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 general-equilibrium model to show that this unique vertical structure, when combined with openness and labor abundance, is critical in explaining a puzzling fact about China's economy: SOEs outperformed non-SOEs in the past decade while the opposite was true in the 1990s. We show how the upstream SOEs extract rents from the liberalized downstream sectors in the process of industrialization and globalization. It implies that the unusual prosperity of SOEs in China can be merely a growth-undermining symptom of the incompleteness of market-oriented reforms rather than a proof of their efficiency dominance over non-SOEs. Emergence, sustainability, and other macroeconomic implications of this model are also discussed.

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

JEL Classifications: E2, F4, O1, P2

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1 Introduction

Major emerging economies (especially BRIC) all practice some forms of state capitalism, which generally refers to the state controlling an important share of the economy while the private sector largely operating in the free market.[1] The case in point is China. The market-oriented reform toward a so-called "Socialist Market Economy with Chinese Characteristics" leads to a rapid expansion of the private sector while state-owned enterprises (SOEs hereafter) as a whole are still an important part of the economy.[2]

State capitalism appears to perform well. From 2001 to 2011, China's total GDP rose from world number six to number two with an annual growth rate of 10.5% on average.[3] Most strikingly, SOEs seem to outperform non-SOEs in the last decade. Figure 1 plots the ratio of profit to sales revenue of SOEs versus non-SOEs between 1993 and 2010, together with the export as the percentage in GDP.

Insert Figure 1 Here

The profitability of SOEs has surpassed that of non-SOEs in the last decade while the opposite was true in the 1990s, even though China has recorded stably high GDP growth rates at about 10% during the whole period. Interestingly, the drastic increase in SOEs' profitability has been co-moving with the rapid rise in China's export to GDP ratio, especially after China entered WTO in 2001, although SOEs' share of export has been decreasing and becoming relatively small (see Table 1). As further corroboration, Figures 2a and 2b present the total profit of industrial enterprises scaled by the number of enterprises and employees, respectively. Again, the profitability of SOEs far outstrips that of non-SOEs in the last decade. In fact, almost all of the 57 Chinese firms on the

[1] The term 'state capitalism' has various meanings, but it is usually characterized by the dominance or existence of a significant number of state-owned business enterprises (see, e.g., Binns (1986), Bremmer (2010)). See also the special issue on 'state capitalism' in the *Economist* on Jan 21st, 2012.

[2] For example, according to the National Bureau of Statistics (NBS) of China, the SOEs still account for about 40% of fixed investments by all (see Lin, Cai and Li (2008)). Note that NBS changes the definition of the state enterprises over time, with some years reporting on state owned enterprises (SOEs) and the other years reporting on state owned and holding enterprises (SOEs and SHEs). SOEs are wholly state-owned firms and SHEs are firms whose majority shares belong to the government or other SOEs. We call all these state enterprises as SOEs and the rest of enterprises as non-SOEs throughout the paper.

[3] Given the recent economic success of BRIC, especially China, some have touted state capitalism as an alternative growth model to the liberal capitalism (see, e.g., the *Economist,* Jan 21st, 2012).

list of Fortune Global 500 in 2011 are SOEs (see Table 2).

Insert Figures 2a and 2b Here

This recent phenomenon is puzzling because it seems to contradict the common notion that the increased competition due to the market-oriented reform (including trade liberalization) would hurt the less efficient firms.[4] It also seems at odd with the literature of resource misallocation, which predicts the incompatibility of fast aggregate growth with less productive firms (SOEs) persistently outperforming more-productive ones (private firms) (see Hsieh and Klenow (2009) and Song, Storesletten and Zilibotti (2011)). The main purpose of this paper is to resolve this puzzle by providing a theory of China's state capitalism.

Our theory is based on a crucial feature of China's state capitalism that emerged around year 2001, namely, SOEs have unchallenged monopolies in most of the upstream industries and key markets while the downstream industries are mostly open to intensive competition among non-SOEs. Since 2001, for example, the manufacturing sector, one of the downstream industries and also the main source of commodity trade, has already become 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 and marked up in prices by SOEs. This important "vertical structure" seems to have received insufficient attention in the literature, and will be documented in detail in Section 2.

The core argument of our theory is as follows: By 2001 or so, low-productivity SOEs had already exited from most downstream industries while the upstream industries are still monopolized by SOEs. Therefore, the enhanced trade liberalization (especially the accession to WTO in December 2001) results in a rapid expansion of the downstream non-SOEs, 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, the upstream SOEs flourish disproportionately more than the non-SOEs in the competitive downstream.[5]

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[4] There exist abundant empirical evidences for the negative impact of state ownership on productivity and investment efficiency in China. See, for example, Sun and Tong (2003) and Dollar and Wei (2007). Most recent evidences include Liu and Siu (2011) and Cao and Liu (2011).

[5] The profitability of SOEs experienced a dramatic pullback around 2008, which could be due to the large negative

Notice that, besides the vertical structure, trade openness and labor abundance are the two other important ingredients of our theory. Without the enlarged external demand due to international trade, downstream non-SOEs would not expand that much, hence upstream SOEs would not be able to make outsized profit. On the other hand, without abundant labor, wage would go up immediately after the expansion of the downstream industries. Then the room for the monopoly pricing on the intermediate goods charged by upstream SOEs would become smaller, as international trade imposes a price ceiling of the downstream goods, and thus the upstream SOEs would not be able to maintain persistent and high profitability.

Although the analytical focus of this paper is on the post-2001 period, our framework can also explain why the fortune of SOEs was the opposite during the 1992-2001 period. The initial deregulation reform and trade liberalization in downstream industries in the 1990s led to the entry and expansion of high-productivity non-SOEs, which beat the SOEs in the same industries. Therefore, many SOEs suffered severe losses and gradually exited from downstream industries, which were eventually dominated by the competitive non-SOEs. The aggregate economy grew fast as a result of this improved resource reallocation, and non-SOEs outperformed SOEs as a whole until SOEs largely exited from the downstream industries, as reflected in Figure 1. However, once the vertical structure came into its full shape around 2001, the remaining SOEs, which mainly stay in the upstream industries, started to outperform non-SOEs as they benefit from the expansion of downstream industries. SOEs as a whole have changed from the victims to the beneficiaries of the market-oriented reform and trade liberalization.

Our model of state capitalism also has important distributive implications on factor returns. Figure 3 shows that the share of labor income in China's total GDP has been persistently declining since 1990. It took a dive around 2001, when China joined WTO. This pattern is first systematically documented by Bai and Qian (2009). It contradicts the common belief that this share should be roughly constant, known as one of the Kaldor facts in standard Neoclassical growth theory (see, e.g., Acemoglu (2008)). It seems also at odd with the standard Heckerscher-Ohlin trade theory (Feenstra (2004)), which implies that labor income share in GDP should increase after trade liberalization because the price of labor, as the abundant factor, should increase relative to the scarce factor

external demand shock (the 2008 global financial crisis). This is also consistent with our theory that the profitability of the upstream SOEs is more responsive to the external demand shocks due to the monopoly markup.

(capital). How come in a labor-abundant country like China the labor income share plunged while its export accelerated after entering the WTO? Besides, the level of this share is also low by international standard.

Insert Figure 3 Here

This puzzle can be resolved within our framework. One key element of our model is the dual economy in the spirit of Lewis (1954). Thus the large labor pool in the non-industrial sector ensures the low and constant wage during the industrialization, which in turns yields the declining labor income share as GDP increases. Trade liberalization boosts industrialization and GDP growth, therefore lowers the labor income share even further. This model implication is consistent with the pattern in Figure 3. The major reforms in the industrial sectors and urban areas started after Deng Xiaoping's South Tour in 1992, so the labor income share began to decline with industrialization. This share plunged around 2001 because the external demand increased sharply as China entered WTO that year.

Our general-equilibrium benchmark model studies two cases. We start with the case of autarky, which highlights the mechanism through which the SOE in the upstream industry extracts monopoly rents from the non-SOEs in the competitive downstream industries in the industrialization process. More specifically, we analytically derive and characterize the profit of the upstream SOE, the labor income share in total GDP, and their relations to the industrialization and aggregate GDP. We show how labor abundance enables the SOE to earn a high monopoly rent by keeping wage low and constant as the economy industrializes. The economic distortion caused by the upstream monopoly is fully demonstrated by comparing this equilibrium with the socially optimal scenario when the upstream monopoly is eliminated.

Then we consider the case with free trade between two countries. We illustrate how international trade boosts the aggregate demand for manufacturing goods (downstream goods), which in turn leads to a higher profit of the SOE in the upstream industry of the home country. The comparative advantage of the export sector largely relies on labor abundance, which creates room for the monopoly markup charged by the upstream SOE. As the wage remains constant after trade liberalization while GDP becomes larger, the labor income share in GDP becomes smaller than that in the autarky case. The key mechanism we highlight here is how international trade provides an opportunity for the upstream SOE to extract more rents from the downstream non-SOEs via large foreign demand and more domestic industrialization.

Finally, we extend the benchmark model to discuss the sustainability of China's state capitalism. We show that, when domestic wage starts to rise endogenously after sufficient industrialization, China may lose its competitive advantage in international markets if the upstream SOEs maintain monopoly power without sufficiently improving their productivities. This is more likely to happen when some other countries catch up and effectively compete with China in the export market. Also, our model implies that the profit of upstream SOE is more sensitively exposed to external demand volatility (due to the markup price effect), even if they do not directly participate in trade. This is consistent with the 2007-2009 episode in Figure 1.

Related literature. We believe that 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.

First, our paper is most closely related to the economic growth literature on resource misallocation across different firms, especially in the context of China's economic development and growth. Song et al. (2011) show how the resource (especially capital) reallocation within the manufacturing sector from the low-productivity SOEs to the high-productivity private firms contributed to China's growth. Their model, similar in spirit to Restuccia and Rogerson (2008) and Hsieh and Klenow (2009), focuses on the horizontal competition between SOEs and private firms in the same industry (or substituting industries), which would imply that the fast aggregate economic growth should be accompanied by SOEs being outperformed by private firms. Our paper complements their view by highlighting the importance of the vertical economic structure, in which SOEs and non-SOEs mainly operate in different and complementary industries. Therefore we can explain why SOEs have outperformed non-SOEs in China in the past decade while the private sector and the aggregate economy have continued to grow fast.[6] Our framework is also general enough to explain the opposite case observed in the 1990s, which is consistent with Song et al. (2011).[7] Another key

[6] Allen, Qian and Qian (2005) find that the private sector in China grew much faster than other sectors and contributed to most of the economy's growth.

[7] Lin (2009) attributed China's high GDP growth to the resource reallocation from the overly capital-intensive

difference is that the source of distortion in Song et al (2011) is capital market distortions, but we highlight the SOE monopoly in the product markets (of upstream industries). We show in general equilibrium that the product market monopoly also indirectly distorts the prices and allocations of production factors even when the factor markets themselves are perfect.

Second, our paper provides the first theoretical model with international trade and structural change that explains the puzzling fact about the declining labor income share in China.[8] By explicitly introducing the dual economy feature with abundant labor (see Du, Park and Wang (2005), Dooley et al. (2007) and Vollrath (2009)), our model explains why the wage may fail to rise relative to the price of capital after liberalizing trade.[9] The decline in labor income share, in our model, is mainly due to the endogenous structural change from the non-industrial sector to the more capital-intensive industrial sector, which is proved to be quantitatively important as in Bai and Qian (2010). Moreover, we also illuminate a novel mechanism through which the labor income share in GDP can be adversely affected by an expansion in foreign demand when the upstream industry is monopolized, even after all the labor has been pulled out of the labor-intensive non-industrial sector.

Third, our paper sheds new light on industrialization and structural change, especially in an open economy (see Matsuyama (2007), Herrendorf, Rogerson and Valentinyi (2011), Yi and Zhang (2010), Brandt, Hsieh and Zhu (2010)). By deviating from the standard assumptions of perfect competition and the horizontal industrial structures,[10] we show that the monopoly in the upstream (and non-traded) industries may impede industrialization by reducing industrial employment and lowering capital accumulation and that upstream monopolists benefit from pro-industrialization policy changes including export-promoting policies and relaxation of the restrictions on labor migration. In our model, international trade facilitates industrialization by enhancing downstream privatization, boosting the total demand for industrial output, and ultimately disciplining the up-

industries to the labor-intensive industries. His hypothesis would suggest that the profitability of SOEs should become monotonically worse after trade openness as China's comparative advantage is defied. However, as discussed earlier, this contradicts what we observe in the last decade. Our paper instead highlights the role of the vertical economic structure in explaining the fact.

[8] Harrison (2002) and Jaumotte and Tytell (2007) show that this phenomenon also exist in many other countries.

[9] See also Gollin (2002), Dooley et al. (2007), Burnstein and Vogel (2011), and Ventura (1997)).

[10] Yi (2003) highlights the role of vertical specialization in international trade.

stream SOE monopoly via international competition in the downstream markets.[11] Conversely, industrialization also propels international trade by channelling more resources into the export sector to exploit more fully the comparative advantage in the abundant labor endowment (Matsuyama (1992)).[12].

Lastly, our model also sheds new light on the effect of partial and gradual institutional reforms in the economic transition literature. While Lau, Qian, and Roland (2000) emphasize how the gradual dual-track reform in China was successful as a Pareto-improving process, Murphy, Shliefer and Vishny (1992) and Young (2000) emphasize more on the economic distortions created in this process (also see Bruno (1972) and Bai et al. (2004)). Our paper documents and theorizes the partial (gradual) reform on SOEs in China. We show how the partial SOE reform, together with trade liberalization, has led to the reversal of fortunes for SOEs and non-SOEs at different stages. We particularly emphasize that the current prosperity of SOEs in China can be merely an undesirable symptom of the gradualism and incompleteness of reform rather than an encouraging driving force for economy growth. We show how the rent extraction from the upstream SOE monopoly may eventually undermine the growth sustainability.

The paper is structured as follows. Section 2 provides a detailed documentation on the related facts. Section 3 presents the benchmark model. Section 4 extends our benchmark model to discuss the sustainability of this development model of state capitalism. Section 5 discusses the emergence of China's state capitalism within our framework. Section 6 briefly discusses several other related issues. The last section concludes.

2 Institutional Background and Quantitative Facts

This section first documents the relevant history of China's SOE reforms in the past three decades and highlights the institutional background on how the "vertical structure" of China's state capitalism came into existence. It then provides detailed quantitative facts about this "vertical structure".

[11] Sachs and Warner (1995) and McMillan and Rodrik (2011) provide mixed empirical evidences in this respect.

[12] Wang (2011) develops a two-country dynamic general-equilibrium model with infinite industries of different capital intensities to show how international trade and dynamic trade policies may affect industrialization, the structural change of industries from labor-intensive to capital-intensive ones within the modern sector, as well as the aggregate growth rate.

2.1 A Brief History of China's SOE Reforms

After China's historical decision on "reform and opening up" in 1978, the central government has taken a gradual, experimental, and pragmatic approach of "crossing the river by touching stones" to reform SOEs (see, e.g., Lin, Cai and Zhou (2008), Xu (2011), and Sachs and Woo (2000)). Reforms were often necessary to reduce economic losses, increase economic growth, and raise living standards, from which the Chinese Communist Party (CCP) derives its governing legitimacy. The central government has been trying to improve SOE performance while maintaining state ownership and control over a large swath of the economy.[13]

Until 1978, virtually all the firms were SOEs in both upstream and downstream industries. Inspired by the success of the household responsibility system in the rural reforms in the early 1980s, the central government first focused on increasing enterprise autonomy through a system that requires managers to meet performance targets in return for retained profit. This system initially improved SOEs performance (see, e.g., Gordon and Li (1995), Groves et al. (1994, 1995), and Li (1997)). However, it quickly ran into troubles because managers were rewarded for success but not punished for failure and were enabled to exploit their effective control over SOE assets at the expense of the state (e.g., Qian (1996)). Although other types of contracts were experimented, SOEs stacked up huge losses, especially due to the increasing competition from non-SOEs, which were mainly foreign enterprises and township and village enterprises (TVE) (see, e.g., Li, Li, Zhang (2000), Cao et al. (1999)). During the 1978-1993 period, the share of SOE's net industrial output decreased from more than 80% to about 65%, even though this period witnessed virtually no closing of any SOEs. Table 3 shows a steady rise in the financial loss and leverage of SOEs, along with a steady drop in the economic significance of SOEs. About 40% of SOEs were loss-makers in 1994 and their debt to equity ratio increased to 200%. These developments put substantial pressure on government revenue, fiscal burden, and banking stability.

[13] Deng Xiaoping proclaimed that "As long as we keep ourselves sober-minded, there is nothing to be feared. We still hold superiority, because we have large and medium state-owned enterprises and township and village enterprises. More importantly, we hold the state power in our hands" (Yahuda (1993)). In 1995, CCP General Secretary Jiang Zemin argued that the dominant public ownership in Chinese economy means that the state should concentrate on public entities' control of economic assets and SOEs leading role in key economic sectors and in the orientation of economic development (see China Daily, March 7, 2000).

After the historical Southern tour of Deng Xiaoping in 1992, China started the second stage of its SOE reforms. In the 14th CCP Congress in 1992 and its Third Plenum in 1993, the central government respectively endorsed and defined the "socialist market economy" based on public ownership, not necessarily public sole proprietorships, as its goal of reform. In the 15th Party Congress in 1997 SOEs were downgraded to a "pillar of the economy", and private ownership was later incorporated into the new Chinese Constitution in 1999. The state launched a so-called "three-year battle" to ameliorate SOEs' situation between 1998 and 2000.

Privatization of SOEs and layoffs of workers began to emerge on a large scale in 1995, when the central government formally set the policy of "nurturing the large and letting the small go" (or *zhuada fangxiao*). The central government explicitly pursued the strategy of retaining state control of 500-1,000 large SOEs in the strategic sectors, and granting them government monopoly, and meanwhile retreating from small and medium-sized SOEs, which were typically located in the labor-intensive competitive industries such as textiles, food processing, and electronics (see, e.g., Cao et al. (1999) and Green and Liu (2005)).[14] Note that the 500 largest SOEs held 37% of the state's industrial assets, contributed 46% of all the tax revenues from SOEs, and totaled 63% of SOEs' profits at the end of 1997 (Lin, Cai and Li (1998)). In comparison, small SOEs, generally controlled by local governments, were performing poorly, especially in the aftermath of enormous entry of non-SOEs into the liberalized industries. For example, 72.5% of local SOEs were unprofitable, whereas 24.3% of central SOEs were unprofitable in 1995 (Zhao (1999)).

After this round of SOE reform, central SOEs consolidated their monopoly position in the upstream industries and reinforced their advantageous position even further through reorganizations such as mergers and groupings. Since the upstream industries are generally in non-tradable sectors, central SOEs are more shielded from intensified competition after the WTO entry. By contrast, although the WTO membership led to further expansion of the non-SOEs as a whole in

[14]Vice-Premier Wu Bangguo said in 1997 that "Control of the [500] largest firms means we have a control of the largest chunk of the state economy." The 10th Five-Year Plan for National Economic and Social Development (for the 2001-2005 period) called for the government to "hold a controlling stake in strategic enterprises that concern the national economy" and also to "uphold the dominance of the public sector of the economy [and] let the state-owned sector play the leading role." In 2006, State-Owned Assets Supervision and Administration Commission (SASAC hereafter) designated defense, electric power and grid, petroleum and petrochemical, telecommunications, coal, civil aviation, and shipping to be strategic industries.

tradable sectors, the non-SOEs nevertheless faced more fierce competitions in the largely liberalized downstream industries. Overall, the monopoly position of SOEs in the upstream is protected and strengthened while the downstream becomes more competitive.[15]

2.2 Quantitative Facts

This subsection first provides some further evidence on firm profitability of SOEs versus non-SOEs since 1993. It then provides detailed evidence on the development of the vertical structure of China's state capitalism in the last two decades.

Complementing Figures 1 and 2, Figure 4 examines firm profitability from yet another angle. The left two panels show that SOEs' presence in the low and medium profit margin subsectors in the industrial sector has declined drastically, especially around 2003, whereas the right panel shows that SOEs' presence in the high profit margin subsectors kept stable at a high level.

Figures 5-6 and Table 2 document the vertical structure. Figure 5 presents SOEs' share in domestically funded fixed asset investment across all urban sectors.[16] The left part of the figure represents the upstream industries, mainly consisting of industries of energy and other key intermediate goods and services. The middle part illustrates the downstream industries, which are mainly composed of industries directly targeting consumption goods and services. Other public sectors, especially those serving for non-profit social purposes, are on the right part of the figure. The figure shows that SOEs have high and stable presences in upstream sectors at well above 50% by 2009, whereas their presence in downstream sectors has decreased dramatically. In particular, the manufacturing sector, which is the main source of export goods, is one of the sectors with the least state investment shares.

Figure 6 further examines SOEs' presence in different subsectors within the industrial sector measured by value-added share from 1995 to 2007. The upstream and downstream industries are on the left and right parts of the figure, respectively. Figure 6a shows the shares of SOEs, whereas

[15] For example, Dean et al. (2010) report that by 2008, total assets of SOEs in China were $6 trillion, or at 133% of Chinese GDP, whereas the corresponding numbers for France, a developed country known for its outsized state control in economy, were $686 billion and 28%, respectively. In particular, there are less than 200 SOEs directly under the SASAC supervision, but their assets account for 62% of GDP.

[16] Unfortunately, the data for value-added are unavailable for urban sectors.

Figure 6b shows SOEs' shares normalized by the initial levels in 1995, the starting point of our sample period, which highlights the percentage change relative to the base year.

Figure 6a shows that SOEs continue to dominate the upstream industrial subsectors but have retreated dramatically from the downstream subsectors. This pattern is even more pronounced in Figure 6b when we adjust for the lower level of initial presence of SOEs in the downstream subsectors. The exit of SOEs from the downstream subsectors seemed to accelerate in the late 1990s, consistent with the aforementioned timeline of China's SOE reform and the approach of "nurturing the large and letting the small go."[17]

To further examine the vertical structure, Table 2 reports on the names, rank, revenues, the headquarter city, and the affiliated industry of the 57 Chinese firms on the list of Fortune Global 500 in 2011. Three of the largest ten Fortune global 500 are from China. Interestingly, almost all the Chinese firms on the list are SOEs. Further, these largest Chinese firms 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 firms on the list. All these evidences point to the salient feature of the vertical structure with SOEs dominating upstream industries in China's economy.

3 Benchmark Model

In this section, we first study the static autarky, which features the "vertical structure" of China's state capitalism. Then we extend it to an open economy to highlight the role of international trade. Labor abundance plays a crucial role in both cases.

3.1 Autarky

3.1.1 Model Environment

Consider a closed economy H, which is populated by a continuum of agents with the measure equal to unity. Agents can be divided to two groups: an elite class with measure equal to $\theta \in (0, 1)$ and

[17] We also investigate SOEs' share in the upstream, downstream, and other subsectors within the industrial sector in terms of revenue, taxes and other charges, total assets, and gross output. These are all the other variables available for the industrial sector. We find similar patterns as in Figure 6.

the grass root with measure $1-\theta$. Agents are identical within each group.

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

$$u(c) = c_n + \frac{\epsilon}{\epsilon-1}\left[\left(\int_0^1 c(i)^{\frac{\eta-1}{\eta}} di\right)^{\frac{\eta}{\eta-1}}\right]^{\frac{\epsilon-1}{\epsilon}}, \ \epsilon > 1, \eta > 1, \tag{1}$$

where c is a consumption vector composed of consumption of numeraire good n (denoted by c_n) and consumptions of a continuum of differentiated goods denoted as $c(i)$ for $i \in [0,1]$. The parameter ϵ is the demand price elasticity for the aggregate of the differentiated goods, and the parameter η represents the elasticity of substitution between the differentiated goods. We assume that $u(c) = -\infty$ if $c_n < 0$, so c_n has to be non-negative in equilibrium. In reality, the differentiated goods can be thought of as the manufacturing goods while the numeraire good may represent the non-manufacturing goods (such as services and the agriculture good).

Technologies All the technologies are constant returns to scales. One unit of labor produces one unit of numeraire good n. 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 symmetric:

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

where $\alpha > 0, \beta > 0, \alpha + \beta < 1$.

The intermediate good m is produced with the following technology

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

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

Endowment and Market Structure Each agent, elite or grass root, is endowed with L units of time (labor) and K units of capital. The production of the intermediate good is monopolized by one firm, which is owned by the "state" but fully controlled by the elite class as if the elite class owns it. The numeraire good and the differentiated goods are produced by competitive private firms, which are owned by the grass root.[18] Only the intermediate good market is a monopoly,

[18] Later we will also examine the case when state firms also exist in the downstream industries competing with private firms.

while all the other markets (goods markets and factor markets) are perfectly competitive with free entry.

Vertical Structure The firm that produces the intermediate good is in the upstream, while all the firms producing the differentiated goods (and the numeraire good) are in the downstream. From the ownership point of view, the upstream firm is an SOE while all the downstream firms are privately-owned enterprises (POEs hereafter). This feature of ownership distribution is referred as the "vertical structure" in this paper, and it is to capture the reality of China economy after 2002. As documented in Section 2, the downstream industries in China have been dominated by competitive private firms since the year around 2001 after the massive privatization of SOEs in the late 1990s. However, SOEs have been still monopolizing some key industries and markets in the upstream.

3.1.2 Characterizing Equilibrium

Let W and R denote the wage and rental price of capital. Let p_n denote the price of numeraire good n , $p(i)$ denote the market price of good $i \in [0,1]$, and p_m denote the price of intermediate good m.

Consumer Problem Let I_e and I_g denote the total income of a representative agent in the elite class and in the grass root, respectively. The total income of the elite class is given by $\theta I_e = \theta [WL + RK] + \Pi_m$, where Π_m is the total profit of the SOE (i.e., it produces intermediate good m). The total income of the grass root is $(1-\theta)I_g = (1-\theta)[WL + RK]$. An agent with income I maximizes the utility function (1) subject to the following budget constraint:[19]

$$p_n c_n + \int_0^1 p(i)c(i)di \leq I,$$

where income $I \in \{I_e, I_g\}$. When I is sufficiently large, the optimal demand for the consumption is given by

$$c_n = \frac{I - p_n^{\epsilon} P^{1-\epsilon}}{p_n};\ c^d(i) = \left(\frac{p_n}{P}\right)^{\epsilon} \left[\frac{p(i)}{P}\right]^{-\eta} \text{ for any } i \in [0,1], \tag{4}$$

[19] We keep p_n explicitly in the formula without substituting it with unity because this numeraire good may not be produced in some rare case, in which p_n can be indeterminate and thus it is inappropriate to call this good n as numeraire good. However, for most cases, it causes no problem by substituting out p_n with one. Wage may conceptually serve as a better numeraire but it would tremendously complicate the analysis.

where the price index P is defined as $P \equiv \left(\int_0^1 p(i)^{1-\eta} di \right)^{\frac{1}{1-\eta}}$. Therefore, the aggregate demand is as follows:

$$D_n = \frac{WL + RK + \Pi_m}{p_n} - p_n^{\epsilon-1} P^{1-\epsilon}; \tag{5}$$

$$D(i) = \left(\frac{p_n}{P}\right)^{\epsilon} \left[\frac{p(i)}{P}\right]^{-\eta}, \text{ for any } i \in [0,1]. \tag{6}$$

Firm Decisions Given R, W and p_m, perfect competition with free entry in the downstream industries implies that the price equals to the unit cost:

$$p(i) = \frac{R^{\alpha} W^{\beta} p_m{}^{1-\alpha-\beta}}{A \alpha^{\alpha} \beta^{\beta} (1-\alpha-\beta)^{1-\alpha-\beta}}, \tag{7}$$

for any $i \in [0,1]$. Hence, $P = p(i)$.

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, by revoking (6) and (7), is

$$D_m = \int_0^1 D(i) \frac{\partial p(i)}{\partial p_m} di = (1-\alpha-\beta) \cdot p_n \cdot [\frac{R^{\alpha} W^{\beta}}{A \alpha^{\alpha} \beta^{\beta} (1-\alpha-\beta)^{1-\alpha-\beta}}]^{1-\epsilon} \cdot p_m{}^{(1-\alpha-\beta)(1-\epsilon)-1}. \tag{8}$$

The monopolist SOE of the intermediate good m maximizes its profit:

$$\Pi_m = \max_{p_m} D_m \cdot \left[p_m - \frac{R^{\gamma} W^{1-\gamma}}{A_m \gamma^{\gamma} (1-\gamma)^{1-\gamma}} \right], \tag{9}$$

which implies

$$p_m = \mu \frac{R^{\gamma} W^{1-\gamma}}{A_m \gamma^{\gamma} (1-\gamma)^{1-\gamma}}, \tag{10}$$

where the price markup $\mu \equiv \frac{(1-\alpha-\beta)(\epsilon-1)+1}{(1-\alpha-\beta)(\epsilon-1)} > 1$. Intuitively, μ is determined by the cost share of the intermediate good in the production of the differentiated goods $(1-\alpha-\beta)$ and the price elasticity of the demand for the aggregate differentiated good (reflected by the term $\epsilon - 1$).

Market Clearing Conditions We assume that the labor endowment L is sufficiently large (to be more precise soon) such that $D_n > 0$, thus the labor market clearing condition is given by

$$L = \underbrace{D_m \frac{\partial \frac{R^{\gamma} W^{1-\gamma}}{A_m \gamma^{\gamma} (1-\gamma)^{1-\gamma}}}{\partial W}}_{\text{by producer of intermediate good } m} + \underbrace{\int_0^1 D(i) \frac{\partial p(i)}{\partial W} di}_{\text{by producers of differentiated goods}} + \underbrace{D_n}_{\text{by producers of good } n}. \tag{11}$$

To ensure $D_n > 0$, we must require $L > \overline{L}$, where $\overline{L}$ is the sum of the first two terms in (11), or the total employment in the non-numeraire sector. Substituting (6), (7), and (8) into (11) yields

$$\overline{L} \equiv \frac{1}{\mu}\left\{\frac{\left[\frac{\mu}{\gamma^\gamma(1-\gamma)^{1-\gamma}}\right]^{1-\alpha-\beta}}{\alpha^\alpha\beta^\beta(1-\alpha-\beta)^{1-\alpha-\beta}}\right\}^{1-\epsilon}\left[(1-\gamma)(1-\alpha-\beta)+\beta\mu\right]$$
$$\cdot\left[A_m^{(1-\alpha-\beta)}A\right]^{\epsilon-1}\left(\frac{R}{W}\right)^{-[\alpha(\epsilon-1)+\gamma(1-\alpha-\beta)(\epsilon-1)]}\left(\frac{p_n}{W}\right)^{\epsilon}. \tag{12}$$

Whenever the numeraire good is produced in equilibrium, the wage must be equal to the marginal product of labor under perfect competition:

$$W = p_n, \tag{13}$$

so the wage is a constant, independent of K, A_m, A, or L. Capital market clears:

$$K = \underbrace{D_m\frac{\partial\frac{R^\gamma W^{1-\gamma}}{A_m\gamma^\gamma(1-\gamma)^{1-\gamma}}}{\partial R}}_{\text{by producer of intermediate good } m} + \underbrace{\int_0^1 D(i)\frac{\partial p(i)}{\partial R}di}_{\text{by producers of differentiated goods}},$$

which, by revoking (6), (8) and (10), is reduced to

$$K = \varkappa\left[A_m^{(1-\alpha-\beta)}A\right]^{\epsilon-1}\left(\frac{R}{W}\right)^{-[1+\alpha(\epsilon-1)+\gamma(1-\alpha-\beta)(\epsilon-1)]}\cdot\left(\frac{p_n}{W}\right)^{\epsilon}, \tag{14}$$

where

$$\varkappa \equiv \frac{1}{\mu}\left\{\frac{\left[\frac{\mu}{\gamma^\gamma(1-\gamma)^{1-\gamma}}\right]^{1-\alpha-\beta}}{\alpha^\alpha\beta^\beta(1-\alpha-\beta)^{1-\alpha-\beta}}\right\}^{1-\epsilon}\left[\gamma(1-\alpha-\beta)+\alpha\mu\right]. \tag{15}$$

By combining (14), (7), (10) and (13), we obtain the equilibrium prices as summarized in the following lemma.

Lemma 1 *Suppose L is sufficiently large. The autarky model has a unique equilibrium, in which the equilibrium prices are given by*

$$R = p_n\cdot\left[A_m^{(1-\alpha-\beta)}A\right]^{\frac{\epsilon-1}{1+\alpha(\epsilon-1)+\gamma(1-\alpha-\beta)(\epsilon-1)}}\left(\frac{K}{\varkappa}\right)^{\frac{-1}{1+\alpha(\epsilon-1)+\gamma(1-\alpha-\beta)(\epsilon-1)}}, \tag{16}$$

$$p_m = p_n\cdot\frac{\mu}{\gamma^\gamma(1-\gamma)^{1-\gamma}}A_m^{-1}\left[A_m^{(1-\alpha-\beta)}A\right]^{\frac{(\epsilon-1)\gamma}{1+\alpha(\epsilon-1)+\gamma(1-\alpha-\beta)(\epsilon-1)}}\left(\frac{K}{\varkappa}\right)^{\frac{-\gamma}{1+\alpha(\epsilon-1)+\gamma(1-\alpha-\beta)(\epsilon-1)}}, \tag{17}$$

$$p(i) = p_n\cdot\left\{\frac{\left[\frac{\mu}{\gamma^\gamma(1-\gamma)^{1-\gamma}}\right]^{1-\alpha-\beta}}{\alpha^\alpha\beta^\beta(1-\alpha-\beta)^{1-\alpha-\beta}}\right\}\left[A_m^{(1-\alpha-\beta)}A\right]^{\frac{-1}{1+\alpha(\epsilon-1)+\gamma(1-\alpha-\beta)(\epsilon-1)}}\left(\frac{K}{\varkappa}\right)^{\frac{-[\alpha+\gamma(1-\alpha-\beta)]}{1+\alpha(\epsilon-1)+\gamma(1-\alpha-\beta)(\epsilon-1)}}, \tag{18}$$

where $\varkappa$ is defined in (15) and W is given by (13).

Now we conduct comparative statics based on the above lemma.

First, (16) implies that $\frac{\partial R}{\partial K} < 0$, $\frac{\partial R}{\partial A_m} > 0$, $\frac{\partial R}{\partial A} > 0$, $\frac{\partial R}{\partial L} = 0$. A larger capital supply K naturally leads to a lower capital return R due to the standard market mechanism. An increase in the Hicks-neutral productivity, either at the upstream (A_m) or downstream (A), leads to a larger marginal productivity of capital and hence a higher capital rental price R. There are two reasons why $\frac{\partial R}{\partial L} = 0$. First, the quasi-linear utility function implies the absence of income effect for the differentiated goods ($\frac{\partial D(i)}{\partial I} = 0$ according to (6)), so a larger labor income due to a higher L has no income effect on the demand for differentiated goods and hence the intermediate good ($\frac{\partial D_m}{\partial I} = 0$ according to (8)). This in turn implies that L has no income effect on the demand for capital. Second, wage does not change with L (shown by (13)) so there exists no substitution effect on the demand for capital either. Thus, R does not change with L for given capital supply K.

Second, (17) implies $\frac{\partial p_m}{\partial K} < 0$, $\frac{\partial p_m}{\partial A_m} < 0$, $\frac{\partial p_m}{\partial A} > 0$, $\frac{\partial p_m}{\partial L} = 0$. An increase in the capital stock drives down the rental price of capital while the wage does not change, and the markup μ is a constant according to (10), hence p_m decreases. $\frac{\partial p_m}{\partial A_m} < 0$ is mainly because an increase in the upstream TFP drives down the factor demand for any given output, which leads to a net decrease in the unit cost although R is increased. However, an increase in the TFP in the downstream industries will lead to a higher equilibrium price for the intermediate good ($\frac{\partial p_m}{\partial A} > 0$), which is because it drives up R and hence the unit cost (recall that wage and the markup do not change). As explained earlier, L , when large enough, has no impact on the demand for the intermediate good or the unit cost of intermediate good, thus it does not affect the equilibrium price p_m.

Third, (18) implies $\frac{\partial p(i)}{\partial K} < 0, \frac{\partial p(i)}{\partial A_m} < 0$, $\frac{\partial p(i)}{\partial A} < 0$, $\frac{\partial p(i)}{\partial L} = 0$. An increase in capital stock K drives down R and p_m, hence the unit cost of the differentiated goods becomes smaller ($\frac{\partial p(i)}{\partial K} < 0$). An increase in the upstream TFP will lower p_m, which dominates the resulting increase in R, so $\frac{\partial p(i)}{\partial A_m} < 0$ as the unit cost for the differentiated good decreases. The factor-saving effect due to an increase in the downstream productivity will dominate the resulting increase in both the rental price of capital and the intermediate good price, consequently $\frac{\partial p(i)}{\partial A} < 0$ due to the reduction in the unit cost. Labor endowment does not affect any input prices for reasons explained before, so $\frac{\partial p(i)}{\partial L} = 0$.

Next, we characterize several key quantities and values in the equilibrium.

By revoking Lemma 1, we obtain the total employment in the non-numeraire sector, (12), as

$$\overline{L}(A, A_m, K) \equiv \varkappa \frac{(1-\gamma)(1-\alpha-\beta)+\beta\mu}{\gamma(1-\alpha-\beta)+\alpha\mu}\left[A_m^{(1-\alpha-\beta)}A\right]^{\frac{\epsilon-1}{1+\alpha(\epsilon-1)+\gamma(1-\alpha-\beta)(\epsilon-1)}}\left(\frac{K}{\varkappa}\right)^{\frac{\alpha(\epsilon-1)+\gamma(1-\alpha-\beta)(\epsilon-1)}{1+\alpha(\epsilon-1)+\gamma(1-\alpha-\beta)(\epsilon-1)}}. \tag{19}$$

It implies that an increase in the productivity A or A_m will lead to more employment in the non-numeraire sector (more industrialization). This structural change (labor reallocation) also occurs when the capital stock K increases ($\frac{\partial \overline{L}(A,A_m,K)}{\partial K} > 0$), as it *tends* to increase the marginal product of labor in the non-numeraire sectors.

Notice that the condition, $L > \overline{L}(A, A_m, K)$, only guarantees that a positive amount of the numeraire good is produced (recall the definition of $\overline{L}$ in (12)). By market clearing, this condition means that, in equilibrium, the elite class and the grass root class as a whole consume a positive amount of the numeraire good. However, a stronger condition is needed to guarantee that both the elite class and the grass root class consume a positive amount of the numeraire good. In fact, D_n is given by (5) only if the grass root class consumes a positive amount of the numeraire good (that is, the grass root income satisfies $I_g \geq p_n^{\epsilon} P^{1-\epsilon}$), which requires (by applying Lemma 1) that $L \geq \frac{\mu-\gamma(1-\alpha-\beta)-\alpha\mu}{(1-\gamma)(1-\alpha-\beta)+\beta\mu}\overline{L}(A, A_m, K)$. Observe that $\frac{\mu-\gamma(1-\alpha-\beta)-\alpha\mu}{(1-\gamma)(1-\alpha-\beta)+\beta\mu} > 1$.

The following lemma summarizes several key macroeconomic variables in the equilibrium

Lemma 2 *Suppose* $L > \frac{\mu-\gamma(1-\alpha-\beta)-\alpha\mu}{(1-\gamma)(1-\alpha-\beta)+\beta\mu}\overline{L}(A, A_m, K)$*. In the autarky equilibrium, the profit of the upstream SOE* Π_m*, the total GDP (per capita)* Y*, and the labor income share in total GDP (denoted by* θ_L*) are given respectively by*

$$\Pi_m = \frac{(1-\alpha-\beta)(\mu-1)}{(1-\gamma)(1-\alpha-\beta)+\beta\mu}\overline{L}(A, A_m, K)p_n, \tag{20}$$

$$Y = \left[L + \frac{\alpha\mu+(1-\alpha-\beta)(\gamma+\mu-1)}{(1-\gamma)(1-\alpha-\beta)+\beta\mu}\overline{L}(A, A_m, K)\right]p_n, \tag{21}$$

$$\theta_L = \frac{L}{L + \frac{\alpha\mu+(1-\alpha-\beta)(\gamma+\mu-1)}{(1-\gamma)(1-\alpha-\beta)+\beta\mu}\overline{L}(A, A_m, K)}, \tag{22}$$

where $\overline{L}(A, A_m, K)$ *is given by (19).*

In Lemma 2, (20) implies that the upstream SOE profit is proportional to the total employment in the non-numeraire sector $\overline{L}(A, A_m, K)$, reflecting the fact that the upstream 'exploits' labor via the structural change of industrialization. (21) indicates that an increase in total GDP is equivalent to an increase in the total employment in the non-numeraire sectors. (22) clearly shows that industrialization (an increase in $\overline{L}(A, A_m, K)$) lowers the labor income share in total GDP.

To highlight the determinants of the upstream SOE profit and the labor income share, we have the following proposition.

Proposition 1 *Suppose* $L > \frac{\mu-\gamma(1-\alpha-\beta)-\alpha\mu}{(1-\gamma)(1-\alpha-\beta)+\beta\mu}\overline{L}(A, A_m, K)$. *In the autarky equilibrium, an increase in the productivity in either the upstream industry or the downstream industries, or an increase in the total capital stock, will raise the monopoly profit of the upstream SOE and decrease the labor income share in GDP (that is,* $\frac{\partial \Pi_m}{\partial A} > 0$, $\frac{\partial \Pi_m}{\partial A_m} > 0, \frac{\partial \Pi_m}{\partial K} > 0$; $\frac{\partial \theta_L}{\partial A} < 0$, $\frac{\partial \theta_L}{\partial A_m} < 0, \frac{\partial \theta_L}{\partial K} < 0$*).*

This proposition states that, under the vertical economic structure, an increase in the productivity of private firms in the downstream industries actually benefits the upstream SOE ($\frac{\partial \Pi_m}{\partial A} > 0$). This is in contrast with the result in the existing literature that efficient private firms compete and drive out less efficient SOEs in the same industries. The intuition is as follows. First, an increase in the downstream productivity A lowers the prices for the differentiated final goods ($\frac{\partial p(i)}{\partial A} < 0$) and hence increases the demand for the differentiated goods ($\frac{\partial D(i)}{\partial A} > 0$), which in turn raises the demand for the upstream intermediate good ($\frac{\partial D_m}{\partial A} > 0$). Second, an increase in the downstream productivity A increases the equilibrium price for the upstream intermediate good ($\frac{\partial p_m}{\partial A} > 0$ as explained earlier) hence the profit per unit of sale ($\frac{\mu-1}{\mu}p_m$). These two forces jointly imply a higher profit of the upstream SOE ($\frac{\partial \Pi_m}{\partial A} > 0$).

An increase in the TFP of the intermediate good also leads to an increase in the upstream profit ($\frac{\partial \Pi_m}{\partial A_m} > 0$) because the quantity of demand can be shown to increase ($\frac{\partial D_m}{\partial A_m} > 0$) as the equilibrium price goes down ($\frac{\partial p_m}{\partial A_m} < 0$) and the effect of quantity expansion dominates the effect of profit reduction per unit of sale (the decrease in $\frac{\mu-1}{\mu}p_m$). When capital stock K increases, R goes down, so the production costs of both the upstream and downstream industries decrease, hence the demand for the intermediate good goes up, which dominates the effect that the unit cost and hence the profit margin ($\frac{\mu-1}{\mu}p_m$) goes down. Consequently, the total profit increases.

To understand $\frac{\partial \theta_L}{\partial A} < 0$ and $\frac{\partial \theta_L}{\partial A_m} < 0$, notice that an increase in productivity A or A_m causes both capital price R and Π_m to go up. By definition, $\theta_L = \frac{WL}{WL+RK+\Pi_m}$, so the labor income share must decrease with A or A_m as W remains constant. When capital stock K increases, the GDP increases because Π_m increases as argued before and RK also increases ($RK = \frac{\alpha\mu+(1-\alpha-\beta)\gamma}{(1-\gamma)(1-\alpha-\beta)+\beta\mu}\overline{L}(A, A_m, K)p_n$); however, the total labor income is still fixed because wage remains constant, implying a decrease in the labor income share in total GDP.

To further understand the consequence of the upstream monopoly, it is natural to ask what the social optimal allocation would look like. Suppose the upstream industry is now liberalized by allowing for free entry. Then the upstream industry also becomes perfectively competitive and has zero profit ($\Pi_m = 0$). All the equilibrium prices and the quantities are still given by the same formula as in Lemma 1 and Lemma 2 except that μ is replaced by one.

Proposition 2 *In the social optimal equilibrium (liberalization of the upstream SOE), the wage is still equal to the numeraire good price, the rental price of capital becomes larger, both the intermediate good and the differentiated goods become cheaper, the total non-numeraire employment and the GDP both become larger, and the labor income share becomes smaller.*

The intuition of Proposition 2 is simple. The alleviation of the upstream monopoly lowers the price of the intermediate good for the standard reason, which in turn lowers the unit costs of the differentiated goods hence their prices. The aggregate demand hence the output of these non-numeraire goods increases, absorbing more labor from the numeraire sector, which in turns drives up the marginal product of capital hence the rental price of capital. The GDP becomes larger because the increase in the output of the non-numeraire goods dominates the reduction in the corresponding prices. Wage remains unchanged so the labor income share in total GDP becomes smaller.

In the past decade, China does witness a rapid increase in the profit of SOEs, which have outperformed the private firms, while the aggregate GDP still increases rapidly. Our analysis stresses the possibility that the unusual prosperity of SOEs can be an undesirable symptom of the society due to the incompleteness of the SOE reform rather than a socially desirable contributing force for China's aggregate economic performance. Our model illustrates the mechanism how the upstream SOE, as a monopolist, is able to extract all the surplus from the private sectors in the downstream. In particular, suppose that the only change is an increase in the productivity of the private firms in the downstream; then the profitability of the upstream SOE will also increase due to its monopoly power, together with the total GDP, even if the productivity of the SOE does not improve. In other words, the high profitability of the upstream SOE can be only the consequence of the dynamisms in the private sectors rather than the cause of the high GDP. Proposition 2 makes it clear that the SOE monopoly is in fact an obstacle to achieving the GDP potential of the economy.

The SOE monopoly also has important distributive implications. It depresses the rental price of capital and hence the capital income share in total GDP, but it raises the labor income share mainly through the reduction of GDP. It hampers the industrialization process (i.e., less non-numeraire employment) and prolongs the period of low wage and low labor income in GDP (due to a lower capital accumulation).[20]

Finally, we make one remark regarding competitions between SOEs and downstream non-SOEs. In our model, a productivity increase in the downstream private firms will raise the upstream SOE profit ($\frac{\partial \Pi_m}{\partial A} > 0$, see Proposition 1), and a productivity increase in the upstream SOE will reduce the unit cost of any downstream private firm ($\frac{\partial p(i)}{\partial A_m} < 0$, see (18) in Lemma 1). This complementarity between the SOE and private firms would be absent if they compete in the same or substitutable industries. However, we must emphasize that competition still exists between the SOE and the private firms on the factor markets even if these markets are perfect. The crowding-out effect can be much stronger if there exist market imperfections. For example, if the market is plagued by financial contracting frictions with collateral constraints, as in kiyotaki and Moore (1997) and Bernanke and Gertler (1989), then the more profitable upstream SOEs can have advantages in obtaining loans than the private firms. Such discrimination can be even more serious if government policies discriminate against non-state ownership. On the labor market, high profitability of SOEs can afford them to pay a higher wage, which can steal talents away from the downstream private firms, which is the real engine of China's growth. In short, the monopoly of SOEs in the upstream industry can create more distortions via the factor markets, beyond the distortions in the product market itself.

[20]This means that the key mechanism for the low and declining labor income share in China is the low wage sustained by the labor abundance in the non-manufacturing sector, which dominates the counter-effect caused by the SOE monopoly.

3.2 Open Economy

Now we study how international trade affects the economic performance, especially the profit of the upstream SOE and the labor income share in GDP, in a two-country free trade world. This open-economy setup is particularly important for understanding China's economy given its high degree of trade openness, especially after its accession to WTO in 2001.

3.2.1 Model Environment

Consider a world with two countries, home (H) and foreign (F). The home country is identical to the economy specified in Section 3.1. Country F is populated with a continuum of identical households with measure equal to unity. We use asterisk to denote the variables for country F. Each household in country F is endowed with L^* units of labor and has the same utility function as in country H (given by (1)).

For simplicity, assume all the firms in country F are private and no capital or intermediate good is needed in the production. Each foreign firm has free access to the following constant-to-scale technologies. One unit of foreign labor can produce either A^* units of numeraire good or one unit of any differentiated good i:

$$F_i^*(l^*) = l^*, \tag{23}$$

for any variety $i \in [0,1]$.[21] However, country H has no access to these technologies. All the markets are perfectly competitive in country F.

Now the two countries are allowed to have free trade. To make our analysis relevant for China (represented by country H in the model), we study the case in which country H exports the differentiated goods (representing manufacturing goods for instance) to country F and imports the numeraire good (representing for example tradable services involving high skills or high-quality agricultural products). In fact, given the technologies, an important source of the comparative advantage of country H in the differentiated goods is its labor abundance, which keeps the wage sufficiently low. The trade is assumed to be balanced. This is a hybrid of Ricardian and Heckscher-Ohlin trade models.

[21] Here foreign labor may be interpreted as a composite of raw labor and the associated human capital (skills).

To make it easy to compare with the autarky economy, we assume that the labor endowment in country H is sufficiently large such that it produces both the differentiated and the non-differentiated goods and also consumes both. Country F also consumes both but only produces the numeraire good. It is verified later that the necessary and sufficient conditions for this equilibrium pattern to occur are the following

$$A^{*1-\epsilon} < \frac{\mu}{2\left[(1-\gamma)(1-\alpha-\beta)+\beta\mu\right]}\overline{\overline{L}}(A, A_m, K), \tag{24}$$

$$\frac{\mu}{2\left[(1-\gamma)(1-\alpha-\beta)+\beta\mu\right]}\overline{\overline{L}}(A, A_m, K) < L^* A^*, \tag{25}$$

and

$$L > \frac{\frac{\mu}{2}-\gamma(1-\alpha-\beta)-\alpha\mu}{(1-\gamma)(1-\alpha-\beta)+\beta\mu}\overline{\overline{L}}(A, A_m, K), \tag{26}$$

where $\overline{\overline{L}}(A, A_m, K)$, as shown later, corresponds to the total employment in the non-numeraire sectors in country H and it is given by

$$\overline{\overline{L}}(A, A_m, K) \equiv 2^{\frac{1}{1+\alpha(\epsilon-1)+\gamma(1-\alpha-\beta)(\epsilon-1)}}\overline{L}(A, A_m, K). \tag{27}$$

Condition (24) ensures that country H has comparative advantage in producing the differentiated goods (i.e., $\frac{p(i)}{p_n} < A^*$) so that only country H will produce the differentiated goods and country F only produces and exports the numeraire good. Condition (25) ensures that country F consumes both numeraire and the differentiated goods. Condition (26) guarantees that each agent in country H, even the grass root, consumes a positive amount of numeraire good (i.e., $I_g > p_n^{\epsilon} P^{1-\epsilon}$). We also assume the following is true:

$$(\epsilon-3)(1-\alpha-\beta)+1 \leq 0, \tag{28}$$

which simply makes $\frac{\frac{\mu}{2}-\gamma(1-\alpha-\beta)-\alpha\mu}{(1-\gamma)(1-\alpha-\beta)+\beta\mu} \geq 1$ in (26). Thus, under assumption (28), condition (26) automatically implies $L > \overline{\overline{L}}(A, A_m, K)$. Therefore, condition (26) also guarantees that country H produces a positive amount of numeraire good in equilibrium.

In such an equilibrium, we must have

$$\begin{aligned} p_n &= p_n^* = W = \frac{W^*}{A^*}, \\ p(i) &= p^*(i) = \frac{R^{\alpha} W^{\beta} {p_m}^{1-\alpha-\beta}}{A\alpha^{\alpha}\beta^{\beta}(1-\alpha-\beta)^{1-\alpha-\beta}}, \\ D(i) &= D^*(i) = \left(\frac{p_n}{P}\right)^{\epsilon}\left[\frac{p(i)}{P}\right]^{-\eta}. \end{aligned}$$

Since now the world total demand for each differentiated good doubles the domestic demand in country H (hence the demand for the intermediate good is also scaled up), the optimal pricing of the intermediate good charged by the monopolist must yield the same markup as in the autarky case (10). As before, the capital market clearing condition determines the equilibrium rental price of capital R. Since all the technologies are constant return to scales, so the world total demand for capital must be also scaled up as the demand for both intermediate good and each differentiated good is scaled up. The total supply of capital, however, is still the same as before (since there is no capital in country F), thus the equilibrium R will be still given by (16) except that K should be replaced by $\frac{K}{2}$ in that formula:

$$R = p_n \cdot \left[A_m^{(1-\alpha-\beta)} A\right]^{\frac{(\epsilon-1)}{1+\alpha(\epsilon-1)+\gamma(1-\alpha-\beta)(\epsilon-1)}} \left(\frac{K}{2\varkappa}\right)^{\frac{-1}{1+\alpha(\epsilon-1)+\gamma(1-\alpha-\beta)(\epsilon-1)}}. \tag{29}$$

Similarly, (10) and (17) jointly yield

$$p_m = p_n \cdot \frac{\mu}{A_m \gamma^\gamma (1-\gamma)^{1-\gamma}} \left[A_m^{(1-\alpha-\beta)} A\right]^{\frac{(\epsilon-1)\gamma}{1+\alpha(\epsilon-1)+\gamma(1-\alpha-\beta)(\epsilon-1)}} \left(\frac{K}{2\varkappa}\right)^{\frac{-\gamma}{1+\alpha(\epsilon-1)+\gamma(1-\alpha-\beta)(\epsilon-1)}},$$

that is, nothing is different from the autarky case except that the total capital supply is as if bing cut by half. The same is true for the price of the differentiated goods (recall (18)).

$$p(i) = p_n \cdot \left\{ \frac{\left[\frac{\mu}{\gamma^\gamma (1-\gamma)^{1-\gamma}}\right]^{1-\alpha-\beta}}{\alpha^\alpha \beta^\beta (1-\alpha-\beta)^{1-\alpha-\beta}} \right\} \left[A_m^{(1-\alpha-\beta)} A\right]^{\frac{-1}{1+\alpha(\epsilon-1)+\gamma(1-\alpha-\beta)(\epsilon-1)}} \left(\frac{K}{2\varkappa}\right)^{\frac{-[\alpha+\gamma(1-\alpha-\beta)]}{1+\alpha(\epsilon-1)+\gamma(1-\alpha-\beta)(\epsilon-1)}}.$$

Lemma 3 *Suppose (24) -(26) and (28) are true. In the free trade equilibrium, the profit in the upstream industry is*

$$\Pi_m = \frac{(1-\alpha-\beta)(\mu-1)}{(1-\gamma)(1-\alpha-\beta)+\beta\mu} \overline{\overline{L}}(A, A_m, K) p_n. \tag{30}$$

The total GDP of home country is given by

$$Y = \left[L + \frac{\alpha\mu + (1-\alpha-\beta)(\gamma+\mu-1)}{(1-\gamma)(1-\alpha-\beta)+\beta\mu} \overline{\overline{L}}(A, A_m, K)\right] p_n$$

and the labor income share is

$$\theta_L = \frac{L}{L + \frac{\alpha\mu+(1-\alpha-\beta)(\gamma+\mu-1)}{(1-\gamma)(1-\alpha-\beta)+\beta\mu} \overline{\overline{L}}(A, A_m, K)},$$

where $\overline{\overline{L}}(A, A_m, K)$ *is given by (27).*

Proof: See the appendix.

When compared with the profit, GDP, and labor income share in the autarky equilibrium summarized by Lemma 2, the only difference is that now $\overline{L}(A, A_m, K)$ is replaced by $\overline{\overline{L}}(A, A_m, K)$ in those formula, reflecting the fact that the key difference is that now the total demand on the differentiated goods is scaled up. Alternatively speaking, international trade boosts industrialization, absorbing more labor away from the numeraire sector to the industrial sectors. The comparative static results are also the same as in Proposition 1.

Observe that the foreign productivity A^* and foreign labor endowment L^* are absent in the expressions of all the prices, profit, GDP, and labor income share in country H, as long as conditions (24) -(26) and (28) are satisfied. There are two reasons. First, the foreign total wealth $A^*L^*p_n$ is large enough such that it has no impact on the export demand on the differentiated goods. Second, country H has *strict* comparative advantage in the differentiated goods in the current equilibrium (i.e., $\frac{p(i)}{p_n}<A^*$). Hence, A^* does not appear in the expressions of the equilibrium outcome. We will explore other cases of equilibrium soon.

Proposition 3 *Suppose (24) -(26) and (28) are true. The monopoly profit of the upstream SOE and the GDP in country H are larger in the free trade equilibrium than in the autarky, but the labor income share in total GDP is smaller in the trade equilibrium.*

The intuition is as follows. Country H has comparative advantage in producing the differentiated goods (i.e., $\frac{p(i)}{p_n} < A^*$ as ensured by condition (24)), so international trade raises the aggregate demand for the differentiated goods, which in turn enhances the total demand for the intermediate good monopolized by the upstream SOE in country H. As a result, the total SOE profit in country H becomes larger than in the autarky. The total GDP is also larger, partly because the total profit is larger and partly because the rental price of capital (hence the capital income) is larger than in the autarky. Since both RK and Π_m increase while the labor income WL remains unchanged, hence the labor income share in total GDP in country H is smaller in the trade equilibrium than in autarky.[22]

[22] An immediate implication from Proposition 3 is that the upstream SOEs will benefit from the export promotion

It is worth emphasizing that condition (26) is very important. A sufficiently large labor supply helps ensure that the wage in country H is sufficiently low so that the differentiated goods produced by country H are still competitive in the international market although the intermediate good is charged with a monopolistic price. It again reflects the fact that country H's comparative advantage in the differentiated goods crucially relies on its labor abundance. Also, only when there exists a sufficiently large amount of labor can the equilibrium wage in country H be constant, independent of the total demand for labor in the non-numeraire sectors. Without this condition, the equilibrium wage in country H may become larger in the trade equilibrium than in autarky, so that the labor income share may become larger than in the current trade equilibrium.

This simple benchmark model of open economy formalizes an important and novel mechanism for how the high profitability of the SOEs in China can be helped by international trade in the past ten years, especially after China's accession to WTO in 2001. The membership of WTO facilitates China's export to the rest of the world, which can tremendously increase the aggregate demand for the upstream goods and services monopolized by SOEs in China and hence SOEs' profit. In our model, trade also leads to an expansion in the total GDP by boosting industrialization, which is consistent with China's experience. Our model shows that international trade can further lower the labor income share in a labor-abundant country like China. The key reason is again the invariant wage implied by the large pool of labor in the agriculture sector while the total GDP increases substantially.[23]

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policies for the goods and services produced in the downstream industries, as they stimulate foreign demand. Such policies include tariff reductions, tax and loan credits, and establishment of free-trade zones or processing trade special zones, *etc.* It may help explain why Chinese government, even as a purely selfish entity, has incentives to adopt various export-oriented trade policies. As long as foreign demand is sufficiently elastic to price subsidies, the total profit gain by the upstream SOE may well exceed the subsidy cost. Also, according to our framework, China would have more incentives to lend money to US, if this can stimulate US consumers to import more from China, as it benefits the upstream SOEs most. Such policies clearly have income redistribution effect on domestic groups.

[23] If the upstream monopoly is abolished so that the world achieves the social optimality, the new equilibrium factor prices and the formula in Lemma 3 remain valid except that μ should be replaced by 1, just as in the autarky case. The comparative static results are also similar to Proposition 2.

3.2.2 Domestic Labor Market Integration

Free mobility of labor is essential in our model to ensure equal wage across different sectors as well as the smooth industrialization. In reality, however, there exist institutional barriers to labor migration, which impede the labor supply for the expanding sectors. In China, the requirement of residence certificate, also known as *hukou* system, has been an important obstacle for people to migrate from rural to urban areas, resulting in a dual domestic labor market.

Now we show explicitly why domestic labor market integration is important for the upstream SOE to extract more monopoly rents in an open economy. Consider the same environment as in the benchmark trade model except that the labor market in country H is dual. More precisely, suppose there exists an upper limit fraction, ω, of total labor that is allowed to work in the non-numeraire sector (living in urban areas) where $\omega \in (0, 1)$. To make the analysis nontrivial, we assume ω is sufficiently small such that $\omega L < \overline{\overline{L}}(A, A_m, K)$, which makes the equilibrium wage W higher in the industrial sectors than that in the non-industrial sector (equal to p_n). We can show that, in the trade equilibrium, as ω increases (*i.e.*, less restrictions on labor movement), the monopoly profit Π_m, the GDP Y, and the labor income all increase. (See the appendix for the proof). The intuition is straightforward: A reduction in labor market frictions will lower the labor cost in the non-numeraire sectors and hence the prices of the differentiated goods, which in turn increases the demand for the differentiated goods and thus enlarges the induced demand for the intermediate good. This would ultimately lead to a higher upstream monopoly profit. Naturally, GDP rises and the total labor income also increases.

The analysis here illuminates how the domestic labor market integration ultimately helps the monopoly rent extraction of the upstream SOE. It may also help us understand from a new angle why China has gradually relaxed labor market restrictions including the *hukou* system in recently years.

4 Extension: Sustainability of China's State Capitalism

Can the SOEs in China keep earning high profit by continuing their monopoly of the upstream industries? Can GDP grow unboundedly without changing the vertical structure? Would the labor income share in total GDP continue to fall? In this section, we provide a simple analysis of these sustainability issues by extending the benchmark model of an open economy. We focus on three specific questions. First, what happens when the capital stock and/or the domestic productivities keeps growing such that the domestic wage starts to rise endogenously after all the labor in the numeraire sector is absorbed away by the other sectors (that is, after industrialization is almost finished)? Second, what happens if there exists a third country that can effectively compete with country H in the export market to country F? Third, what happens if the export demand from country F changes exogenously?[24]

4.1 Wage Increase

Recall in our benchmark model that country H's comparative advantage in the differentiated goods (or interpreted as the manufacturing sectors) is largely due to the labor abundance condition (26), which implies a constant (and low) wage despite the enlarged demand for the differentiated goods due to international trade. However, according to (19) and (27), this condition can be violated when L becomes sufficiently small (due to population decline or aging),[25] or when K becomes sufficiently large (due to capital accumulation), or when the productivity A or A_m gets big enough. In other words, as country H becomes sufficiently developed, condition (26) no longer holds.

More precisely, consider an environment similar to that in subsection 3.2. But suppose that K becomes big enough so that the following becomes true:

$$L < \overline{\overline{L}}(A, A_m, K), \tag{31}$$

which guarantees that country H will no longer produce the numeraire good. This could be interpreted as a development stage at which country H has already accumulated a sufficient amount of capital so that all the labor in country H has been absorbed by the non-numeraire sectors (that is, after sufficient industrialization).

First, we consider the case when capital K in country H is moderately high. More precisely, K is big enough to make (31) be true. But, at the same time, K is also small enough such that the

[24] A full-blown answer to these important sustainability questions must require a complicated dynamic analysis, which is beyond the scope of this paper and left for future research.

[25] In fact, United Nations estimates that the population between age 18 and age 30 in China hit the peak in 2010.

following is satisfied:

$$A^*L^* > \frac{\mu}{2\left[(1-\gamma)(1-\alpha-\beta)+\beta\mu\right]} L^{\frac{[(1-\gamma)(1-\alpha-\beta)+\beta](\epsilon-1)}{\epsilon}} \left[\overline{\overline{L}}(A, A_m, K)\right]^{\frac{1+\alpha(\epsilon-1)+\gamma(1-\alpha-\beta)(\epsilon-1)}{\epsilon}}. \quad (32)$$

In this case, we have the following result:[26]

Proposition 4 *Suppose capital K in country H is moderately high (i.e.,(31) and (32) are true). Under some auxiliary conditions, we have the following free trade equilibrium. Country H specializes in producing the differentiated goods, and country F specializes in producing the numeraire good; both countries consume both the numeraire and the differentiated goods. Moreover, the total GDP in country H is given by*

$$Y = B \cdot \left(A_m^{1-\alpha-\beta} A\right)^{\frac{\epsilon-1}{\epsilon}} K^{\frac{\alpha(\epsilon-1)+\gamma(1-\alpha-\beta)(\epsilon-1)}{\epsilon}} L^{\frac{(\epsilon-1)\{\gamma\beta+(1-\alpha)(1-\gamma)\}}{\epsilon}} p_n, \quad (33)$$

where B is a constant[27]*, and the factor income shares in GDP are all constant:*

$$\begin{aligned} \frac{WL}{Y} &= \frac{(1-\gamma)(1-\alpha-\beta)+\beta\mu}{\mu}, \quad (34) \\ \frac{RK}{Y} &= \frac{\gamma(1-\alpha-\beta)+\alpha\mu}{\mu}, \\ \frac{\Pi_m}{Y} &= \frac{(\mu-1)(1-\alpha-\beta)}{\mu}. \end{aligned}$$

Proof: See the Appendix.

In proposition 4, condition (32) guarantees that country F also consumes the numeraire good in the equilibrium. (33) shows that the aggregate output is of decreasing return to scale in the factor inputs although the production functions for the intermediate good and the differentiated goods are all of constant return to scale in capital and labor and no one works in the numeraire sector in country H. This is precisely because the monopoly of the upstream SOE enables it to

[26] To highlight the key intuition and to simplify the analysis, in this section we do not emphasize the effect of the domestic income inequality in country H on the trade equilibrium. We can assume that the wealth is redistributed via a non-distorting taxation and transfer (for example, in a lump-sum fashion) among the agents in country H such that everyone ends up with identical wealth (and consumption). In the next section we will explicitly discuss the impact of income inequality.

[27] More precisely, $B \equiv \left[\frac{(1-\gamma)(1-\alpha-\beta)+\beta\mu}{\gamma(1-\alpha-\beta)+\alpha\mu} + 1 + \frac{\frac{\mu-1}{\mu}(1-\alpha-\beta)}{\varkappa\left(\frac{\left[\frac{\mu}{\gamma^\gamma(1-\gamma)^{1-\gamma}}\right]^{1-\alpha-\beta}}{\alpha^\alpha\beta^\beta(1-\alpha-\beta)^{1-\alpha-\beta}}\right)^{\epsilon-1}}\right] \frac{\left[\frac{\gamma(1-\alpha-\beta)+\alpha\mu}{(1-\gamma)(1-\alpha-\beta)+\beta\mu}\right]^{\frac{(\epsilon-1)\{\gamma\beta+(1-\alpha)(1-\gamma)\}}{\epsilon}}}{(2\varkappa)^{-\frac{1}{\epsilon}}}$.

"steals away" part of the total output by indirectly distorting the wage and capital in the general equilibrium, although the factor markets themselves are perfect. In fact, (33) restores to constant return to scale once the monopoly is replaced by perfect competition ($\mu = 1$).

(33) and (34) also jointly determine the wage in country H, which now depends on the domestic factor endowment and productivities. This is different from the benchmark model in the previous section. More specifically, $\frac{\partial W}{\partial L} < 0; \frac{\partial W}{\partial A} > 0; \frac{\partial W}{\partial A_m} > 0; \frac{\partial W}{\partial K} > 0$. That is, the wage will increase as the economy develops after all the labor in the numeraire sector is absorbed out. (34) states that the labor income share in total GDP will be a constant, independent of the domestic factor endowment or productivity. Combined with the previous results in the benchmark model, this proposition indicates that, as the economy develops, the labor income share first declines and then stays constant after all the labor moves to the non-numeraire sectors. Proposition 4 also implies that the upstream SOE profit continues to get larger when the domestic productivity or factor endowment increases ($\frac{\partial \Pi_m}{\partial A} > 0; \frac{\partial \Pi_m}{\partial A_m} > 0; \frac{\partial \Pi_m}{\partial L} > 0; \frac{\partial \Pi_m}{\partial K} > 0$), but its share in total GDP is now also a constant.

It is easy to check that the marginal decrease in the price of the differentiated goods due to an increase in K is smaller than that in the benchmark case (that is, $\left|\frac{\partial p(i)}{\partial K}\right|$ is smaller when $L < \overline{\overline{L}}(A, A_m, K)$ than when $L > \overline{\overline{L}}(A, A_m, K)$). This is because the equilibrium wage now increases with K while it is constant in the benchmark case. This can potentially undermine the competitive advantage of country H in the differentiated goods.

Second, we consider that K (or equivalently, A orA_m) continues to increase and becomes large enough so that condition (32) is violated. This can sufficiently reduce the prices of the differentiated goods in country H such that country F no longer consumes the numeraire good (an alternative way to understand this is that country H becomes rich enough to consume all the numeraire goods produced in the world).

Proposition 5 *Suppose capital K in country H is sufficiently high (i.e.,(32) is not true). Under some auxiliary conditions, we have the following free trade equilibrium. Country H specializes in producing the differentiated goods and country F specializes in producing the numeraire good; country H consumes both the numeraire and the differentiated goods while country F only consumes* *the differentiated goods. Moreover, the total GDP in country H is given by*

$$Y = \left[\frac{1}{(\widetilde{\mu} - \mu)(1 - \alpha - \beta)(\epsilon - 1)} + 1 \right] A^* L^* p_n, \tag{35}$$

and the factor income shares in GDP are:

$$\begin{aligned} \frac{WL}{Y} &= \beta + (1 - \alpha - \beta) \frac{1 - \gamma}{\widetilde{\mu}}, \\ \frac{RK}{Y} &= \alpha + (1 - \alpha - \beta) \frac{\gamma}{\widetilde{\mu}}, \\ \frac{\Pi_m}{Y} &= (1 - \alpha - \beta) \frac{\widetilde{\mu} - 1}{\widetilde{\mu}}, \end{aligned}$$

where $\widetilde{\mu}$, the markup, is uniquely determined by the following equation

$$\frac{\left[(\widetilde{\mu} - \mu)(1 - \alpha - \beta)(\epsilon - 1)\right]^{\frac{1}{\epsilon - 1}}}{\widetilde{\mu}^{(1-\alpha-\beta)}} = \frac{\frac{(A^* L^*)^{\frac{\epsilon}{\epsilon - 1}}}{\left[\beta + (1-\alpha-\beta)\frac{1-\gamma}{\widetilde{\mu}}\right]^{-1+\alpha+\gamma(1-\alpha-\beta)}} \cdot \left[\frac{1 + (\widetilde{\mu} - \mu)(1-\alpha-\beta)(\epsilon - 1)}{(\widetilde{\mu} - \mu)(1-\alpha-\beta)(\epsilon-1)}\right]}{\left[\frac{\left(\left[\alpha + (1-\alpha-\beta)\frac{\gamma}{\widetilde{\mu}}\right]\frac{L}{K}\right)^{\alpha+\gamma(1-\alpha-\beta)}}{A\alpha^{\alpha}\beta^{\beta}\left[A_m \gamma^{\gamma}(1-\gamma)^{1-\gamma}(1-\alpha-\beta)\right]^{1-\alpha-\beta} L}\right]^{-1}}. \tag{36}$$

In this new equilibrium, the predictions for several key variables are different from the previous equilibria and thus should be highlighted.

First, (35) shows that the GDP of country H now depends explicitly on foreign variables (A^* and L^*). This is because now households in country F only consume the differentiated goods, therefore the foreign expenditure on the differentiated goods is simply binding at the total income level of country F ($A^* L^* p_n$), which is in the expression for country H's GDP (see (35)).

Second, the markup $\widetilde{\mu}$ is not a constant, as indicated by (36). Notice that the external demand for the differentiated goods ($D^*(i) = \frac{A^* L^* p_n}{p(i)}$) has unit price elasticity. Therefore, the new markup charged by the upstream SOE (denoted by $\widetilde{\mu}$) is some weighted average of the optimal markup for the foreign market (infinity) and the optimal markup for the domestic market (μ), thus $\widetilde{\mu} > \mu$. In addition, (36) also implies the following properties of $\widetilde{\mu}$:

$$\frac{\partial \widetilde{\mu}}{\partial A^*} > 0; \frac{\partial \widetilde{\mu}}{\partial L^*} > 0; \frac{\partial \widetilde{\mu}}{\partial K} < 0; \frac{\partial \widetilde{\mu}}{\partial L} < 0; \frac{\partial \widetilde{\mu}}{\partial A} < 0; \frac{\partial \widetilde{\mu}}{\partial A_m} < 0. \tag{37}$$

The intuition is straightforward. $\widetilde{\mu}$ increases when the foreign demand becomes more important (as A^* or L^* becomes larger) and it decreases when the domestic demand of country H becomes more important (as K, L, A or A_m increases). In particular, $\widetilde{\mu} = \mu$ when $A^*L^* = 0$, returning to the benchmark autarky model. Observe that the profitability (or profit margin) of the upstream SOE, defined as the ratio of profit to sales revenue, is $\frac{\widetilde{\mu}-1}{\widetilde{\mu}}$. According to (37), the SOE profitability increases when the foreign demand increases and it decreases when the domestic productivities or factor endowments become larger.[28]

Third, the share of SOE profit in GDP in country H is larger than in the previous equilibrium, but it decreases when domestic productivities or factor endowments increase (as K, L, A or A_m increases).

Fourth, the labor income share in country H is no longer a constant, but rather increases as domestic productivities or factor endowments increase. This is due to the change in markup $\widetilde{\mu}$. In other words, the Cobb-Douglass production functions in the non-mumeraire sectors do not necessarily yield a constant factor income share in country H although no numeraire good is produced.

In summary, the above two propositions show how capital accumulation (an increase in capital) in country H may shift the economy into different equilibria, in which many key variables such as the SOE profitability and the labor income share in total GDP have different and sometimes even opposite properties. Similar analyses can be conducted by exploring different equilibrium regimes based on the increase in other domestic variables such as L, A or A_m.[29]

So far, we have assumed that no unfavorable changes occur outside country H, which can be unrealistic and will be relaxed in the next two subsections.

4.2 Export Competition

Consider the open-economy scenario characterized by Proposition 4, in which country H only produces the non-numeraire goods but consumes both. There, the equilibrium price markup for the intermediate good in country H is $\mu \equiv \frac{(1-\alpha-\beta)(\epsilon-1)+1}{(1-\alpha-\beta)(\epsilon-1)}$. Also, we can prove that the equilibrium

[28] This may help us better understand why the profitability (not just the profit) of the SOEs ($\frac{\widetilde{\mu}-1}{\widetilde{\mu}}$) can be increasing as the economy develops.

[29] The analysis for A or A_m is almost identical to the analysis of K because in most cases what matter is only the value $\overline{\overline{L}}(A, A_m, K)$.

price for the differentiated good $p(i)$ can be expressed as a function of μ:

$$p(i) = \Gamma(\mu) \cdot p_n, \forall i \in [0,1],$$

where function $\Gamma(\cdot)$ is defined as[30]

$$\begin{aligned}\Gamma(\varpi) \quad \equiv \quad & \frac{2^{\frac{1}{\epsilon}} \left[\gamma^{\gamma}(1-\gamma)^{1-\gamma}\right]^{\frac{-(1-\alpha-\beta)}{\epsilon}}}{\left[\alpha^{\alpha}\beta^{\beta}(1-\alpha-\beta)^{1-\alpha-\beta}\right]^{\frac{1}{\epsilon}}} \left[A_m^{(1-\alpha-\beta)} A\right]^{\frac{-1}{\epsilon}} K^{\frac{-[\alpha+\gamma(1-\alpha-\beta)]}{\epsilon}} L^{-\frac{(1-\gamma)(1-\alpha-\beta)+\beta}{\epsilon}} \\ & \cdot \frac{[\gamma(1-\alpha-\beta)+\alpha\varpi]^{\alpha+\gamma(1-\alpha-\beta)} \left[(1-\gamma)(1-\alpha-\beta)+\beta\varpi\right]^{(1-\gamma)(1-\alpha-\beta)+\beta}}{\varpi^{\alpha+\beta}}. \qquad (38)\end{aligned}$$

Now suppose there comes a third country that can export differentiated good i (to country F) at price $T \cdot p_n$ for any $i \in [0,1]$ at a sufficiently large amount. To make the analysis nontrivial, assume that $T < A^*$ so that country F would prefer to import the differentiated goods from this country in the absence of country H. In other words, this third country is a potential competitor of country H for the market in country F. Obviously, nothing changes in country H and F when T is large enough to satisfy the following:

$$T > \Gamma(\mu). \qquad (39)$$

However, when the third country manages to lower T (due to technological progress or policy subsidies for instance) such that $T \in [\Gamma(1), \Gamma(\mu))$, then country H will have to set $p(i)$ equal to $T \cdot p_n$ in order to beat its trade competitor. It implies that the upstream SOE has to lower its price markup. The new markup level, denoted by $\widehat{\mu}$, is determined by the following equation:[31]

$$\Gamma(\widehat{\mu}) = T. \qquad (40)$$

Thus a more stringent (lower) T implies a lower price markup and lower SOE profit in country H. However, if $T < \Gamma(1)$, then country H loses the market of country F. In that case, a sufficient increase in the upstream or downstream productivity or capital endowment will be necessary in order to regain its competitiveness in the differentiated goods in the global market (refer to (38)). To summarize,

Proposition 6 *When $T \cdot p_n$, the price of the differentiated goods charged by a potential competitor, is sufficiently high (given by (39)), the upstream industry in country H charges monopoly price*

[30] Conjecture: $\Gamma'(\varpi) > 0$ for any $\varpi \in [1, \mu]$. This can be confirmed when no capital is needed for production in the model ($\alpha = \gamma = 0$) or when no labor is needed in the non-numeraire goods ($\beta = 1 - \gamma = 0$).

[31] Assume, for simplicity, that the optimal production and trade patterns in country H and F are not change.

markup equal to μ*; When* $T \in [\Gamma(1), \Gamma(\mu))$*, the SOE lowers the price makeup to* $\widehat{\mu}$*, which is determined by (40); When* $T < \Gamma(1)$*, the upstream SOE in country H has to improve its productivity* A_m *if it wants to maintain its international competitiveness of the differentiated goods.*

This proposition points out that, when international competition becomes tougher, the SOE monopolist in country H eventually has to improve its productivity in order to maintain its monopoly profit or even just to survive in the free trade economy. When applied to China, this proposition suggests that the monopoly rent of upstream SOEs would decrease or even disappear if they fail to have sufficient increase in their productivities, because potentially there exist many other developing countries that can effectively compete with China for the export markets. Correspondingly, the growth potential of GDP in China would be also undermined if its domestic productivity fails to increase as fast as its potential trade competitors.

Another way to interpret this proposition is that, holding the outside countries (including T) unchanged, now if China's population (labor force) shrinks sufficiently, due to the fertility decision or aging problems for example, then the rise of labor cost in China would push up the production cost of the exports (see (38)) and hence weaken China's competitiveness in its exports, which would eventually push down the SOE profit or GDP growth.

4.3 Change in External Demand

A critical feature of China's model of state capitalism is that the domestic upstream SOEs extract monopoly rents from the downstream private producers and the immobile production factors (such as labor) via foreign consumers. Therefore, a higher external demand translates into a higher monopoly profit in the upstream SOEs. But what happens if foreign demand changes due to, for example, the 2008 world financial crisis?

Now we investigate the consequence of some exogenous economic change of the trade partner, or country F in our framework. From country H's point of view, an exogenous decline in its external demand from country F can result from a decrease in the total labor endowment of country F (L^*) or a decrease in the productivity of the numeraire good (A^*).

For simplicity, we consider the equilibrium regime characterized by Proposition 5. This proposition implies, not surprisingly, that a decline in A^* (or L^*) leads to a decrease in both the monopoly profit Π_m and GDP (i.e., $\frac{\partial \Pi_m}{\partial A^*} > 0$ and $\frac{\partial Y}{\partial A^*} > 0$; $\frac{\partial \Pi_m}{\partial L^*} > 0$ and $\frac{\partial Y}{\partial L^*} > 0$). In addition, the labor income share should increase when A^* (or L^*) declines, mainly due to the shrinkage of GDP, even though the wage also decreases. More generally, the decline in A^* (or L^*) would decrease the SOE profit and GDP in country H, sometimes weakly.[32]

The analysis suggests that, for a trade-dependent country like China, the upstream SOE profit and the total GDP can be adversely affected by external demand shocks. In particular, the model suggests that a large volatility of the external demand may lead to an even larger volatility of the upstream SOE profit due to the markup price effect. This is consistent with Figure 1, as we can see that the SOE profit increased faster than the non-state firms when export increased but it also dropped more dramatically than the non-state firms when experiencing negative external demand shocks during the 2007-2009 world financial crisis. Different from the SOEs, the profitability of the non-state enterprises was much more stable and did not move closely with the export.

Our analysis hints that, as the share of China's GDP increases in the world economy, it can be important for China to push up its domestic consumption demand, not only to buffer the unexpected short-run negative external demand shocks but also to improve its long-run sustainability.

5 Emergence of China's State capitalism

The benchmark model is designed to capture what happened in China after 2001, when the privatization of downstream industries was almost completed. Nevertheless, our framework can incorporate the opposite pattern in the 1990s.

As Figure 1 shows, the profitability of SOEs was below that of non-SOEs from the early 1990s and the gap was widened substantially between 1994 and 1998. SOEs experienced a sharp increase in profitability between 1998 and 2000, a period of massive SOE privatization (so-called "three-year battle", as mentioned in Section 2), and finally surpassed non-SOEs around 2000.

We argue that the above phenomenon is due to the gradual liberalization of the downstream industries in the 1990s, a process in which the vertical structure of today's state capitalism gradually

[32] In the equilibrium regimes characterized in the benchmark trade model and in Proportion 4, we can see that the GDP, SOE profit, and labor income share of country H are independent of A^* and L^*, as the external demand is smaller than foreign income $A^* L^* p_n$.

emerged. As documented in Section 2, China accelerated its reform process and drastically increased the openness to FDI since 1992. With the entry and expansion of the high-productivity non-SOEs, domestic or foreign, many SOEs lost the competition and had to rely on subsidies from the government or other SOEs to maintain operation. This drove down the average profitability of SOEs as a whole, although the country as a whole grew rapidly due to the better resource allocation from the low-productivity SOEs to the high-productivity non-SOEs, as formalized in Song et al. (2011). During the period of massive SOE privatization in the downstream industries in 1998-2000, most of those money-losing SOEs gradually exited from competitive downstream industries and, therefore, the average profitability of SOEs started to rise. The vertical structure featured in today's state capitalism in China came into the full shape around 2001, by which almost all the money-losing SOEs had retreated from the competitive downstream industries while the remaining SOEs still stay and monopolize in the upstream industries. The fortune of SOEs as a whole has been reversed afterwards.[33]

The aforementioned emerging process of the state capitalism can actually be formalized in our framework. To fix the idea, first imagine the same setting as the benchmark model of autarky except that now the downstream industries are partially liberalized. Let ϕ denote the fraction of downstream industries that are liberalized, where SOEs and non-SOEs are engaged in perfect competition. Non-SOEs are not allowed to enter any of the rest $1-\phi$ fraction of the industries, each of which is monopolized by one state firm. So $\phi = 0$ at the beginning of the economic reform. The production function for industry i is still given by (2) for each $i \in [0, 1]$, where $A = A_p$ if it is a private firm, and $A = A_s$ if it is a state firm. We assume $A_s < A_p$.

Without government subsidies, SOEs will exit completely in those liberalized industries and be replaced by competitive private firms. The SOEs in the regulated industries are delegated to managers who cannot collude, so they are engaged in monopolistic competition. We can prove that,

[33] Brandt, Tombe and Zhu (2010) empirically find, but have not yet formally explained, the following "V"–shaped pattern of distortions in China's TFP: it first decreased during 1985 and 1997 and then increased in the last decade. Our model can explain this non-monotonic pattern as follows. The distortion between state and non-state-controlled sectors declined as the SOEs gradually exited from the downstream industries during 1985-1997, and the distortion 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.

when $\frac{A_p}{A_s}$ is sufficiently large, the total profit of SOEs is maximized when the downstream industries are fully liberalized ($\phi = 1$). See the appendix for proof. This can be intuitively explained as follows. The low productivity of an SOE monopolist in the downstream has two negative effects on the total SOE profit. One is that the profit earned from that monopolized industry is small. The other is that the induced demand for the upstream intermediate good from this particular industry is also small. In addition, once some industries are already liberalized, the profit of those monopolized SOEs will be reduced even further due to the cross-industry substitution effect. On the other hand, part of the lost demand for the intermediate good is recovered due to the expansion of those liberalized downstream industries. It turns out that, when $\frac{A_p}{A_s}$ is sufficiently large, the net effect will be such that, the larger the fraction of downstream industries that are liberalized, the more profit the upstream industry can earn due to the larger induced demand for the intermediate good, which dominates the monopoly profit loss in the whole downstream industries due to liberalization. Thus the profit-maximizing ϕ should be one (full liberalization).

Now consider the case when some downstream SOEs are subsidized by the government to keep operating and compete with private firms in the same liberalized industries. This indeed occurred in China. To break even, an SOE in the liberalized industry needs a subsidy equal to $\frac{R^\alpha W^\beta {p_m}^{1-\alpha-\beta}}{\alpha^\alpha \beta^\beta (1-\alpha-\beta)^{1-\alpha-\beta}} \left(\frac{1}{A_s} - \frac{1}{A_p} \right)$ for each unit of output produced by this SOE. The more this SOE produced, the more subsidy it needs. In particular, if the subsidy comes from other SOEs (for example, the upstream SOE), then it can hurt the total SOE profit if the SOE production scale is maintained at a high level in the downstream. Obviously, GDP still increases in ϕ and in reducing the remaining SOEs in the liberalized industries.

Economic openness also plays an important role in facilitating the liberalization of the downstream industries. An SOE in the liberalized downstream industry would lose more money (or need more subsidy) when competing with private firms because the latter become more cost effective as productivity A_p becomes larger or more capital is available for private firms (consider foreign direct investment). Besides, external demand increases, creating more room for the entry of new private firms.

6 Discussions

In this section, we briefly address several remaining issues within our framework.

6.1 Income Distribution and Domestic Demand

For the sake of simplicity, we have assumed that both the elite class and grass roots are rich enough such that both groups will consume numeraire goods in the benchmark model. The sustainability analysis also proceeds by circumventing the issue of household income distribution. However, by design, our original model setting enables us to offer a non-trivial analysis on the causes and consequences of income inequality under our framework of state capitalism.

The non-homothetic utility function, (1), implies that household income inequality would affect the aggregate consumption demand for the differentiated goods even when holding the aggregate income fixed. More precisely, at any given price, the domestic aggregate demand for the differentiated goods is fully determined by the aggregate income of the poor households who only consume the differentiated goods and the fraction of households who are rich enough to also consume a positive amount of numeraire good. In particular, the aggregate demand for the differentiated goods can be depressed if the income distribution deteriorates such that a larger fraction of total wealth is concentrated in a decreasing fraction of rich households. This is because the demand for the differentiated goods does not increase with income when the income exceeds a certain threshold, as seen in (4).

Our previous model analysis shows that, as domestic productivity increases and/or capital accumulates, the labor income share in GDP typically declines while the capital share and the SOE profit typically increase. International trade lowers the labor income share even further. All these suggest that income tends to concentrate to the elite group, so the domestic consumption demand for industrial goods tends be more and more depressed. On the other hand, the depressed aggregate demand for the industrial products deters industrialization and GDP expansion. This makes foreign demand even more important for China's structural change (industrialization) and economic growth.

6.2 Subsidies and Taxes

An alternative hypothesis to explain the recent higher profitability of SOEs relative to non-SOEs is that SOEs receive more subsidies or pay less tax, which is conceptually complementary to our theory. However, if this is the key reason, then it still remains unclear why the better performance of SOEs was not observed in China in the earlier periods, especially given that the subsidies for SOEs were larger in the last century.

Table 4 reports the data related to the tax and subsidies of industrial enterprises in China. Column (2) shows that share of total taxes paid by SOEs have been decreasing over time and reached about 50% in recent years. In comparison, columns (3) and (4) show that the share of the value-added and profits from SOEs in the industrial sector is below 34% and 27%, respectively. These results suggest that, if anything, SOEs pay much higher effective tax rates than non-SOEs. In other words, if government provides more subsidies to SOEs than to non-SOEs, those subsidies are unlikely in the form of lower taxes. Direct subsidies to SOEs, as shown in column (5) are decreasing over time and are relatively small both in absolute magnitude and as a percentage of GDP, SOE value-added, or SOE gross profits.

It is possible that the Chinese government indirectly subsidizes SOEs with preferential access to large amounts of low-cost loans through financial intermediaries, which are largely state controlled. However, it is not obvious why the Chinese government would subsidize SOEs while simultaneously imposing much higher effective tax rates on SOEs. Also, even if such indirect policy subsidies may well exist, it is difficult to accurately differentiate and clarify the causality. As mentioned earlier, a free-competition financial market (with frictions) itself would still favor SOEs to non-SOEs if the former are more profitable in the first place.

In addition, some explicit policy subsidies to SOEs could be merely the consequence of the industry locations of these firms instead of their state-ownership. The Chinese government designates a range of industries as strategic and provides various kinds of support to those industries. If those industries happen to be monopolized by SOEs, then the subsidies to those industries automatically become the subsidies to SOEs. In other words, non-SOEs would have also received those subsidies if they are also in those strategic industries. For example, the Chinese government has subsidized many industries without state ownership such as alternative energy and telecom equipment.

6.3 Causes of Monopoly

According to our theory, once the downstream industries are fully liberalized, the high profitability of the upstream firm is mainly due to its monopoly position, not to state-ownership itself. If a non-SOE obtains the monopoly position, it can also earn high profit. Our benchmark model , therefore, takes the monopoly of upstream SOE as given, based on the empirical evidences provided in Section 2. It would be important to carefully analyze the true cause of monopoly in each different upstream industry, if we want to think further about the more fundamental roots of such vertical structure or the procedures of possible reforms in reality, which are beyond the scope of this paper.

However, we want to make three clarifications or qualifications. First, although some of the upstream industries are prone to be natural monopoly, it is still the government-granted monopoly that are dominant in most upstream industries, as partly revealed by the empirical evidences documented in Section 2. Natural monopoly alone does not permanently shield an inefficient incumbent firm from being replaced, as it is always exposed to potential competition from new entrants or existing players within the sector, especially if the monopoly profit is persistently much higher than other industries or if the inefficiency is excessively high. Non-SOEs would have entered the high-profit upstream industries if allowed. Second, some upstream services are non-tradable or largely non-traded due to regulation, such as the railway constructions, electricity, and telecommunication services. Such industries are still shielded from foreign competition after China's accession to WTO. Third, in reality, not all the downstream industries are privatized (for example, tobacco industry is still largely monopolized by SOEs in China), and not every upstream industry is purely monopolized by state firms or earn huge profits.

7 Conclusion

We provide a simple model of China's state capitalism that highlights a vertical structure featured in the recent Chinese economy, namely, SOEs monopolize key industries and markets in the upstream, whereas downstream industries are largely liberalized and left to intense competition among non-SOEs. We show that this vertical structure, when combined with trade openness and labor abundance, can explain the puzzling fact that SOEs have achieved an unprecedentedly high profitability, dwarfing the performance of non-SOEs, in the last decade, while the economy as a whole has still attained a high growth rate after China's accession to WTO in 2001. The key mechanism is as follows. Upstream SOEs are able to extract monopolistic rents on the intermediate inputs that these firms provide to non-SOEs in the liberalized downstream industries. The downstream private industries have expanded with the trade liberalization and domestic industrialization by taking advantage of China's abundant labor. Consequently, upstream SOEs have outperformed non-SOEs in the liberalized downstream industries, although the key driving force for China's aggregate growth is still the dynamism of the private sector.

We also demonstrate how our framework can explain the persistently low and declining labor income share in China's GDP in the past two decades and why SOEs as a whole were outperformed by non-SOEs in the 1990s, before this vertical structure of state capitalism had fully emerged. Our theory points to the incompleteness of the market-oriented reforms as the fundamental cause for the recent unusual prosperity of China's SOEs. We extend the benchmark model to show why this development model of state capitalism may not be sustainable.

This paper adopts a positive and qualitative approach, and it represents only a first step toward the better understanding of state capitalism in countries like China. Several directions seem particularly appealing for future research. First, what are the quantitative implications of our model, especially when extended to an explicit dynamic framework? Second, how to better understand the political-economy aspects of such a model of state capitalism? Third, given the institutional features illuminated in our model, what should we do to ensure sustainable growth and how to do it? In a globalization age like today, we believe that a deep understanding of state capitalism is of fundamental importance to China and the world economy at large.

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8 Appendix

8.1 Proof of Lemma 3

First, we prove why (24) -(26) are needed. To ensure the trade pattern in the equilibrium be as described earlier, we must require

$$\frac{p(i)}{p_n} < A^*,$$

or equivalently

$$\frac{1}{A\alpha^{\alpha}\beta^{\beta}\left(1-\alpha-\beta\right)^{1-\alpha-\beta}}\left(\frac{\mu}{A_m\gamma^{\gamma}\left(1-\gamma\right)^{1-\gamma}}\right)^{1-\alpha-\beta}\left(\frac{K}{2b}\right)^{\frac{-[\alpha+\gamma(1-\alpha-\beta)]}{1+\alpha(\epsilon-1)+\gamma(1-\alpha-\beta)(\epsilon-1)}} < A^*.$$

The positive production of the numeraire good in country H requires $L > \overline{\overline{L}}$, where

$$\overline{\overline{L}} \equiv 2^{\frac{1}{1+\alpha(\epsilon-1)+\gamma(1-\alpha-\beta)(\epsilon-1)}}\,\overline{L}(A, A_m, K),$$

which is the total labor employed in the non-numeraire sectors in country H in the trade equilibrium. On the other hand, the positive consumption of the numeraire good in country F requires

$$D_n^* = A^*L^* - \frac{\int p(i)D^*(i)di}{W} > 0,$$

or equivalently

$$A^*L^* - \left(A\alpha^{\alpha}\beta^{\beta}\left(1-\alpha-\beta\right)^{1-\alpha-\beta}\left(\frac{A_m\gamma^{\gamma}\left(1-\gamma\right)^{1-\gamma}}{\mu}\right)^{1-\alpha-\beta}\left(\frac{K}{2b}\right)^{\frac{[\alpha+\gamma(1-\alpha-\beta)]}{1+\alpha(\epsilon-1)+\gamma(1-\alpha-\beta)(\epsilon-1)}}\right)^{\epsilon-1} > 0.$$

The individual consumption in country H is given by

$$\begin{aligned}
c_n^e &= L + \left(\frac{K}{2b}\right)^{\frac{-1}{1+\alpha(\epsilon-1)+\gamma(1-\alpha-\beta)(\epsilon-1)}}\cdot K + \frac{\left[\frac{1}{A\alpha^{\alpha}\beta^{\beta}(1-\alpha-\beta)^{1-\alpha-\beta}}\right]^{1-\epsilon}}{\left[\frac{\mu}{A_m\gamma^{\gamma}(1-\gamma)^{1-\gamma}}\right]^{(1-\alpha-\beta)(\epsilon-1)}} \\
&\quad \cdot\left(\frac{K}{2b}\right)^{\frac{\alpha(\epsilon-1)+\gamma(1-\alpha-\beta)(\epsilon-1)}{1+\alpha(\epsilon-1)+\gamma(1-\alpha-\beta)(\epsilon-1)}}\cdot\left[\frac{1}{\theta}\frac{2(1-\alpha-\beta)}{\left(1-\alpha-\beta\right)\left(\epsilon-1\right)+1} - 1\right], \\
c_n^g &= L + \left(\frac{K}{2b}\right)^{\frac{-1}{1+\alpha(\epsilon-1)+\gamma(1-\alpha-\beta)(\epsilon-1)}}\cdot K - \frac{\left[\frac{1}{A\alpha^{\alpha}\beta^{\beta}(1-\alpha-\beta)^{1-\alpha-\beta}}\right]^{1-\epsilon}}{\left[\frac{\mu}{A_m\gamma^{\gamma}(1-\gamma)^{1-\gamma}}\right]^{(1-\alpha-\beta)(\epsilon-1)}}\cdot \\
&\quad \cdot\left(\frac{K}{2b}\right)^{\frac{\alpha(\epsilon-1)+\gamma(1-\alpha-\beta)(\epsilon-1)}{1+\alpha(\epsilon-1)+\gamma(1-\alpha-\beta)(\epsilon-1)}}, \\
c^j(i) &= \left\{\frac{1}{A\alpha^{\alpha}\beta^{\beta}\left(1-\alpha-\beta\right)^{1-\alpha-\beta}}\left(\frac{\mu}{A_m\gamma^{\gamma}\left(1-\gamma\right)^{1-\gamma}}\right)^{1-\alpha-\beta}\left(\frac{K}{2b}\right)^{\frac{-[\alpha+\gamma(1-\alpha-\beta)]}{1+\alpha(\epsilon-1)+\gamma(1-\alpha-\beta)(\epsilon-1)}}\right\}^{-\epsilon}, \\
\forall i &\in [0,1],\ \forall j \in \{e, g\}.
\end{aligned}$$

The aggregate consumption of the numeraire good in country H is

$$
\begin{aligned}
C_0 &= L + (\frac{K}{2b})^{\frac{-1}{1+\alpha(\epsilon-1)+\gamma(1-\alpha-\beta)(\epsilon-1)}} \cdot K + \frac{[\frac{1}{A\alpha^\alpha\beta^\beta(1-\alpha-\beta)^{1-\alpha-\beta}}]^{1-\epsilon}}{[\frac{\mu}{A_m\gamma^\gamma(1-\gamma)^{1-\gamma}}]^{(1-\alpha-\beta)(\epsilon-1)}} \\
& \cdot (\frac{K}{2b})^{\frac{\alpha(\epsilon-1)+\gamma(1-\alpha-\beta)(\epsilon-1)}{1+\alpha(\epsilon-1)+\gamma(1-\alpha-\beta)(\epsilon-1)}} [\frac{2(1-\alpha-\beta)}{(1-\alpha-\beta)(\epsilon-1)+1} - 1].
\end{aligned}
$$

For completeness, the total (or individual) consumption in country F is given by $c_n^* = A^*L^* - [\frac{1}{A\alpha^\alpha\beta^\beta(1-\alpha-\beta)^{1-\alpha-\beta}}]^{1-\epsilon}[\frac{\mu}{A_m\gamma^\gamma(1-\gamma)^{1-\gamma}}]^{(1-\alpha-\beta)(1-\epsilon)}(\frac{K}{2b})^{\frac{\alpha(\epsilon-1)+\gamma(1-\alpha-\beta)(\epsilon-1)}{1+\alpha(\epsilon-1)+\gamma(1-\alpha-\beta)(\epsilon-1)}}$ and $c^*(i) = \left\{\frac{1}{A\alpha^\alpha\beta^\beta(1-\alpha-\beta)^{1-\alpha-\beta}}(\frac{\mu}{A_m\gamma^\gamma(1-\gamma)^{1-\gamma}})^{1-\alpha-\beta}(\frac{K}{2b})^{\frac{-[\alpha+\gamma(1-\alpha-\beta)]}{1+\alpha(\epsilon-1)+\gamma(1-\alpha-\beta)(\epsilon-1)}}\right\}^{-\epsilon}, \forall i \in [0,1]$. Condition (25) guarantees that $c_n^* > 0$. The total GDP in country F is $I^* = L^*W^* = L^*A^*W$.

To ensure that even the grass root in country H consumes a positive amount of numeraire good, we have

$$
\begin{aligned}
RK + WL &> p_n^\epsilon P^{1-\epsilon} \\
\Leftrightarrow \ L &> \left[p_n \cdot \frac{\left[A_m^{(1-\alpha-\beta)}A\right]^{\frac{-1}{1+\alpha(\epsilon-1)+\gamma(1-\alpha-\beta)(\epsilon-1)}}}{\alpha^\alpha\beta^\beta(\frac{1-\alpha-\beta}{\frac{\mu}{\gamma^\gamma(1-\gamma)^{1-\gamma}}})^{1-\alpha-\beta}}(\frac{K}{2\varkappa})^{\frac{-[\alpha+\gamma(1-\alpha-\beta)]}{1+\alpha(\epsilon-1)+\gamma(1-\alpha-\beta)(\epsilon-1)}}\right]^{1-\epsilon} \\
& - \left[A_m^{(1-\alpha-\beta)}A\right]^{\frac{(\epsilon-1)}{1+\alpha(\epsilon-1)+\gamma(1-\alpha-\beta)(\epsilon-1)}}(\frac{K}{2\varkappa})^{\frac{-1}{1+\alpha(\epsilon-1)+\gamma(1-\alpha-\beta)(\epsilon-1)}}K \\
\Leftrightarrow \ L &> \frac{\frac{\mu}{2} - \gamma(1-\alpha-\beta) - \alpha\mu}{(1-\gamma)(1-\alpha-\beta) + \beta\mu} \equiv \overline{L}(A, A_m, K).
\end{aligned}
$$

Therefore, the condition of $\frac{\frac{\mu}{2}-\gamma(1-\alpha-\beta)-\alpha\mu}{(1-\gamma)(1-\alpha-\beta)+\beta\mu} \geq 1$ means that $(1-\alpha-\beta)(\epsilon-3)+1 \leq 0$.

It is easy to confirm that

$$
\overline{\overline{L}}(A, A_m, K) \equiv 2^{\frac{1}{1+\alpha(\epsilon-1)+\gamma(1-\alpha-\beta)(\epsilon-1)}}\overline{L}(A, A_m, K).
$$

8.2 Proof of Proposition 4

Suppose that the SOE takes the wage as exogenously given. The labor market clearing condition in country H is

$$
\begin{aligned}
L &= \int [D(i) + D^*(i)] \cdot \frac{\partial p(i)}{\partial W} di + D_m \frac{\partial \frac{R^\gamma W^{1-\gamma}}{A_m\gamma^\gamma(1-\gamma)^{1-\gamma}}}{\partial W} \\
&= 2\frac{p_n^\epsilon}{W^\epsilon}\left[\frac{\left(\frac{R}{W}\right)^{\alpha+\gamma(1-\alpha-\beta)}\left(\frac{\widetilde{\mu}}{A_m\gamma^\gamma(1-\gamma)^{1-\gamma}}\right)^{1-\alpha-\beta}}{A\alpha^\alpha\beta^\beta(1-\alpha-\beta)^{1-\alpha-\beta}}\right]^{1-\epsilon}\beta\left[1 + \frac{(1-\gamma)(1-\alpha-\beta)}{\widetilde{\mu}\beta}\right],
\end{aligned}
$$

since

$$p_m = \frac{\widetilde{\mu} R^{\gamma} W^{1-\gamma}}{A_m \gamma^{\gamma} (1-\gamma)^{1-\gamma}}.$$

That is,

$$L = 2\frac{p_n^{\epsilon}}{W^{\epsilon}} \left[\frac{\left(\frac{R}{W}\right)^{\alpha+\gamma(1-\alpha-\beta)} \left(\frac{\widetilde{\mu}}{A_m \gamma^{\gamma}(1-\gamma)^{1-\gamma}}\right)^{1-\alpha-\beta}}{A \alpha^{\alpha} \beta^{\beta} (1-\alpha-\beta)^{1-\alpha-\beta}} \right]^{1-\epsilon} \beta \left[1 + \frac{(1-\gamma)(1-\alpha-\beta)}{\widetilde{\mu}\beta}\right]. \tag{41}$$

The capital labor market clearing condition in country H is

$$K = \int [D(i) + D^*(i)] \cdot \frac{\partial p(i)}{\partial R} di + D_m \frac{\partial \frac{R^{\gamma} W^{1-\gamma}}{A_m \gamma^{\gamma}(1-\gamma)^{1-\gamma}}}{\partial R}.$$

From (14), we obtain

$$K = 2b \left(\frac{R}{W}\right)^{-[1+\alpha(\epsilon-1)+\gamma(1-\alpha-\beta)(\epsilon-1)]} \cdot \left(\frac{p_n}{W}\right)^{\epsilon},$$

which, together with (41), yields

$$\frac{\mu^{(1-\alpha-\beta)(1-\epsilon)-1} \cdot [\gamma(1-\alpha-\beta) + \alpha\mu]}{\left[\widetilde{\mu}^{1-\alpha-\beta}\right]^{1-\epsilon} \left[\beta + \frac{(1-\gamma)(1-\alpha-\beta)}{\widetilde{\mu}}\right]} = \frac{K}{L} \frac{R}{W},$$

where $b \equiv \left[A_m^{(1-\alpha-\beta)} A\right]^{\epsilon-1} \varkappa$.

When $\widetilde{\mu} = \mu$, the above equation becomes

$$\frac{R}{W} = \frac{\gamma(1-\alpha-\beta) + \alpha\mu}{\beta\mu + (1-\gamma)(1-\alpha-\beta)} \frac{L}{K}.$$

Consequently,

$$\begin{aligned}
W &= (2b)^{\frac{1}{\epsilon}} \left[L \cdot \frac{\gamma(1-\alpha-\beta)+\alpha\mu}{(1-\gamma)(1-\alpha-\beta)+\beta\mu}\right]^{\frac{-[1+\alpha(\epsilon-1)+\gamma(1-\alpha-\beta)(\epsilon-1)]}{\epsilon}} K^{\frac{\alpha(\epsilon-1)+\gamma(1-\alpha-\beta)(\epsilon-1)}{\epsilon}} p_n, \\
R &= (2b)^{\frac{1}{\epsilon}} \left[L \cdot \frac{\gamma(1-\alpha-\beta)+\alpha\mu}{(1-\gamma)(1-\alpha-\beta)+\beta\mu}\right]^{\frac{[1-\alpha-\gamma(1-\alpha-\beta)](\epsilon-1)}{\epsilon}} K^{\frac{\alpha(\epsilon-1)+\gamma(1-\alpha-\beta)(\epsilon-1)}{\epsilon}-1} p_n, \\
W^* &= A^* p_n,
\end{aligned}$$

$$
\begin{aligned}
p_m &= (2b)^{\frac{1}{\epsilon}} \frac{\mu K^{\frac{\alpha(\epsilon-1)+\gamma(1-\alpha-\beta)(\epsilon-1)}{\epsilon}-\gamma}}{A_m \gamma^{\gamma}(1-\gamma)^{1-\gamma}} \left[L \cdot \frac{\gamma(1-\alpha-\beta)+\alpha\mu}{(1-\gamma)(1-\alpha-\beta)+\beta\mu} \right]^{\frac{(\epsilon-1)\{\gamma\beta-(1-\gamma)\alpha\}-(1-\gamma)}{\epsilon}} p_n, \\
p(i) &= \frac{(2b)^{\frac{1}{\epsilon}} \left[\frac{\mu}{A_m\gamma^{\gamma}(1-\gamma)^{1-\gamma}}\right]^{1-\alpha-\beta}}{A\alpha^{\alpha}\beta^{\beta}(1-\alpha-\beta)^{1-\alpha-\beta}} K^{\frac{-[\alpha+\gamma(1-\alpha-\beta)]}{\epsilon}} \left[L \cdot \frac{\gamma(1-\alpha-\beta)+\alpha\mu}{(1-\gamma)(1-\alpha-\beta)+\beta\mu} \right]^{-\frac{(1-\gamma)(1-\alpha-\beta)+\beta}{\epsilon}} p_n, \\
D(i) &= D^*(i) = (2b)^{-1} K^{\alpha+\gamma(1-\alpha-\beta)} \frac{\left[L \cdot \frac{\gamma(1-\alpha-\beta)+\alpha\mu}{(1-\gamma)(1-\alpha-\beta)+\beta\mu}\right]^{(1-\gamma)(1-\alpha-\beta)+\beta}}{\left(\frac{\left[\frac{\mu}{\gamma^{\gamma}(1-\gamma)^{1-\gamma}}\right]^{1-\alpha-\beta}}{A_m^{1-\alpha-\beta}A\alpha^{\alpha}\beta^{\beta}(1-\alpha-\beta)^{1-\alpha-\beta}}\right)^{\epsilon}}, \\
D_m &= (b)^{-1} K^{\gamma} \frac{\left[L \cdot \frac{\gamma(1-\alpha-\beta)+\alpha\mu}{(1-\gamma)(1-\alpha-\beta)+\beta\mu}\right]^{(1-\gamma)}}{\left(\frac{\left[\frac{\mu}{A_m\gamma^{\gamma}(1-\gamma)^{1-\gamma}}\right]^{1-\alpha-\beta}}{A\alpha^{\alpha}\beta^{\beta}(1-\alpha-\beta)^{1-\alpha-\beta}}\right)^{\epsilon-1}} \frac{A_m\gamma^{\gamma}(1-\gamma)^{1-\gamma}(1-\alpha-\beta)}{\mu}, \\
\Pi_m &= D_m \frac{\mu-1}{\mu} p_m \\
&= \frac{\mu-1}{\mu} \frac{\left[A_m^{(1-\alpha-\beta)}A\right]^{\frac{\epsilon-1}{\epsilon}} (\varkappa)^{-1} \cdot K^{\frac{\alpha(\epsilon-1)+\gamma(1-\alpha-\beta)(\epsilon-1)}{\epsilon}}}{\frac{(2\varkappa)^{-\frac{1}{\epsilon}}}{1-\alpha-\beta}\left[L \cdot \frac{\gamma(1-\alpha-\beta)+\alpha\mu}{(1-\gamma)(1-\alpha-\beta)+\beta\mu}\right]^{\frac{(1-\epsilon)\{\gamma\beta+(1-\alpha)(1-\gamma)\}}{\epsilon}}} \left(\frac{\left[\frac{\mu}{\gamma^{\gamma}(1-\gamma)^{1-\gamma}}\right]^{1-\alpha-\beta}}{\alpha^{\alpha}\beta^{\beta}(1-\alpha-\beta)^{1-\alpha-\beta}}\right)^{1-\epsilon} p_n,
\end{aligned}
$$

$$
\begin{aligned}
GDP &= WL + RK + \Pi_m \\
&= \left[\frac{(1-\gamma)(1-\alpha-\beta)+\beta\mu}{\gamma(1-\alpha-\beta)+\alpha\mu} + 1 + \frac{\frac{\mu-1}{\mu}(b)^{-1}}{(1-\alpha-\beta)^{-1}} \left(\frac{\left[\frac{\mu}{A_m\gamma^{\gamma}(1-\gamma)^{1-\gamma}}\right]^{1-\alpha-\beta}}{A\alpha^{\alpha}\beta^{\beta}(1-\alpha-\beta)^{1-\alpha-\beta}}\right)^{1-\epsilon} \right] \\
&\quad \cdot K^{\frac{\alpha(\epsilon-1)+\gamma(1-\alpha-\beta)(\epsilon-1)}{\epsilon}} \left[L \cdot \frac{\gamma(1-\alpha-\beta)+\alpha\mu}{(1-\gamma)(1-\alpha-\beta)+\beta\mu} \right]^{\frac{(\epsilon-1)\{\gamma\beta+(1-\alpha)(1-\gamma)\}}{\epsilon}} (2b)^{\frac{1}{\epsilon}} p_n.
\end{aligned}
$$

It is easy to obtain $\frac{WL}{GDP}$, $\frac{RK}{GDP}$ and $\frac{\Pi_m}{GDP}$.

To ensure positive consumption of the numeraire good in country H, we must require

$$
GDP > \int D(i)p(i)di \tag{42}
$$

which is true if and only if

$$
\frac{(1-\alpha-\beta)+(\beta+\alpha)\mu}{\gamma(1-\alpha-\beta)+\alpha\mu} > (\varkappa)^{-1} \left(\frac{\left[\frac{\mu}{\gamma^{\gamma}(1-\gamma)^{1-\gamma}}\right]^{1-\alpha-\beta}}{\alpha^{\alpha}\beta^{\beta}(1-\alpha-\beta)^{1-\alpha-\beta}}\right)^{1-\epsilon} \left[\frac{1}{2} - \frac{\mu-1}{\mu}(1-\alpha-\beta)\right]. \tag{43}
$$

The above equation must always hold whenever

$$
(1-\alpha-\beta)(\epsilon-3)+1 \leq 0, \tag{44}
$$

because $\frac{1}{2} - \frac{\mu-1}{\mu}(1-\alpha-\beta) \leq 0$. If $(1-\alpha-\beta)(\epsilon-3)+1 > 0$, then (43) holds if and only if

$$(1-\alpha-\beta) + (\beta+\alpha)\mu \quad > \quad \left(\frac{\left[\alpha^{\alpha}\beta^{\beta}(1-\alpha-\beta)^{1-\alpha-\beta}\right]^{(-1+\epsilon)2} \mu^{2(1-\alpha-\beta)(1-\epsilon)-1}}{\left[\gamma^{\gamma}(1-\gamma)^{1-\gamma}\right]^{2(1-\alpha-\beta)(1-\epsilon)}} \right)^{-1} \left[\frac{1}{2} - \frac{\mu-1}{\mu}(1-\alpha-\beta)\right].$$

We also need to ensure that

$$W^* L^* > \int D^*(i) p(i) di$$

so that country F also consumes the numeraire. The above condition is reduced to

$$A^* L^* > \left[A_m^{(1-\alpha-\beta)} A\right]^{\frac{\epsilon-1}{\epsilon}} (2\varkappa)^{\frac{1}{\epsilon}-1} K^{[\alpha+\gamma(1-\alpha-\beta)]\frac{\epsilon-1}{\epsilon}} \frac{\left[L \cdot \frac{\gamma(1-\alpha-\beta)+\alpha\mu}{(1-\gamma)(1-\alpha-\beta)+\beta\mu}\right]^{[(1-\gamma)(1-\alpha-\beta)+\beta]\frac{\epsilon-1}{\epsilon}}}{\left(\frac{\left[\frac{\mu}{\gamma^{\gamma}(1-\gamma)^{1-\gamma}}\right]^{1-\alpha-\beta}}{\alpha^{\alpha}\beta^{\beta}(1-\alpha-\beta)^{1-\alpha-\beta}}\right)^{\epsilon-1}}.$$

To ensure that country H does not produce the numeraire good, we must require $p_n < W$, which can be shown equivalent to $L < \overline{\overline{L}}(A, A_m, K)$. To ensure country F does not produce the differentiated good, we must require

$$W^* > p(i)$$

or equivalently

$$A^* > (2\varkappa)^{\frac{1}{\epsilon}} \left[A_m^{(1-\alpha-\beta)} A\right]^{\frac{-1}{\epsilon}} \frac{\frac{\left[\frac{\mu}{\gamma^{\gamma}(1-\gamma)^{1-\gamma}}\right]^{1-\alpha-\beta}}{\alpha^{\alpha}\beta^{\beta}(1-\alpha-\beta)^{1-\alpha-\beta}} K^{\frac{-[\alpha+\gamma(1-\alpha-\beta)]}{\epsilon}}}{\left[L \cdot \frac{\gamma(1-\alpha-\beta)+\alpha\mu}{(1-\gamma)(1-\alpha-\beta)+\beta\mu}\right]^{\frac{(1-\gamma)(1-\alpha-\beta)+\beta}{\epsilon}}}.$$

8.3 Proof of Proposition 5

Under the trade pattern, we have

$$\begin{aligned} p(i) &= p^*(i) = \frac{R^{\alpha} W^{\beta} p_m{}^{1-\alpha-\beta}}{A\alpha^{\alpha}\beta^{\beta}(1-\alpha-\beta)^{1-\alpha-\beta}}, \\ p_n &= p_n^* = \frac{W^*}{A^*}, \\ D^*(i) &= \frac{W^* L^*}{p^*(i)}, \end{aligned}$$

$$
\begin{aligned}
GDP &= p_n A^* L^* + \int D(i) p(i) di, \\
A^* L^* &= \frac{[WL + RK] + \Pi_m}{p_n} - p_n^{\epsilon-1} P^{1-\epsilon} \\
&= \frac{WL + RK + \Pi_m}{p_n} - p_n^{\epsilon-1} p(i)^{1-\epsilon}.
\end{aligned}
$$

Hence,

$$
\begin{aligned}
D_m &= \int [D(i) + D^*(i)] \frac{\partial p(i)}{\partial p_m} di \\
&= \int \left[\left(\frac{p_n}{P}\right)^{\epsilon} \left[\frac{p(i)}{P}\right]^{-\eta} + \frac{W^* L^*}{p^*(i)} \right] \frac{p(i)}{p_m} (1 - \alpha - \beta) \, di \\
&= p_n^{\epsilon} \frac{p(i)^{1-\epsilon}}{p_m} (1 - \alpha - \beta) + \frac{W^* L^*}{p_m} (1 - \alpha - \beta) \, .
\end{aligned}
$$

and

$$
\begin{aligned}
\Pi_m &= \max_{p_m} D_m \cdot \left[p_m - \frac{R^{\gamma} W^{1-\gamma}}{A_m \gamma^{\gamma} (1-\gamma)^{1-\gamma}} \right] \\
&= \max_{p_m} (1 - \alpha - \beta) \left[p_n^{\epsilon} \frac{p(i)^{1-\epsilon}}{p_m} + \frac{W^* L^*}{p_m} \right] \cdot \left[p_m - \frac{R^{\gamma} W^{1-\gamma}}{A_m \gamma^{\gamma} (1-\gamma)^{1-\gamma}} \right],
\end{aligned}
$$

FOC of which is

$$
(1 - \alpha - \beta)(\epsilon - 1) B p_m{}^{(1-\alpha-\beta)(1-\epsilon)+1} - c [(1 - \alpha - \beta)(\epsilon - 1) + 1] B p_m{}^{(1-\alpha-\beta)(1-\epsilon)} - W^* L^* c = 0,
$$

and the second order condition

$$
[(1 - \alpha - \beta)(1 - \epsilon) + 1] p_m + c [(1 - \alpha - \beta)(\epsilon - 1) + 1] > 0,
$$

where

$$
\begin{aligned}
B &= p_n^{\epsilon} \left[\frac{R^{\alpha} W^{\beta}}{A \alpha^{\alpha} \beta^{\beta} (1 - \alpha - \beta)^{1-\alpha-\beta}} \right]^{1-\epsilon}, \\
c &= \frac{R^{\gamma} W^{1-\gamma}}{A_m \gamma^{\gamma} (1-\gamma)^{1-\gamma}}.
\end{aligned}
$$

When $(1 - \alpha - \beta)(1 - \epsilon) + 1 > 0$, the LHS of FOC is strictly increasing in p_m. So there exists a unique and positive solution for $p_m(B, c, W^* L^*)$. The second order condition is also satisfied. In addition,

$$
\frac{\partial p_m}{\partial B} < 0; \frac{\partial p_m}{\partial c} > 0; \frac{\partial p_m}{\partial (W^* L^*)} > 0.
$$

Without loss of generality, we denote the solution as

$$p_m = \widetilde{\mu} \cdot c,$$

where the price markup $\widetilde{\mu}$ is generally a function of $(B, c, W^* L^*)$. Obviously, $\widetilde{\mu} = \mu$ when $W^* L^* = 0$, and $\widetilde{\mu} > \mu$ whenever $W^* L^* > 0$, simply because the foreign demand is less elastic (unity elasticity). In fact,

$$\begin{aligned} \widetilde{\mu} &= \mu + \frac{W^* L^*}{(1-\alpha-\beta)(\epsilon-1) B (\widetilde{\mu} c)^{(1-\alpha-\beta)(1-\epsilon)}} \\ &\leq \mu + \frac{W^* L^*}{(1-\alpha-\beta)(\epsilon-1) p_n (A^*)^{(1-\epsilon)}} \\ &= \mu + \frac{A^{*\epsilon} L^*}{(1-\alpha-\beta)(\epsilon-1)}. \end{aligned}$$

Now we have the following equation:

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

where RHS is decreasing in $\widetilde{\mu}$. Now let us see whether LHS increases in $\widetilde{\mu}$, which is true iff

$$\begin{aligned} \widetilde{\mu} &< \mu \frac{(\epsilon-1)(1-\alpha-\beta)}{(\epsilon-1)(1-\alpha-\beta)-1} \\ &= \mu \left[1 + \frac{1}{(\epsilon-1)(1-\alpha-\beta)-1}\right]. \end{aligned}$$

8.4 Proof in Section 5

Consider any industry j that is monopolized by an SOE, this firm faces the following demand function

$$D(j) = \left(\frac{p_n}{P}\right)^\epsilon \left[\frac{p(j)}{P}\right]^{-\eta},$$

where the aggregate price P and p_n are taken as given by the SOE. Then it would choose

$$p(j) = \frac{\eta}{\eta-1} \frac{R^\alpha W^\beta {p_m}^{1-\alpha-\beta}}{A_s \alpha^\alpha \beta^\beta (1-\alpha-\beta)^{1-\alpha-\beta}}.$$

On the other hand, for any liberalized industry j' the perfect competition implies

$$p(j') = \frac{R^{\alpha} W^{\beta} {p_m}^{1-\alpha-\beta}}{A_p \alpha^{\alpha} \beta^{\beta} (1-\alpha-\beta)^{1-\alpha-\beta}},$$

so the aggregate price level

$$\begin{aligned} P &= \left(\int_0^1 p(i)^{1-\eta} di \right)^{\frac{1}{1-\eta}} \\ &= \left((1-\phi) \left[\frac{\eta}{\eta-1} \frac{1}{A_s} \right]^{1-\eta} + \phi \left[\frac{1}{A_p} \right]^{1-\eta} \right)^{\frac{1}{1-\eta}} \frac{R^{\alpha} W^{\beta} {p_m}^{1-\alpha-\beta}}{\alpha^{\alpha} \beta^{\beta} (1-\alpha-\beta)^{1-\alpha-\beta}}. \end{aligned}$$

The induced demand for the intermediate good from the SOE monopolist in industry j is

$$D(j) \frac{(1-\alpha-\beta)}{p_m} \frac{p(j)}{\frac{\eta}{\eta-1}}.$$

The total demand for the intermediate good is

$$\begin{aligned} & \phi \frac{(1-\alpha-\beta) \, p(j')}{p_m} \left(\frac{p_n}{P} \right)^{\epsilon} \left[\frac{p(j')}{P} \right]^{-\eta} + (1-\phi) \left(\frac{p_n}{P} \right)^{\epsilon} \left[\frac{p(j)}{P} \right]^{-\eta} \frac{(1-\alpha-\beta)}{p_m} \frac{p(j)}{\frac{\eta}{\eta-1}} \\ = \; & p_n^{\epsilon} \frac{(1-\alpha-\beta)}{p_m} \frac{\phi \left(\frac{1}{A_p} \right)^{1-\eta} + (1-\phi) \left[\frac{1}{A_s} \right]^{1-\eta} \left(\frac{\eta}{\eta-1} \right)^{-\eta}}{\left[(1-\phi) \left[\frac{\eta}{\eta-1} \frac{1}{A_s} \right]^{1-\eta} + \phi \left[\frac{1}{A_p} \right]^{1-\eta} \right]^{\frac{\epsilon-\eta}{1-\eta}}} \left[\frac{R^{\alpha} W^{\beta} {p_m}^{1-\alpha-\beta}}{\alpha^{\alpha} \beta^{\beta} (1-\alpha-\beta)^{1-\alpha-\beta}} \right]^{1-\epsilon}, \end{aligned}$$

so the total profit of the upstream SOE is

$$p_n^{\epsilon} \frac{(1-\alpha-\beta)}{p_m} \frac{\phi \left(\frac{1}{A_p} \right)^{1-\eta} + (1-\phi) \left[\frac{1}{A_s} \right]^{1-\eta} \left(\frac{\eta}{\eta-1} \right)^{-\eta}}{\left[(1-\phi) \left[\frac{\eta}{\eta-1} \frac{1}{A_s} \right]^{1-\eta} + \phi \left[\frac{1}{A_p} \right]^{1-\eta} \right]^{\frac{\epsilon-\eta}{1-\eta}}} \left[\frac{R^{\alpha} W^{\beta} {p_m}^{1-\alpha-\beta}}{\alpha^{\alpha} \beta^{\beta} (1-\alpha-\beta)^{1-\alpha-\beta}} \right]^{1-\epsilon} \left[\frac{\mu-1}{\mu} p_m \right],$$

and the total downstream SOE profit is

$$\begin{aligned} & (1-\phi) \left(\frac{p_n}{P} \right)^{\epsilon} \left[\frac{p(j)}{P} \right]^{-\eta} \left(\frac{\eta}{\eta-1} - 1 \right) \frac{R^{\alpha} W^{\beta} {p_m}^{1-\alpha-\beta}}{A_s \alpha^{\alpha} \beta^{\beta} (1-\alpha-\beta)^{1-\alpha-\beta}} \\ = \; & p_n^{\epsilon} \frac{(1-\phi) \left[\frac{\eta}{\eta-1} \frac{1}{A_s} \right]^{-\eta} \left(\frac{1}{\eta-1} \right) \frac{1}{A_s}}{\left((1-\phi) \left[\frac{\eta}{\eta-1} \frac{1}{A_s} \right]^{1-\eta} + \phi \left[\frac{1}{A_p} \right]^{1-\eta} \right)^{\frac{\epsilon-\eta}{1-\eta}}} \left[\frac{R^{\alpha} W^{\beta} {p_m}^{1-\alpha-\beta}}{\alpha^{\alpha} \beta^{\beta} (1-\alpha-\beta)^{1-\alpha-\beta}} \right]^{1-\epsilon}. \end{aligned}$$

Therefore, the aggregate profit of SOE is

$$\left[\frac{(1-\alpha-\beta)}{p_m}\frac{\phi\left(\frac{1}{A_p}\right)^{1-\eta}+(1-\phi)\left[\frac{1}{A_s}\right]^{1-\eta}\left(\frac{\eta}{\eta-1}\right)^{-\eta}}{\left[(1-\phi)\left[\frac{\eta}{\eta-1}\frac{1}{A_s}\right]^{1-\eta}+\phi\left[\frac{1}{A_p}\right]^{1-\eta}\right]^{\frac{\epsilon-\eta}{1-\eta}}}+\frac{(1-\phi)\left[\frac{\eta}{\eta-1}\frac{1}{A_s}\right]^{-\eta}\left(\frac{1}{\eta-1}\right)\frac{1}{A_s}}{\left((1-\phi)\left[\frac{\eta}{\eta-1}\frac{1}{A_s}\right]^{1-\eta}+\phi\left[\frac{1}{A_p}\right]^{1-\eta}\right)^{\frac{\epsilon-\eta}{1-\eta}}}\right]$$

$$\cdot p_n^{\epsilon}\left[\frac{R^{\alpha}W^{\beta}{p_m}^{1-\alpha-\beta}}{\alpha^{\alpha}\beta^{\beta}(1-\alpha-\beta)^{1-\alpha-\beta}}\right]^{1-\epsilon},$$

which is maximized when $\phi=1$ if

$$\frac{(1-\alpha-\beta)\left[1-\left(\frac{\eta}{\eta-1}\right)^{-\eta}\left[\frac{A_p}{A_s}\right]^{1-\eta}\right]}{\left(\frac{1}{\eta-1}\right)\left[\frac{\eta}{\eta-1}\right]^{-\eta}\left[\frac{A_p}{A_s}\right]^{1-\eta}}>p_m.$$

.

8.5 Proof in Section 3.2.2

In order to understand the equilibrium under labor market frictions (i.e., $\omega L<\overline{\overline{L}}(A,A_m,K)$ and $L>\overline{\overline{L}}(A,A_m,K)$), we consider the equilibrium in Proposition 4 where $L<\overline{\overline{L}}(A,A_m,K)$. In that equilibrium, country H consumes a positive amount of numeraire good and the equilibrium prices are a function of the total labor in the non-numeraire sectors, L. We can imagine that now country H obtains an additional amount of labor endowment, $(1-\omega)L$, which can only produce the numeraire good. Hence, the trade equilibrium under labor market frictions is similar with the one in Proposition 4, that is, equilibrium prices are completely determined by the urban labor ωL, unrelated to the rural labor $(1-\omega)L$. More specifically, to obtain the trade equilibrium prices, we only need to replace L with ωL in Proposition 4. The only difference now is that home country uses the additional amount of labor endowment $(1-\omega)L$ to to produce more numeraire goods, which are completely consumed domestically; that is, the rural labor does not affect the trade equilibrium prices and hence the equilibrium consumption in country F.

Clearly, when ω increases (which is equivalent to L increasing in Proposition 4), the monopoly profit Π_m and the GDP Y increase. Also, the labor income $(\omega L)W+[(1-\omega)L]p_n$ increase by noting that $W>p_n$. Nevertheless, the labor income share θ_L decreases in ω. In fact, by $\theta_L=\frac{(\omega L)W+[(1-\omega)L]p_n}{(\omega L)W+KR+\Pi_m+[(1-\omega)L]p_n}$, the labor income share for the non-numeraire sectors, ther term $\frac{(\omega L)W}{(\omega L)W+KR+\Pi_m}$, is constant based on Proposition 4; by adding the term $[(1-\omega)L]p_n$ on both the numerator and the denominator, we have that θ_L is decreasing in ω.

Table 1. Chinese Exports by Enterprise Ownership

Exports are in billions of US dollars. The data are from China Custom. Some years of data are missing.

Year	Total Exports	Exports by Ownership SOEs	Exports by Ownership non-SOEs	% of export from SOEs
1994	121.01	84.94	36.06	70.20
1995	148.78	99.25	49.53	66.71
1996	151.05	86.04	65.01	56.96
1997	182.79	102.74	80.05	56.21
1998	183.81	96.85	86.96	52.69
2000	249.20	116.45	132.76	46.73
2002	325.60	122.85	202.75	37.73
2004	593.33	153.58	439.75	25.88
2006	968.94	191.33	777.60	19.75
2008	1430.69	257.48	1173.21	18.00
2010	1577.75	234.30	1343.45	14.85

Table 2. Chinese firms in 2011 Fortune Global 500

Company Name	Fortune Rank	Revenues ($millions)	Headquarter	Industry
Sinopec Group	5	273422	Beijing	Oil and Refinery
China National Petroleum	6	240192	Beijing	Oil and Refinery
State Grid	7	226294	Beijing	Electricity Power
Industrial & Commercial Bank of China	77	80501	Beijing	Banking
China Mobile Communications	87	76673	Beijing	Telecom
China Railway Group	95	69973	Beijing	Construction and Infrastructure
China Railway Construction	105	67414	Beijing	Construction and Infrastructure
China Construction Bank	108	67081	Beijing	Banking
China Life Insurance	113	64635	Beijing	Insurance
Agricultural Bank of China	127	60536	Beijing	Banking
Bank of China	132	59212	Beijing	Banking
Dongfeng Motor	145	55748	Wuhan	Automobile
China State Construction Engineering	147	54721	Beijing	Construction and Infrastructure
China Southern Power Grid	149	54449	Guangzhou	Electricity Power
Shanghai Automotive	151	54257	Shanghai	Automobile
China National Offshore Oil	162	52408	Beijing	Oil and Refinery
Sinochem Group	168	49537	Beijing	Material: Chemical
China FAW Group	197	43434	Changchun	Automobile
China Communications Construction	211	40414	Beijing	Construction and Infrastructure
Baosteel Group	212	40327	Shanghai	Material: Metal
CITIC Group	221	38985	Beijing	Financial
China Telecommunications	222	38469	Beijing	Telecom
China South Industries Group	227	37996	Beijing	Defense
China Minmetals	229	37555	Beijing	Material: Metal
China North Industries Group	250	35629	Beijing	Defense
China Huaneng Group	276	33681	Beijing	Electricity Power
HeBei Iron & Steel Group	279	33549	Shijiazhuang	Material: Metal
People's Insurance Co. of China	289	32579	Beijing	Insurance
Shenhua Group	293	32446	Beijing	Energy
China Metallurgical Group	297	32076	Beijing	Construction and Infrastructure
Aviation Industry Corp. of China	311	31006	Beijing	Aerospace
Shougang Group	326	29181	Beijing	Material: Metal
Ping An Insurance	328	28927	Shenzhen	Insurance
Aluminum Corp. of China	331	28871	Beijing	Material: Metal
Wuhan Iron & Steel	341	28170	Wuhan	Material: Metal
China Post Group	343	28094	Beijing	Postal
Huawei Technologies	352	27356	Shenzhen	Telecom Equipment
Sinosteel	354	27266	Beijing	Material: Metal
COFCO	366	26469	Beijing	Agriculture Trading and Processing
Jiangsu Shagang Group	367	26388	Zhangjiagang	Material: Metal
China United Network Communications	371	26025	Shanghai	Telecom
China Datang	375	25915	Beijing	Electricity Power
Bank of Communications	398	24264	Shanghai	Banking
China Ocean Shipping	399	24250	Beijing	Shipping
China Guodian	405	24016	Beijing	Electricity Power
China Electronics	408	23761	Beijing	Electronics
China Railway Materials Commercial	430	22631	Beijing	Material: Railway
China National Aviation Fuel Group	431	22630	Beijing	Oil and Refinery
Sinomach	435	22487	Beijing	Machinery
Henan Coal & Chemical	446	21715	Zhengzhou	Energy
Lenovo Group	450	21594	Beijing	Computer
Jizhong Energy Group	458	21255	Xingtai	Energy
China Shipbuilding Industry	463	21055	Beijing	Ship Building
China Pacific Insurance (Group)	467	20878	Shanghai	Insurance
ChemChina	475	20715	Beijing	Material: Chemical
Zhejiang Materials Industry Group	484	20001	Hangzhou	Material: Metal
China National Building Material Group	485	19996	Beijing	Material: Construction

Table 3. Descriptive Statistics on Industrial SOEs

Table 3 present the descriptive statistics on SOEs in the industrial sector. The data are from CEIC and National Bureau of Statistics.

Year	% of Work Force	% of Net Output	% of Sales	Gross Profits (Billion Yuan)	Total Losses (Billion Yuan)	Gross Profit to Assets (%)	% of Loss Making SOEs	Debt to Equity Ratio	SOE Layoffs (Million)	Total Number of SOEs	Average Assets (Million Yuan)	Profits to Sales (%)
1978	72.1			51	4.2	15.5						
1979	70.7			56	3.6	16.1						
1980	70.0	81.5	80.9	59	3.4	16.0						16.3
1981	70.0	78.9		58	4.6	15.0				62065	6	
1982	70.0	78.3		60	4.8	14.4				63063	7	
1983	69.8			64	3.2	14.4						
1984	68.7	77.3		71	2.7	14.9						
1985	68.7	74.5	73.0	74	3.2	13.2	9.6			70342	8	12.6
1986	68.4	73.1	72.8	69	5.4	10.6	13.1			70511	9	10.4
1987	68.4	72.5	71.5	79	6.1	10.6	13.0			72803	10	10.0
1988	68.7	71.2	69.2	89	8.2	10.4	10.9			72494	12	9.1
1989	68.6	70.6	69.1	74	18.0	7.2	16.0			73501	14	6.7
1990	68.4	70.1	68.8	39	34.9	3.2	27.6			74775	16	3.3
1991	68.3	67.9	66.7	40	36.7	2.9	25.8			75248	19	2.9
1992	68.3	65.0	63.6	54	36.9	3.3	23.4			74066	22	3.2
1993	67.9	56.7	58.7	82	45.3	2.5	28.8	2.07		80586	40	3.6
1994	66.4	53.8	51.7	83	48.3	2.2	30.9	2.11		79731	48	3.8
1995	66.5	53.8	48.8	67	64.0	1.4		1.92		87905	54	2.5
1996	66.3	48.5	46.3	41	79.1	0.8	33.6	1.87		86982	61	1.5
1997	65.0	46.4	43.5	43	83.1	0.7	38.2	1.89		74388	79	1.5
1998	57.3	57.0	51.8	53	115.1	0.7	40.6	1.80	5.9	64737	116	1.6
1999	54.5	56.3	50.9	100	96.7	1.2	39.2	1.63	6.5	61301	131	2.8
2000	51.1	54.3	49.6	241	70.4	2.9	34.1	1.57	6.6	53489	157	5.7
2001	21.5	51.7	46.9	239	75.2	2.7	36.0	1.46	5.2	46767	188	5.4
2002	41.5	48.3	43.1	263	66.9	3.0	36.1	1.46	4.1	41125	217	5.5
2003	36.3	44.9	40.0	384	68.0	4.1	35.2	1.46	2.6	34280	276	6.6
2004	32.2	42.4	35.4	545	83.7	5.0	37.4	1.31	1.5	35597	308	7.6
2005	26.8	37.7	34.0	652	107.2	5.5	35.5	1.32	0.6	27477	428	7.6
2006	24.1	35.8	31.9	849	117.6	6.3	31.9	1.30		24961	541	8.4
2007	22.2	34.2	30.2	1080	89.1	6.8	25.8	1.30		20680	765	8.8
2008			29.1	906	343.5	4.8	27.4	1.44		21313	886	6.1
2009			27.3	929	155.4	4.3	26.3	1.53		20510	1052	6.1
2010				1474	113.3	5.9	21.4	1.52		20253	1223	7.6

Table 4. Taxes and Subsidies for Industrial Enterprises

Table 4 reports the value added taxes payable and other business taxes and charges, value added, profit, and subsidy of industrial SOE and SHEs and other industrial enterprises. The data are from China Finance Yearbook and CEIC.

Year	GDP (Billion RMB)	Taxes from SOEs (%)	Value-Added from SOEs (%)	Profits from SOEs (%)	SOE Taxes (Billion Yuan)	SOE Value Added (Billion Yuan)	SOE Profits (Billion Yuan)	Subsidy to SOEs (billion RMB)	Subsidy to SOEs / GDP (%)	SOE Profit / Gov't Revenue (%)	SOE Taxes / Gov't Revenue (%)
	(1)	(2)	(3)	(4)	(7)	(8)	(9)	(5)	(6)	(10)	(11)
1978	365	89.0		84.9	28		51			44.9	24.9
1979	406	88.8		86.0	30		56			49.1	26.3
1980	455	87.7	81.5	84.6	32	130	59			50.5	27.7
1981	489	86.2	78.9	85.0	34	132	58			49.3	29.2
1982	532	85.6	78.3	84.9	37	137	60			49.3	30.9
1983	596	84.5		83.0	39		64			46.9	28.7
1984	721	83.6	77.3	82.8	45	173	71			43.0	27.2
1985	902	81.9	74.5	79.4	60	204	74	-51	-5.62	36.8	29.7
1986	1028	82.7	73.1	78.6	65	218	69	-32	-3.16	32.5	30.7
1987	1206	81.8	72.5	78.3	73	253	79	-38	-3.12	35.8	33.1
1988	1504	80.4	71.2	75.0	88	306	89	-45	-2.97	37.8	37.5
1989	1699	80.8	70.6	74.3	103	346	74	-60	-3.52	27.9	38.7
1990	1867	80.4	70.1	69.3	111	357	39	-58	-3.10	13.2	38.0
1991	2178	79.2	67.9	62.6	126	402	40	-51	-2.34	12.8	40.0
1992	2692	77.1	65.0	55.0	141	484	54	-44	-1.65	15.4	40.4
1993	3533	70.5	56.7	51.0	164	728	82	-41	-1.16	18.8	37.7
1994	4820	65.2	53.8	46.1	205	790	83	-37	-0.76	15.9	39.2
1995	6079	64.7	53.8	40.7	221	831	67	-33	-0.54	10.7	35.4
1996	7118	63.6	48.5	27.7	232	874	41	-34	-0.47	5.6	31.4
1997	7897	61.4	46.4	25.1	248	919	43	-37	-0.47	4.9	28.7
1998	8440	70.0	57.0	36.0	285	1108	53	-33	-0.40	5.3	28.8
1999	8968	69.8	56.3	43.6	308	1213	100	-29	-0.32	8.7	26.9
2000	9921	67.8	54.3	54.8	347	1378	241	-28	-0.28	18.0	25.9
2001	10966	65.7	51.7	50.5	366	1465	239	-30	-0.27	14.6	22.3
2002	12033	63.8	48.3	45.5	398	1594	263	-26	-0.22	13.9	21.1
2003	13582	61.2	44.9	46.0	462	1884	384	-23	-0.17	17.7	21.3
2004	15988	31.3	42.4	45.7	299	2321	545	-22	-0.14	20.7	11.3
2005	18494	54.0	37.7	44.0	622	2718	652	-19	-0.10	20.6	19.7
2006	21631	52.2	35.8	43.5	754	3259	849	-18	-0.08	21.9	19.5
2007	26581	49.9	34.2	39.8	919	3997	1080	-28	-0.10	21.0	17.9
2008	31405	44.4		29.7	1065		906	-16	-0.05	14.8	17.4
2009	34051	48.0		26.9	1271		929	-15	-0.04	13.6	18.5

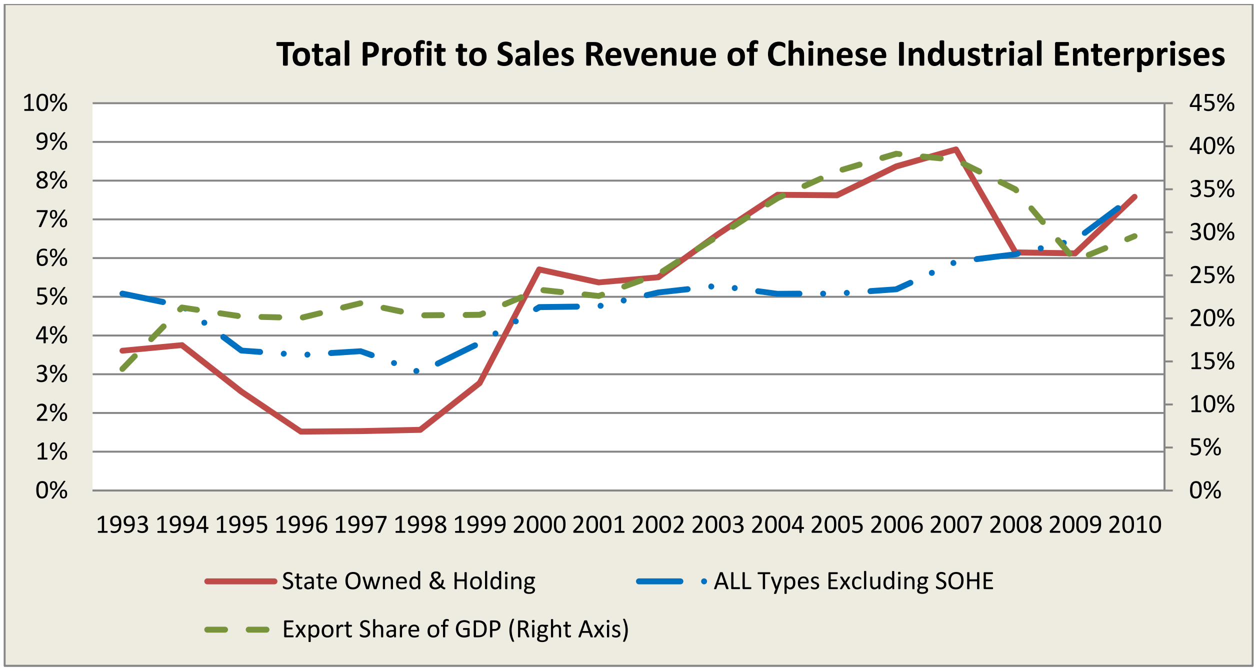

Figure 1: Total profit to sales revenues of Chinese enterprises in the industrial sector. We use CEIC (Table CN.BF: Industrial Financial Data: By Enterprise Type) to obtain Total profit to Sales Revenue. In this table, CEIC categorizes industrial enterprises into: state owned & holding, private, HMT & foreign, collective owned, shareholding corporations, foreign funded, and Hong Kong, Macau & Taiwan funded. We divide all the industrial enterprises into state owned & holding and the rest. The right axis shows the ratio of export to GDP, also obtained from *CEIC*.

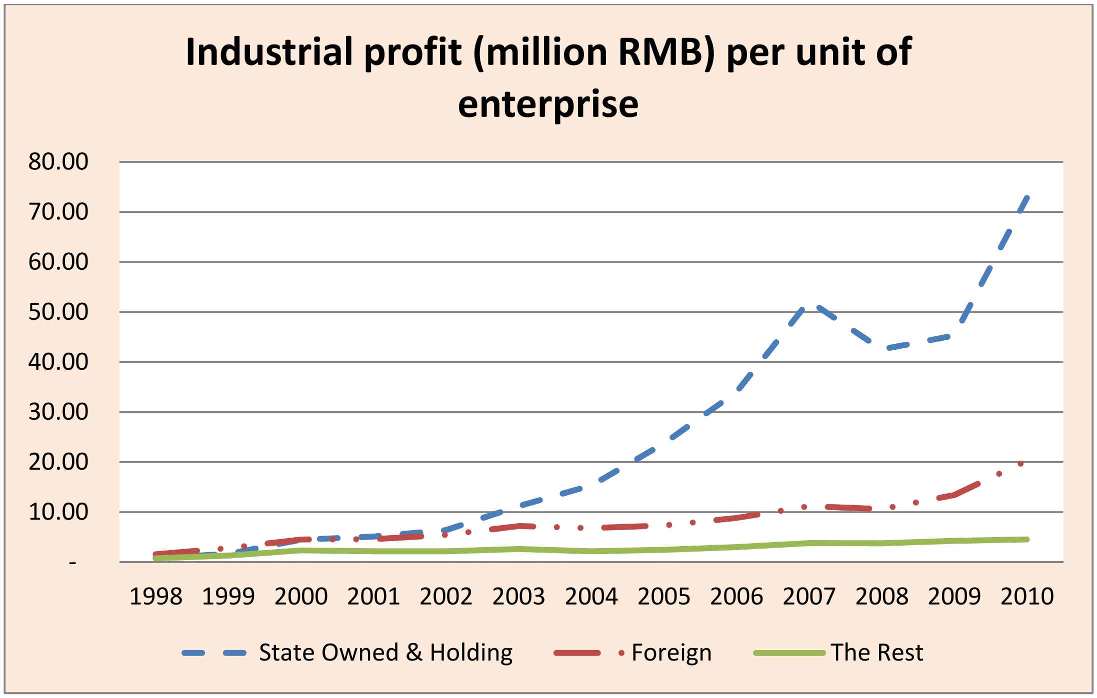

Figure 2a: Average profit per industrial enterprise for 1998-2010

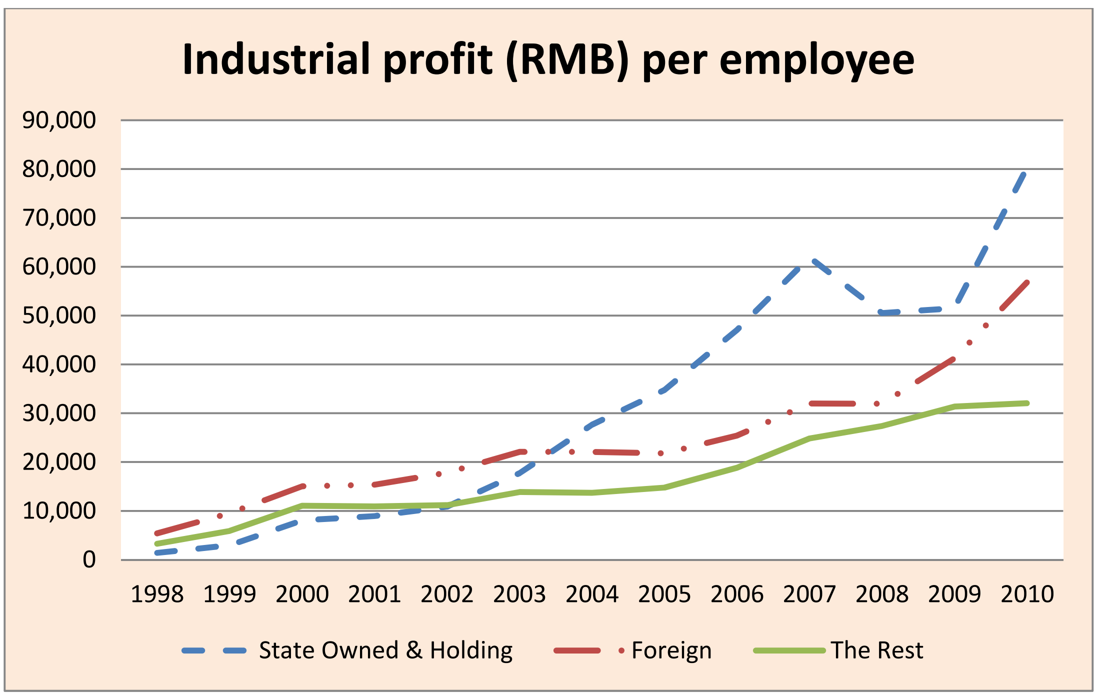

Figure 2b: Average profit per employee for 1998-2010

Figure 2: Industrial profit by enterprises of different ownership structure for the industrial sector. Figure 2a and 2b reports respectively the total profit of industrial enterprises divided by the number of enterprises and the number of employees. It reports separately for three types of enterprises according to ownership structure. The data are from CEIC.

Figure 3: The shares of labor compensation in national income under different Definitions.
We use the data from Bai and Qian (2010) to reproduce their Figure 2 here.

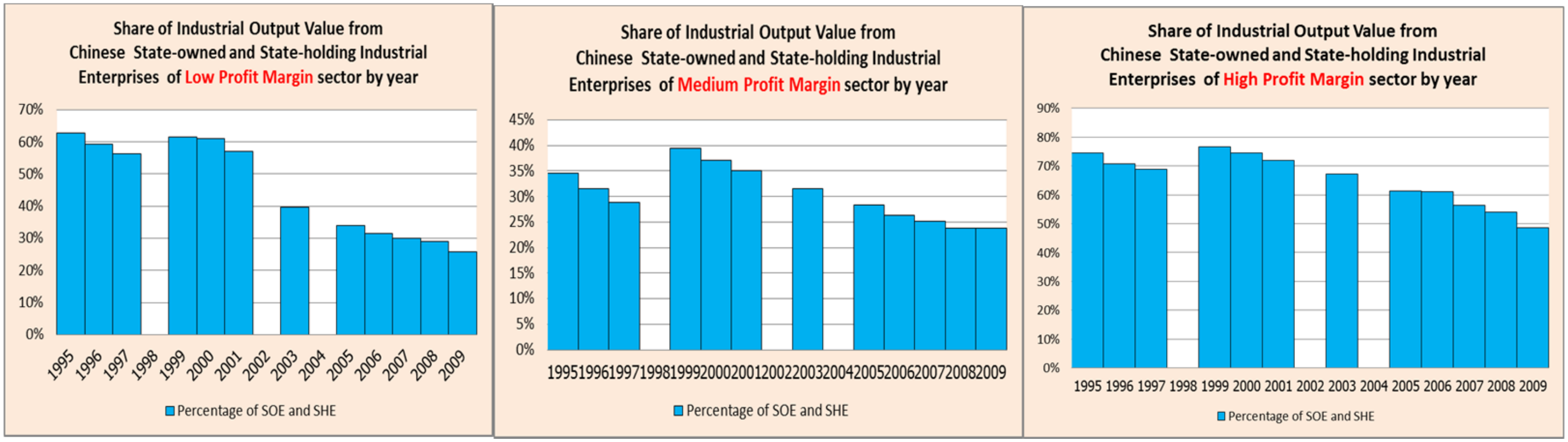

Figure 4: Share of industrial output value from state enterprises in the industrial sector. The criteria that we use to breakdown the share of the state enterprises' gross industrial output value (GIOV) is a measure of profit margin, ratio of profit to industrial cost (%) from 1995-2010. Profits and costs data are from CEIC (Table CN.OE03 and 04). The low profit margin subsectors are those with less than or equal to 5% profit margin, which include subsectors such as textiles and agriculture. The median profit subsectors are those with profit margin of 5% - 10%, which include subsectors such as mining and food. The high profit subsectors are those with greater than 10% profit margin, which include subsectors such as petrochemical, tobacco, and pharmaceuticals. The vertical axis is GIOV of the state enterprises as a percentage of total GIOV. GIOV of all enterprises is from CEIC (Table CN.BD03: Gross Industrial Output: By Industry). GIOV of the state enterprises is from National Bureau of Statistics (NBS) Yearbook because CEIC does not have this data. Also, GIOV of the state enterprises 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 definition of the state enterprises back and forth. NBS uses "state-owned industrial enterprises" in 1995-1997; "state-owned and state holding industrial enterprises" in 1999-2003 and 2005-2009.

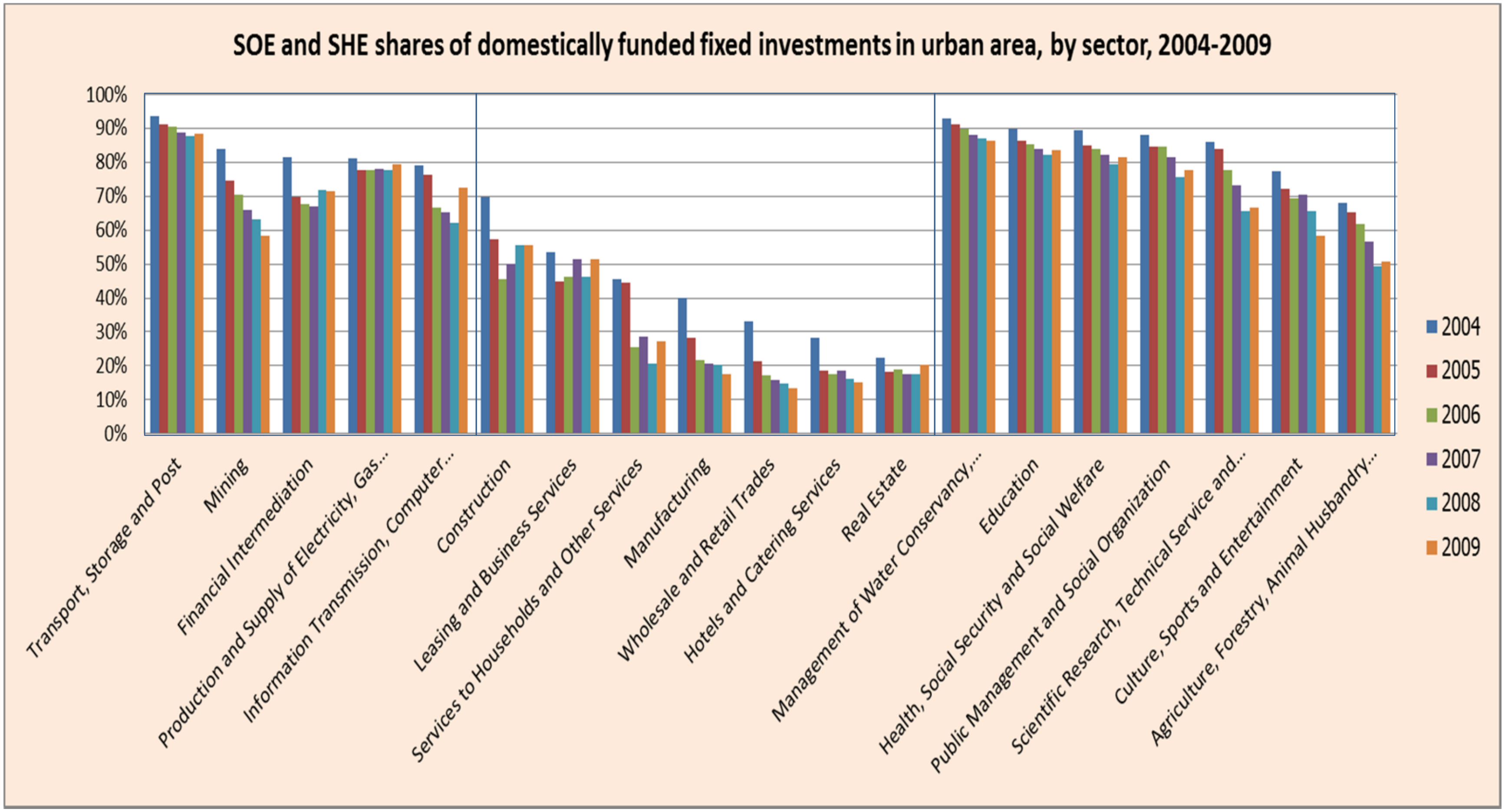

Figure 5: Investments in fixed assets in urban area by ownership for all sectors. The data are from the following tables of National Bureau of Statistics (NBS) of China: Investment in Urban Area by Sector, Source of Funds, Jurisdiction of Management and Registration Status. Note that NBS has changed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

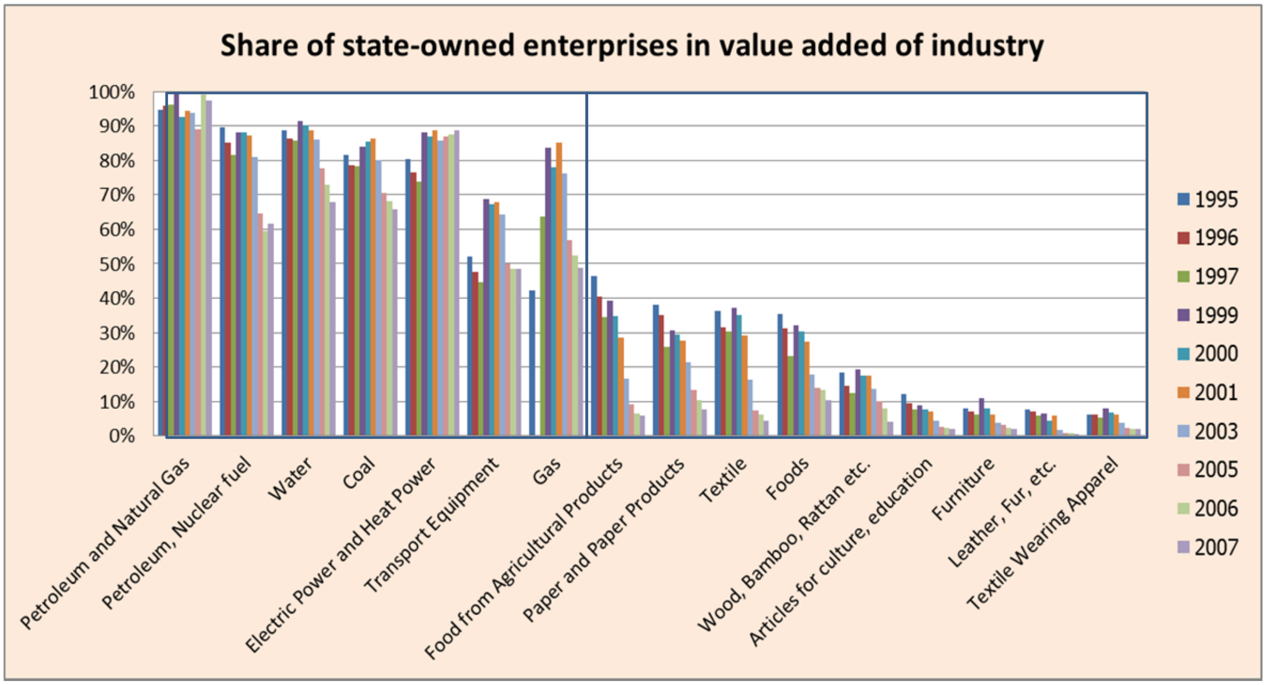

Figure 6a: Share of state enterprises in industrial value-added.

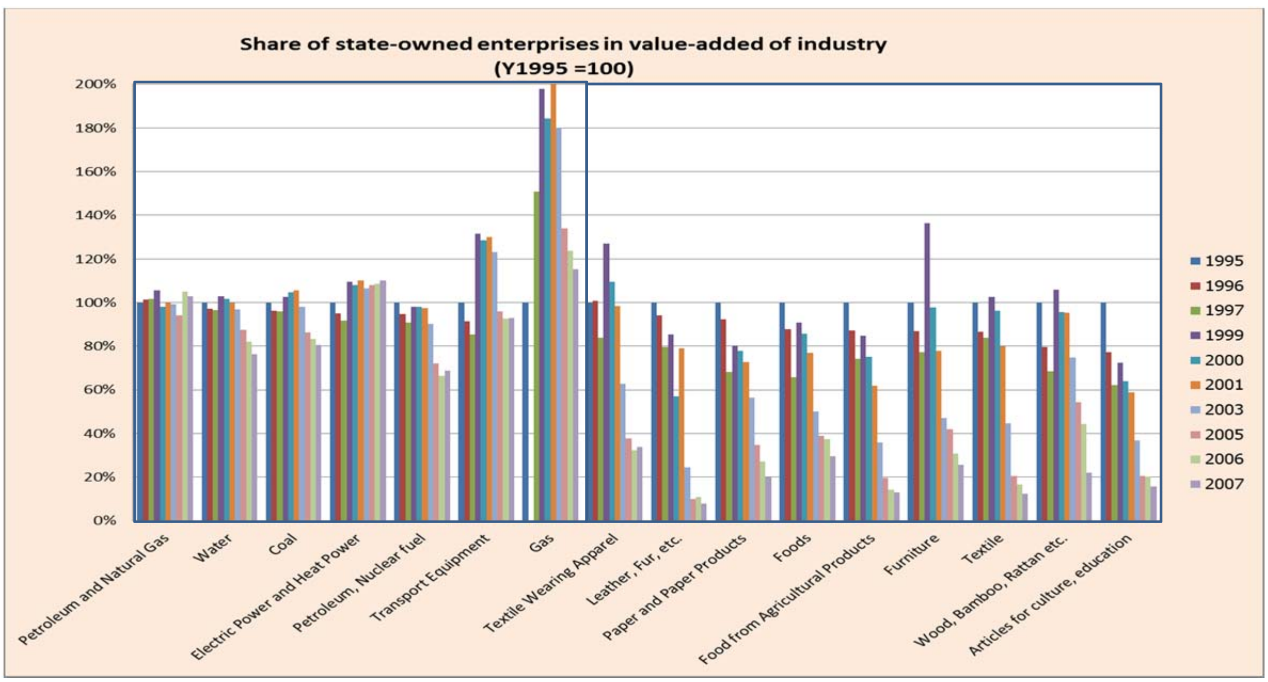

Figure 6b: Share of state enterprises in value-added as a percentage of its 1995 value.

Figure 6: Share of state enterprises in industrial value added of the industrial sector. The data are from National Bureau of Statistics (NBS) of China, Table 14-2, and Table 14-6. Note that NBS has changed the title of state related enterprises over time. NBS uses “state-owned industrial enterprises” in 1995-1997; “state-owned and state-holding” in 1999-2003 and 2005-2009. The data are missing in 1998, 2002, and 2004.