A MODEL OF CHINA'S STATE CAPITALISM*

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This version: January 2016

Abstract

China's state-owned enterprises (SOEs) performed poorly compared to non-SOEs back in the 1990s. Yet despite their lower productivity, these SOEs began exhibiting higher overall profitability than the non-SOEs sometime after 2001, even though the markets became increasingly liberalized and GDP growth rates remained consistently high. To address this growth puzzle, we develop a general equilibrium model based on the following under-appreciated vertical structure featured in China's state capitalism: SOEs monopolize key upstream industries, whereas downstream industries are largely open to private competition. We show how the upstream SOEs extract rents from the liberalized downstream industries in the process of structural change and globalization. The unprecedented prosperity of SOEs is shown to be a symptom of the incompleteness of market-oriented gradual reforms, which distorts factor prices, impedes structural change, depresses GDP and reduces public welfare. We also explain how this vertical structure emerged in equilibrium and why this development model is not sustainable. General implications for other countries are also discussed.

Key Words: Structural Change; Growth and Development; State Capitalism; Chinese Economy; State-Owned Enterprises

JEL Classifications: E02, F63, O10, O43, P31

*We would like to thank the participants at the NBER Summer Institute Growth Meeting, SED, Dallas Fed-SHUFE International Economics Conference, China Economics Summer Institute, China Summer Institute of Finance, Shanghai Macro Conference, HKUST Conference on Governance and Development, IMF, US Department of State, US Department of Treasury, US International Trade Commission, as well as seminars at numerous universities for comments. For valuable discussions and comments, we are particularly grateful to Chong-En Bai, Loren Brandt, Chang-Tai Hsieh, Jennifer Huang, Chad Jones, Joe Kaboski, Justin Yifu Lin, Rachel Ngai, Barry Naughton, Albert Park, Diego Restuccia, Gerard Roland, Michael Song, Jian Wang, Shang-Jin Wei, Laura Wu, Yang Yao, Alwyn Young, Yifan Zhang, Xiaodong Zhu, and Fabrizio Zilibotti. Yong Wang acknowledges the financial support from GRF (#644112). Lerong Li, Dara Panichakarn, Chenlai Shi, and Xiaotong Su have all provided able research assistance.

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1 Introduction

Major emerging economies all practice some form of state capitalism, where the state controlls an important share of the economy while the private sector largely operates in the free market.[1] A case in point is China. The market-oriented reforms to establish a "socialist market economy with Chinese characteristics" led to a rapid expansion of the private sector but state-owned enterprises (SOEs) have remained an important part of the economy. For this reason, SOEs have become the focus of recent research on state capitalism and economic growth of China.[2]

Against the backdrop of the economic success of BRIC countries (especially China) contrasted with the recent deep recession in the developed world, some have touted state capitalism as a legitimate alternative growth model.[3] From 2001 to 2011, China's total GDP rose from sixth in the world to second, with an annual average growth rate of approximately 10%. Most strikingly, the profitability (measured by the profit-to-revenue ratio) of SOEs surpassed that of non-SOEs after around 2001, although the opposite was true in the 1990s (see Figure 1). In fact, SOEs account for 63.2% of the largest 500 Chinese enterprises (in terms of revenues) in 2011 and 81.88% of their total profits and the ten most profitable firms are all SOEs (World Bank (2012)). Also, 53 out of the 57 Chinese firms on the list of the Fortune Global 500 in 2011 are SOEs.[4]

[**INSERT FIGURE 1 HERE**]

This phenomenon appears puzzling as it seems to contradict the common notion that enhanced competition due to market-oriented reforms, including trade liberalization, hurts less efficient firms (i.e., SOEs).[5] Also, given that China recorded stable and high GDP growth rates from 1992 to 2008 (Naughton (2005, 2007), Zhu (2012)), the phenomenon also seems at odds with the general view that fast aggregate growth is impossible when a large number of less productive firms (SOEs) persistently outperform more productive ones (private firms) (Restuccia and Rogerson (2008), Hsieh

[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)).

[2] See, e.g., Che (2009), Pearson (2014), Song, Storesletten and Zilibotti (2011), Wen (2015), Yao (2014) and Zhu (2012).

[3] See, e.g., the special issue on "state capitalism" of the Economist published on Jan 21, 2012. However, Lardy (2014), among others, casts doubt on the success of China's state capitalism. Also see Malesky and London (2014).

[4] Table A0 in the Appendix provides more detailed information about these 57 firms.

[5] There exists abundant empirical evidence showing that SOES are less productive and have lower investment efficiency than non-SOEs (Sun and Tong (2003), Dollar and Wei (2007), Liu and Siu (2011), Zhu (2012), and Cao and Liu (2011)).

and Klenow (2009), Jones (2013)). The main objective of our paper is to explain this puzzling phenomenon by developing a theory of China's state capitalism.

Our theory highlights a crucial feature of China's state capitalism which emerged approximately a decade ago. SOEs have monopolized key upstream industries (such as energy) and also have continually consolidated this power through government-arranged mergers, whereas downstream industries (such as most manufacturing of consumption goods, accommodation and catering) have been liberalized and have become mostly open to private competition. In other words, the key upstream sectors are still largely controlled by the *state*, whereas the downstream industries operate under *capitalism*. This important "vertical structure" has received insufficient attention in the literature, and will be documented in detail in Section 2.

Our core argument is as follows: By 2001 or so, low-productivity SOEs had already exited from most of the liberalized downstream industries while the upstream industries were still monopolized by SOEs. When non-SOEs expanded due to productivity growth and factor accumulation in the competitive downstream industries, demand increased for intermediate goods and services, which were monopolized by the SOEs in the upstream industries. Consequently, even without any productivity improvement, the upstream SOEs would flourish more than the non-SOEs in the competitive downstream sectors. In addition, the liberalized trade (China joined the WTO in December 2001) created more external demand for the downstream tradeable (see Yu (2014) and Khandelwal, Schott and Wei (2014)), which ultimately enabled upstream SOEs to extract even more rents in the process of globalization. This linkage between trade and vertical structure helps explain why SOEs' profitability co-moved closely with the export-to-GDP ratio in Figure 1, even though SOEs' share in total (direct) export was small (the share decreased from 70.20% in 1994 all the way down to 18.00% in 2008; see Table A5 in the Appendix).

Although the rent extraction mechanism within the vertical structure works for autarkies and economies with small populations, trade openness and labor abundance both play important augmenting roles. Without the enlarged external demand due to international trade, downstream non-SOEs would not expand as much, and hence upstream SOEs would not be able to make such huge profits (see Proposition 4). Without abundant labor, the upstream SOEs would not be able to maintain persistently high profitability because wages would rise more rapidly, which would not only depress the induced demand for upstream intermediate inputs but also limit the magnitude of the monopoly markups charged by upstream SOEs due to international competition in downstream industries. Our model highlights how the rent extraction of upstream SOEs interacts with trade globalization and structural change (industrialization) simultaneously.

Although this paper focuses mainly on the 2001-2008 period, our framework also explains why SOEs experienced a reversal of fortune 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. As a result, low-productivity SOEs suffered severe losses and gradually exited from downstream industries.[6] During this period, non-SOEs outperformed SOEs as a whole until most of the unprofitable SOEs exited from competitive downstream industries. However, as the vertical structure came into full shape, the remaining SOEs, which mainly stayed in the upstream industries, started to outperform non-SOEs as they benefitted disproportionately from the expansion of downstream private industries. SOEs as a whole were no longer victims but rather beneficiaries of the market-oriented reform and trade liberalization, even though their productivity was still lower than that of non-SOEs. Such a reversal of fortune for SOEs crucially depended on the emergence of the vertical structure. If it were a horizontal structure, namely, SOEs and non-SOEs always compete in the same or horizontally substituting industries, then SOEs would suffer when non-SOEs improve their productivity (see the formal proof in Appendix A).

To formalize the idea, our general equilibrium benchmark model studies two cases: autarky and free trade. The autarky case highlights the mechanism through which SOEs in the upstream industries extract monopoly rents from the non-SOEs in the competitive downstream industries during the process of structural change. We analytically characterize the profits of the upstream SOEs, aggregate GDP, and their explicit connections to structural change. We demonstrate how an increase in the productivity of downstream non-SOEs would benefit upstream SOEs through the vertical structure and how labor abundance helps upstream SOEs during industrialization. We also show that elimination of the upstream SOE monopoly would lead to more industrialization, larger GDP, and greater social welfare. In other words, the vertical structure (upstream SOE monopoly and downstream liberalization) creates distortions and welfare loss, which echoes the view that partial reforms or incremental reforms have their pitfalls. In the open-economy case, we highlight the new mechanism through which international trade enables the upstream SOEs to extract even more rents from the downstream non-SOEs, which expand via trade thanks to cheaper labor.

We extend the benchmark model to discuss the emergence (past) and sustainability (future)

[6] See Lin et al. (1998), Naughton (2005, 2007), Xu (2011), Song et al. (2011), and Yao (2014).

of China's model of state capitalism. On emergence, we show how the vertical structure *per se* (that is, SOEs only monopolize upstream sectors whereas downstream sectors are open to private competition) can be rationalized as an equilibrium outcome of SOEs' maximizing aggregate profits. On sustainability, we show that, when domestic wages rise endogenously to a high enough level, China's downstream private industries will be strangled by the upstream SOE monopoly and will lose international competitiveness if upstream SOEs fail to lower markups and improve productivity.

Related literature To the best of our knowledge, this paper is the first to document and theoretically model the vertical structure underlying China's state capitalism. It contributes to several strands of literature on growth, macro development and institutional reforms.

First, our paper sheds new light on structural change by introducing the vertical structure into the non agriculture sector. We show how upstream monopolist firms benefit from structural change (industrialization), but at the same time impede industrialization. Our approach complements existing approaches, which typically treat the industrial (or modern) sector either as a single industry or a sector with multiple horizontally differentiated industries in a closed economy.[7] The vertical structure is also critical in explaining how international trade not only facilitates industrialization but also disproportionately benefits the upstream nontradable sector, which differs from the predictions of open economy models featuring a horizontal structure (Mastuyama (2009) and Uy, Yi and Zhang (2013)). However, if labor costs rise sufficiently with structural change, trade globalization would amplify the strangling effect of the upstream monopoly on structural change and total GDP. In other words, trade openness is a double-edged sword for upstream (inefficient) SOEs, depending on domestic labor cost and productivity.

Second, our paper contributes to the growth literature about resource misallocation. Whereas the existing literature emphasizes how low aggregate total factor productivity (TFP) can result from factor misallocation across horizontally differentiated firms or subindustries (Restuccia and Rogerson (2008), Hsieh and Klenow (2009), Brandt, Van Biesebroeck and Zhang (2012)),[8] we stress how productivity increases in downstream firms benefit rather than hurt low-productivity upstream firms (SOEs), that is, the vertical structure mechanism. The vertical structure also explains how low-productivity firms may benefit from economic deregulation and trade liberalization, different

[7] See Acemoglu and Guerrieri (2008), Caselli and Coleman (2001), Kongsamut, Rebelo and Xie (2001), Ngai and Pissarides (2007), Restuccia, Yang and Zhu (2008), Buera and Kaboski (2012), Herrendorf, Rogerson and Valentinyi (2013), *etc.*

[8] Jones (2013) investigates how the effect of horizontal resource misallocation is amplified through intermediate inputs.

from the predictions of horizontal-structure models. Moreover, we highlight a different source of distortion. The existing literature largely focuses on factor market distortions such as capital allocation inefficiency.[9] Our paper complements that literature by highlighting monopoly distortions in product markets, which through general equilibrium effects also indirectly distort factor prices and allocations even when factor markets themselves are perfect (also see Wang (2014a)). Parente and Prescott (1999) study how monopoly in the output market hampers adoption of better technology, but there is no vertical structure.

Third, our model contributes to the literature on economic transition and institutional reforms, especially in China.[10] While Lau, Qian and Roland (2000) emphasize the success of China's gradual dual-track reform as a Pareto-improving process, Murphy, Shleifer and Vishny (1992) and Young (2000) stress the economic distortions created by this gradualism (also see Bruno (1972) and Bai et al. (2004)). We analyze a new aspect of the incompleteness of gradualism in China's market-oriented reforms: the downstream (typically tradable) industries are liberalized, whereas the upstream (nontradable or trade-regulated) industries remain monopolized by SOEs. We argue that the unprecedented prosperity of SOEs is not evidence of SOE superiority but is rather an undesirable symptom of gradualism and incompleteness of reform. It is the downstream liberalized industries, which are expanding with industrialization and globalization, that are truly driving China's economic growth.[11]

Fourth, our paper sheds new light on China's SOE reforms in the context of growth and development. The early literature mostly focused on how the governance structure and productivity of SOEs improved and how SOEs gradually exited (from the downstream sectors) in the 1990s.[12] In contrast, we emphasize how SOE profitability increased over the past decade during the process of structural change and globalization. In this regard, our paper is closely related to Song et al. (2011), who show how the profitability of the monopolist SOEs in capital-intensive sectors increased as SOEs retreated from the competitive and labor-intensive sectors using a horizontal-structure framework with financial frictions. Our paper complements their research in several important

[9] See Dollar and Wei (2007), Song et al. (2011), Hsieh and Song (2015), Brandt, Tombe and Zhu (2013), Wang (2015b), *etc.*

[10] See Naughton (2005, 2007), Che (2009), Roland (2000), Xu (2011), Yao (2014), Wang (2015a), *etc.*

[11] 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. For more analyses on China's economic growth, see Yao (2014), Young (2003) and Zhu (2012), among others.

[12] See, e.g., Groves, Hong, McMillan, and Naughton (1994), Li (1997), Lin et al. (1998), Naughton (2005, 2007), Yao (2014).

aspects. First, in our model, SOE profitability increases mainly because of rent extraction through the vertical structure, independent of financial market frictions or the difference in capital intensities between SOEs and non-SOEs highlighted in their horizontal-structure model. Second, we show that structural change and trade globalization both play important roles in determining the profitability of SOEs and non-SOEs at each development stage, whereas Song et al. focus on the manufacturing sector by abstracting away rural-urban migration and international specialization in trade.[13] Finally, the key objectives of the two papers are very different. We aim to explain why the profitability of SOEs exceeded that of non-SOEs, and also explore the endogenous emergence, efficiency and sustainability of China's state capitalism model which features a vertical structure, whereas Song et al. (2011) focus on resolving the puzzle of why China was able to simultaneously enjoy high output growth, sustained returns on capital and a large foreign surplus.

The paper is structured as follows. Section 2 documents the institutional background of SOE reforms and quantitatively documents several key features of China's state capitalism. Section 3 presents the benchmark model. Section 4 and Section 5 study the emergence and sustainability of China's state capitalism, respectively. Section 6 discusses several extensions and conceptual clarifications. Section 7 presents preliminary empirical evidence. Section 8 explores the model's general implications for other countries. The last section concludes.

2 Background and Facts

In this section we first briefly document the history of China's SOE reforms in the past three decades and highlight the institutional background of how the vertical structure of China's state capitalism came into existence. Then we document detailed quantitative facts about this vertical structure, which serve as the basis for the theoretical model developed in subsequent sections.

2.1 A Brief History of China's SOE Reforms

After China's historical decision to "reform and open up" in 1978, the central government adopted a gradual, experimental, and pragmatic approach of "crossing the river by touching the stones" to reforming SOEs. The central government has tried to improve SOE performance while maintaining

[13] For the quantitative importance of structural change for China's growth, refer to Zhu (2012), Dekle and Vandenbroucke (2012), and Cao and Birchenall (2013).

state ownership and control over a large swath of the economy (Lin (2009), Naughton (2005, 2007) and Xu (2011)).

Until 1978, virtually all firms were SOEs or collectively-owned in both upstream and downstream industries. During the 1980s, the first stage of SOE reforms started, focusing on increasing enterprise autonomy through a system that required managers to meet performance targets in return for retained profit. This system initially improved SOEs' performance (Groves et al. (1994), Li (1997)). However, it quickly ran into trouble because managers were rewarded for success but not punished for failure and were able to exploit their effective control over SOE assets. Although other types of contracts were tested, SOEs accumulated huge losses, especially as they faced increasing competition from non-SOEs which mainly consisted of foreign-invested enterprises and township and village enterprises (Naughton (2007)). During the 1978-1993 period, the share of SOEs' net industrial output decreased from more than 80% to about 58.7%, even though virtually no SOEs closed down. The financial loss and leverage of SOEs rose steadily whereas their economic significance persistently declined. About 30.9% of SOEs made losses in 1994 and their debt-to-equity ratio reached 211% (see Table A6).

The second stage of SOE reforms began after the historical Southern tour of Deng Xiaoping in 1992. At the 14th Chinese Communist Party Congress in 1992 and the Third Plenum in 1993, the central government endorsed the creation of a "socialist market economy" based on public ownership as its reform goal. At the 15th Party Congress in 1997 SOEs were called a "pillar of the economy", and the legal status of private ownership was formally endorsed by the new constitution in 1999. The state launched a so-called "three-year battle" to restructure SOEs between 1998 and 2000.

Privatization of SOEs and layoffs of workers began on a large scale in 1995, when the central government formally set the policy of "nurturing the large and letting the small go" (*zhuada fangxiao*). The central government explicitly pursued the strategy of retaining state control of 500 to 1,000 large SOEs in strategic sectors, where competition was severely restricted through administrative regulation.[14] Meanwhile, the government closed down or privatized most of the small and medium-sized SOEs, which were typically located in downstream industries such as footwear and apparel (see, e.g., Green and Liu (2005), Naughton (2007), World Bank (2012)). By the end of

[14] The 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.

1997, the 500 largest SOEs accounted for 37% of state industrial assets, 46% of all tax revenues from SOEs, and 63% of SOE profits. In comparison, small SOEs, generally controlled by local governments, performed poorly, especially after extensive 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 (Szamosszegi and Kyle (2011) and World Bank (2012)).

Throughout and after this round of SOE reform, central SOEs consolidated their monopoly position in upstream industries and reinforced their advantageous position even further through reorganizations such as mergers and groupings within the same industry. Since the upstream industries are generally in nontradable or regulated sectors, central SOEs were still shielded from competition after the WTO entry. By contrast, non-SOEs faced fierce competition in the largely liberalized downstream industries, which are typically tradeable and open to foreign direct investment. Overall, the monopoly position of SOEs in upstream industries was protected and strengthened while the downstream industries became more competitive.[15]

2.2 Stylized Facts

This subsection first documents the quantitative facts about 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 over the last two decades.

Figure 2 divides the industrial sector into two groups based on profit margin (*i.e.*, profit-to-revenue ratio) and compares the SOE shares in these two groups from 1995 to 2009.[16] The left panel shows that SOEs always have a significantly higher presence in the high-profit-margin group than the other group, although both numbers decline over time. The right panel shows that, relative to 1995, SOEs' presence declined more dramatically in the low-profit-margin group. This unbalanced compositional shift indicates that sectorial asymmetry is an important aspect of the relative performance of SOEs versus non-SOEs illustrated in Figure 1.

[INSERT FIGURE 2 HERE]

[15] For example, Dean et al. (2010) report that by 2008, total assets of SOEs in China were $6 trillion, or 133% of Chinese GDP, whereas the corresponding numbers for France, whose SOE precentage is among the highest in all the capitalist developed economies, were $686 billion and 28%, respectively. In particular, fewer than 200 SOEs come directly under SASAC supervision, but their assets account for 62% of GDP.

[16] Although we are aware that some upstream state sectors may not have outsized profitability for some years during our sample period, overall those sectors are few and those years are limited. Our focus is on explaining the macroeconomic phenomenon that SOEs enjoyed much higher profitability during the 2002-2007 period than in the 1990s.

To further explore the distribution of SOEs and non-SOEs in different sectors, we divide the industries into upstream and downstream industries based on upstreamness scores, which are calculated from China's Input-Output tables for four different years (1995, 1997, 2002, 2007) following Antras et al. (2012). The upstream (downstream) industries are those in the top (bottom) tertile of the upstreamness scores. Although upstreamness scores vary slightly across years, the classifications of upstream and downstream industries remain relatively consistent.[17] Figure 3 decomposes Figure 1 into upstream and downstream industries. It shows that, conditional on ownership type, upstream firms enjoyed a greater profitability than downstream firms. In particular, upstream SOEs experienced a faster growth in profitablity than downstream non-SOEs.[18]

[INSERT FIGURE 3 HERE]

The next few tables and figures document the under-appreciated feature of China' state capitalism: upstream industries are dominated by SOEs whereas downstream industries are largely liberalized and dominated by non-SOEs.

[INSERT FIGURE 4 HERE]

Figure 4 compares the shares of SOEs in upstream and downstream industries within the industrial sector. Panel 4a plots the value-added share of SOEs in upstream versus downstream industries from 1995 to 2007. It shows that SOEs consistently dominated the upstream industries, whereas their presence in downstream industries was not only low but also decreased more dramatically in percentage terms (Panel 4b). Furthermore, Table 1 reports the regression results showing that, even after controlling for industry-level capital intensities, SOEs are still disproportionately concentrated in upstream industries. This pattern is robust to various measures of SOE proportions.

[INSERT TABLE 1 HERE]

Table 2 presents another two important facts about China's state capitalism. First, both the Lerner Index and the average revenue-based Herfindahl-Hirschman Indices (HHI) of the upstream

[17] Table A1 in the Appendix provides the upstreamness indexes for each industry and describes how upstream and downstream industries are classified accordingly.

[18] Note that the return on fixed assets is lower for SOEs than non-SOEs, but it does not necessarily represent direct evidence for lower profitability of SOEs because SOEs are more capital intensive and the market structure is not fully competitive. See Section 6 and the related proof in Appendix H for more discussions.

industries are more than twice as large as those of downstream industries during the past decade, suggesting a much less competitive market structure in the upstream industries.[19,20] Second, upstream output almost exclusively serves the domestic market, whereas the downstream industries are much more export-oriented. For the industrial sector, the export-to-output ratio (export exposure) is 21.9% in the downstream industries versus 5.5% in the upstream industries. The upstream-downstream difference in export exposure is presumably even more striking for the whole economy after nontradable service sectors are also included. Even though some upstream inputs or services are technically tradable, but downstream private firms must purchase from domestic upstream SOEs rather than importing directly due to government regulations.[21]

[INSERT TABLE 2 HERE]

The facts documented above apply to the industrial sector. The same features remain true at the national level, although data availability, especially time series data for various performance measures, is much more limited.[22]

[INSERT FIGURE 5 HERE]

Figure 5a shows that in all urban sectors SOEs' share in upstream sectors far exceeded their share in downstream sectors in terms of domestic fixed asset investment from 2004 to 2009.[23] Figure 5b shows that SOEs dominated non-SOEs in the upstream sectors in various dimensions, but the opposite was true in downstream sectors. The exceptions are firm numbers and total employment,

[19] For further extensive evidence of SOE monopolies (in upstream industries), see World Bank (2012). The existence of administrative monopoly in the "strategic industries" is also officially acknowledged by the Central Committee of the Communist Party of China (see People's Daily, Nov. 16, 2013).

[20] Strictly speaking, the industrial enterprise database is not exactly a firm-level database, and it contains no information about the firm affiliation of individual enterprises. A large enterprise like Sinopec, China Telecom, or Bank of China is composed of thousands, or even tens of thousands of enterprises in the database, so the database is ill-suited for accurate investigations on market structures. Thus, the HHI estimate should be read with caution because it is likely to substantially underestimate the extent of industry concentration (also see World Bank (2012)). However, we will follow the convention in the pertinent literature and use enterprises and firms interchangably in this paper.

[21] Petroleum is a case in point. China is a net importer of raw petroleum. However, virtually no downstream private firms are allowed to directly import oils from abroad; instead, they must purchase oil or related products from domestic upstream SOEs such as Sinopec Group and China National Petroleum.

[22] Table A2 provides the streamness scores for all the sectors based on China's Input-Output table. The classification into upstream and downstream sectors by tertiles is therefore different from that for the industrial sector alone (Table A1). Note that firm-level data are not available for nonindustry sectors in 2007, so we use the Input-Output table in 2008 to compute the streamness scores required in Figure 5, which is for all sectors.

[23] Data for value added are unavailable for urban sectors.

but they imply that the dominance of SOEs over non-SOEs is even more pronounced in terms of average performance per firm (or per employee) or in terms of average firm size.

Table 3 shows that the vertical structure is a salient feature of China when considering the largest firms. The 57 Chinese firms on the list of the Fortune Global 500 in 2011 are highly skewed toward state ownership and are also highly concentrated in upstream industries such as oil and power generation. This pattern is exceptional from a global perspective, especially when compared with countries with "liberal capitalism" such as the US and France. Note that, among all the developed economies, France is widely regarded as having an unusually high presence of SOEs.

[INSERT TABLE 3 HERE]

3 Benchmark Model

In this section, we develop a simple two-sector general equilibrium model with structural change based on the facts documented in the last section. We first study the case of autarky, which features the vertical structure in China's state capitalism. Then we extend the model to an open economy to examine the role of international trade.

3.1 Autarky

3.1.1 Model Environment

Consider a closed economy H, which is populated by a continuum of agents with measure equal to unity. Agents are divided into two groups: an elite class with measure equal to $\theta \in (0,1)$ and the grassroots with measure $1-\theta$. Agents are identical within each group. The economy has two sectors: an agricultural sector producing the numeraire good n and an industrial sector. Within the industrial sector, there is a vertical structure with the upstream industry producing intermediate good m and the downstream industry producing a composite consumption good d.

Preference All the agents have the same utility function

$$u(c_n, c_d) = c_n + \frac{\epsilon}{\epsilon - 1} c_d^{\frac{\epsilon-1}{\epsilon}}, \ \epsilon > 1, \tag{1}$$

where c_n and c_d denote consumption of good n and good d, respectively. ϵ is the price elasticity of demand for good d. Both c_n and c_d must be nonnegative.

Technologies All the technologies are constant returns to scale.[24] One unit of labor produces A_n units of good n. To produce good d requires capital k, labor l, and intermediate good m. The production function is

$$F_d(k, l, m) = Ak^{\alpha} l^{\beta} m^{1-\alpha-\beta}, \tag{2}$$

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

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 grassroots, is endowed with L units of time (labor) and K units of capital. The intermediate good m is produced by a monopolist firm, which is owned by the "state" but fully controlled by the elite class as if the elite class owns it. Good n and good d are produced by competitive private firms, which are owned by the grassroots. Only the intermediate goods market is a monopoly, whereas all other markets (goods markets and factor markets) are perfectly competitive with free entry.[25]

Vertical Structure The firm that produces the intermediate good is in the upstream industry, whereas all the firms producing good d are in the downstream industry. So good d is also referred to as the "downstream good". From the ownership point of view, the upstream firm is an SOE while all the downstream firms are privately-owned enterprises (POEs). This feature of ownership distribution (upstream SOE monopoly plus downstream capitalism) is referred to as the "vertical structure". As documented in Section 2, the downstream industries in China have been dominated by competitive private firms since the massive privatization of SOEs in the late 1990s. However, SOEs still monopolize key upstream industries.

[24] Deviations from this assumption will be discussed in Section 6.3.

[25] Later, the composite good d will be decomposed into a continuum of differentiated goods in Section 4, in which we discuss the liberalization process in the downstream industries, and in Section 6, where downstream private firms are engaged in monopolistic competition so that private firms also earn positive profits.

3.1.2 Characterizing Equilibrium

Let W and R denote the wage and the rental price of capital, respectively. Let p_n, p_d, and p_m denote the prices of good n, downstream good d, and intermediate good m, respectively.[26]

Consumer Problem Let I_g and I_e denote the total income of a representative agent in the grassroots and in the elite class, respectively. Clearly, $I_g = WL + RK$ and $I_e = I_g + \frac{\Pi_m}{\theta}$, where Π_m is the total profit of the SOE. An agent with income I maximizes the utility function (1) subject to the budget constraint $p_n c_n + p_d c_d \leq I$, where $I \in \{I_e, I_g\}$. When I is sufficiently large (to be explained more precisely shortly), the aggregate demand is as follows:

$$D_n = \frac{WL + RK + \Pi_m}{p_n} - \left(\frac{p_n}{p_d}\right)^{\epsilon-1}; \tag{4}$$

$$D_d = \left(\frac{p_n}{p_d}\right)^{\epsilon}. \tag{5}$$

Firm Decisions Perfect competition with free entry in the downstream sector implies that the price equals the marginal cost:

$$p_d = \frac{R^{\alpha} W^{\beta} {p_m}^{1-\alpha-\beta}}{A\alpha^{\alpha}\beta^{\beta}(1-\alpha-\beta)^{1-\alpha-\beta}}. \tag{6}$$

Using Shephard's Lemma, we obtain the aggregate demand for m from (5) and (6):

$$D_m = (1-\alpha-\beta) \cdot p_n^{\epsilon} \cdot [\frac{R^{\alpha} W^{\beta}}{A\alpha^{\alpha}\beta^{\beta}(1-\alpha-\beta)^{1-\alpha-\beta}}]^{1-\epsilon} \cdot {p_m}^{(1-\alpha-\beta)(1-\epsilon)-1}. \tag{7}$$

The upstream monopolist SOE, which produces good m, maximizes its profit:

$$\Pi_m = \max_{p_m} D_m \cdot \left[p_m - \frac{R^{\gamma} W^{1-\gamma}}{A_m \gamma^{\gamma}(1-\gamma)^{1-\gamma}}\right], \tag{8}$$

which implies that

$$p_m = \mu \frac{R^{\gamma} W^{1-\gamma}}{A_m \gamma^{\gamma}(1-\gamma)^{1-\gamma}}, \tag{9}$$

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

where μ is the endogenous markup given by

$$\mu \equiv \frac{(1-\alpha-\beta)(\epsilon-1)+1}{(1-\alpha-\beta)(\epsilon-1)}. \tag{10}$$

Clearly, $\mu > 1$. Intuitively, μ is determined by the cost share of the intermediate good in the production of the downstream good d (i.e., the term $(1-\alpha-\beta)$) and the price elasticity of demand for good d (reflected by the term $\epsilon - 1$).[27]

Market Clearing Conditions The labor market clearing condition is given by

$$L = \underbrace{D_m \frac{\partial \frac{R^\gamma W^{1-\gamma}}{A_m \gamma^\gamma (1-\gamma)^{1-\gamma}}}{\partial W}}_{\text{by producer of intermediate good } m} + \underbrace{D_d \frac{\partial p_d}{\partial W}}_{\text{by producers of downstream good } d} + \underbrace{D_n \frac{1}{A_n}}_{\text{by producers of good } n}. \tag{11}$$

To ensure $D_n > 0$, we require that $L > \overline{L}$, where $\overline{L}$ denotes total employment in the industrial sector (that is, the non-numeraire part of the economy), or the sum of the first two terms on the right-hand side of (11). As long as good n is produced in equilibrium (i.e., $L > \overline{L}$), wages are the same across all the sectors and are equal to the marginal product of labor in the agriculture sector:

$$W = A_n p_n, \tag{12}$$

which implies that wage increases with agricultural productivity A_n but does not change with K, A_m, A, or L.[28] The capital market also clears:

$$K = \underbrace{D_m \frac{\partial \frac{R^\gamma W^{1-\gamma}}{A_m \gamma^\gamma (1-\gamma)^{1-\gamma}}}{\partial R}}_{\text{by producer of intermediate good } m} + \underbrace{D_d \frac{\partial p_d}{\partial R}}_{\text{by producers of downstream good } d}. \tag{13}$$

By combining (13), (6), (9) and (12), we obtain the equilibrium prices as summarized in the following lemma.

Lemma 1 *Suppose L is sufficiently large (to be strictly defined in Proposition 1). There exists a*

[27] For simplicity, this benchmark model mainly aims to capture the rent extraction mechanism of upstream SOEs via the vertical structure. Discussions on how to obtain endogenously variable markups (profit margins) will be deferred until Section 6.1.

[28] When all the labor has been absorbed into the industrial sector, the equilibrium wage shall depend on K, A_m, A, and L. See equation (33) in Section 5. Ge and Yang (2014) document facts about China's wage structure.

unique equilibrium, in which wage W is given by (12) and the other prices are given by

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

$$p_m = p_n \cdot \frac{\mu \varkappa^{\xi\gamma} A_n^{1-\gamma} A_m^{-1}}{\gamma^{\gamma} (1-\gamma)^{1-\gamma}} \left[\left(A_n^{\alpha+\gamma(1-\alpha-\beta)-1} A_m^{1-\alpha-\beta} A \right)^{\epsilon-1} K^{-1} \right]^{\xi\gamma}, \tag{15}$$

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

where $\varkappa$ and ξ are exogenous parameters defined as

$$\varkappa \equiv \frac{\gamma(1-\alpha-\beta)+\alpha\mu}{\mu} \left\{ \frac{\left[\frac{\mu}{\gamma^{\gamma}(1-\gamma)^{1-\gamma}} \right]^{1-\alpha-\beta}}{\alpha^{\alpha}\beta^{\beta}(1-\alpha-\beta)^{1-\alpha-\beta}} \right\}^{1-\epsilon}, \tag{17}$$

$$\xi \equiv \frac{1}{1+\alpha(\epsilon-1)+\gamma(1-\alpha-\beta)(\epsilon-1)}. \tag{18}$$

Observe that (15) implies $\frac{\partial p_m}{\partial A} > 0$, that is, an increase in the TFP of private firms in the downstream leads to a higher price for the intermediate good monopolized by the upstream SOE. This is due to the general equilibrium effect that R is driven up as the marginal productivity of capital increases ($\frac{\partial R}{\partial A} > 0$ implied by (14)), so p_m increases with the upstream production cost as the markup stays unchanged. On the other hand, (16) implies $\frac{\partial p_d}{\partial A_m} < 0$, that is, a more productive upstream SOE helps lower the price of the downstream good produced by private firms. This is because an increase in the upstream TFP lowers p_m (as implied by (15)), which dominates the resulting increase in R.

Next, we characterize several key quantities and values in the equilibrium. Substituting (5), (6), and (7) into (11), then applying Lemma 1, we derive the following expression for the total employment in the industrial sector:

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

So an increase in industrial productivity, A or A_m, will attract more labor from the agricultural sector into the industrial sector, whereas an increase in agricultural productivity A_n has the opposite effect on industrialization. Industrialization is also facilitated by capital accumulation

$(\frac{\partial \overline{L}(A_n, A, A_m, K)}{\partial K} > 0)$, as it tends to increase the marginal product of labor in the industrial sector.

When $L > \overline{L}(A_n, A, A_m, K)$, the elite class consumes a positive amount of good n. To ensure that the grassroots class also consumes good n $(I_g > p_n^{\epsilon} p_d^{1-\epsilon})$, a stronger condition is required:

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

which we impose throughout the paper. Observe that $\frac{\mu-\gamma(1-\alpha-\beta)-\alpha\mu}{(1-\gamma)(1-\alpha-\beta)+\beta\mu} > 1$.

The following proposition characterizes several key macroeconomic variables in the equilibrium.

Proposition 1 *Suppose (20) is true. In the autarky equilibrium, the upstream SOE's profit* Π_m *and the total GDP (per capita)* Y *are given by*

$$\Pi_m = \frac{(1-\alpha-\beta)(\mu-1)}{(1-\gamma)(1-\alpha-\beta)+\beta\mu} \overline{L}(A_n, A, A_m, K) A_n p_n, \tag{21}$$

$$Y = \left[L + \frac{\alpha\mu + (1-\alpha-\beta)(\gamma+\mu-1)}{(1-\gamma)(1-\alpha-\beta)+\beta\mu} \overline{L}(A_n, A, A_m, K)\right] A_n p_n, \tag{22}$$

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

Proof: Simple thus skipped. This proposition demonstrates how the key macroeconomic variables in our model are related to structural change (industrialization) characterized by $\overline{L}$. (21) implies that the upstream SOE profit is proportional to the total industrial employment $\overline{L}(A_n, A, A_m, K)$, reflecting the fact that the upstream extracts more rent as industrialization deepens. (22) indicates that GDP strictly increases with total industrial employment, revealing that structural change drives up total output. Also, (22) and (19) together imply that aggregate output exhibits decreasing returns to scale with respect to the factor inputs, even though all the technologies are constant returns to scale. This "efficiency loss" is due to the upstream SOE's extracting monopoly rent.

To highlight the determinants of the upstream SOE's profit, we summarize the comparative static results of (21) as follows.

Proposition 2 *Suppose (20) is true. In the autarky equilibrium, an increase in the productivity of downstream POEs will increase the monopoly profit of the upstream SOE* $(\frac{\partial \Pi_m}{\partial A} > 0)$*. The upstream SOE's profit will also increase with its own TFP and total capital stock* $(\frac{\partial \Pi_m}{\partial A_m} > 0$ *and* $\frac{\partial \Pi_m}{\partial K} > 0)$*.*

This proposition states that, under the vertical structure, an increase in the productivity of private firms in the downstream industry actually benefits the upstream SOE ($\frac{\partial \Pi_m}{\partial A} > 0$). This is a key result of the paper. The intuition is as follows. First, an increase in the downstream productivity A lowers the price for the downstream final good ($\frac{\partial p_d}{\partial A} < 0$) and hence increases its demand ($\frac{\partial D_d}{\partial A} > 0$), 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) and hence also increases the profit per unit of sale ($\frac{\mu-1}{\mu} p_m$). These two forces jointly lead to a higher profit for the upstream SOE ($\frac{\partial \Pi_m}{\partial A} > 0$). Note that this prediction is diametrically opposite to the result in the existing literature, in which SOEs and private firms are typically assumed to compete in the same or substituting industries, which is referred to as a horizontal structure (e.g., Hsieh and Klenow (2009), Song et al. (2011)). In that setting, an increase in the productivity of private firms would hurt rather than boost the upstream SOE's profit due to the competition effect (see Appendix A for the mathematical proof).

Not surprisingly, the upstream SOE's profit also increases with its own TFP ($\frac{\partial \Pi_m}{\partial A_m} > 0$) because the demand increases ($\frac{\partial D_m}{\partial A_m} > 0$) as the price drops ($\frac{\partial p_m}{\partial A_m} < 0$) and the effect of quantity expansion dominates the effect of profit reduction per unit of sale (the decrease in $\frac{\mu-1}{\mu} p_m$). To see why $\frac{\partial \Pi_m}{\partial K} > 0$, note that when capital stock K increases, R decreases, so the production costs of both the upstream and downstream industries will decrease; the demand for the intermediate good will go up, which dominates the effect of a reduction in profit per unit of sale ($\frac{\mu-1}{\mu} p_m$). Consequently, the total profit increases.[29]

The following proposition characterizes the equilibrium when the upstream monopoly is completely eliminated (i.e., free entry) so that the upstream market is perfectly competitive.

Proposition 3 *Suppose (20) is true. Under certain mild regularity conditions, when the upstream industry is fully liberalized and hence becomes perfectly competitive, the rental price of capital will rise, both the intermediate good and the downstream good will become cheaper, total industrial employment and total GDP will both become larger, and the welfare of the grassroots will be strictly higher whereas the elite group will become strictly worse off.*

Proof: See the Appendix. The intuition for Proposition 3 is the following. Eliminating the

[29] In the benchmark model, we mainly characterize firm profits. Other performance measures such as profit-to-revenue ratio and return on fixed assets will be carefully discussed in Section 6 and Section 7.

upstream monopoly lowers the price of the intermediate good, which in turn lowers the price of the downstream good. Therefore, the output of the downstream industry increases, absorbing more labor from the agricultural sector. This, in turn, drives up the marginal product of capital and hence the rental price of capital. GDP expands primarily because the elimination of the upstream monopoly facilitates structural change, moving more labor from the relatively low value-added agricultural sector to the relatively high value-added industrial sector. The total capital income rises because the increase in the total rental income of capital (RK) more than compensates for the dissipation of the monopoly profit (Π_m). Meanwhile, the equilibrium wage stays unchanged unless agricultural productivity A_n changes, because L is sufficiently large so that the agricultural good is still produced. So the total GDP grows from the factor income point of view.

In the past decade, China has witnessed a more rapid increase in the profits of SOEs than private firms, while the aggregate GDP has continued to rise steadily. As such, SOE defenders claim that the existing SOEs are contributing significantly to China's economic exuberance and there is no need for major reforms as SOEs are performing better than non-SOEs. Our analysis stresses a diametrically opposite view: the unusual prosperity of SOEs is an undesirable symptom of the incompleteness of the SOE reforms. Our model highlights how an upstream SOE monopolist extracts rents from the private firms in the downstream industry. In particular, it is clear from Proposition 1 and Proposition 2 that both total GDP and the upstream SOE's profits would increase when the downstream private firms increase their TFP, even if the TFP of the upstream SOE remains unchanged. In other words, high profits of the upstream SOE can only be a consequence of the dynamism of the downstream private industry; it is the downstream private firms, rather than the SOE, that are truly driving the GDP expansion. In fact, Proposition 3 makes it clear that the SOE monopoly is an obstacle to realizing the GDP potential of the economy.

Finally, we make one remark regarding competition between upstream SOEs and downstream non-SOEs. In our model, the vertical structure implies that there exists mutually beneficial complementarity between the SOE and private firms: a productivity increase in the downstream private firms raises the upstream SOE's profit and a productivity increase in the upstream SOE reduces the unit cost of any downstream private firm ($\frac{\partial p_d}{\partial A_m} < 0$, as explained earlier). However, competition still exists between the SOE and the private firms in the factor markets. The crowding out effect can be even stronger when market imperfections exist. For example, if the financial market is plagued by contracting frictions with collateral constraints in the spirit of Kiyotaki and Moore

(1997) and Bernanke and Gertler (1989), then the more profitable upstream SOEs would enjoy advantages over private firms in obtaining loans, *ceteris paribus*. With respect to the labor market, a high profitability of SOEs means that they can pay a higher wage, which can steal talent away from the downstream private firms and hence undermine their performance. In short, the monopoly of SOEs in the upstream industry can create distortions via the factor markets beyond the distortions in the product market itself. Factor market distortions can be the consequence, rather than the cause, of the high profitability of SOEs.

3.2 Open Economy

Next, we extend our analysis to study how international trade affects the profit of the upstream SOE through the vertical structure. Trade globalization is particularly relevant for China's reforms and development, especially after its accession to the WTO in 2001.[30]

Consider a world with two countries, home (H) and foreign (F). The home economy is identical to the one specified in Section 3.1. Country F is populated with a continuum of identical households with measure equal to unity. Each household is endowed with L^* units of labor and has the same preferences as households in country H, given by (1). All of the firms in country F are private and no capital or intermediate good is needed in production. Each foreign firm has free access to the following constant-returns-to-scale technologies: One unit of foreign labor, interpreted as a composite of raw labor and associated human capital, can produce either A^* units of good n or one unit of good d. All markets are perfectly competitive in country F. Trade is free between the two countries. This is a hybrid of Ricardian and Heckscher-Ohlin trade models.[31] Without loss of generality, A_n is normalized to unity.

To make our analysis relevant for China (country H in the model), we focus mainly on the case in which country H has comparative advantage in good d, which may be interpreted as a composite of manufacturing goods. Specifically, country H exports d and imports good n, interpreted as tradable services and agricultural products. Moreover, the labor endowment in country H is sufficiently large that in equilibrium country H produces and consumes both good d and good n and Country

[30] See, *e.g.*, Wang (2013, 2015a), Yao (2014), Yu (2014), Khandelwal, Schott and Wei (2014), *etc.*

[31] We choose not to adopt the pure Ricardian trade framework primarily because we wish to make the model general enough to accommodate discussions on the role of capital intensities of different industries and relative labor abundance in the vertical structure and international trade argument, especially given that capital market imperfectness is usually believed to be important for the issues under investigation.

F also consumes both but only produces good n.[32] The necessary and sufficient conditions for this equilibrium pattern are the following:

$$A^{*1-\epsilon} < \frac{\mu\overline{\overline{L}}(A, A_m, K)}{2\left[(1-\gamma)(1-\alpha-\beta)+\beta\mu\right]}, \tag{23}$$

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

and

$$L > \frac{\frac{\mu}{2}-\gamma(1-\alpha-\beta)-\alpha\mu}{(1-\gamma)(1-\alpha-\beta)+\beta\mu}\overline{\overline{L}}(A, A_m, K), \tag{25}$$

where $\overline{\overline{L}}(A, A_m, K)$ is the total industrial employment in country H and is given by

$$\overline{\overline{L}}(A, A_m, K) \equiv 2^{\xi}\overline{L}(1, A, A_m, K), \tag{26}$$

where ξ is given by (18).

Condition (23) ensures that country H has a comparative advantage in producing good d so that only country H produces good d and country F only produces and exports good n. Condition (24) ensures that country F consumes both good n and downstream good d. Condition (25) guarantees that each agent in country H, even the grassroots, consumes a positive amount of good n (i.e., $I_g > p_n^{\epsilon} p_d^{1-\epsilon}$). For simplicity, assume the following is true:

$$(\epsilon-3)(1-\alpha-\beta)+1 \leq 0, \tag{27}$$

in which case condition (25) automatically implies $L > \overline{\overline{L}}(A, A_m, K)$, ensuring that country H produces a positive amount of good n in equilibrium.

Lemma 2 *Suppose (23) -(25) and (27) are true. In the free trade equilibrium, the upstream SOE's profit and total GDP in country H are given by*

$$\Pi_m = \frac{(1-\alpha-\beta)(\mu-1)}{(1-\gamma)(1-\alpha-\beta)+\beta\mu}\overline{\overline{L}}(A, A_m, K)p_n, \tag{28}$$

$$Y = \left[L + \frac{\alpha\mu+(1-\alpha-\beta)(\gamma+\mu-1)}{(1-\gamma)(1-\alpha-\beta)+\beta\mu}\overline{\overline{L}}(A, A_m, K)\right]p_n, \tag{29}$$

[32] Other possible equilibrium patterns will be studied in Section 5 or in the Appendix.

where $\overline{\overline{L}}(A, A_m, K)$ is given by (26).

Proof: See the Appendix. Compared with the autarky equilibrium (Proposition 1), the only difference is that now $\overline{L}(A_n, A, A_m, K)$ is replaced by $\overline{\overline{L}}(A, A_m, K)$ in the formulas, reflecting the fact that international trade scales up the total demand for (and hence the output of) the downstream good d.[33] The comparative static results are also similar to those in Proposition 2. More formally, the comparison between autarky and open economy is stated in the following proposition.

Proposition 4 *Suppose (23)-(25) and (27) are true. The monopoly profit of the upstream SOE and the GDP in country H are larger in the free trade equilibrium than in autarky.*

The intuition is straightforward. Country H has comparative advantage in good d, so openness to trade raises the aggregate demand for good d, 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 autarky. The total GDP is also larger, partly because the total profit Π_m is larger and partly because the rental capital income (RK) is larger than in autarky. In fact, $\overline{\overline{L}}(A, A_m, K) > \overline{L}(1, A, A_m, K)$ precisely reflects the fact that trade openness boosts industrialization by absorbing more labor into the industrial sector, which leads to higher upstream profit and higher GDP.

Note that country H's comparative advantage in good d crucially depends on the labor abundance condition (25), which ensures that the wage in country is sufficiently low to offset the markup cost for the intermediate input m. Later, we will examine what happens when condition (25) does not hold.

This simple benchmark model of an open economy formalizes an important and novel mechanism for how the high profitability of SOEs in China depends on international trade. Entering WTO in 2001 facilitated China's downstream exports and hence increased the induced aggregate demand for the upstream goods and services monopolized by SOEs. Consequently, SOE profits have risen with trade liberalization. Consistent with our model predictions, trade liberalization also leads to GDP expansion by boosting industrialization.

[33] Observe that the foreign productivity A^* and foreign labor endowment L^* are absent in the above formulas under the given assumptions. There are two reasons. First, the foreign total wealth $A^*L^*p_n$ is large enough that it has no impact on the export demand on good d due to the quasi-linear utility function. Second, country H has strict comparative advantage in good d in the current equilibrium (i.e., $\frac{p_d}{p_n} < A^*$). Hence, given the numeraire, A^* does not appear in any expressions of the equilibrium outcome except for the foreign wage. Later, we will explore the equilibrium properties when (23)-(25) and (27) are no longer all satisfied.

Moreover, the analysis also suggests that a small change in external demand may lead to a large change in the upstream SOE's profits due to the markup price effect. This is consistent with Figure 1, which shows that SOE profitability increased disproportionately more than the nonstate firms' profitability when exports expanded until 2007. SOE profitability dropped more dramatically than non-SOEs' profitability when confronted by negative external demand shocks in 2008 during the global financial crisis. This may explain why SOE profitability co-moves closely with the export-to-GDP ratio even though upstream SOEs do not directly participate in trade. If the economic structure is horizontal, then we would not be able to simultaneously explain all of the features observed in Figure 1.

Proposition 4 implies that the upstream SOE can benefit from export promotion policies for the downstream industries, as such policies can stimulate foreign demand. Such export-facilitating policies include reductions in tariffs on imported inputs, tax reductions and loan subsidies, establishment of free-trade zones or processing trade zones, etc. The proposition partly explains why the Chinese government (or the elite group) would want to adopt various export-oriented trade policies. As long as foreign demand is sufficiently price elastic, the total profit gained by the upstream SOE may well exceed the subsidy cost. If we push the logic a step further, it may even help us better understand the current account surplus in China: the Chinese government (the elite group) have incentives to make loans to the US as it enables US consumers to import more from China which ultimately benefits upstream SOEs. This is particularly true given that China's domestic consumption demand is indeed relatively weak, as partly captured by the quasi-linear utility function in our model.

4 Emergence of State Capitalism

The benchmark model explains how the upstream SOEs in China have become so profitable in the last decade via rent extraction through the vertical structure, which came into full shape after the massive privatization of downstream SOEs in the late 1990s. This section has two purposes. One is to show how to rationalize the emergence of the vertical structure in our framework. The other is to show how the same framework explains the opposite pattern observed in the 1990s: private firms outperformed SOEs in terms of profitability before the vertical structure fully emerged.

Consider the same setting as the benchmark model of autarky except that now the downstream good d is an aggregate of a continuum of differentiated goods:

$$c_d = \left(\int_0^1 c(i)^{\frac{\eta-1}{\eta}} di \right)^{\frac{\eta}{\eta-1}}, \text{ for } \eta > 1 \tag{30}$$

where $c(i)$ is consumption of differentiated good i, $i \in [0,1]$, and η is the elasticity of substitution between the differentiated goods. Let ϕ denote the fraction of downstream industries that are liberalized, where SOEs and non-SOEs are engaged in perfect competition and entry is free. The remaining $1-\phi$ fraction of the industries are regulated such that each of them is monopolized by one state firm. The production function for a firm in 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 $A_s < A_p$. We have $\phi = 0$ before the downstream liberalization and $\phi = 1$ when the vertical structure is fully developed (assumed in the previous sections).

Without subsidies, SOEs will be completely driven out by competitive private firms in the liberalized industries. The downstream SOEs are delegated to different managers so they are engaged in monopolistic competition among those regulated downstream industries. Suppose the elite group wants to maximize the total profit of all the upstream and downstream SOEs by choosing an optimal degree of downstream liberalization ϕ.

Proposition 5 *(Endogenous Vertical Structure) In equilibrium, the profit-maximizing elite group will choose to only monopolize the upstream sector and fully liberalize the downstream sectors (*$\phi = 1$*) when private firms are sufficiently more productive than state firms:*

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

Proof. See the Appendix. The intuition is as follows. When a downstream industry is liberalized, the SOE in that industry will lose profit. On the other hand, this liberalized downstream industry will have a larger demand for upstream input than before, which increases the upstream SOE's profit. In addition, the profit of the remaining monopolist SOEs in the downstream industry will be reduced due to the cross-industry substitution effect. It turns out that when $\frac{A_p}{A_s}$ is sufficiently large, the indirect profit gain in the upstream industry from downstream liberalization dominates the direct profit loss in all the liberalized industries. Thus the profit-maximizing ϕ should be one, that is, liberalize all downstream industries. This explains the endogenous emergence of the vertical structure (upstream SOE monopoly plus downstream private competition with free entry).[34]

Now consider the case when some downstream SOEs are subsidized by the government so they can keep operating and compete with private firms in the same liberalized industries. To break even, an SOE 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 it produces. The more this SOE produces, the more subsidy it needs. In particular, the total SOE profits are reduced when the subsidy comes from other profitable SOEs such as upstream SOEs. This helps explain why in reality the aggregate profitability of SOE was indeed lower than that of non-SOEs during the gradual liberalization reforms in the 1990s.

As Figure 1 shows, SOEs were less profitable than non-SOEs in the early 1990s and the gap widened substantially between 1994 and 1998. SOEs experienced a sharp increase in profitability between 1998 and 2000, a period featuring massive privatization of downstream SOEs and consolidation of upstream SOEs (the "three-year battle" mentioned in Section 2), and finally SOEs surpassed non-SOEs in profitability around 2000.

We argue that this phenomenon is due to the gradual liberalization of downstream industries in the 1990s, a process through which the vertical structure of today's state capitalism gradually emerged. As documented in Section 2, the market-oriented economic reform accelerated after 1992 and the openness to foreign direct investment (FDI) and trade also deepened. With the entry and expansion of high-productivity non-SOEs, domestic or foreign, many SOEs had to rely on subsidies from the government or other SOEs to maintain operation. This drove down the average profitability of SOEs, although the aggregate GDP grew rapidly due to improved 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 the money-losing SOEs exited from the 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 full shape around 2001, and the fortune of SOEs as a whole has been reversed since then.[35]

[34] There are at least two reasons why it is not optimal to have a reverse vertical structure, *i.e.*, the downstream industries are monopolized by SOEs whereas the upstream industry is liberalized. First, in practice, members of WTO are required to liberalize the tradable sectors, so administrative monopoly over those tradable sectors is politically difficult to defend. Second, a significant proportion of upstream industries are nontradables, so downstream liberalization typically leads to more significant aggregate productivity growth than upstream liberalization, if one must choose between the two.

[35] Brandt, Tombe and Zhu (2013) empirically find, but have not yet formally explained, the following "V"-shaped

5 Sustainability of State Capitalism

Is this development model of state capitalism sustainable? Will the upstream SOEs always be able to make huge profits as the economy develops? We briefly address this important issue by extending the benchmark open economy model in Section 3.2.[36]

First of all, observe that the overall SOE profitability has been declining quite substantially ever since the global financial crisis in 2008. As explained in Section 4, this phenomenon is consistent with the vertical structure mechanism of our model: When the external demand for country H's downstream tradable d decreases (e.g., due to a large negative shock to country F's productivity A^*), the upstream SOEs are hurt more severely than downstream non-SOEs because of the markup effect.

Next, we examine the effect of upstream SOE monopoly on growth sustainability. We will show that, after country H passes the so-called "Lewis turning point", the rising labor cost will render the economy increasingly vulnerable to international competition. Moreover, the upstream SOE monopoly will eventually choke off GDP growth if its productivity A_m fails to increase sufficiently.

To see this, suppose the GDP of country H increases when capital accumulates (K becomes larger) and/or productivity improves (A or A_m becomes larger). At some point, condition (25) will be violated and the equilibrium trade pattern will change. More specifically, suppose the following two conditions are satisfied:

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

and

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

Condition (31) implies that all the labor in country H is absorbed into the industrial sector. Condition (32) ensures that country F also consumes good n in equilibrium. Then under some additional auxiliary conditions, the two countries fully specialize in equilibrium: Country H specializes in good

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 nonmonotonic pattern. 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 have monopolized the upstream industries and benefited disproportionately more from the trade liberalization than the downstream private sectors.

[36] A full-blown answer to these questions may require an explicit dynamic framework, but the key insights we want to highlight can be obtained in the static model via comparative statics. For dynamic analyses of multi-sector growth models with trade, structural change and endogenous sequential reforms, see Ju, Lin, and Wang (2014) and Wang (2014b, 2015).

d, and country F only produces good n; both countries consume both goods. In this equilibrium, the wage rate is given by

$$W = \frac{(1-\gamma)(1-\alpha-\beta)+\beta\mu}{\mu}\frac{Y}{L}, \tag{33}$$

where output Y is given by

$$Y = B \cdot \left(A_m^{1-\alpha-\beta} A\right)^{\frac{\epsilon-1}{\epsilon}} K^{\frac{\alpha(\epsilon-1)+\gamma(1-\alpha-\beta)(\epsilon-1)}{\epsilon}} L^{\frac{(\epsilon-1)[\gamma\beta+(1-\alpha)(1-\gamma)]}{\epsilon}} p_n, \tag{34}$$

where B is a constant (refer to Appendix D for the details and the proof). (34) and (33) jointly imply that wage increases with domestic industrial productivity and capital stock ($\frac{\partial W}{\partial A} > 0$, $\frac{\partial W}{\partial A_m} > 0$, and $\frac{\partial W}{\partial K} > 0$). This is different from the benchmark equilibrium, in which wage increases only with marginal productivity of labor in sector n (A_n), independent of A, A_m or K. The reason is that now all the labor in sector n has been absorbed out, so the economy has passed the "Lewis turning point".[37]

Normalize p_n to one. The equilibrium price for good d is given by $p_d(\mu) \equiv \Gamma(\mu)$, where $\Gamma(\cdot)$ is an increasing function(see Appendix D for detailed characterizations of $\Gamma(\cdot)$). Imagine there is another developing country, V, which can produce good d at cost p_v. Suppose $p_v < A^*$ so that country F would import good d from country V in the absence of country H. Facing this potential competition, the upstream SOE in country H has to solve a limit pricing problem.

More concretely, three different scenarios exist. When $p_v \geq \Gamma(\mu)$, where μ is given by (10), the upstream SOE in country H charges the original markup μ and nothing would change. When $p_v \in [p_d(1), \Gamma(\mu))$ (due to, for example, country V's having lower labor cost, weaker upstream monopoly, or higher upstream productivity), the SOE in country H has to lower its markup at least to $\Gamma(p_v)$ to remain internationally competitive. If a complete elimination of the markup is still insufficient ($p_v < p_d(1)$), then the upstream SOE must improve its productivity A_m; otherwise it would strangle the development of the downstream capitalist industry, which in turn would hurt the upstream SOE itself.

In summary, the implication for China is that the markup and monopoly rent of upstream SOEs would eventually decrease or even disappear if they fail to sufficiently improve productivity, because labor cost rises more rapidly after the economy passes the "Lewis turning point", whereas developing countries such as Vietnam or Bangladesh may effectively compete with China thanks to

[37] For more discussions, see Lewis (1954), Vollrath (2009), and Ge and Yang (2014).

cheaper labor. In addition, if China's population (labor force) shrinks sufficiently (for example, due to fertility decline or aging problems), then the rising labor cost would also increase p_d, which hurts both the SOE profit and the total output. In other words, international trade in the downstream sector will eventually discipline the SOE behavior in the nontradable upstream sector via the value-added chain, even though downstream trade will initially tolerate the low productivity and high markup pricing of the upstream SOEs when labor is sufficiently cheap.

6 Extensions and Discussions

6.1 Variable SOE Markup

In the benchmark model developed in Section 3, the endogenous SOE markup μ is constant, given by (10), which does not square well with Figure 1, where the profit margin (profit-to-revenue ratio) of SOEs changes over time. To address this issue, we extend our benchmark model in three alternative ways, each of which independently and endogenously generates time-variant profit margins that are consistent with Figure 1.

Extension 1. The constant markup obtained in the benchmark model ($\phi = 1$) results from the technical assumption that the downstream production function is Cobb-Douglas, which implies a constant share of expenditure for intermediate good m. The markup is no longer constant when the downstream production function is a general CES function as follows:

$$F_d(l, m) = \left[(A \cdot l)^{\frac{\rho-1}{\rho}} + m^{\frac{\rho-1}{\rho}}\right]^{\frac{\rho}{\rho-1}}, \rho \in [0, \infty], \tag{35}$$

where A is the downstream (private) labor-augmenting technology and ρ is the substitution elasticity between labor l and intermediate input m. Capital is omitted for simplicity. The upstream technology (of the monopolist SOE) is $F_m(l) = A_m l$. Everything else is identical to the autarky model in Section 3.1, which is a special case with $\rho = 1$.

Proposition 6 *Suppose the downstream production function is of general CES as specified in (35) and $\rho \in (1, \epsilon)$. In equilibrium the upstream SOE markup μ increases with the downstream labor productivity of private firms ($\frac{\partial \mu}{\partial A} > 0$). Moreover, $\frac{\partial \mu}{\partial A} = 0$ when $\rho = 1$.*

See Appendix F for the formal proof of the most general case when $\rho \in [0, \infty]$ and the associated economic intuitions. This proposition implies that the profit margin (equal to $\frac{\mu-1}{\mu}$) of the upstream SOE increases with productivity of downstream POEs when the substitutability between labor and upstream input falls into the interval $(1, \epsilon)$. However, the profit margin is constant when $\rho = 1$ (the benchmark model without capital).

Extension 2. The SOE profits and revenues in Figure 1 include those of both the upstream and downstream SOEs. In reality, some SOEs will remain in the downstream industries despite their gradual exit (that is, $\phi < 1$). The extended model developed in Section 4 implies that the ratio of aggregate SOE profits to aggregate SOE revenues is given by

$$\frac{\mu - 1}{\mu}\varpi(\phi) + \frac{1}{\eta}(1 - \varpi(\phi)), \forall \phi \in [0, 1], \tag{36}$$

where $\varpi(\phi)$ denotes the revenue share of upstream SOEs in all the SOEs. Recall $\frac{\mu-1}{\mu}$ is the profit margin of the upstream SOEs whereas the profit margin of the downstream SOEs is $\frac{1}{\eta}$. Suppose the upstream SOEs have a higher profit margin than downstream firms ($\frac{\mu-1}{\mu} > \frac{1}{\eta}$), as suggested by the empirical evidence in Section 2. We show that $\varpi'(\phi) > 0$, which means that greater downstream sector liberalization leads to a higher revenue share of upstream SOEs, so (36) strictly increases with ϕ (see Appendix G for the proof). In other words, the composition effect drives up the aggregate profit-to-revenue ratio for SOEs. This prediction is consistent with China's experience as shown in Figure 1 for the period between 1998 and 2007.

Extension 3. In reality upstream SOEs are being consolidated horizontally (i.e., within-industry mergers) in the reform process as documented in Section 2, so the number of oligopolist SOEs is shrinking, which also tends to increase the SOE markup. More formally, imagine a new setting identical to that in Section 3.1 except that the upstream industry is now an oligopoly with N symmetric SOEs instead of a monopoly (a special case when $N = 1$). It is straightforward to show that the equilibrium markup will be $\mu' \equiv \frac{N[(1-\alpha-\beta)(\epsilon-1)+1]}{N[(1-\alpha-\beta)(\epsilon-1)+1]-1}$, which strictly increases when N falls.

6.2 Alternative Market Structure

In the benchmark model, downstream private firms by assumption make zero profit due to perfect competition, so it is natural for the model to generate a higher profitability for upstream SOEs than for downstream POEs.[38] However, this technical simplification is unimportant for the key mechanism we aim to highlight in this paper, namely, the vertical structure enables the upstream monopolist SOE to extract rents from the downstream private firms in the process of structural change and trade liberalization. To see this, suppose that the downstream industry now consists of a continuum of fully liberalized subindustries as specified in (30) in Section 4. Each subindustry is monopolized by a distinct private firm, which earns positive profits through monopolistic competition. It can be shown that, when L is sufficiently large, the upstream SOE's profit Π_m and the downstream POEs' total profit Π_d are given, respectively, by

$$\Pi_m = \frac{(\eta-1)(1-\alpha-\beta)(\mu-1)}{\mu\eta} p_d^{1-\epsilon};\ \Pi_d = \frac{1}{\eta-1} p_d^{-\epsilon},$$

where

$$p_d = \frac{\left(\frac{\eta}{\eta-1}\right)^{1+\epsilon[\alpha+\gamma(1-\alpha-\beta)]} \left(\frac{\mu}{\gamma(1-\alpha-\beta)+\alpha\mu}\right)^{\frac{2-\xi}{\xi(1-\epsilon)}} \varkappa^{\frac{1}{\xi(1-\epsilon)}}}{\left(A_p A_m^{1-\alpha-\beta}\right)^{\frac{1}{\xi}} K^{[\alpha+\gamma(1-\alpha-\beta)]\xi}},$$

and $\varkappa$ and ξ are given by (17) and (18), respectively. It is clear that $\frac{\partial \Pi_m}{\partial A_p} > 0$, meaning that the upstream SOE can extract more rents from the downstream POEs when the latter improve their productivity, while the POEs now make strictly positive profits ($\Pi_d > 0$).

Alternatively, instead of comparing profitability of SOEs and POEs, we can compare their revenues, which are always positive independent of market structure assumptions. It turns out that average revenue per firm for SOEs has also exceeded that for POEs since the late 1990s, similar to the profit margin pattern in Figure 1(see Figure A1c in the Appendix). In Section 7, we will also study other performance measures.

6.3 Causes of Monopoly

Whereas natural monopoly may play a role, administrative monopoly seems to be dominant in accounting for the high profitability in most upstream industries. Theoretically speaking, natural monopoly alone does not permanently shield inefficient incumbent firms from the possibility of being replaced by potential or existing competitors in an industry, especially when monopoly profits are persistently much higher than profits in other industries or when the incumbent is hugely inefficient.

[38] Note that the profit measure for Figure 1 is accounting profit (i.e., revenue minus labor cost) instead of economic profit (i.e., revenue minus labor and capital cost), so, theoretically speaking, the profit-to-revenue ratio in Figure 1 can be strictly positive even if economic profit is zero.

A comparison of the Chinese firms on the Global Fortune 500 list with those from other countries (recall Table 3) reveals the following facts. First, upstream industries with natural monopoly are not necessarily state-owned (e.g., AT&T is a private company). Second, natural monopoly itself does not necessarily imply high profitability. Third, the most profitable firms are not necessarily in the upstream industries. Therefore, natural monopoly or being in the upstream industries is neither a necessary nor sufficient condition for high profitability. Governmental forces such as administrative monopoly in selected industries are presumably crucial in explaining why China's SOEs are so profitable and so highly concentrated in upstream industries. In fact, if an increasing-returns-to-scale technology is introduced for the upstream SOE in our model, the vertical structure would enable this upstream SOE to extract even more profit in the process of industrialization and trade globalization, which would make our argument even stronger.

In our model, the upstream firm is able to achieve high profitability because of its monopoly position, not state ownership *per se*. Theoretically speaking, if the monopoly position can be obtained by a non-SOE such as a politically connected private firm, our analysis in Sections 3 and 5 would still apply. Nevertheless, Section 4 shows that the vertical structure (that is, SOEs exit from the liberalized downstream sector but still monopolize the upstream industry) is an equilibrium outcome, in which upstream monopoly power is endogenously granted to a state-owned firm because stated-owned firms are fully controlled and "effectively" owned by the elite group (see Proposition 5).

6.4 Further Remarks on Capital Intensity and Subsidy

First, notice that our model allows for any arbitrary difference in capital intensities between upstream and downstream industries (measured by γ and α, respectively). In fact, the key mechanism is valid even when no capital is needed for production at all ($\alpha = \gamma = 0$), so the capital intensity difference or capital market imperfectness plays no crucial role in our argument.

Second, it turns out that the ROFA (Return on Fixed Assets, measured by profit divided by fixed assets) of SOEs is lower than that of POEs in the industrial sector during the 1998-2007 period. How can this be reconciled with the array of quantitative facts that SOEs are more profitable than non-SOEs shown earlier? We show that when the output market is not perfectly competitive, firms may exhibit unequal profit-to-capital ratios even when the capital market is perfect. In particular, the profit-to-capital ratio is strictly lower for a firm with a higher capital intensity (see Appendix

H for the formal proof). In other words, a lower ROFA does not necessarily mean that the firm has weaker market power or lower profitability, nor is it direct evidence for the existence of financial market frictions or subsidies.

7 Preliminary Empirical Evidence

The purpose of this section is to provide preliminary empirical evidence on the relevance of the vertical structure mechanism in explaining the extraordinary performance of SOEs. The key novel mechanism formalized in this paper is that the monopolist SOEs in the upstream industries are able to extract more rents from the downstream non-SOEs (or, loosely speaking, POEs), when the latter expand due to productivity increase and/or better accessibility to the world market in the process of structural change and trade globalization.

Let Π_m, V_m, k_m and l_m denote, respectively, the profit, sales revenue, physical capital, and employment of the upstream SOE. The benchmark model predicts the following:

$$\frac{\partial \Pi_m}{\partial A} > 0, \frac{\partial V_m}{\partial A} > 0, \frac{\partial}{\partial A}\left(\frac{\Pi_m}{k_m}\right) > 0, \frac{\partial}{\partial A}\left(\frac{V_m}{k_m}\right) > 0.$$

In addition, extensions in Section 6 also predict that $\frac{\partial}{\partial A}\left(\frac{\Pi_m}{V_m}\right) > 0$ when $\rho \in (1, \epsilon)$ (see Proposition 6) and that $\frac{\partial}{\partial A}\left(\frac{\Pi_m}{l_m}\right) > 0$.

We use the Chinese industrial enterprise data provided by NBS (1998-2007) and run the following regression with the sample of individual upstream SOEs:

$$\begin{aligned} y_{i,j,t} \quad = \quad & \beta_0 + \beta_1 \cdot UpSoeTFP_{j,t} + \beta_2 \cdot UpPoeTFP_{j,t} + \beta_3 \cdot DownSoeTFP_{j,t} + \beta_4 \cdot DownPoeTFP_{j,t} \\ & + \beta_5 \cdot Total\_Assets_{i,t} + \beta_6 \cdot DownExportShare_{j,t} + \beta_7 \cdot HHI_{j,t} + \beta_8 \cdot TFP_{i,t} \\ & + \beta_9 \cdot Capital\_Intensity_{j,t} + Firm_i + Year_t + \varepsilon_{i,j,t}, \end{aligned}$$

where the dependent variable $y_{i,j,t}$ is one of the following six performance measures of SOE i in (upstream) industry j at year t: profit Π_m (344), revenue V_m (325), ROFA $\frac{\Pi_m}{k_m}$ (return on fixed assets, measured by profits divided by fixed assets (309)), fixed asset turnover $\frac{V_m}{k_m}$ (revenue divided by fixed assets), profit margin $\frac{\Pi_m}{V_m}$ (profit divided by revenue), and profit-to-employee ratio $\frac{\Pi_m}{l_m}$ (344/210). The numbers in parentheses are the corresponding codes in the NBS data set.

We simultaneously test multiple predictions of the model primarily because we want to mitigate the impact of potential data limitation problems and also to clarify several conceptual issues. For example, there may exist measurement errors for profits because firms may untruthfully report their profits for purposes such as tax evasion or political promotion. Moreover, theoretically, assumptions on asymmetric market structures in our benchmark model trivially imply different profit levels of upstream SOEs and downstream POEs. To address these concerns, we use both profits and revenues as dependent variables. To alleviate concerns that profits merely reflect the size of firms, we also use ROFA, fixed asset turnover, profit margin and profit-to-employee ratios as alternative dependent variables.

We control for year and firm fixed effects in the regressions. The firm fixed effect is important as it can at least partly take care of the unobserved and time-invariant component of firm characteristics such as a firm's political ability to obtain more favorable treatment from government or banks. The year fixed effect takes care of all of those unobserved or omitted common macroeconomic shocks.

We are mainly interested in how the performance of an SOE i in upstream industry j in year t is affected by the corresponding weighted average TFP of downstream POEs in year t ($DownPoeTFP_{j,t}$), which is measured using the follow formula:

$$DownPoeTFP_{j,t} = \sum_{k \in \text{downstream}} \eta_{j,k,t} \cdot PoeTFP_{k,t},$$

where $PoeTFP_{k,t}$ is the median TFP of the POEs in downstream industry k in year t and $\eta_{j,k,t}$ is the output share of upstream industry j which forms the input for downstream industry k in year t. Obviously, for different upstream industries, the composition of the corresponding downstream industries will vary. Following Hsieh and Klenow (2009) and Hsieh and Song (2015), we use revenue-based TFPs. We present the results when TFP is measured using the Olley-Pakes method, though the results based on the Levinsohn-Petrin method are very similar.[39] If the vertical structure

[39] For the rent extraction story in our vertical structure mechanism, the ideal measurement of TFP is quantity-based TFP instead of the revenue-based TFPs. Du et al. (2013) follow De Loecker and Warzynski (2012) to decompose firm-level markup and productivity using the same China Industrial Enterprise Survey Data. By using difference-in-differences methods, they find that SOEs are generally associated with higher markup and lower production efficiency than non-SOEs, which suggests that the high profitability of upstream SOEs cannot be primarily explained by their own productivity. Their findings lend strong support to our vertical structure argument. However, the original method of De Loecker and Warzynski is valid only when [1] firms are not financially constrained, [2] good firm-level data on price and quantity are available, and [3] the quality of output remains unchanged or can be well measured, none of which is satisfied for the data set on China that we are using, so the estimated quantity-based TFP measure

argument is empirically relevant, we should expect β_4 to be positive and significant.

For the purpose of comparison, we also include the corresponding weighted average TFPs of three other groups of enterprises: upstream SOEs, upstream POEs and downstream SOEs. These TFPs are constructed using the same approach as for $DownPoeTFP_{j,t}$. In addition, for reasons argued in Song et al. (2011) and Hsieh and Song (2015), we control for the TFP of the particular upstream SOE i ($TFP_{i,t}$) and the capital intensity of upstream industry j measured by total fixed assets divided by total employment ($Capital\_Intensity_{j,t}$).[40] Unfortunately, no good measure of enterprise-level implicit subsidies is available. Instead, we use the logarithm of the total assets of SOE i ($Total\_Assets_{i,t}$) as a proxy for the time-variant component of the ability of the corresponding SOE to obtain favorable government support such as financial subsidies, as more subsidies should lead to larger assets after controlling for the industry's capital intensity and enterprise productivity. Another independent variable is the export-output ratio (exports (213)/sales (209)) for the industries that are downstream of industry j ($DownExportShare_{j,t}$). This variable captures the additional effect of the relative external demand for downstream output on upstream SOE performance, and it is employed to explore the empirical relevance of accessibility to the world market for the vertical structure mechanism (see Yu (2014) and Khandelwal, Schott and Wei (2014) for more empirical evidence on the relevance of trade liberalization for China). We control for the market structure of upstream industry j measured by the revenue-based Herfindahl-Hirschman Index ($HHI_{j,t}$). $\varepsilon_{i,j,t}$ is the error term. To mitigate the influence of outliers while preserving the underlying relations, we conduct quantile regressions.

The following table presents the regression results.

[Insert Table 4 Here]

Most importantly, β_4 is always positive and significant in all six regressions, which is consistent with the vertical structure mechanism formalized in the model. That is, an increase in the downstream POE productivity increases the demand for the output of upstream SOEs and hence boosts their profitability.[41]

in existing literature must be read with all these caveats.

[40] Replacing total assets by fixed assets, which may allow us to also control for capital intensity, does not affect our results, and the coefficient estimates of fixed assets are generally positive and significant. Because we include firm and year fixed effects, we have controlled for the industry-level fixed capital intensity as in Song et al. (2011).

[41] This key result also remains robust when the dependent variables are at the industry level instead of the enterprise level. However, for industry-level regressions, the sample size becomes much smaller, TFPs across industries are not

In contrast, β_2 is always negative and significant, consistent with the standard prediction under the horizontal structure (see Restuccia and Rogerson (2008), Hsieh and Klenow (2009), Song et al. (2011)). That is, an increase in an upstream POE's productivity reduces the demand for the output of SOEs in the same (upstream) industries and hence hurts their profitability. Thus, the empirical results confirm our theoretical predictions that the vertical and horizontal structures have diametrically opposite implications (refer to Appendix A and Proposition 2 for mathematical proofs).[42] In addition, β_6 is positive and significant at the 5% level in columns (1) and (5) and significant at the 10% level in columns (2) and (6). These results support the vertical structure mechanism because they show that holding the downstream productivity fixed, an increase in relative external demand for downstream output can promote upstream SOEs' performance.

All the empirical results suggest that the effect of the vertical structure mechanism remains robustly significant after controlling for alternative contributing factors.

To check the robustness of the main results, we also directly examine the correlation between upstream enterprise-level SOE performance and the corresponding downstream aggregate demand without using TFP measures, after controlling for industry-level capital intensity and/or firm size (total assets), among others. This is to circumvent the array of complicated issues associated with constructing revenue-based and/or quantity-based TFP measures and computing enterprise-level markups. Recall that the vertical structure mechanism essentially works through the input-output demand channel, *i.e.*, expansion of downstream aggregate demand (for any exogenous reasons) would boost upstream enterprise-level monopolist SOE performance, *ceteris paribus.* Regression results do confirm a robust and significant positive correlation between these two variables, consistent with the vertical structure mechanism. Refer to Table A3 and Table A4 for more details.

In summary, all the preliminary regression results indicate that the vertical structure mechanism is empirically relevant after controlling for other possible mechanisms argued in the pertinent literature. Since the primary objective of this paper is to build a simple qualitative model to investigate the cause and consequence of the under-appreciated vertical structure mechanism in

comparable, factors such as financial subsidies become even more difficult to control for, reverse causality becomes potentially more severe, and the composition effect is more difficult to rule out, so we mainly report the enterprise-level regression results, which should be more reliable.

[42] Observe that β_1 is always insignificant, which may suggest that upstream SOEs are not exactly competing with each other, perhaps due to internal coordination by the government. The situation is similar for β_3. However, this paper will mainly focus on the interaction between SOEs and non-SOEs rather than the interaction among SOEs themselves.

China's state capitalism, we leave the sophisticated quantitative investigations for future research.[43]

8 Implications for Other Countries

Although this paper is mainly motivated by observations on China, the analytical framework applies to related issues in other economies, especially in emerging markets and transitional economies.

For instance, Vietnam is another transitional socialist economy that has seen rapid growth since its market-oriented reform in the mid-1980s. The country joined WTO in 2006, five years after China, and has essentially followed a path similar to China's by gradually liberalizing some downstream industries and actively participating in international trade (Malesky and London (2014)). Our analysis may alert Vietnam to the potential downside of state capitalism.

India is another fast-growing emerging economy with a large population. However, for political economy reasons, the Indian government regulates upstream industries by setting prices lower than their production cost (such as electricity), so these key intermediate inputs and services are often unstably supplied. The vulnerability of the upstream sector chokes off the downstream manufacturing development and retards the country's industrialization and urbanization (Bardhan (2010)) . As a consequence, the magnitudes of India's manufacturing exports and the scale of FDI inflows are much smaller than those of China despite the fact that India joined WTO six years earlier than China and its labor is on average even cheaper than Chinese labor (Bosworth and Collins (2008) and Wang (2013)).

Russia's state capitalism is different from that of China. In Russia, upstream industries such as natural gas and oil are largely owned by the state but controlled by powerful oligarchs (Shleifer and Triesman (1999) and Myerson and Braguinsky (2007)). Russia has a relatively small population and high labor cost, which partly explains why the downstream manufacturing sector has no comparative advantage like it does in China or Vietnam. Policy hurdles could be another important reason. For instance, Russia was not a member of WTO until August 2012. The underdevelopment of the downstream industries further compels the upstream oligarchs to directly sell most of their natural gas and oil abroad at the international price, which in turn has important implications for

[43] It is challenging to establish causality rigorously due to data limitation. Calibrations are presumably required to quantify the contribution of the vertical structure mechanism and exploit quantitative welfare implications, ideally in a full-fleged dynamic and open conomy setting with markups carefully disentangled from productivity (see Edmond, Midrigan and Xu (2014)).

domestic industrialization, growth sustainability, and income distribution. Similar analyses may be applicable to other resource-abundant countries such as Brazil, Australia, and mid-east OPEC members.

9 Conclusion

We develop a simple model of China's state capitalism that highlights a vertical structure, in which some key upstream industries are controlled by the state via SOE monopoly, whereas downstream industries are largely liberalized and operate under capitalism. We show that this vertical structure, when combined with trade openness and labor abundance, can explain the puzzling fact that SOEs have achieved an unprecedented high profitability, dwarfing the performance of non-SOEs in the last decade. Our theory points to the incompleteness of the market-oriented reforms as the fundamental cause for the recent unusual prosperity of China's SOEs. Our framework can also explain why non-SOEs outperformed SOEs in the 1990s before this vertical structure of state capitalism had fully emerged.

This paper is mainly qualitative and serves as only a first step toward a deeper understanding of state capitalism in countries like China. Several directions deserve future research. First, more comprehensive quantitative implications of the current model and its dynamic extension can be explored.[44] Second, various political-economy aspects of such a model of state capitalism can be studied (Roland (2000), Li and Zhou (2005), Xu (2011), Yao (2014), Wang (2015b), Wen (2015)). Third, it would be interesting to study firm dynamics, size distributions, and industry dynamics by introducing cross-firm productivity heterogeneity into the vertical structure (see Melitz (2003), Luttmer (2007), or Restuccia and Rogerson (2008), Samaneigo (2010)). Fourth, factor market frictions can be incorporated to quantitatively gauge their impact on firm profits, GDP, as well as income distribution within this framework of state capitalism. A deep understanding of state capitalism is of fundamental importance to both China and the world economy.

[44] Wang (2014b) 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 and industry upgrading from labor-intensive ones to capital-intensive ones.

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Math Appendix (for online publication)

A. Horizontal Structure

This is to show that SOE profit is hurt by an increase in the TFP of private firms under horizontal structure, which is opposite to the prediction in the vertical structure. For ease of comparison, we adopt a horizontal-structure setup similar to Song et al. (2011). Suppose households' utility function is a strictly increasing function of the aggregate consumption. The final output Y is produced by "horizontally" combining the output of the private firm product Y_p and that of the SOE product Y_s in a CES form with substitution elasticity σ:

$$Y = (Y_p^{\frac{\sigma-1}{\sigma}} + Y_s^{\frac{\sigma-1}{\sigma}})^{\frac{\sigma}{\sigma-1}}, \sigma > 1.$$

Suppose labor is the only input that the technologies are given by

$$Y_p = A_p L_p; Y_s = A_s L_s.$$

Furthermore, assume perfect competition and free entry in the private sector but a monopoly market structure in the sector that produces Y_s. Labor market clears in this autarky general equilibrium

$$L_p + L_s = L,$$

where L is the total labor endowment. It can be shown that the profit of the SOE is given by

$$\Pi = \frac{WL}{\sigma\left[\left(\frac{A_s}{A_p}\frac{\sigma-1}{\sigma}\right)^{1-\sigma} + 1\right] - 1}.$$

Suppose we normalize wage to be unity. Clearly, $\frac{\partial \Pi}{\partial A_p} < 0$. That is, an increase in private TFP hurts the monopoly profit of the SOE when private firms and the SOE are producing horizontally differentiated goods. The intuition is that the demand for the SOE product declines as the private good becomes cheaper due to its productivity increase, hence the SOE profit goes down. It is diametrically different from the prediction under vertical structure ($\frac{\partial \Pi_m}{\partial A} > 0$), as highlighted in Proposition 2.

Suppose, instead, we choose the final output as the numeraire, then we have

$$W = \left[\left(\frac{1}{A_s} \frac{\sigma}{\sigma - 1} \right)^{1-\sigma} + \left(\frac{1}{A_p} \right)^{1-\sigma} \right]^{-\frac{1}{1-\sigma}},$$

and therefore,

$$\Pi = \frac{\left[\left(\frac{1}{A_s} \frac{\sigma}{\sigma-1} \right)^{1-\sigma} + \left(\frac{1}{A_p} \right)^{1-\sigma} \right]^{-\frac{1}{1-\sigma}} L}{\sigma \left[\left(\frac{A_s}{A_p} \frac{\sigma-1}{\sigma} \right)^{1-\sigma} + 1 \right] - 1}.$$

We can show that $\frac{\partial \Pi}{\partial A_p} < 0$ holds whenever $\sigma \geq 2$. It also holds when $\sigma \in (1, 2)$ and

$$\frac{A_s}{A_p} > \frac{\sigma}{\sigma - 1} \left[\frac{(\sigma - 1)^2}{\sigma(2 - \sigma)} \right]^{\frac{1}{1-\sigma}}. \tag{38}$$

The intuition is as follows. When A_p increases, it has a positive income effect on the demand for SOE product, which increases the SOE profit. On the other hand, it also has a negative substitution effect on the demand for the SOE product, which reduces the SOE profit. When the substitution elasticity between the SOE product and the private product is sufficiently large ($\sigma \geq 2$), the substitution effect dominates, so $\frac{\partial \Pi}{\partial A_p} < 0$. When $\sigma \in (1, 2)$, the productivity of private firms has to be sufficiently small (that is, (38) is satisfied) so that the substitution effect still dominates the income effect.

B. Proof of Proposition 3

One set of sufficient conditions is that the upstream technology is sufficiently capital intensive whereas the downstream technology is sufficiently labor intensive. More precisely, $\gamma = 1$, $\alpha > 0$, and β is sufficiently large such that

$$\left[1 + \frac{1}{(1 - \alpha - \beta)(\epsilon - 1)} \right]^{\alpha} < \left(1 + \frac{\frac{\alpha}{1-\beta}}{(1 - \alpha - \beta)(\epsilon - 1)} \right)^{1-\beta}. \tag{39}$$

The key results (i.e., predictions for upstream and downstream prices, total industrial employment, industrial output, welfare, etc.) also hold when capital is not needed for production at all, namely, $\gamma = \alpha = 0$, even though now the rental price is always $R = 0$.

Now we provide the proof for the above claim and also the characterization for the general case.

Consider the general case in which everything is identical to the setting in Section 3.1 except that the upstream industry has N symmetric SOEs, where N can be any positive integer. In particular, when $N = 1$, it returns to the original setting with only one firm monopolizing the upstream industry. When $N \to \infty$, the upstream becomes perfectly competitive. It is straightforward to show that for any arbitrary N, (14)-(19), (21) and (22) all still hold except that the markup μ is now given by

$$\mu \equiv \frac{N\left[(1-\alpha-\beta)(\epsilon-1)+1\right]}{N\left[(1-\alpha-\beta)(\epsilon-1)+1\right]-1},$$

which obviously decreases with N. For Proposition 3, it suffices to compare the two cases when

$N = 1$ and $N = \infty$. To avoid the trivial cases, we always assume that the upstream intermediate input is crucial for downstream production, i.e., $1-\alpha-\beta > 0$.

[1] (14), (17) and (18) immediately implies that R strictly decreases with μ if and only if $\alpha > 0$ or $\gamma > 0$ or both. So R strictly increases after upstream liberalization. $R = 0$ always holds if $\alpha = \gamma = 0$.

[2] Using (15), (17) and (18), we can show that p_m strictly increases with μ when $\alpha > 0$ or $1 > \gamma > 0$, or both. More precisely,

$$p_m = p_n \cdot \frac{\mu \varkappa^{\xi\gamma} A_n^{1-\gamma} A_m^{-1}}{\gamma^{\gamma}\left(1-\gamma\right)^{1-\gamma}} \propto \mu\varkappa^{\xi\gamma} \propto \left[\gamma\left(1-\alpha-\beta\right)+\alpha\mu\right]^{\xi\gamma} \mu^{[(1-\alpha-\beta)(1-\epsilon)-1]\xi\gamma+1}$$

so $\frac{\partial p_m}{\partial \mu} > 0$ if and only if

$$\xi\gamma\alpha\mu + \left[\gamma\left(1-\alpha-\beta\right)+\alpha\mu\right]\left\{\frac{\alpha\left(\epsilon-1\right)+1-\gamma}{1+\alpha\left(\epsilon-1\right)+\gamma(1-\alpha-\beta)(\epsilon-1)}\right\} > 0,$$

which is always true when $\alpha > 0$ or $1 > \gamma > 0$, or both. For binary comparison, p_m becomes strictly smaller after the full liberalization of the upstream if and only if

$$\begin{aligned}
\left[\gamma\left(1-\alpha-\beta\right)+\alpha\mu\right]^{\xi\gamma} \mu^{[(1-\alpha-\beta)(1-\epsilon)-1]\xi\gamma+1} &> \left[\gamma\left(1-\alpha-\beta\right)+\alpha\right]^{\xi\gamma}, \\
\left[\gamma\left(1-\alpha-\beta\right)+\alpha\mu\right]^{\xi\gamma} \mu^{\frac{1-\gamma+\alpha(\epsilon-1)}{1+\alpha(\epsilon-1)+\gamma(1-\alpha-\beta)(\epsilon-1)}} &> \left[\gamma\left(1-\alpha-\beta\right)+\alpha\right]^{\xi\gamma}
\end{aligned}$$

which is always true except when $1-\gamma = \alpha = 0$. It is also true when $\alpha = \gamma = 0$, because in that case p_m drops from $\mu \frac{A_n}{A_m} p_n$ to $\frac{A_n}{A_m} p_n$.

[3] Using (16), (17) and (18), we can show that p_d becomes strictly smaller after the full liberalization of the upstream industry if and only if

$$\left[\frac{(1-\alpha-\beta)(\epsilon-1)+1}{(1-\alpha-\beta)(\epsilon-1)}\right]^{\alpha+(\gamma-1)(1-\alpha-\beta)} < \left[\frac{\gamma(1-\alpha-\beta)+\alpha+\frac{\alpha}{(1-\alpha-\beta)(\epsilon-1)}}{\gamma(1-\alpha-\beta)+\alpha}\right]^{\alpha+\gamma(1-\alpha-\beta)}. \quad (40)$$

In particular, it holds when $\gamma = 1$, $\alpha > 0$, and β is sufficiently large ($\frac{1-\beta}{\alpha}$ is sufficiently small) such that

$$\left[1+\frac{1}{(1-\alpha-\beta)(\epsilon-1)}\right] < \left[1+\frac{\frac{\alpha}{1-\beta}}{(1-\alpha-\beta)(\epsilon-1)}\right]^{\frac{1-\beta}{\alpha}}.$$

In addition, p_d also becomes strictly smaller after the full liberalization when $\alpha = \gamma = 0$, because $p_d = \frac{W^{\beta}p_m^{1-\beta}}{A\beta^{\beta}(1-\beta)^{1-\beta}}$, where p_m decreases and W remains constant (equal to$A_n p_n$).

[4] Downstream industrial output in equilibrium is given by (5), which strictly decreases with p_d. So the total output for downstream good d strictly increases after the full liberalization of the upstream if and only if (39) is true.

[5] Total industrial employment, by invoking (19), (17) and (18), is given by

$$\begin{aligned}
&\overline{L}(A_n, A, A_m, K) \\
\propto\ & [\gamma(1-\alpha-\beta)+\alpha\mu]^{\xi-1}\,\mu^{[(1-\alpha-\beta)(1-\epsilon)-1]\xi}\,[(1-\gamma)(1-\alpha-\beta)+\beta\mu] \\
=\ & [\gamma(1-\alpha-\beta)+\alpha\mu]^{-\frac{\alpha(\epsilon-1)+\gamma(1-\alpha-\beta)(\epsilon-1)}{1+\alpha(\epsilon-1)+\gamma(1-\alpha-\beta)(\epsilon-1)}}\,\mu^{\frac{\alpha-(1-\gamma)(1-\alpha-\beta)}{1+\alpha(\epsilon-1)+\gamma(1-\alpha-\beta)(\epsilon-1)}(\epsilon-1)}\left[\frac{(1-\gamma)(1-\alpha-\beta)+\beta\mu}{\mu}\right],
\end{aligned}$$

which becomes strictly larger after the upstream full liberalization if and only if

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

In particular, the above inequality is equivalent to (39) when $\gamma = 1$ and $\alpha > 0$. When $\alpha = \gamma = 0$, $\overline{L}(A_n, A, A_m, K) \propto \mu^{(1-\beta)(1-\epsilon)-1}[(1-\beta)+\beta\mu]$, which strictly decreases with μ, so it becomes strictly larger after full liberalization.

[6] GDP (per capita) Y, by revoking (22), strictly increases with $\frac{\alpha\mu+(1-\alpha-\beta)(\gamma+\mu-1)}{(1-\gamma)(1-\alpha-\beta)+\beta\mu}\overline{L}(A_n, A, A_m, K)$,

or

$$\left[\frac{\gamma(1-\alpha-\beta)+\alpha\mu}{\mu}\left\{\mu^{1-\alpha-\beta}\right\}^{1-\epsilon}\right]^{\xi}\frac{(1-\beta)\mu-(1-\alpha-\beta)(1-\gamma)}{\gamma(1-\alpha-\beta)+\alpha\mu},$$

which becomes strictly larger after full liberalization if and only if

$$\begin{aligned}&\left[\frac{\gamma(1-\alpha-\beta)+\alpha\mu}{\mu}\left\{\mu^{1-\alpha-\beta}\right\}^{1-\epsilon}\right]^{\xi}\frac{(1-\beta)\mu-(1-\alpha-\beta)(1-\gamma)}{\gamma(1-\alpha-\beta)+\alpha\mu}\\ < \;&[\gamma(1-\alpha-\beta)+\alpha]^{\xi-1}[(1-\beta)-(1-\alpha-\beta)(1-\gamma)],\end{aligned}$$

which is equivalent to (39) when $\gamma = 1$ and $\alpha > 0$. However, Y becomes smaller after full liberalization when $\alpha = \gamma = 0$, because, without capital, we have $Y = WL + \Pi_m$, where W stays unchanged but Π_m becomes zero after upstream liberalization.

[7] Welfare. Using (4) and (5), together with (22), we can derive the welfare of an average household (assuming equal income across all the agents after lump-sum transfer from elite to grass roots):

$$\begin{aligned}u(c_n,c_d) &= c_n+\frac{\epsilon}{\epsilon-1}c_d^{\frac{\epsilon-1}{\epsilon}}=\frac{WL+RK+\Pi_m}{p_n}-\left(\frac{p_n}{p_d}\right)^{\epsilon-1}+\frac{\epsilon}{\epsilon-1}\left[\left(\frac{p_n}{p_d}\right)^{\epsilon}\right]^{\frac{\epsilon-1}{\epsilon}}\\ &= A_nL+\frac{\varkappa^{\xi}\left[(1-\alpha-\beta)(\mu-1)+\frac{\mu}{\epsilon-1}\right]}{\gamma(1-\alpha-\beta)+\alpha\mu}\left[A_n^{\alpha+\gamma(1-\alpha-\beta)-1}A_m^{1-\alpha-\beta}AK^{\alpha+\gamma(1-\alpha-\beta)}\right]^{\xi(\epsilon-1)},\end{aligned}$$

which becomes strictly larger after full liberalization when γ and α are not both zero if and only if

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

which is never possible.

The welfare of a representative grass-roots household is given by

$$\begin{aligned}&A_nL+\frac{\varkappa^{\xi}\left[(1-\alpha-\beta)(\mu-1)+\frac{\mu}{\epsilon-1}\right]}{\gamma(1-\alpha-\beta)+\alpha\mu}\left[A_n^{\alpha+\gamma(1-\alpha-\beta)-1}A_m^{1-\alpha-\beta}AK^{\alpha+\gamma(1-\alpha-\beta)}\right]^{\xi(\epsilon-1)}-\frac{\Pi_m}{p_n}\\ =\;&A_nL+\frac{\varkappa^{\xi}\left[(1-\alpha-\beta)(\mu-1)+\frac{\mu}{\epsilon-1}\right]}{\gamma(1-\alpha-\beta)+\alpha\mu}\left[A_n^{\alpha+\gamma(1-\alpha-\beta)-1}A_m^{1-\alpha-\beta}AK^{\alpha+\gamma(1-\alpha-\beta)}\right]^{\xi(\epsilon-1)}\\ &-\frac{(1-\alpha-\beta)(\mu-1)}{(1-\gamma)(1-\alpha-\beta)+\beta\mu}\overline{L}(A_n,A,A_m,K)A_n\end{aligned}$$

which strictly increases with

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

which becomes strictly larger after full liberalization when γ and α are not both zero iff

$$\left[\gamma\left(1-\alpha-\beta\right)+\alpha\mu\right]^{-[\alpha+\gamma(1-\alpha-\beta)]}\,\mu^{\alpha+(\gamma-1)(1-\alpha-\beta)}<\left[\gamma\left(1-\alpha-\beta\right)+\alpha\right]^{-[\alpha+\gamma(1-\alpha-\beta)]}$$

or

$$\left[1+\frac{1}{(1-\alpha-\beta)(\epsilon-1)}\right]^{\alpha+(\gamma-1)(1-\alpha-\beta)}<\left[1+\frac{\frac{\alpha}{\gamma(1-\alpha-\beta)+\alpha}}{(1-\alpha-\beta)(\epsilon-1)}\right]^{\alpha+\gamma(1-\alpha-\beta)},$$

which is equivalent to (39) when $\gamma=1$ and $\alpha>0$. When $\alpha=\gamma=0$, the grass-roots welfare also becomes strictly larger after full liberalization because their income remains constant but p_d becomes strictly lower.

On the other hand, the welfare of a representative elite household becomes strictly worse off after upstream liberalization because each earns income $WL+RK+\frac{\Pi_m}{\theta}$, which is strictly larger than average income Y whenever $\Pi_m>0$. Using (4) and (5), together with (22), we can derive the welfare of a household with the average income level Y is given by

$$\begin{aligned}u(c_n,c_d) &= c_n+\frac{\epsilon}{\epsilon-1}c_d^{\frac{\epsilon-1}{\epsilon}}=\frac{WL+RK+\Pi_m}{p_n}-\left(\frac{p_n}{p_d}\right)^{\epsilon-1}+\frac{\epsilon}{\epsilon-1}\left[\left(\frac{p_n}{p_d}\right)^{\epsilon}\right]^{\frac{\epsilon-1}{\epsilon}}\\ &= A_nL+\frac{\varkappa^{\xi}\left[\left(1-\alpha-\beta\right)\left(\mu-1\right)+\frac{\mu}{\epsilon-1}\right]}{\gamma\left(1-\alpha-\beta\right)+\alpha\mu}\left[A_n^{\alpha+\gamma(1-\alpha-\beta)-1}A_m^{1-\alpha-\beta}AK^{\alpha+\gamma(1-\alpha-\beta)}\right]^{\xi(\epsilon-1)},\end{aligned}$$

which becomes strictly smaller after full liberalization when γ and α are not both zero iff

$$(1-\alpha-\beta)(\epsilon-1)+1>\frac{\alpha}{\gamma\left(1-\alpha-\beta\right)+\alpha},$$

which is always true. So the welfare loss of an elite household is even larger after full liberalization. When $\alpha=\gamma=0$, each of the elite households' welfare also becomes strictly smaller after full liberalization when θ is sufficiently small, because their income drops too much despite the decrease in p_d.

C. Proof of Lemma 2

First, we show why (23)-(25) are needed. To ensure the trade pattern in equilibrium as described earlier, we require that $\frac{p_d}{p_n} < A^*$, or equivalently

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

where $b \equiv \left[A_m^{(1-\alpha-\beta)}A\right]^{\epsilon-1}\varkappa$. The positive production of good n in country H requires $L > \overline{\overline{L}}$, where $\overline{\overline{L}} \equiv 2^{\frac{1}{1+\alpha(\epsilon-1)+\gamma(1-\alpha-\beta)(\epsilon-1)}}\overline{L}(1, A, A_m, K)$. $\overline{\overline{L}}$ is the total industrial employment in country H. Positive consumption of good n in country F requires $D_n^* = A^*L^* - \frac{p_d D_d^*}{W} > 0$,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

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

The aggregate consumption of the numeraire good in country H is

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

For completeness, the total (or individual) consumption in country F is given by

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

and

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

Condition (24) guarantees that $c_n^* > 0$. The total GDP in country F is $I^* = L^*W^* = L^*A^*W$. To ensure that even the grassroots in country H consumes a positive amount of good n, we require $RK + WL > p_n^{\epsilon} p_d^{1-\epsilon}$, which is equivalent to $L > \frac{\frac{\mu}{2}-\gamma(1-\alpha-\beta)-\alpha\mu}{(1-\gamma)(1-\alpha-\beta)+\beta\mu}\overline{\overline{L}}(A, A_m, K)$. Therefore, condition $\frac{\frac{\mu}{2}-\gamma(1-\alpha-\beta)-\alpha\mu}{(1-\gamma)(1-\alpha-\beta)+\beta\mu} \geq 1$ means that $(1-\alpha-\beta)(\epsilon-3)+1 \leq 0$. The capital market clearing condition implies

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

Observe that R is still given by (14) except that K is replaced by $\frac{K}{2}$. To understand why, first notice that the demand functions for good d are identical in the two countries ($D_d = D_d^* = \left(\frac{p_n}{p_d}\right)^{\epsilon}$, due to the lack of income effect implied by the quasi-linear utility function), so the monopolist SOE charges the same markup as in the autarky case (9). As the world total demand for good d doubles the domestic demand in country H, the demand for the intermediate good is also scaled up (recall that good d is produced only in country H). Labor is abundant in country H but only half of the capital endowment is used to serve domestic demand for good d, plus the fact that all the technologies are constant returns to scale, so in equilibrium K is replaced by $\frac{K}{2}$ in formula (14). Similarly, (9) and (40) jointly yield

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

The same is true for the price of downstream good d :

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

D. Proof for Section 5

[1] The labor market clearing condition in country H is

$$\begin{aligned} L &= (D_d + D_d^*) \cdot \frac{\partial p_d}{\partial W} + D_m \frac{\partial \frac{R^\gamma W^{1-\gamma}}{A_m \gamma^\gamma (1-\gamma)^{1-\gamma}}}{\partial W} \\ &= 2\frac{p_n^\epsilon}{W^\epsilon} \left[\frac{\left(\frac{R}{W}\right)^{\alpha+\gamma(1-\alpha-\beta)} \left(\frac{\widetilde{\mu}}{A_m\gamma^\gamma(1-\gamma)^{1-\gamma}}\right)^{1-\alpha-\beta}}{A\alpha^\alpha\beta^\beta\left(1-\alpha-\beta\right)^{1-\alpha-\beta}} \right]^{1-\epsilon} \beta \left[1 + \frac{(1-\gamma)(1-\alpha-\beta)}{\widetilde{\mu}\beta} \right], \quad (42) \end{aligned}$$

The capital market clearing condition in country H is $K = (D_d + D_d^*) \cdot \frac{\partial p_d}{\partial R} + D_m \frac{\partial \frac{R^\gamma W^{1-\gamma}}{A_m\gamma^\gamma(1-\gamma)^{1-\gamma}}}{\partial R}$, which implies $K = 2b\left(\frac{R}{W}\right)^{-[1+\alpha(\epsilon-1)+\gamma(1-\alpha-\beta)(\epsilon-1)]} \cdot \left(\frac{p_n}{W}\right)^\epsilon$, where $b \equiv \left[A_m^{(1-\alpha-\beta)}A\right]^{\epsilon-1} \varkappa$. These two factor market clearing conditions imply $\frac{\mu^{(1-\alpha-\beta)(1-\epsilon)-1}\cdot[\gamma(1-\alpha-\beta)+\alpha\mu]}{\left[\widetilde{\mu}^{1-\alpha-\beta}\right]^{1-\epsilon}\left[\beta+\frac{(1-\gamma)(1-\alpha-\beta)}{\widetilde{\mu}}\right]} = \frac{K}{L}\frac{R}{W}$. 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, $W^* = A^* p_n$,

$$\begin{aligned} W &= (2b)^{\frac{1}{\epsilon}} \left[L \cdot \frac{\gamma(1-\alpha-\beta)+\alpha\mu}{(1-\gamma)(1-\alpha-\beta)+\beta\mu} \right]^{\frac{-[1+\alpha(\epsilon-1)+\gamma(1-\alpha-\beta)(\epsilon-1)]}{\epsilon}} K^{\frac{\alpha(\epsilon-1)+\gamma(1-\alpha-\beta)(\epsilon-1)}{\epsilon}} p_n, \quad (43) \\ R &= (2b)^{\frac{1}{\epsilon}} \left[L \cdot \frac{\gamma(1-\alpha-\beta)+\alpha\mu}{(1-\gamma)(1-\alpha-\beta)+\beta\mu} \right]^{\frac{[1-\alpha-\gamma(1-\alpha-\beta)](\epsilon-1)}{\epsilon}} K^{\frac{\alpha(\epsilon-1)+\gamma(1-\alpha-\beta)(\epsilon-1)}{\epsilon}-1} p_n. \end{aligned}$$

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

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

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

which proves (34), where

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

(33) can be easily obtained by using (34) and (43). To ensure positive consumption of good n in country H, we require $GDP > D_d p_d$, which is true if and only if

$$
\frac{(1-\alpha-\beta)+(\beta+\alpha)\mu}{\gamma(1-\alpha-\beta)+\alpha\mu} > (\varkappa)^{-1}\left(\frac{\left[\frac{\mu}{\gamma^\gamma(1-\gamma)^{1-\gamma}}\right]^{1-\alpha-\beta}}{\alpha^\alpha\beta^\beta(1-\alpha-\beta)^{1-\alpha-\beta}}\right)^{1-\epsilon}\left[\frac{1}{2} - \frac{\mu-1}{\mu}(1-\alpha-\beta)\right]. \quad (44)
$$

The above equation must always hold whenever (27) holds because $\frac{1}{2}-\frac{\mu-1}{\mu}(1-\alpha-\beta)\leq 0$. To ensure country F also consumes good n, we must require $W^*L^* > D_d^* p_d$, which is reduced to (32). To ensure that country H does not produce good n, we must require $p_n < W$, which is equivalent to $L < \overline{\overline{L}}(A, A_m, K)$. Note that for simplicity we ignore the effect of the domestic income inequality in country H by assuming that the wealth is redistributed in a lump-sum fashion among the agents in country H such that everyone ends up with identical wealth (and consumption). To ensure country F does not produce d, we must require $W^* > p_d$, or equivalently

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

[2] It is straightforward to show that the following is true:

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

It can be shown that $\Gamma'(\varpi) > 0$ for any $\varpi \in [1, \mu]$. This can be easily seen when no capital is needed for production in the model ($\alpha = \gamma = 0$) or when no labor is needed in the industrial sector ($\beta = 1-\gamma = 0$).

E. Proof of Proposition 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 $p(i)$ denotes the market price of good $i \in [0,1]$ and the price index P is defined as $P \equiv \left(\int_0^1 p(i)^{1-\eta}di\right)^{\frac{1}{1-\eta}}$. The aggregate price P and p_n are taken as given by the SOE, so 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,

$p(j') = \frac{R^{\alpha}W^{\beta}{p_m}^{1-\alpha-\beta}}{A_p\alpha^{\alpha}\beta^{\beta}(1-\alpha-\beta)^{1-\alpha-\beta}}$ for any liberalized industry j', so the aggregate price level

$$\begin{aligned} P &= \left(\int_0^1 p(i)^{1-\eta} di\right)^{\frac{1}{1-\eta}} \\ &= \left((1-\phi)\left[\frac{\eta}{\eta-1}\frac{1}{A_s}\right]^{1-\eta} + \phi\left[\frac{1}{A_p}\right]^{1-\eta}\right)^{\frac{1}{1-\eta}} \frac{R^{\alpha}W^{\beta}{p_m}^{1-\alpha-\beta}}{\alpha^{\alpha}\beta^{\beta}\left(1-\alpha-\beta\right)^{1-\alpha-\beta}}. \end{aligned} \tag{45}$$

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

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

so the total profit of the upstream SOE is

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

and the total revenue of the upstream SOE is

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

The total downstream SOE profit is

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

and the total downstream SOE revenue is

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

Therefore, the aggregate profit of SOE is

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

which is maximized when $\phi=1$ if $\frac{A_p}{A_s}>\left(\frac{\eta-1}{\eta}\right)\left[\frac{\eta-1}{\eta}+\frac{\mu}{\eta(\mu-1)(1-\alpha-\beta)}\right]^{\frac{1}{\eta-1}}$ given all the factor prices (R and W) and optimal price choice of upstream intermediate input p_m.

F. Proof for Proposition 6.

Proposition 6 is a special case of the following general result:

$$\frac{\partial\mu}{\partial A}\begin{cases}<0, & \begin{array}{c}\text{when } \rho\in[0,1)\cup(\epsilon,\infty)\\ \text{or when } \rho=\infty \text{ and } 1\leq\frac{A_m}{A}<\frac{\epsilon}{\epsilon-1}\end{array}\\ =0, & \begin{array}{c}\text{when } \rho=1 \text{ or when } \rho=\epsilon\\ \text{or when } \rho=\infty \text{ and } \frac{A_m}{A}\in(\frac{\epsilon}{\epsilon-1},\infty)\end{array}\\ >0, & \text{when } \rho\in(1,\epsilon)\\ \text{not defined}, & \text{when } \rho=\infty \text{ and } \frac{A_m}{A}\in(0,1)\end{cases}.$$

Now we first prove the above statement and then provide the economic intution for these mathematical results.

Proof. It is straightforward to obtain $p_d=\left[\left(\frac{w}{A}\right)^{1-\rho}+p_m^{1-\rho}\right]^{\frac{1}{1-\rho}}$, where wage $w=A_n$. Good n is still used as the numeraire. Using $D_d=\left(\frac{p_n}{p_d}\right)^{\epsilon}$ and Shepherd's Lemma, we can write down the monopolist upstream SOE's optimization problem as follows:

$$\max_{p_m} \left[p_m - \frac{w}{A_m}\right] \left(\frac{p_n}{p_d}\right)^{\epsilon} \left[\left(\frac{w}{A}\right)^{1-\rho} + p_m^{1-\rho}\right]^{\frac{1}{1-\rho}-1} p_m^{-\rho},$$

FOC:

$$\left[1 - \rho\left(1 - \frac{w}{A_m p_m}\right)\right] \left[\left(\frac{w}{A p_m}\right)^{1-\rho} + 1\right] + (\rho - \epsilon)\left[1 - \frac{w}{p_m A_m}\right] = 0$$

Define upstream markup as $\mu \equiv \frac{p_m}{\left(\frac{w}{A_m}\right)}$, the above equation can be rewritten as

$$\left[1 - \rho + \rho\frac{1}{\mu}\right] \left[\left(\frac{A_m}{A}\frac{1}{\mu}\right)^{1-\rho} + 1\right] + (\rho - \epsilon)\left[1 - \frac{1}{\mu}\right] = 0. \tag{46}$$

Using the Implicit Function Theorem, we have

$$\frac{d\frac{1}{\mu}}{d\frac{A_m}{A}} = \frac{-(1-\rho)\left[1 - \rho\left(1 - \frac{1}{\mu}\right)\right]\left(\frac{A_m}{A}\frac{1}{\mu}\right)^{-\rho}\frac{1}{\mu}}{\left[(1-\rho)^2\mu + (2-\rho)\rho\right]\left(\frac{A_m}{A}\frac{1}{\mu}\right)^{1-\rho} + \epsilon}. \tag{47}$$

Observe that the denominator is always strictly larger than zero for any $\rho \geq 0$ and $\mu \geq 1$. Also, $sign(\frac{d\mu}{d\frac{A}{A_m}})$=$sign(\frac{d\frac{1}{\mu}}{d\frac{A_m}{A}})$. When $0 \leq \rho < 1$, then the numerator of (47) is strictly negative, so $\frac{d\frac{1}{\mu}}{d\frac{A_m}{A}} < 0$. When $\rho = 1$ (back to the C-D case), $\frac{d\frac{1}{\mu}}{d\frac{A_m}{A}} = 0$ based on (47). When $\rho = \epsilon$, (46) holds if and only if $\mu = \frac{\epsilon}{\epsilon - 1}$, and therefore $\frac{d\frac{1}{\mu}}{d\frac{A_m}{A}} = 0$. When $\epsilon < \rho < \infty$, then the second term on the left hand side of (46) must be strictly positive, so $\left[1 - \rho + \rho\frac{1}{\mu}\right]$ must be strictly negative. In that case, when $\frac{A_m}{A}$ increases, $\frac{1}{\mu}$ must decrease to keep (46) valid, thus $\frac{d\frac{1}{\mu}}{d\frac{A_m}{A}} < 0$. When $1 < \rho < \epsilon$, the second term on the left hand side of equation (46) must be strictly negative, so $\left[1 - \rho + \rho\frac{1}{\mu}\right]$ must be strictly positive. So the numerator of (47) is larger than zero; then $\frac{d\frac{1}{\mu}}{d\frac{A_m}{A}} > 0$.

When $\rho = \infty$, (37) degenerates to the linear form as follows: $F_d(l, m) = A \cdot l + m$, which means that the downstream demand for m is positive iff $\frac{p_m}{w} \leq \frac{1}{A}$, in which case $p_d = p_m$. The monopolist upstream SOE's optimization problem as follows:

$$\max_{p_m \in [\frac{w}{A_m}, \frac{w}{A}]} \left[p_m - \frac{w}{A_m}\right] \left(\frac{p_n}{p_m}\right)^{\epsilon},$$

which yields $p_m = \min\{\frac{\epsilon}{\epsilon-1}\frac{w}{A_m}, \frac{w}{A}\}$. The markup is therefore given by $\mu = \frac{p_m}{\frac{w}{A_m}} = \min\{\frac{\epsilon}{\epsilon-1}, \frac{A_m}{A}\}$, while at the same time, μ must be no smaller than one. More explicitly,

$$\begin{aligned} \mu &= \frac{\epsilon}{\epsilon-1} \text{ when } \frac{\epsilon}{\epsilon-1} \leq \frac{A_m}{A} \\ \mu &= \frac{A_m}{A} \text{ when } 1 \leq \frac{A_m}{A} < \frac{\epsilon}{\epsilon-1} \end{aligned}$$

When $\frac{A_m}{A} < 1$, downstream demand for good m will be zero, so good m is not produced and the markup for m is not well defined. Proposition 6 is a summary of all the above different cases.

The intuition is the following. First of all, observe that markup μ always moves in the same direction with p_m when holding both A_m and A_n (labor productivity of the numeraire good n) fixed because the unit cost of m is fixed due to constant wage rate. Now, holding other things constant, suppose A increases, then p_d decreases, so the demand and hence output of downstream output d increases due to the substitution effect between good d and the numeraire good n (no income effect on d due to the quasi-linear utility function). There are two competing effects induced by an increase in output d.

One is the substitution effect between input m and labor l in producing good d, that is, the downstream firms' demand for good m decreases if A increases when $\rho \in (1, \infty)$, because downstream firms will use labor to substitute out m, so it depresses p_m (and also markup μ). The other is the income effect, that is, the increased demand for d (due to a lower p_d) in turn induces a larger demand for m, pushing up p_m. Consequently, the net effect on p_m depends on which effect dominates. It turns out that when the substitution elasticity between labor and m in downstream production is sufficiently high ($\rho \in (\epsilon, \infty)$), the substitution effect dominates, so the upstream SOE markup decreases. When $\rho \in (1, \epsilon)$, the income effect dominates, so p_m and μ increase.

When $\rho \in [0, 1)$, an increase in A will result in an increase in the downstream firms' cost expenditure share on m, which increases the net price demand elasticity for m, partly because the price demand elasicity for d itself is sufficiently large ($\epsilon > 1$) and the aggregate demand for d goes up due to the substitution effect between d and n, so the optimal markup μ will decrease as decided by the profit-maximizing monopolist producer of good m. When $\rho = 1$ or $\rho = \epsilon$, the opposite effects exactly cancel out, so μ remains unchanged. When $\rho = \infty$ and $\frac{A_m}{A} \in (0, 1)$, the net price demand elasticity for m is no larger than unity, so the monoply problem for good m is not well defined.

G. Proof for $\varpi'(\phi) > 0$ in equation (36)

For given liberalization fraction ϕ, the total sales revenues of SOEs (including both upstream and downstream) is

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

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

Therefore, total SOE profits divided by total SOE revenues is given by

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

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

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

which strictly increases with ϕ when $\frac{\mu-1}{\mu} > \frac{1}{\eta}$.

H. Capital Intensity and Profitability

This is to show that, if a firm has market power in the output market, then for any given positive markup for the output price, a higher capital intensity automatically implies a lower ROA (return on assets) when the factor markets are perfect. In other words, a low ROA itself does not necessarily imply low profitability (equivalent to low mark up) or capital market imperfectness.

More precisely, suppose the production function of a firm is $Y = AK^{\alpha}L^{1-\alpha}$, and suppose both capital and labor markets are perfect with exogenous rental price R and wage rate W. Let P denote the output price, which could include the markup if this firm has certain monopoly power. The accounting profit (denoted by Π_1) reported in the data for this firm is $\Pi_1 = PY - WL$, whereas the economic profit according to theory (denoted by Π_2) for this firm is $\Pi_2 = PY - WL - RK$.

Claim: $\frac{\Pi_1}{K} = R[\frac{\mu-1}{\alpha} + 1]$; $\frac{\Pi_2}{K} = \frac{\mu-1}{\alpha}R$.

Proof. Note that the first-order conditions for labor and capital jointly imply $k \equiv \frac{K}{L} = \frac{W}{R}\frac{\alpha}{(1-\alpha)}$, and final good price P is markup μ multiplied by marginal cost: $P = \mu\frac{R^{\alpha}W^{1-\alpha}}{A\alpha^{\alpha}(1-\alpha)^{1-\alpha}}$,where $\mu \geq 1$. Thus

$$\begin{aligned}
\frac{\Pi_1}{K} &= P\frac{Y}{K} - \frac{WL}{K} \\
&= PAk^{\alpha-1} - \frac{R(1-\alpha)}{\alpha} \\
&= PA\left[\frac{W}{R}\frac{\alpha}{(1-\alpha)}\right]^{\alpha-1} - \frac{R(1-\alpha)}{\alpha} \\
&= \mu\frac{R^{\alpha}W^{1-\alpha}}{A\alpha^{\alpha}(1-\alpha)^{1-\alpha}}A\left[\frac{W}{R}\frac{\alpha}{(1-\alpha)}\right]^{\alpha-1} - \frac{R(1-\alpha)}{\alpha} \\
&= R\left(\frac{\mu-1}{\alpha} + 1\right).
\end{aligned}$$

Thus $\frac{\Pi_2}{K} = \frac{\Pi_1}{K} - R = \frac{\mu-1}{\alpha}R$.

So we have that both $\frac{\Pi_1}{K}$ and $\frac{\Pi_2}{K}$ strictly decrease with α whenever $\mu > 1$ (the firm has market power). In other words, a higher capital intensity (larger α) would automatically imply a lower $\frac{\Pi_1}{K}$ when $\mu > 1$.

Figures and Tables

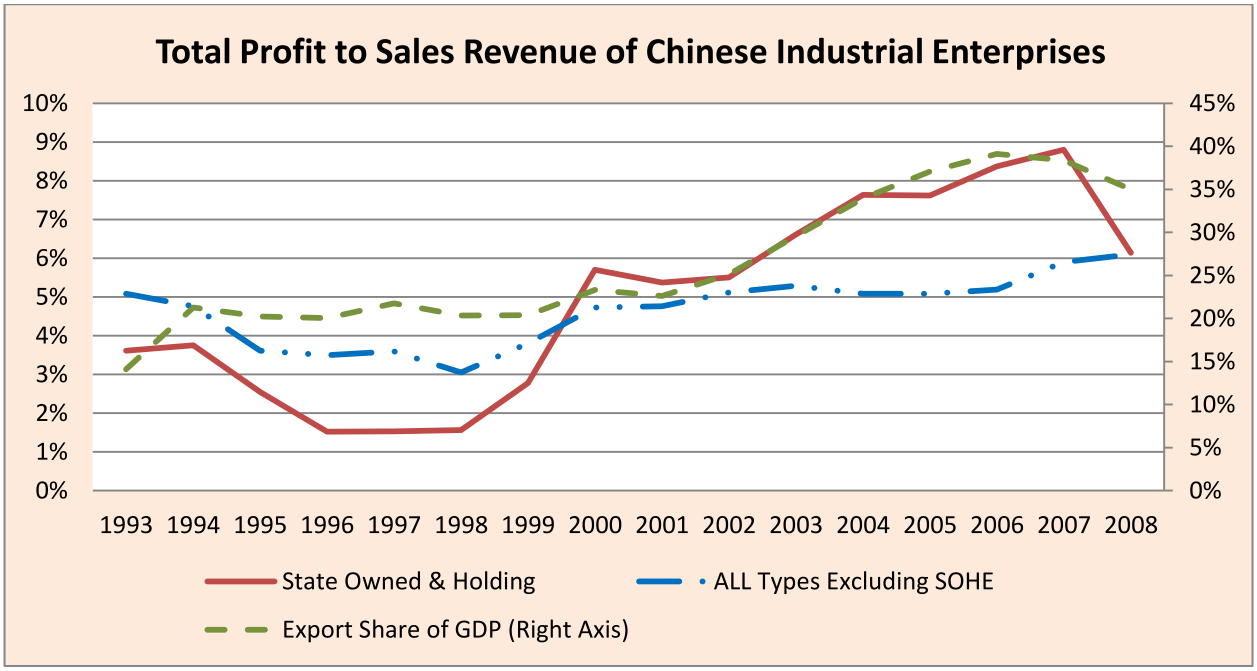

Figure 1: Total profit to sales revenue of Chinese enterprises in the industrial sector. We use CEIC (Table CN.BF: Industrial Financial Data: By Enterprise Type) to obtain total profit to sales revenue. In this table, CEIC categorizes industrial enterprises into state owned & holding, private, HMT & 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.

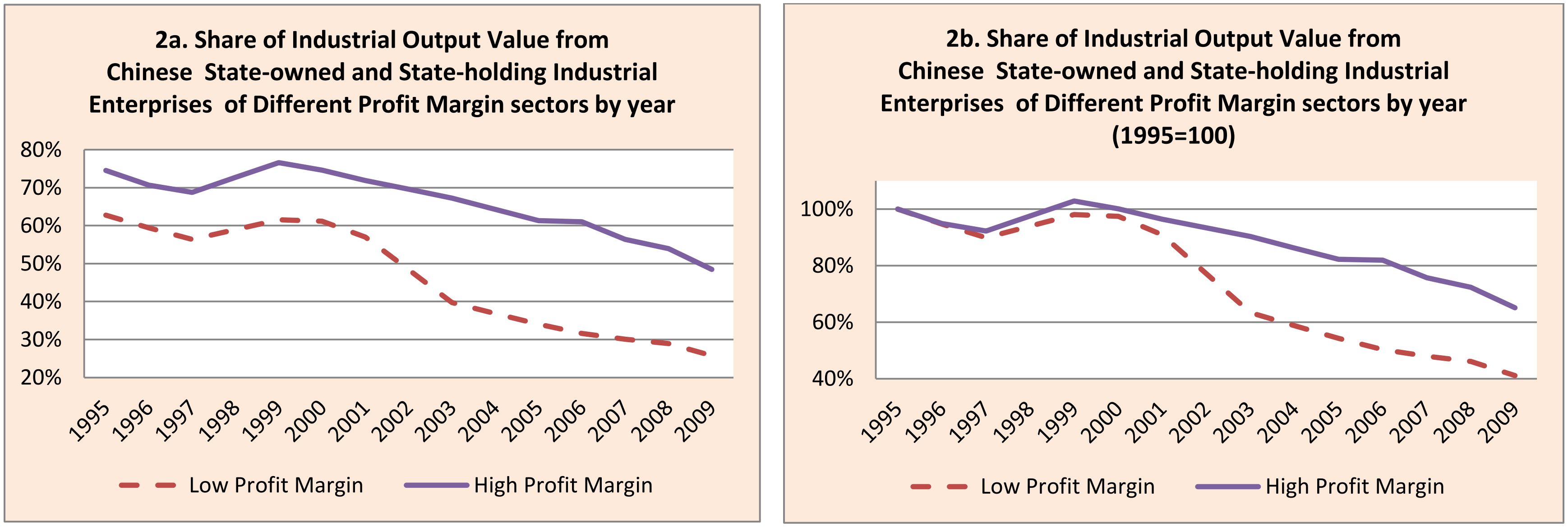

Figure 2: Share of output value from state enterprises in the industrial sector. The criterion that we use to break down the share of the state enterprises' gross industrial output value (GIOV) is profit margin during 1995-2009. Related data are obtained from CEIC (Table CN.OE03 and 04). The low profit margin subsectors are those with less than or equal to 5% profit margin, which include subsectors such as textiles and agriculture. The high profit subsectors are those with greater than 10% profit margin, which include subsectors such as petrochemical, tobacco, and pharmaceuticals. In Figure 3a, the vertical axis is GIOV of the state enterprises as a percentage of total GIOV. GIOV of all enterprises is obtained from CEIC (Table CN.BD03: Gross Industrial Output: By Industry). GIOV of the state enterprises is obtained from the 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 years 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; and "state-owned and state-holding industrial enterprises" in 1999-2003 and 2005-2008. In Figure 3b, we report the share of state enterprises as a percentage of its 1995 value.

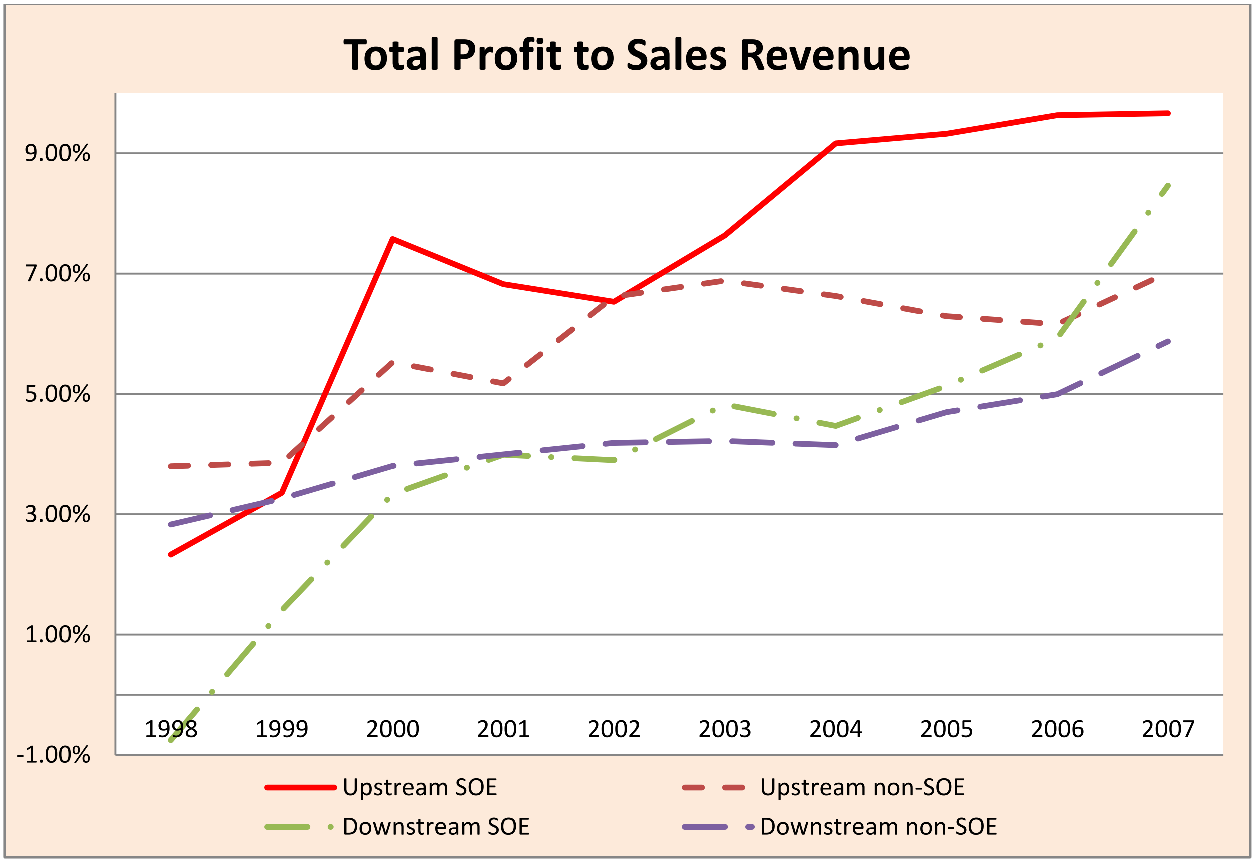

Figure 3: Total profit to sales revenue of Chinese enterprises in the industrial sector. We use NBS industrial enterprises data to obtain total profit to sales revenue and divide all the industrial enterprises into state owned & holding and the rest.

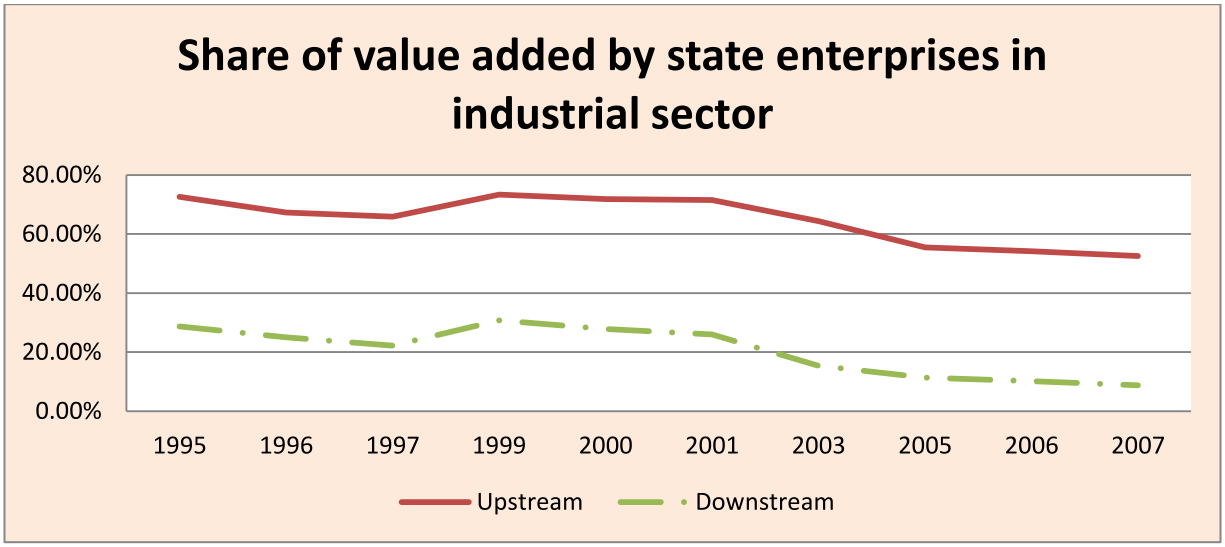

Figure 4a: Share of state enterprises in value added for the industrial sector.

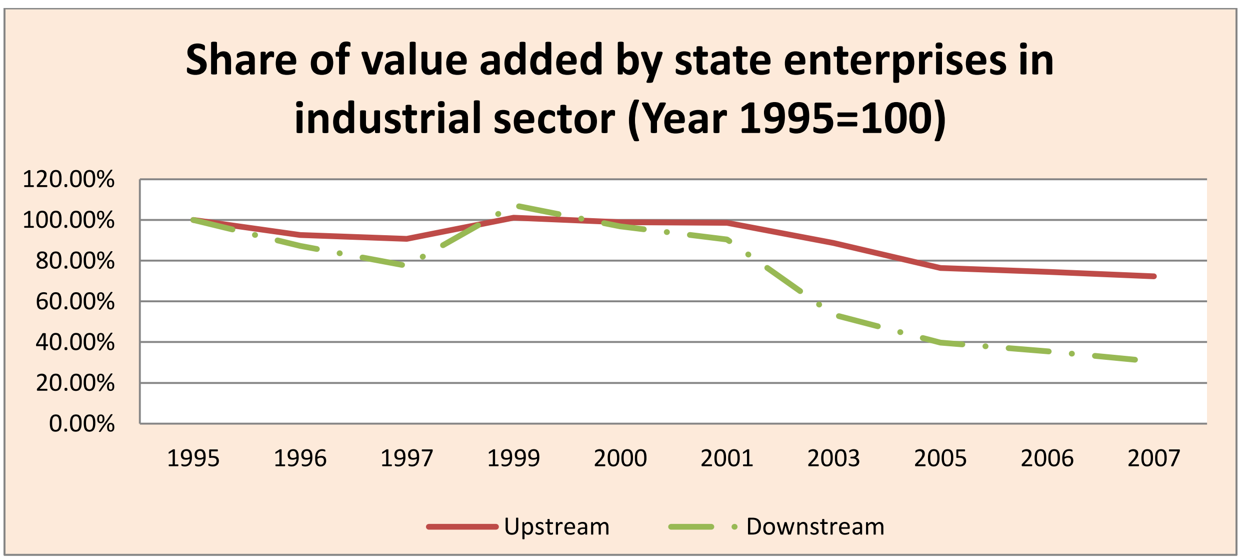

Figure 4b: Share of state enterprises in value added as a percentage of its 1995 value for the industrial sector.

Figure 4: SOE share in the industrial sector. Figures 4a-4b report the share of state enterprises in industrial value added with the data from the 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; and "state-owned and state-holding industrial enterprises" in 1999-2003 and 2005-2007. The data are missing for 1998, 2002, and 2004.

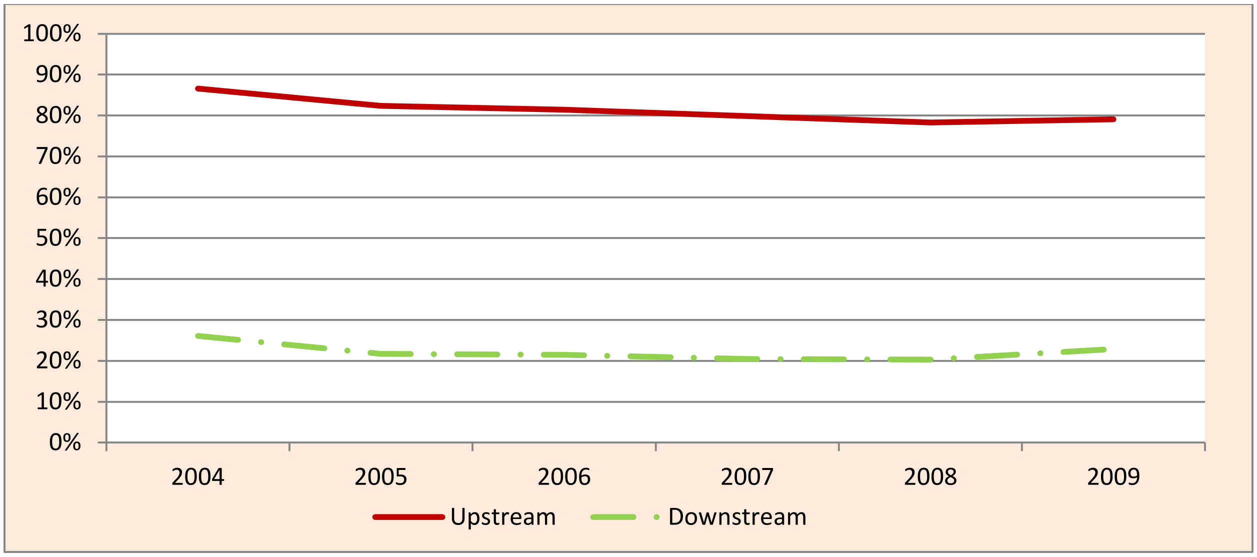

Figure 5a: SOE share of investment in fixed assets from aggregate data for all sectors, 2004-2009

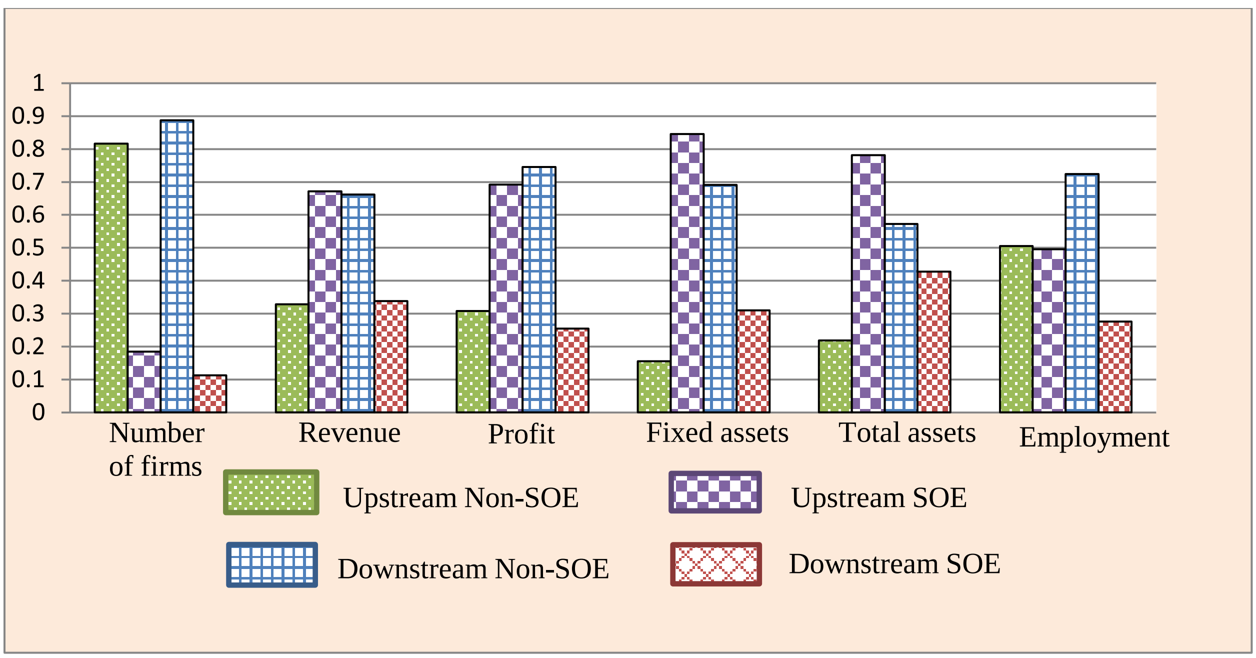

Figure 5b: SOE share of several variables from NBS enterprise-level data for all sectors, 2008

Figure 5: SOE share of all sectors: Figure 5a reports the investments in fixed assets in urban areas by ownership for all sectors using data from the following tables of the 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 Tables 6-14 of 2004; "state-owned and state-holding" in Tables 6-14 of 2005; "state-holding" in Tables 6-14 of 2006; and "state-holding" in Tables 5-14 of 2007-2008. Data for the state enterprises before year 2004 are not available. Figure 5b reports the SOE share for several variables using NBS enterprise-level all sector data available for 2008.

Table 1. SOE Shares and Upstream Indices

SOE Share	(1) Industrial Output	(2) Employees	(3) Industrial Value	(4) Sales Revenue	(5) Fixed Asset	(6) Total Asset
UpDummy	0.175***	0.199***	0.183***	0.188***	0.233***	0.223***
	(3.232)	(3.531)	(3.344)	(3.491)	(4.093)	(3.962)
Capital Intensity	0.001***	0.001**	0.001***	0.001***	0.001**	0.001**
	(3.171)	(2.493)	(2.711)	(3.302)	(2.164)	(2.101)
Constant	0.297***	0.339***	0.314***	0.289***	0.392***	0.388***
	(9.383)	(10.252)	(9.763)	(9.144)	(11.712)	(11.773)
N	373	407	373	407	407	407

*, **, and *** indicate that t-statistics in parentheses are significant at the 10%, 5% and 1% level, respectively.

Table 2. Several Features of Different Industrial Sectors in China: 1998-2007

Industry	Lerner Index	Export Exposure	Herfindahl-Hirschman Index
Average across all upstream enterprises	0.0257	0.0554	0.0065
Average across all midstream enterprises	0.0153	0.0324	0.0024
Average across all downstream enterprises	0.0073	0.2188	0.0028

Data Source: NBS.

Table 3. Comparison of Fortune Global 500 Firms in 2011 from China, U.S., and France

Country	Total #	SOE #	SOE %	Upstream #	Upstream %	Down-stream #	Down-stream %	Misc. Number	Misc. %
China	57	53	93	25	46	11	20	3	5
US	133	4	3	17	14	64	51	8	6
France	35	4	11	3	9	16	46	0	0

An enterprise is classified as an SOE if the government owns at least 50% of it. The upstream classification of industries is according to Table A2 which is based on the scores computed using data from the Chinese Input-Output table following the methodology of Antras et al. (2012). Misc. refers to those companies in miscellaneous industries such as aerospace or defense, which cannot be classified into any stream based on the Input-Output table.

Table 4: Performance of SOEs in Upstream Industries

VARIABLE	(1) Profit	(2) Revenue	(3) ROFA	(4) Turnover	(5) Profit Margin	(6) Profit/ Employee
$UpSoeTFP_{j,t}$	0.051	-0.001	0.004	-0.010	0.051	0.041
	(1.46)	(-0.04)	(0.11)	(-0.43)	(1.28)	(1.34)
$UpPoeTFP_{j,t}$	-0.047**	-0.021***	-0.016*	-0.025***	-0.056***	-0.043**
	(-2.06)	(-3.84)	(-1.83)	(-2.99)	(-2.65)	(-2.14)
$DownSoeTFP_{j,t}$	-0.036	-0.023***	-0.030*	-0.068***	-0.037	-0.032
	(-1.72)	(-3.19)	(-1.91)	(-4.21)	(-1.46)	(-1.45)
$DownPoeTFP_{j,t}$	0.111***	0.047***	0.053*	0.062**	0.104***	0.097***
	(3.40)	(2.75)	(1.89)	(2.32)	(2.83)	(3.46)
Log (Total $Assets_{i,t}$)	0.199**	0.456***	0.010	-0.123	0.129***	0.189***
	(3.11)	(15.95)	(0.19)	(-1.47)	(3.30)	(2.92)
$DownTradeShare_{j,t}$	0.074**	0.038*	0.027	0.029	0.095**	0.061*
	(2.06)	(1.88)	(1.00)	(0.89)	(2.55)	(1.92)
$HHI_{j,t}$	-0.091***	0.007	-0.069***	-0.004	-0.118***	-0.098***
	(-3.67)	(0.44)	(-3.13)	(-0.10)	(-4.17)	(-3.05)
$TFP_{i,t}$	0.146***	0.093***	0.098***	0.108***	0.157***	0.158***
	(9.25)	(3.87)	(4.79)	(3.65)	(12.92)	(10.44)
Capital $Intensity_{i,t}$	-0.303**	-0.151***	-0.159	-0.230**	-0.315**	-0.260**
	(-2.40)	(-2.92)	(-1.56)	(-2.19)	(-2.15)	(-2.49)
Constant	0.508***	0.355***	0.611***	0.717***	0.546***	0.502***
	(6.83)	(11.19)	(9.68)	(10.67)	(8.21)	(6.58)
N	102,106	102,106	101,730	101,730	102,106	101,902
R^2	0.04	0.28	0.011	0.02	0.04	0.04

We use the Chinese industrial enterprise data provided by NBS (1998-2007). Industries in the top (bottom) terciles according to the upstreamness index constructed using data from China's Input-Output table (1995, 1997, 2002, 2007) following the methodology of Antras et al. (2012) are upstream (downstream) industries. The dependent variable is one of the six performance measures: Profit, revenue, return on fixed assets, asset turnover (revenue divided by total assets), profit margin (profit divided by revenue), and profit per employee. We control for year and enterprise fixed effects in all the regressions. Robust *t*-statistics clustered by industry and by year are reported in parentheses. ***, **, * indicate significance at the 1%, 5% and 10% levels (two-tailed), respectively.

Figures and Tables in the Appendix

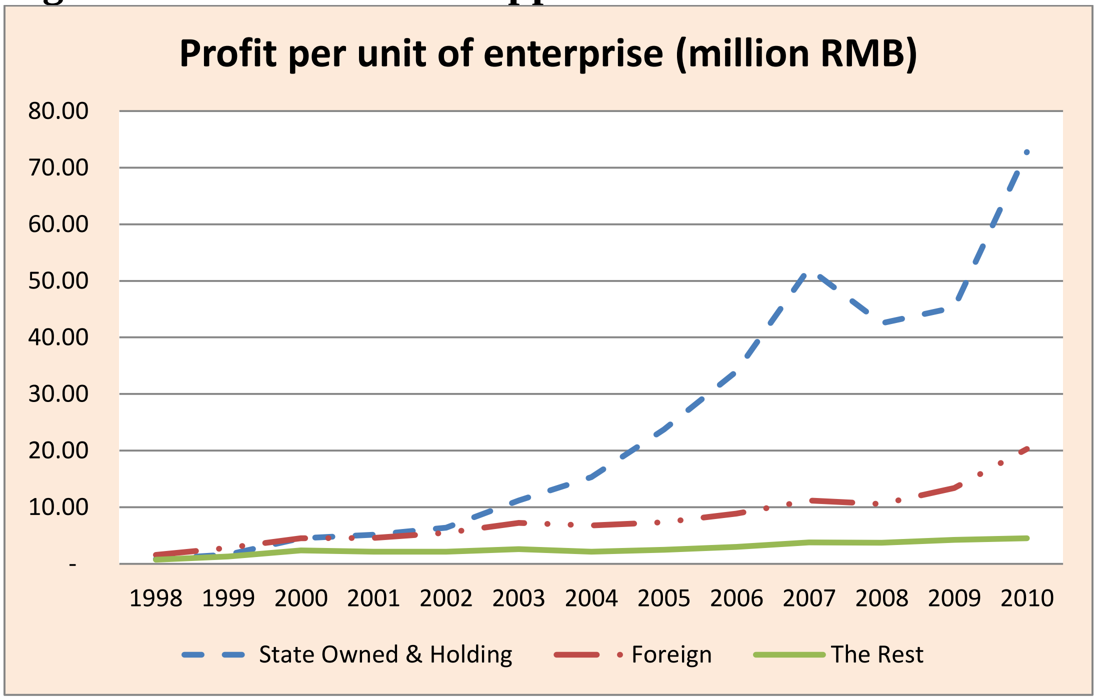

Figure A0a: Profit per industrial enterprise for 1998-2010

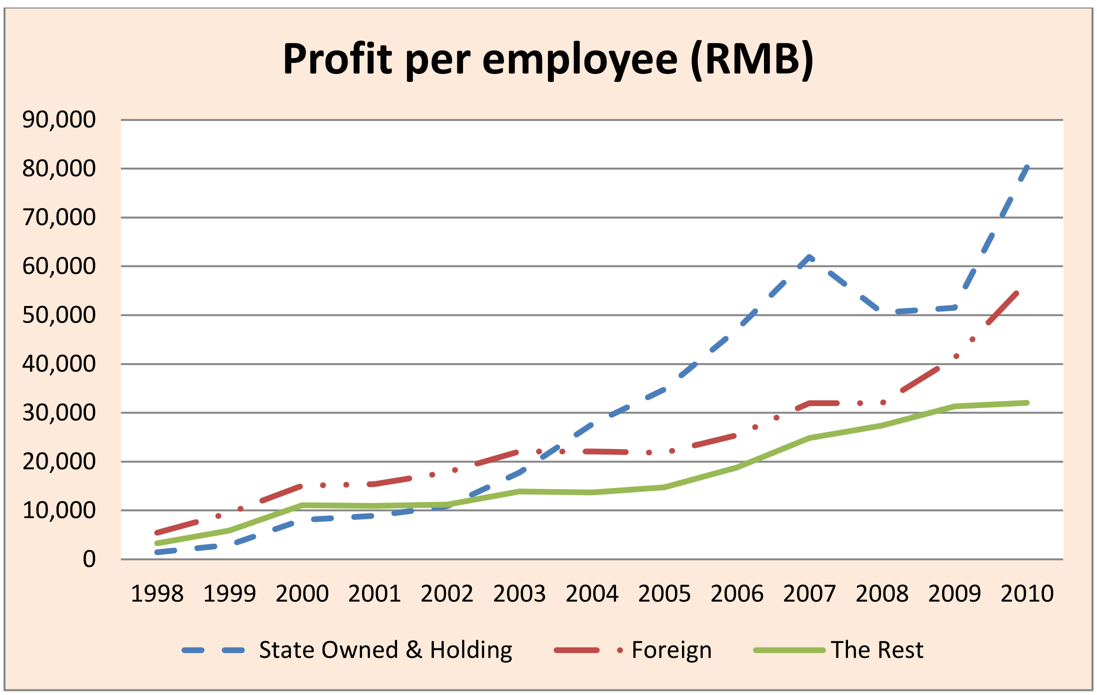

Figure A0b: Profit per employee for 1998-2010

Figure A0: Profit by ownership structure of enterprises for the industrial sector.
Figures A0a and A0b report, respectively, the total profit of industrial enterprises divided by the number of enterprises and the number of employees for three types of enterprises according to ownership structure. The data come from CEIC.

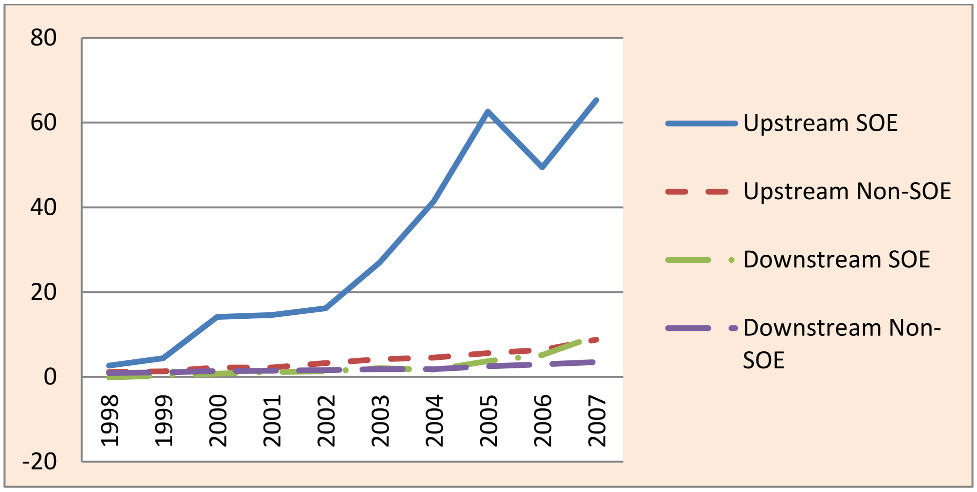

Figure A1a: Average profit per industrial enterprise for 1998-2007 (million RMB)

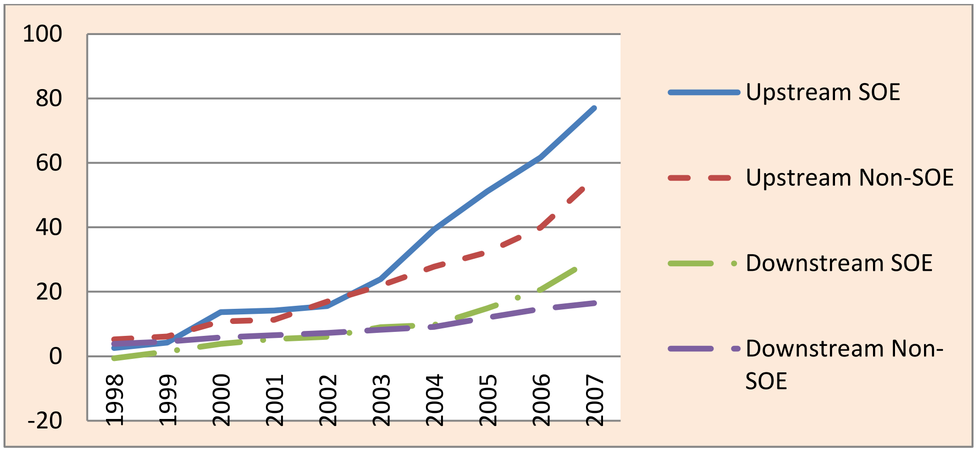

Figure A1b: Average profit per employee for 1998-2007 (thousand RMB)

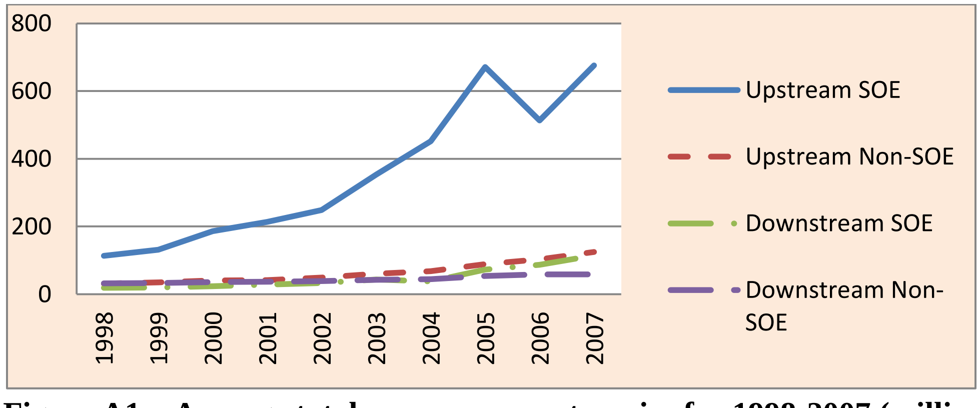

Figure A1c: Average total revenue per enterprise for 1998-2007 (million RMB)

Figure A1: Industrial profit by ownership structure of enterprises for the industrial sector.
Data Source: NBS.

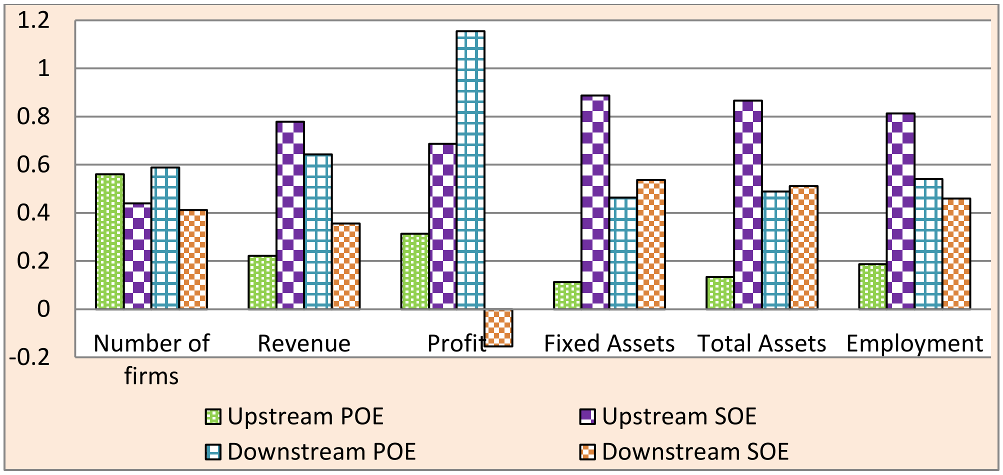

Figure A2a. Shares of different firms in the industrial sector in 1998

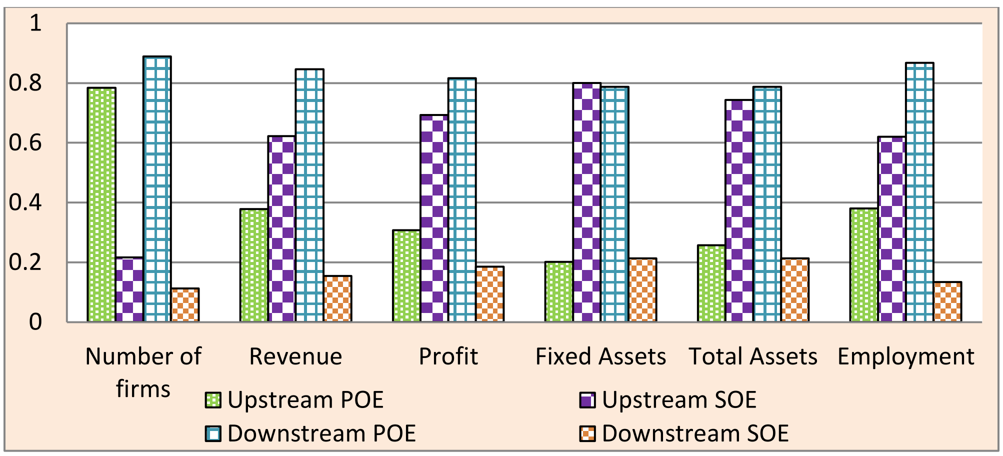

Figure A2b. Shares of different firms in the industrial sector in 2007

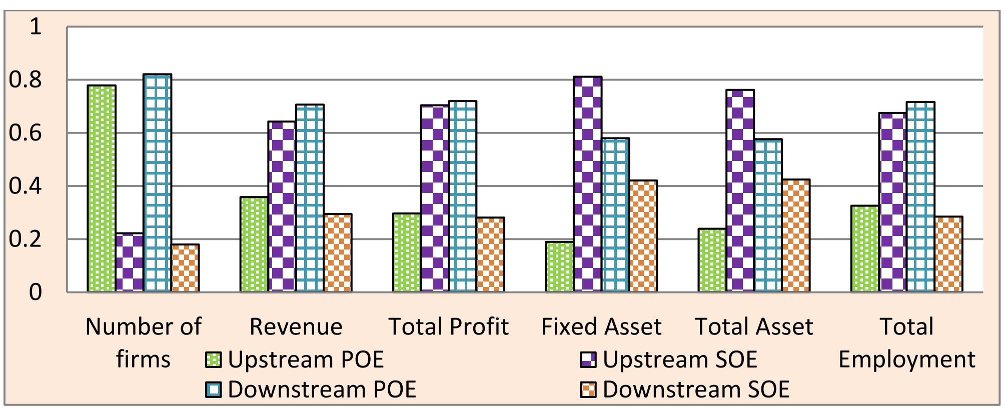

Figure A2c. Average shares of different firms in the industrial sector in 1998-2007

Figure A2: SOE share in the industrial sector.
Date Source: NBS.

Table A0. Chinese firms in 2011 Fortune Global 500

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

Table A1. Stream Classification for Industrial Sectors

Ind #	Industry	2007 Stream Score	Profit Margin	Export Exposure	Herfindahl-Hirschman Index
	Upstream				
1	Coal	5.64	0.0613	0.0175	0.0096
2	Petroleum and Natural Gas	5.83	0.1589	0.0103	0.1016
3	Ferrous Metal Ores	5.60	0.0733	0.0086	0.0065
4	Non-Ferrous Metal Ores	5.60	0.0654	0.0092	0.0081
6	Other Ores	4.23	0.0296	0.0077	0.2250
17	Paper and Paper Products	4.42	0.0207	0.0386	0.0031
20	Petroleum, Nuclear fuel	4.91	0.0228	0.0072	0.0200
21	Raw chemical materials	4.71	0.0251	0.0979	0.0024
27	Smelting Ferrous Metals	4.58	0.009	0.048	0.0099
28	Smelting and Pressing of Non-ferrous Metals	4.58	0.0172	0.0478	0.0045
38	Electric Power and Heat Power	5.22	0.0045	0.0375	0.0111
39	Gas	5.83	-0.0284	0.0106	0.0224
	Average across all enterprises in upstream		0.0257	0.0554	0.0065
	Middle Stream				
5	Nonmetal Ores	4.23	0.0353	0.0075	0.0042
34	Communication Equipment, computer	4.22	0.012	0.0276	0.0057
29	Metal Products	4.11	0.0223	0.017	0.0008
16	Furniture	3.43	0.0251	0.0665	0.0026
33	Electrical Machinery and Equipment	3.35	0.0313	0.0227	0.0029
30	General Purpose Machinery	3.09	0.0224	0.0449	0.0014
31	Special Purpose Machinery	3.09	0.0039	0.0454	0.0020
15	Wood, Bamboo, Rattan etc.	3.43	0.0208	0.0662	0.0025
22	Medicines	3.38	0.0097	0.005	0.0038
40	Water	3.71	-0.0504	0.0023	0.0082
	Average across all enterprises in midstream		0.0153	0.0324	0.0024
	Downstream				
8	Food from Agricultural Products	2.57	-0.0026	0.2555	0.0013
9	Foods	2.57	-0.0126	0.4934	0.0028
10	Beverages	2.57	-0.0304	0.4935	0.0060
13	Textile Wearing Apparel	2.48	0.0209	0.5405	0.0010
14	Leather, Fur, etc.	2.48	0.0217	0.5376	0.0018
18	Printing, Media	2.48	-0.0045	0.0289	0.0019
19	Articles for culture, education	1.22	0.0201	0.0474	0.0024
26	Non-metallic Mineral Products	3.03	0.0162	0.0244	0.0005
32	Transport Equipment	2.75	0.0068	0.0705	0.0086
35	Machinery	3.09	0.0004	0.0465	0.0067
36	Artwork and other manufacturing	2.66	0.0177	0.0575	0.0045
37	Recycling	2.58	0.0162	0.0589	0.0032
	Average across all enterprises in downstream		0.0073	0.2188	0.0028

Note: Stream scores are calculated by following Antras et al. (2012) using China's Input-Output table. More details are available upon request as to how various adjustments are appropriately made. Data Source: NBS.

Table A2. Stream Classification for All Sectors

Ind #	Industry	2008 Stream Score
	Upstream	
7	Extraction of petroleum and natural gas	5.83
8	Mining and processing of ferrous metal ores	5.60
44-45	Production and distribution of electric power and heat power and gas	5.22
43	Recycling and disposal of waste	5.16
25	Processing of petroleum, coking, processing of nuclear fuel	4.91
26/29	Manufacture of chemical raw materials and chemical products / Manufacture of rubber	4.71
33	Smelting and processing of non-ferrous metals	4.58
22/23 /24	Manufacture of paper and paper production / Printing and recorded / Manufacture of articles for culture, education and sport activity media	4.42
10	Mining and processing of nonmetal ores	4.23
34	Manufacture of metal products	4.11
	Middle Stream	
46	Production and distribution of tap water	3.71
51-55, 57-58	Railway transport / Road transport / Urban public transport / Water transport / Air transport / Loading/unloading, removal, and other transport services / Storage	3.63
68-71	Banking / Securities / Insurance / Other financial activities	3.62
73	Leasing	3.60
59	Postal services	3.44
20-21	Processing of timber, manufacture of wood, bamboo, rattan, palm, and straw products / Manufacture of furniture	3.43
39	Manufacture of electrical machinery and equipment	3.35
1	Farming	3.17
35-36, 41	Manufacture of general purpose machinery / Manufacture of special purpose machinery / Manufacture of measuring instruments and machinery for cultural activity and office work	3.09
31	Manufacture of non-metallic mineral products	3.03
	Downstream	
63-65	Wholesale trade / Retail trade	2.94
37	Manufacture of transport equipment	2.75
66-67	Accommodation / Catering	2.67
42	Manufacture of artwork and other manufacturing	2.66
60-62	Telecommunications and other information transfer services / Computer services / Software	2.62
82-83	Resident services / Other services	2.58
13-15	Processing of food from agricultural products / Manufacture of foods / Manufacture of beverages	2.57
18-19	Manufacture of textile, apparel, footwear, and caps / Manufacture of leather, fur, feather and related products	2.48
92	Entertainment	2.48
72	Real estate	1.76
47-50	Construction of buildings, and civil engineering / Renovation / Decoration / Other construction	1.06

Note: Various adjustments have been made. For example, some industries are deleted because there is no match from the Input-Output table or they are irrelevant noncommercial sectors. Details are available upon request.

Table A3. Investigation on Upstream Performance and Downstream Demand [1]

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLE	Profit	Revenue	ROFA	Turnover	Profit Margin	Profit per Employee
$DownOutput_{j,t}$	0.491***	0.376***	0.001***	0.001**	0.001*	0.001***
	(3.497)	(4.833)	(2.614)	(2.091)	(1.862)	(3.099)
$UpOutput_{j,t}$	0.007**	-0.109**	0.001***	-0.001	0.001***	0.001
	(2.523)	(-2.676)	(3.573)	(-0.214)	(3.321)	(1.373)
Capital $Intensity_{j,t}$	-0.502	0.780*	-0.001**	-0.005***	-0.001	-0.019
	(-1.196)	(2.076)	(-2.965)	(-3.885)	(-1.508)	(-1.790)
$HHI_{j,t}$	-0.318*	-0.001	-0.010*	-0.157**	-0.019	-0.407
	(-1.845)	(-1.560)	(-1.880)	(-2.731)	(-1.646)	(-0.790)
Constant	0.113***	0.136***	0.623***	0.146***	0.051***	0.380***
	(8.359)	(8.791)	(13.493)	(19.332)	(5.044)	(13.841)
N	378,422	378,422	376,518	376,518	378,422	378,039
R^2	0.033	0.105	0.010	0.008	0.006	0.030

Notes: Robust t-values corrected for clustering at the firm level are in parentheses. *, ** , and *** indicate significance at the 10, 5 and 1 percent levels, respectively. Estimates in this table include year-specific fixed effects and firm-specific effects. The total industrial output of downstream and upstream industries is the mean of all the firms. The data were winsorized at the 1% level before the estimation.

Table A4. Investigation on Upstream Performance and Downstream Demand [2]

VARIABLE	(1) Profit	(2) Revenue	(3) ROFA	(4) Turnover	(5) Profit Margin	(6) Profit per Employee
$DownOutput_{j,t}$	0.457***	3.251***	0.001**	0.001**	0.001*	0.001***
	(3.716)	(4.576)	(2.592)	(2.803)	(1.872)	(3.107)
$UpOutput_{j,t}$	0.007***	-0.105**	0.001***	-0.001	0.001***	0.001
	(3.259)	(-2.684)	(3.499)	(-0.363)	(3.555)	(1.532)
Capital $Intensity_{j,t}$	-4.213	90.230**	-0.001**	-0.006***	-0.001	-0.017
	(-1.094)	(2.785)	(-2.909)	(-4.126)	(-1.461)	(-1.680)
Log (Total $Assets_{i,t}$)	3,225***	48,977***	-0.019	-3.606***	0.013***	9.466***
	(8.355)	(6.300)	(-1.349)	(-7.306)	(4.581)	(5.945)
$HHI_{j,t}$	-2.988*	-2.736	-10.450*	-1.787**	-1.904	-3.508
	(-1.819)	(-1.503)	(-1.902)	(-2.735)	(-1.587)	(-0.699)
Constant	-0.225***	-0.375***	0.826***	0.523***	-0.083**	-0.609***
	(-6.177)	(-5.467)	(4.835)	(10.62)	(-2.595)	(-3.735)
N	378,422	378,422	376,518	376,518	378,422	378,039
R^2	0.049	0.146	0.010	0.021	0.009	0.044

Notes: Robust t-values corrected for clustering at the firm level are in parentheses.*, **, and *** indicate significance at the 10, 5 and 1 percent levels, respectively. Estimates in this table include year-specific fixed effects and firm-specific effects. The total industrial output of downstream and upstream industries is the mean of all the firms. The data were winsorized at the 1% level before the estimation.

Table A5. Chinese Exports by Enterprise Ownership

Year	Total Exports	Exports by Ownership		% of export from SOEs	Gross Industrial Output from SOEs (%)
		SOEs	non-SOEs		
1994	121.01	84.94	36.06	70.20	37.34
1995	148.78	99.25	49.53	66.71	33.97
1996	151.05	86.04	65.01	56.96	36.32
1997	182.79	102.74	80.05	56.21	31.62
1998	183.81	96.85	86.96	52.69	49.63
2000	249.20	116.45	132.76	46.73	47.34
2002	325.60	122.85	202.75	37.73	40.78
2004	593.33	153.58	439.75	25.88	34.81
2006	968.94	191.33	777.60	19.75	31.24
2008	1430.69	257.48	1173.21	18.00	28.37

Note: Exports are in billions of US dollars. The data come from China Customs. Data for some years are missing.

Table A6. Descriptive Statistics on Industrial SOEs

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

Note: The data come from CEIC and the National Bureau of Statistics.

Table A7. Taxes and Subsidies for Industrial Enterprises

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)	(8)	(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

Note: This table reports the value-added taxes payable and other business taxes and charges, value added, profit, and subsidy of industrial SOEs and SHEs and other industrial enterprises. The data come from China Finance Yearbook and CEIC.