$$\Pi_m - \phi\tau\frac{W}{\widehat{p}}\frac{[(1-\tau)R]^{\alpha-1}W^{\beta}{p_m}^{1-\alpha-\beta}}{A_s\alpha^{\alpha-1}\beta^{\beta}(1-\alpha-\beta)^{1-\alpha-\beta}}.$$

Figures and Tables in the Main Text

Figure 1: Total Profit to Sales Revenues of Chinese Industrial Enterprises: 1993-2010

Note for Figure 1: We use information from CEIC Table CN.BF: Industrial Financial Data: By Enterprise Type to obtain Total profit to Sales Revenue. In this table, CEIC categorizes enterprise into: State Owned & Holding, Private, HMT & Foreign, Collective Owned, Share Holding Corp, Foreign Funded, and HK, Macau & Taiwan Funded. In this graph we show only two types State owned/holding and Private. Current Account balance and GDP are also from CEIC.

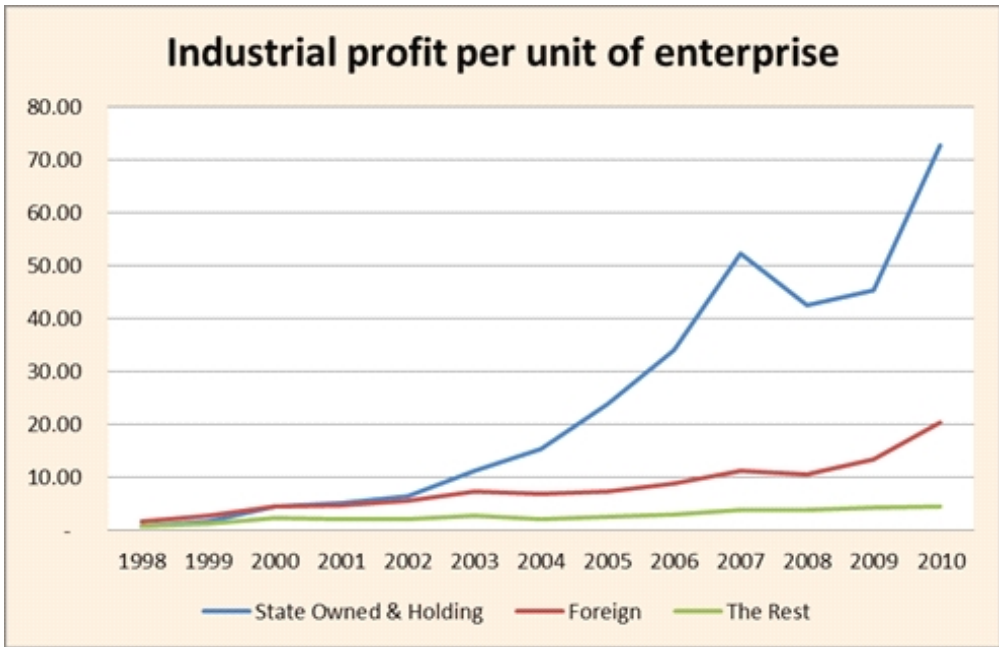


Figure 2a: Average Profit per Industrial Enterprise (by Different Ownership Structure): 1998-2010

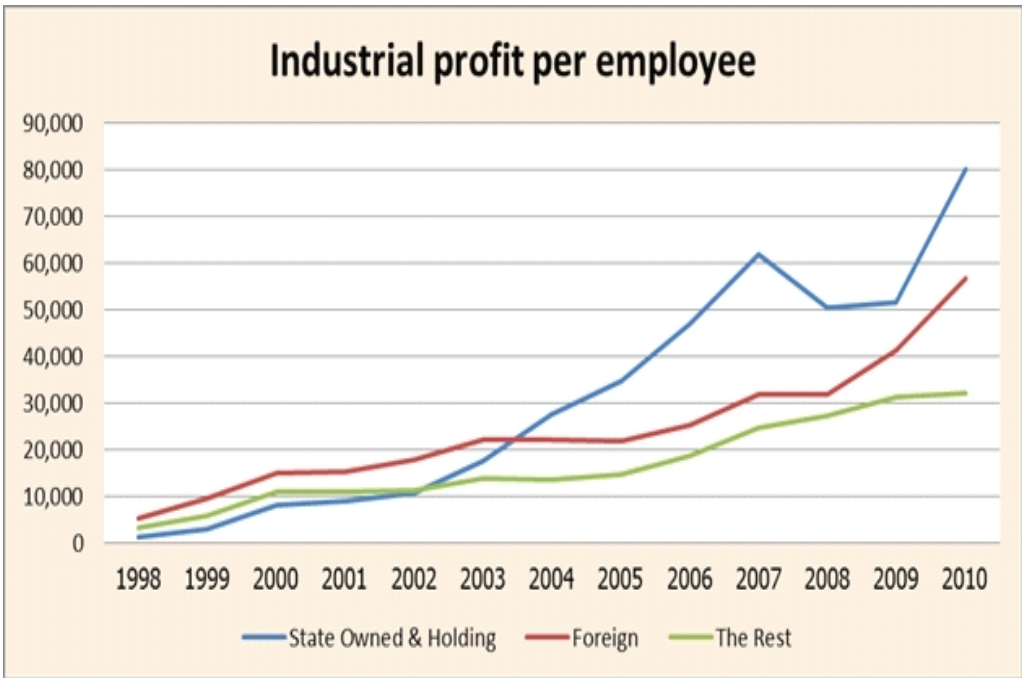


Figure 2b: Average Profit per Employee for Industrial Enterprise (by Different Ownership Structure): 1998-2010

Note for Figures 2a and 2b: Data Source: The CEIC.

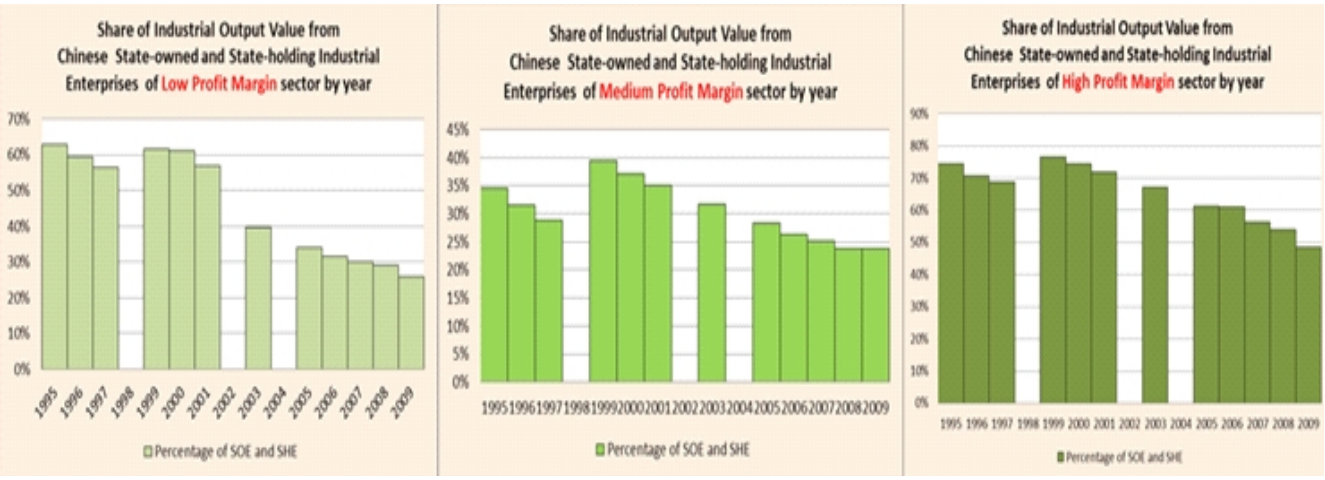


Figure 3: Share of Industrial Output Value from State Related Enterprises.

Note for Figure 3: The criteria to breakdown the share of State owned and state-holding enterprise's Gross industrial output value (GIOV) is a measure of profit margin, Ratio of Profit to Industrial Cost (%) from 1998-2010. Profits and costs data comes from CEIC (Table CN.OE03 and 04). Low profit margin sectors are those with less than or equal to 5% profit margin, which include sectors such as textiles and agriculture. The median profit sectors are those with profit margin of 5 % - 10%, which include sectors such as mining and food. The high-profit sectors are those with greater than 10% profit margin, which include sectors such as petrochemical, tobacco, and pharmaceuticals. The vertical axis is "Gross Industrial Output Value of State-owned and State-holding Industrial Enterprises (SOHE) in proportion of the total Gross Industrial Output Value (GIOV). GIOV of all enterprises in industrial sector is obtained from CEIC, Table CN.BD03: Gross Industrial Output: By Industry. GIOV of state enterprise is obtained directly from NBS Yearbook because CEIC does not have this data. Also, GIOV of state enterprises data is missing from NBS yearbook for year 1998, 2002, and 2004. Note also that in the table "Main Indicators by Industrial Sector of State portion", NBS has changed the title of the table back and forth. So the definition of State sector may not be perfectly consistent over time. In 1995-1997, NBS uses "State-owned industrial enterprises"; in 1999-2003, NBS uses "State-owned and State Holding Industrial enterprises"; in 2004: NBS uses "State-owned and State-controlled Industrial Enterprises"; and in 2005-2009, NBS uses "State-owned and State Holding Industrial enterprises".

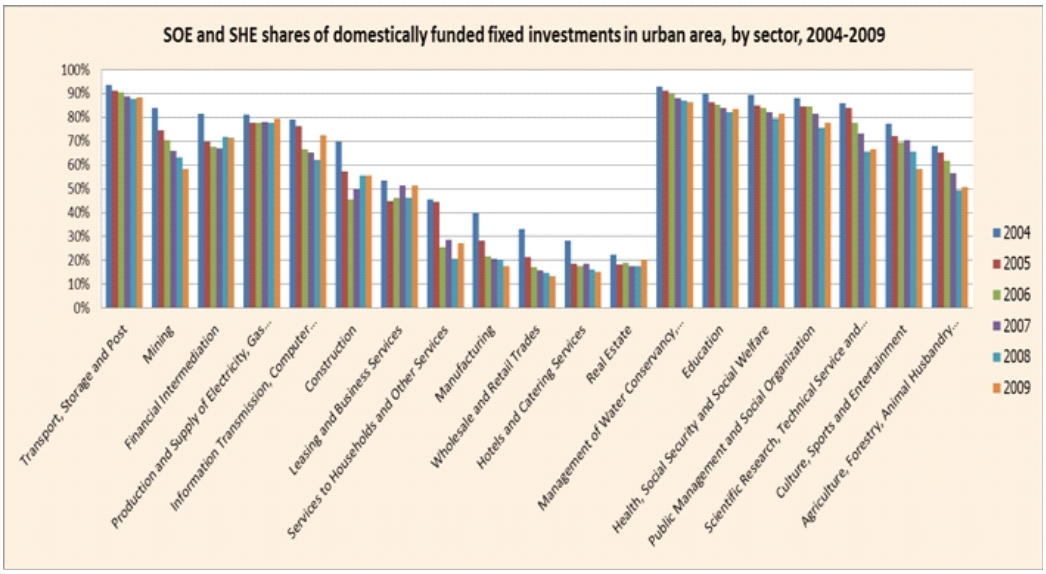
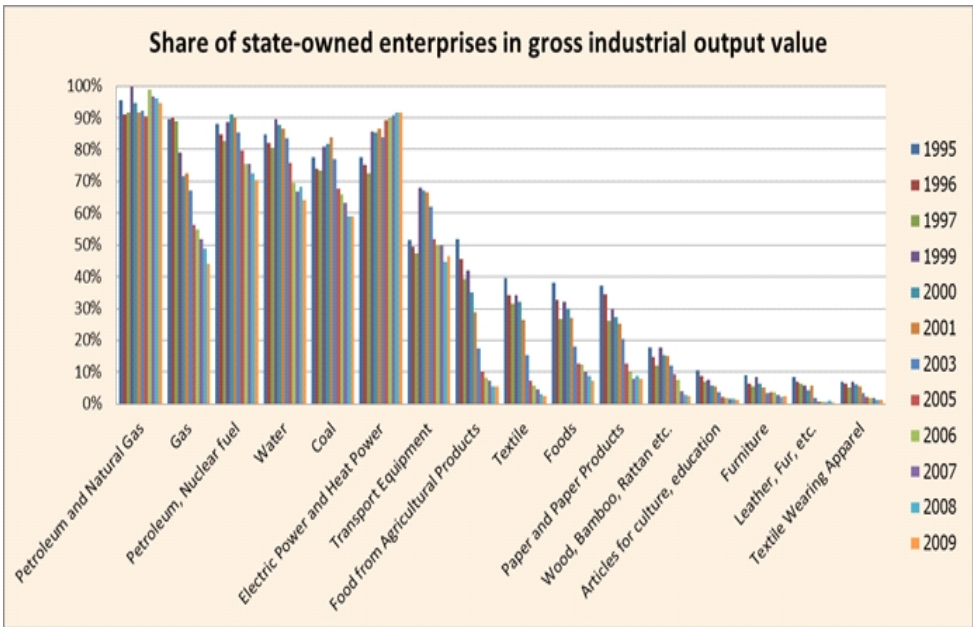


Figure 5: Investments in Fixed Assets in Urban Area by Sector.

Notes for Figure 5: The data are from the following tables of National Bureau of Statistics of China: Investment in Urban Area by Sector, Source of Funds, Jurisdiction of Management and Registration Status. Note NBS has changed the column title of state related ownership over time. In Table 6-14 of 2004, NBS uses "State-owned and State-controlled"; in Table 6-14 of 2005, NBS uses "State-owned and State-holding"; in Table 6-14 of 2006, NBS uses "State-holding"; and in Table 5-14 of 2007-2009, NBS uses "State-holding". Before Year 2004, data for the state sector is not available.



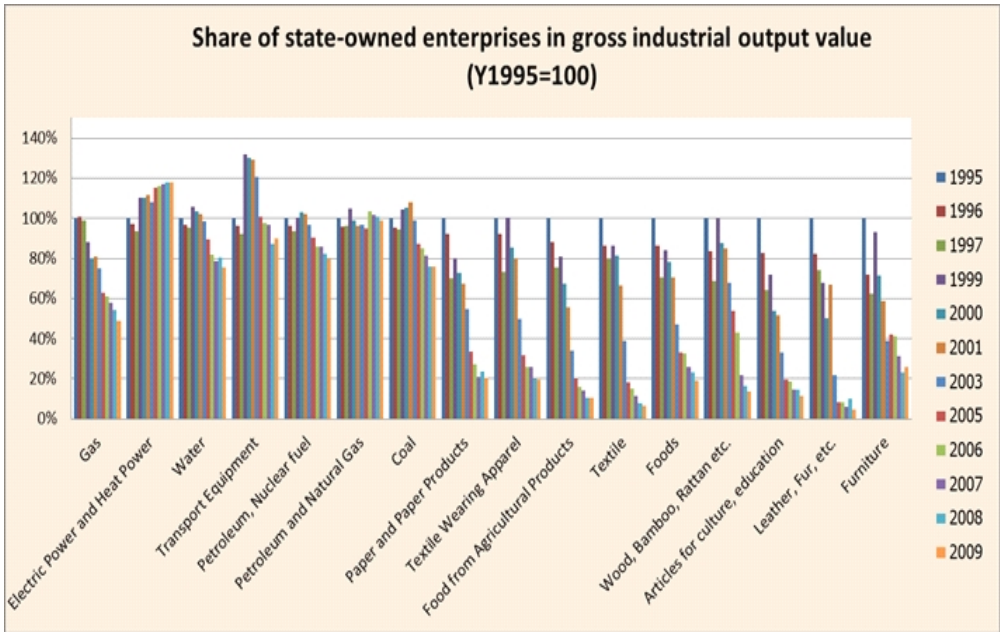


Figure 6: Share of State-owned enterprises in Gross Industrial Output Value.

Note for Figure 6: The data are from National Bureau of Statistics of China, Table 14-2, and Table 14-6. Note NBS has changed the title of state related enterprises over time. In 1995-1997, NBS uses "State-owned Industrial Enterprises"; in 1998, data is missing; in 1999-2003, NBS uses "State-owned and State-holding"; in 2002, data is missing; in 2004, NBS uses "State-owned and State controlled"; in 2005-2009, NBS uses "State-owned and State-holding".

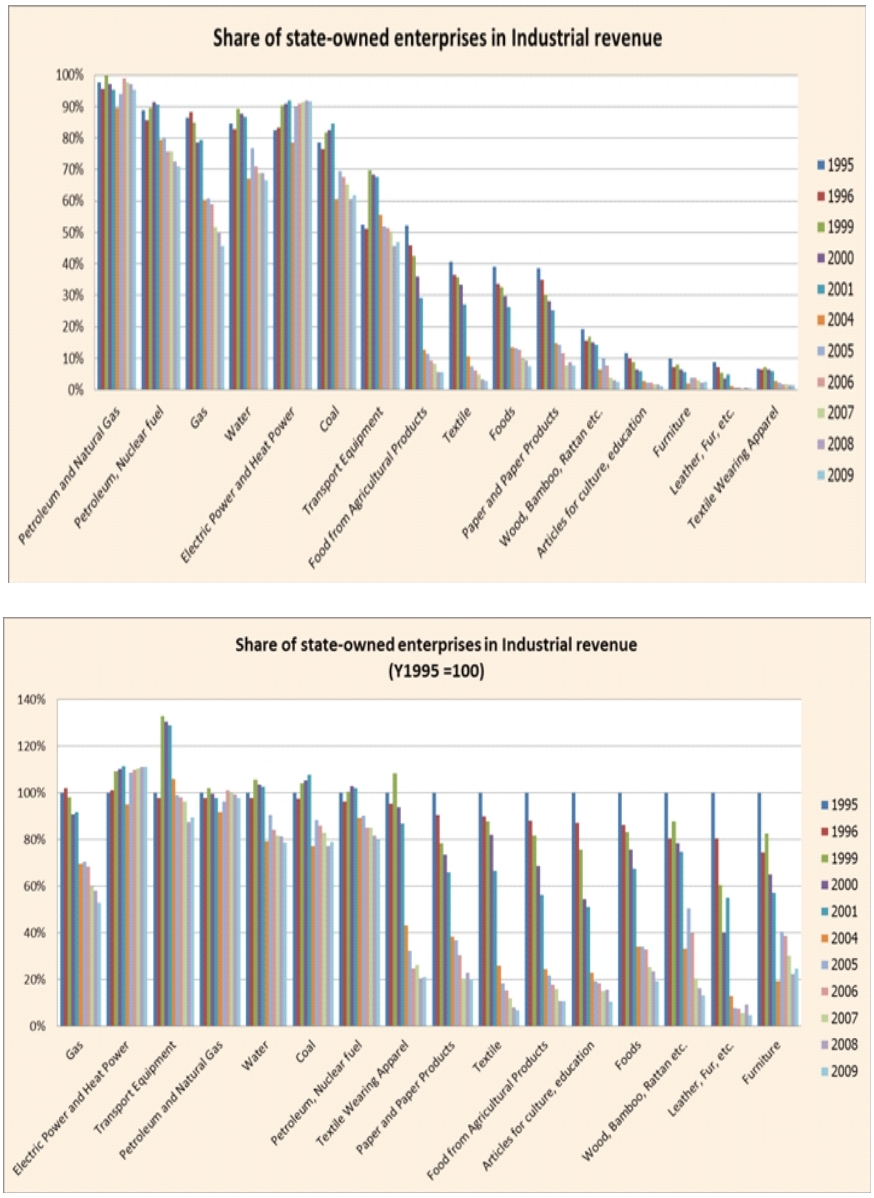
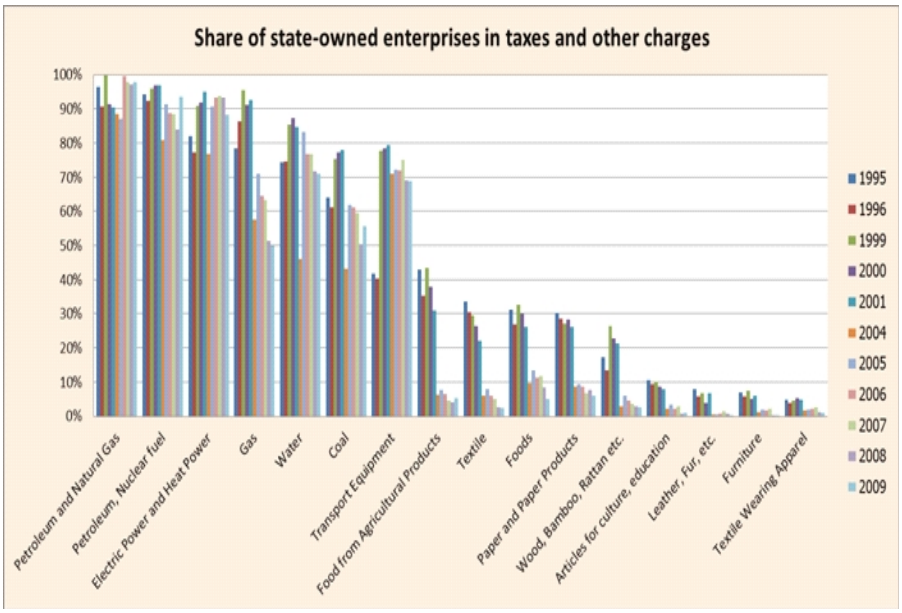


Figure 7: Share of State-Owned Enterprises in Industrial Revenue.

Notes for Figure 7: The data are from National Bureau of Statistics of China, Table 14-2, and Table 14-6. Note NBS has changed the title of state related enterprises over time. In 1995-1997, NBS uses "State-owned Industrial Enterprises"; in 1998, data is missing; in 1999-2003, NBS uses "State-owned and State-holding"; in 2002, data is missing; in 2004, NBS uses "State-owned and State controlled"; in 2005-2009, NBS uses "State-owned and State-holding".



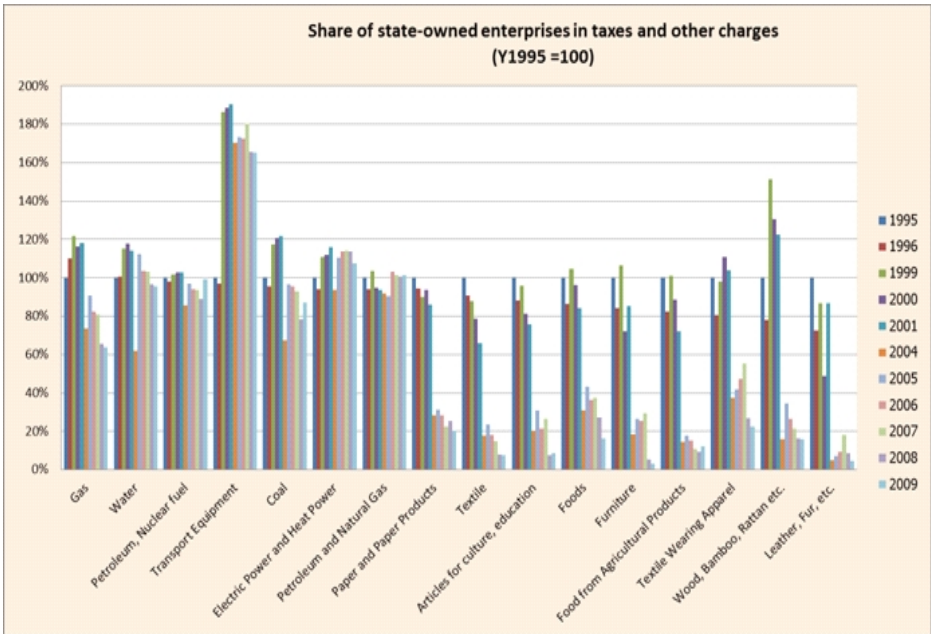


Figure 8: Share of State-Owned Enterprises in Industrial Taxes and other Charges.

Notes for Figure 8: The data are from National Bureau of Statistics of China, Table 14-2, and Table 14-6. Note NBS has changed the title of state related enterprises over time. In 1995-1997, NBS uses "State-owned Industrial Enterprises"; in 1998, data is missing; in 1999-2003, NBS uses "State-owned and State-holding"; in 2002, data is missing; in 2004, NBS uses "State-owned and State controlled"; in 2005-2009, NBS uses "State-owned and State-holding".

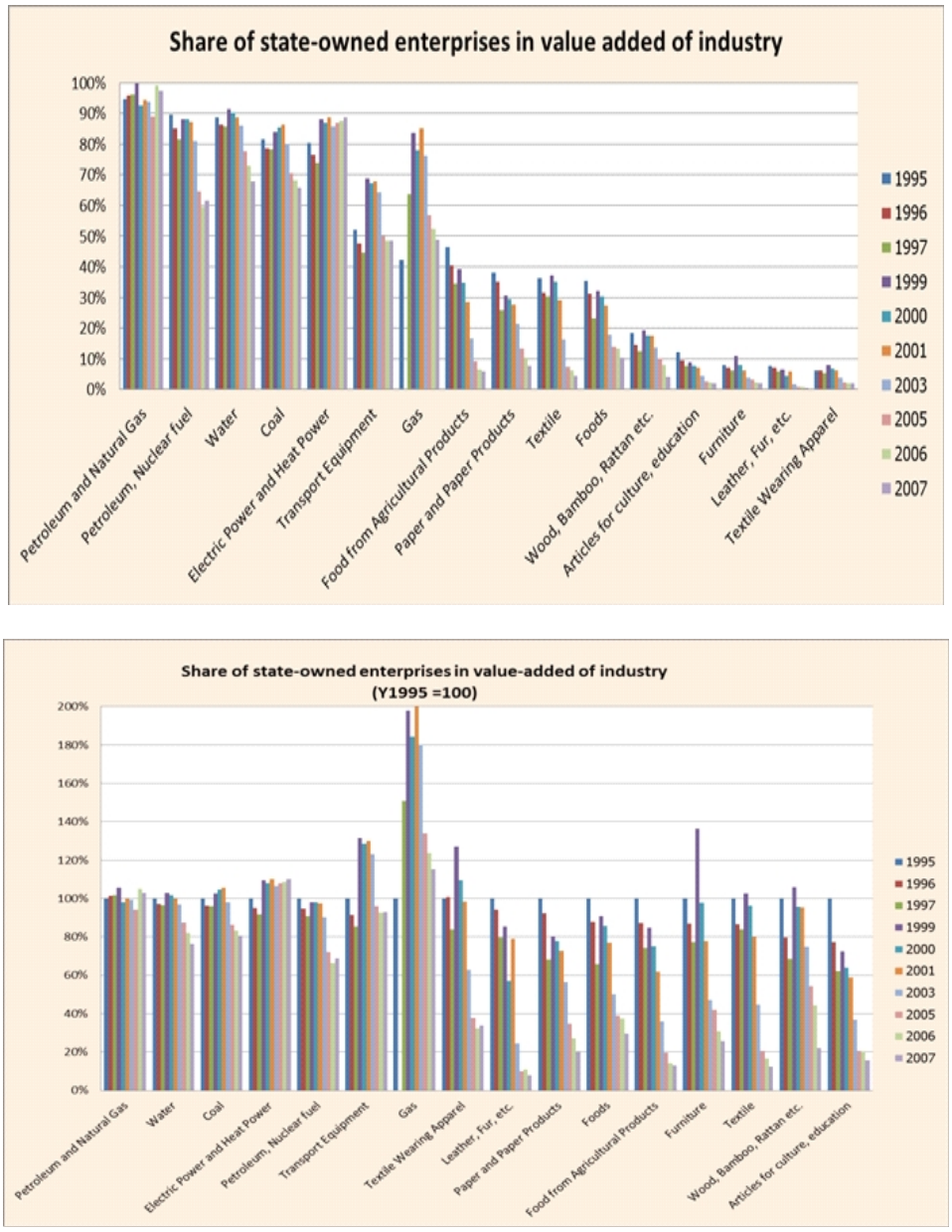


Figure 9: Share of State-owned enterprises in Industrial Value Added.

Notes for Figure 9: The data are from National Bureau of Statistics of China, Table 14-2, and Table 14-6. Note NBS has changed the title of state related enterprises over time. In 1995-1997, NBS uses "State-owned Industrial Enterprises"; in 1998, data is missing; in 1999-2003, NBS uses "State-owned and State-holding"; in 2002, data is missing; in 2004, NBS uses "State-owned and State controlled"; in 2005-2009, NBS uses "State-owned and State-holding".

Figure 10: China's Labor Income Share (replicated from Bai and Qian, 2010)

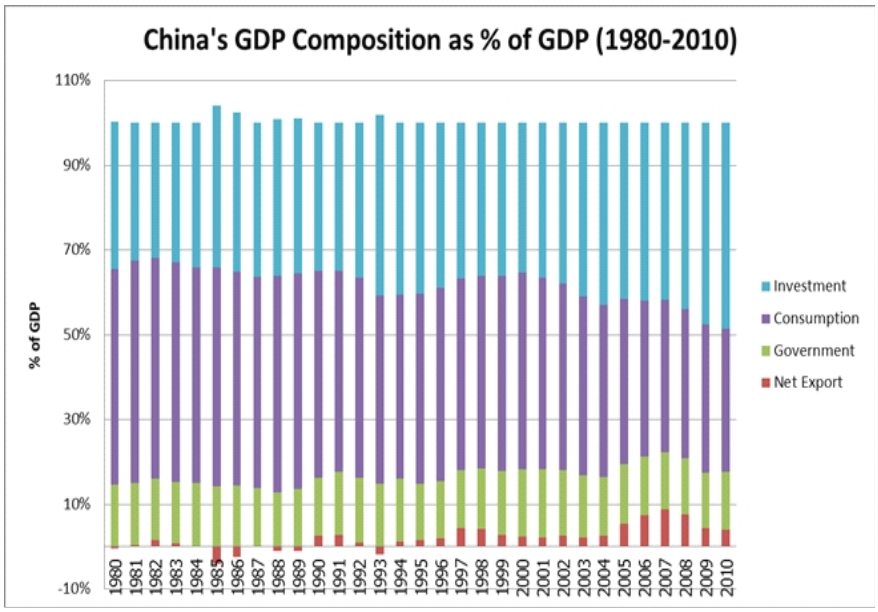


Figure 11: China's GDP composition as % of GDP. (Source: CEIC National Accounts)