A Model of China's Economic Vertical Structure*

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Abstract

This paper develops a general equilibrium model of the Chinese economy that highlights its "vertical structure", namely that state-owned enterprises (SOEs) monopolizes key upstream industries while downstream industries are largely open to private competition. The study shows that this vertical structure helps to explain various aspects of Chinese economic development, including SOE performance, structural changes, and resource misallocation. It demonstrates that upstream SOEs extract rents from liberalized downstream industries in the process of industrialization and globalization, that the vertical structure hinders industrialization, and that the vertical structure also helps to better understand why SOEs receive subsidies in the credit market. Counterfactual analyses using Chinese firm-level data from 1998 to 2007 confirm that the upstream SOE monopoly has a significant negative effect on output and welfare; in the presence of this monopoly, a certain level of preferential credit subsidies to SOEs actually improves welfare by alleviating the upstream undersupply problem. We also show how the vertical structure emerges as an equilibrium outcome and how this model framework can be useful for countries beyond China.

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

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

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1 Introduction

An underappreciated feature of China's economy is the state controlling the economy in a vertical economic structure: State-owned enterprises (SOEs) monopolize key industries and markets in the upstream, whereas the downstream industries are largely open to private competition. This paper first systematically documents this vertical structure and then presents a general equilibrium to analyzes, theoretically and quantitatively, the implications this vertical structure, which helps to explain various aspects of Chinese economic development, including SOE performance, structural changes, and resource misallocation.

An underappreciated feature of the Chinese economy emerged only after 2000: SOEs monopolized key upstream industries (such as energy, telecommunications, and finance) and continually consolidated this power through government-arranged mergers, whereas downstream industries (such as most manufacturing of consumption goods and consumption services) were mostly liberalized and became open to private competition. This asymmetry in both ownership and market structure between upstream and downstream industries is referred to as vertical structure. Detailed documentation of this fact is provided in Section 2.

We develop a simple general-equilibrium model to show how this vertical strucures and analyzes its implications. Specifically, our model consists of two sectors: an agriculture sector and a non-agriculture sector. Within the non-agriculture sector, there is a vertical structure with upstream SOE monopolies and downstream non-SOEs engaged in perfect competition. The agriculture sector is more labor-intensive than the non-agriculture sector. In equilibrium, when the productivity of the downstream non-SOEs increases or when capital accumulates, labor will be reallocated from the agricultural sector to the non-agriculture sector, and the value-added share of the agriculture sector will decline. However, wages remain low in this industrialization process because the labor abundance in the agricultural sector helps downstream private firms remain cost-competitive. The expansion of downstream private production enables upstream SOEs to sell more and hence extract more monopoly rents. We show that the elimination of the upstream SOE monopoly would result in more industrialization, larger GDP, and greater social welfare. In other words, the vertical structure (upstream SOE monopoly plus downstream liberalization) creates distortions and welfare loss, which echoes the view that partial reforms or incremental reforms have their pitfalls. Trade liberalization in the downstream sector further creates external demand for downstream goods, which facilitates upstream SOEs in extracting even more profits from the expanding downstream private sector.

Our model has various impications. First, our theoretical model demonstrates how industrialization, globalization, and labor abundance, when combined with the vertical structure, jointly account for the unprecedented prosperity of SOEs, despite their relatively low productivity and

trade liberalization, in the period between 2002 and 2007 in China.vOne striking phenomenon in China is that the profitability of SOEs surpassed that of non-SOEs between 2002 and 2007, right before the global financial crisis, while the opposite was true in the 1990s (see Figure **??**).[1] This is puzzling because China joined the World Trade Organization (WTO) in December 2001, and the relative prosperity of SOEs in the post-entry period seems to contradict the common notion that enhanced competition due to trade liberalization (or other market-oriented reforms) should hurt less efficient firms.[2] Second, we show how the vertical structure hinders industrialization, reduces GDP, and harms public welfare. Third, reducing credit subsidies might actually reduce welfare in the presence of the upstream monopoly. The credit subsidy has partly mitigated the under-supply problem caused by the upstream monopoly. Thus, removing the credit subsidy without eliminating the upstream monopoly would exacerbate the under-supply problem and might result in welfare loss, which echoes the view of **?**.

In Section 4, we use 1998-2007 China's Industrial Firm Survey data to quantify the impact of the upstream SOE monopoly on social welfare and total output based on our vertical-structure model. For quantitative purposes, we further introduce credit subsidies to upstream SOEs as a second source of market distortion, because preferential credit policy toward SOEs is well documented in the pertinent literature and is also widely regarded as a significant advantage of SOEs over non-SOEs in China. We evaluate the impact of the upstream monopoly in the intermediate goods market with the presence of discrimination in the capital market. Note that these two distortions may counteract each other. On one hand, the preferential credit subsidy would directly result in capital misallocation between SOEs and non-SOEs, reducing GDP and welfare. On the other hand, the preferential credit subsidy would lower the production cost of upstream SOEs, which may mitigate the under-supply distortion caused by the upstream monopoly along the supply chain. Alternatively speaking, reducing credit subsidies might actually reduce welfare in the presence of the upstream monopoly.

Our quantitative investigations deliver two key findings. First, counterfactual analyses show that both distortions caused significant welfare loss. However, the output gain by only eliminating the upstream monopoly is always larger than that by only eliminating the credit subsidy for every year during our sample period of 2002 through 2007, suggesting that the upstream monopoly is quantitatively more harmful than the credit subsidy. Second, the GDP gain is consistently positive for all years when the upstream monopoly is removed; however, eliminating the credit subsidy alone would actually reduce GDP for the years 2004-2007. This finding confirms that the credit subsidy

[1] Similar patterns hold when using alternative measures such as profit per firm or profit per employment. This paper focuses on the pre-2008 period. The global financial crisis in 2008 is more complicated and deserves separate detailed treatment. We leave it for future research.

[2] Abundant empirical evidence shows that SOEs are less productive and efficient than non-SOEs; see, e.g., **?????**.

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Several extensions are discussed in Section 5. In particular, we explain how this vertical structure emerges as an equilibrium outcome. We show that when non-SOEs are sufficiently more productive than SOEs, it is optimal to liberalize all downstream industries and only keep the upstream industries monopolized by SOEs in order to maximize the total profits of SOEs in the whole economy. In Section 6, we illustrate with examples how the model framework helps us better understand relevant phenomena in countries beyond China, suggesting that the model developed here may provide a general analytical framework to think about the role of the state and the market in economic development (see **???**). Section 7 concludes.

Related literature. Within the limit of our knowledge, this paper is the first to document and the first to theoretically formalize the underappreciated economic vertical structure of China, which remains relevant today. We also show that the model framework is useful not only for China but also for developing and transitional economies at large. Our paper is most closely related to four strands of literature.

First, it sheds new light on structural change and economic growth by introducing the vertical structure into the non-agriculture sector (see **????**). We show how upstream monopolist firms may impede industrialization and lower GDP when an economy features a vertical structure, whereas the existing pertinent literature mostly assumes a horizontal structure (i.e., resource reallocation across horizontally substitutable sectors with symmetric market structures).[3]

Second, our model contributes to the literature on economic transition and institutions, especially the role of state in development, by analyzing the vertical structure as a new aspect of incompleteness in market-oriented reforms (see **???**). Specifically, we show how the vertical structure endogenously emerged, how it caused the subsequent prosperity of SOEs, and why the prosperity of SOEs was an undesirable symptom of partial reforms instead of evidence against further SOE reforms. Therefore, our paper echoes the view that partial reforms have pitfalls.[4] Our model also illustrates a new type of development paradigm, in which the state runs the economy by controlling the commanding height (*i.e.*, key upstream sectors) in the process of (downstream) liberalization, industrialization and globalization (see **???**).[5]

Third, our paper contributes to the literature studying SOEs in China. The existing literature has intensively discussed various sources and symptoms of SOE inefficiency such as misalignment

[3]Exceptions include **?**, but his focus is not on SOEs or China. Other Recent literature on China's structural change includes **???**, but none of them examines the role of vertical structure.

[4]For analyses emphasizing the negative side of gradualism and/or partial reforms, see **????**. For more positive views, see **??????**.

[5]See also **??**.

of managerial incentives, state property rights, extra social and policy objectives, factor market distortions (especially the financial market), and information asymmetry (e.g., **?????????**). In contrast, we highlight the SOE monopoly of upstream industries as a new and independent source of inefficiency. Our general equilibrium model also explains why this inefficiency can be sustained and what its implications are.

Fourth, our paper complements the existing literature on resource misallocation, which largely assumes a horizontal structure (e.g., **??????**). In contrast, we show how a vertical structure could generate opposite results. Namely, when the productivity of private firms increases, it would enhance the profits of SOEs in the upstream sector but hurt the profits of SOEs in a horizontally substitutable sector. In a closely related paper, **?** builds a more sophisticated model of production networks to show that subsidizing upstream sectors may improve welfare when market imperfections exist, but his model does not focus on explaining the profitability differences between SOEs and non-SOEs, nor does it analyze the role of structural change and trade globalization as in our paper.[6]

2 Benchmark Model

In this section, we develop a general equilibrium model of vertical structure with structural change based on the facts documented in Section 2. We study autarky and open economy sequentially.

2.1 Autarky

2.1.1 Model Environment

Consider a closed economy populated by a continuum of agents with a measure equal to unity. Agents are divided into two groups: an elite class with a measure equal to $\theta \in (0,1)$ and the grassroots with a measure $1-\theta$. Agents are identical within each group. The economy has two sectors: an agriculture 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. All the agents share the following 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. All technologies are constant returns to scale. One unit of labor produces A_n units of good n. To produce good d requires capital k, labor

[6] **?** discusses misallocation with vertical linkages, but not specifically about SOEs or China.

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 $\gamma \in [0,1)$. Each agent, elite or grassroots, is endowed with L units of time (labor) and K units of capital. 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. Goods n and d are produced by competitive privately owned enterprises (POEs hereafter), which are owned by the grassroots. Only the upstream market is a monopoly, whereas all other goods and factor markets are perfectly competitive with free entry. The sectorial asymmetry in both state ownership and market structure (upstream SOE monopoly plus downstream POEs perfect competition) is referred to as the "vertical structure", as documented in Section 2.

Let W, p_n, p_d, and p_m denote the wage, the prices of good n, downstream good d, and intermediate good m, respectively. Without loss of generality, normalize p_n to one. Let R denote the rental price of capital faced by downstream private firms. To capture the feature that the upsteam SOE may receive favorable loans, we assume that the upstream SOE receives a credit subsidy at a rate of τ, that is, the upstream SOE faces a subsidized rental price of capital, $R(1-\tau)$.

2.1.2 Characterizing Equilibrium

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

$$p_d = \frac{R^{\alpha}W^{\beta}{p_m}^{1-\alpha-\beta}}{A\alpha^{\alpha}\beta^{\beta}(1-\alpha-\beta)^{1-\alpha-\beta}}. \tag{4}$$

Applying Shephard's Lemma on (4), together with the aggregate demand for d, $D_d = \left(\frac{p_n}{p_d}\right)^{\epsilon}$, derived from household utility maximization, we obtain the demand function for m:

$$D_m = (1-\alpha-\beta)\cdot p_n^{\epsilon}\cdot\left[\frac{R^{\alpha}W^{\beta}}{A\alpha^{\alpha}\beta^{\beta}(1-\alpha-\beta)^{1-\alpha-\beta}}\right]^{1-\epsilon}\cdot {p_m}^{-[(1-\alpha-\beta)(\epsilon-1)+1]}. \tag{5}$$

The upstream monopolist SOE maximizes its profit, which implies

$$p_m = \mu\frac{(R(1-\tau))^{\gamma}W^{1-\gamma}}{A_m\gamma^{\gamma}(1-\gamma)^{1-\gamma}}, \tag{6}$$

where μ is the endogenous markup given by

$$\mu \equiv \frac{(1-\alpha-\beta)(\epsilon-1)+1}{(1-\alpha-\beta)(\epsilon-1)} > 1, \tag{7}$$

because the price demand elasticity for m from downstream good d is $(1-\alpha-\beta)(\epsilon-1)+1$, as shown in (5).

The labor market clearing condition is given by

$$L = \underbrace{D_m \frac{\partial \frac{(R(1-\tau))^{\gamma} W^{1-\gamma}}{A_m \gamma^{\gamma}(1-\gamma)^{1-\gamma}}}{\partial W}}_{\text{by producer of intermediate good } m} + \underbrace{D_d \frac{\partial p_d}{\partial W}}_{\text{by producers of downstream good } d} + \underbrace{D_n \frac{1}{A_n}}_{\text{by producers of good } n}, \tag{8}$$

where D_d and D_n are the aggregate demand for goods d and n, given by $D_d = \left(\frac{p_n}{p_d}\right)^{\epsilon}$ and (5), respectively (here we presume that the elite agents as well as the grassroot agents consume both good d and good n; that is, the measure in front of D_m and D_d is 1). Let $\overline{L}$ denote the total industrial employment or the sum of the first two terms on the right-hand side of (8). As long as good n is produced in equlibrium, wages are equal to the marginal product of labor in the agriculture sector:

$$W = A_n, \tag{9}$$

which implies that wage increases with agricultural productivity A_n but does not change with K, A_m, A, or L.[7] The capital market also clears:

$$K = \underbrace{D_m \frac{\partial \frac{(R(1-\tau))^{\gamma} W^{1-\gamma}}{A_m \gamma^{\gamma}(1-\gamma)^{1-\gamma}}}{\partial \left(R\left(1-\tau\right)\right)}}_{\text{by producer of intermediate good } m} + \underbrace{D_d \frac{\partial p_d}{\partial R}}_{\text{by producers of downstream good } d}. \tag{10}$$

For exposition clarity, we first focus on the case where there is no capital subsidy to the upstream SOE (i.e., $\tau = 0$) until Proposition 4. By combining (10), (4), (6) and (9), we obtain the equilibrium prices as summarized in the following lemma.

Lemma 1 *Suppose L is sufficiently large (or, more precisely, inequality (17)). There exists a*

[7] When all the labor has been absorbed into the industrial sector (that is, when the economy has passed the so-called "Lewis turning point" defined below), the equilibrium wage depends on K, A_m, A, and L.

unique equilibrium, in which wage W is given by (9) and the other prices are given by

$$R = \varkappa^{\xi}\left[\left(A_n^{\alpha+\gamma(1-\alpha-\beta)-1}A_m^{1-\alpha-\beta}A\right)^{\epsilon-1}K^{-1}\right]^{\xi}, \tag{11}$$

$$p_m = \frac{\mu\varkappa^{\xi\gamma}A_n^{1-\gamma}A_m^{-1}}{\gamma^{\gamma}(1-\gamma)^{1-\gamma}}\left[\left(A_n^{\alpha+\gamma(1-\alpha-\beta)-1}A_m^{1-\alpha-\beta}A\right)^{\epsilon-1}K^{-1}\right]^{\xi\gamma}, \tag{12}$$

$$p_d = \left(\frac{\gamma(1-\alpha-\beta)+\alpha\mu}{\varkappa^{\xi}\mu}\right)^{\frac{1}{\epsilon-1}}\left[A_n^{\alpha+\gamma(1-\alpha-\beta)-1}A_m^{1-\alpha-\beta}AK^{\alpha+\gamma(1-\alpha-\beta)}\right]^{-\xi}, \tag{13}$$

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

$$\varkappa \equiv \frac{\gamma(1-\alpha-\beta)+\alpha\mu}{\mu}\left\{\frac{\left[\frac{\mu}{\gamma^{\gamma}(1-\gamma)^{1-\gamma}}\right]^{1-\alpha-\beta}}{\alpha^{\alpha}\beta^{\beta}(1-\alpha-\beta)^{1-\alpha-\beta}}\right\}^{1-\epsilon}, \tag{14}$$

$$\xi \equiv \frac{1}{1+\alpha(\epsilon-1)+\gamma(1-\alpha-\beta)(\epsilon-1)}. \tag{15}$$

Observe that (12) implies $\frac{\partial p_m}{\partial A}>0$, that is, an increase in the TFP of downstream private firms yields a higher price of good m 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 (11)), so p_m increases with the upstream production cost as the markup stays unchanged. On the other hand, (13) 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 (12)), which dominates the resulting increase in R.

We can easily obtain the total industrial employment:

$$\overline{L}(A_n,A,A_m,K) \equiv \varkappa^{\xi}\frac{(1-\gamma)(1-\alpha-\beta)+\beta\mu}{\gamma(1-\alpha-\beta)+\alpha\mu}\left[\frac{\left(A_m^{1-\alpha-\beta}A\right)^{\epsilon-1}}{A_n^{\epsilon}}\right]^{\xi}K^{1-\xi}. \tag{16}$$

An increase in industrial productivity, A or A_m, will attract more labor from the agriculture 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 ($\frac{\partial\overline{L}(A_n,A,A_m,K)}{\partial K}>0$), since it tends to increase the marginal product of labor in the industrial sector. To ensure that the grassroot agents also consume good n, we must require:

$$L > \frac{\mu-\gamma(1-\alpha-\beta)-\alpha\mu}{(1-\gamma)(1-\alpha-\beta)+\beta\mu}\overline{L}(A_n,A,A_m,K), \tag{17}$$

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

Proposition 1 *Suppose (17) is true. In the autarky equilibrium, the upstream SOE's profit* Π_m *and the total GDP (per capita)* Y *are given by*

$$\Pi_m = \frac{(1-\alpha-\beta)(\mu-1)}{(1-\gamma)(1-\alpha-\beta)+\beta\mu}\overline{L}(A_n, A, A_m, K)A_n, \tag{18}$$

$$Y = \left[L + \frac{\alpha\mu+(1-\alpha-\beta)(\gamma+\mu-1)}{(1-\gamma)(1-\alpha-\beta)+\beta\mu}\overline{L}(A_n, A, A_m, K)\right]A_n, \tag{19}$$

where $\overline{L}(A_n, A, A_m, K)$ *is given by (16).*

Proposition 1 is a novel result of our paper. It underscores, when labor is abundant (condition (17) holds), how the key macroeconomic variables in our model are related to structural change (industrialization) characterized by $\overline{L}$. (18) 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. (19) indicates that GDP strictly increases with total industrial employment $\overline{L}$, revealing that structural change drives up total output. Also, (19) and (16) 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 extracting monopoly rent.

To highlight the determinants of the upstream SOE's profit, we summarize the comparative static results on (18) as follows.

Proposition 2 *Suppose (17) 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* $\frac{\partial\Pi_m}{\partial K}>0$*).*

Proposition 2 states that, under the vertical structure, an increase in the productivity of private firms in the downstream industry actually benefits the upstream SOE ($\frac{\partial\Pi_m}{\partial A}>0$).[8] 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 margin ($\frac{\mu-1}{\mu}p_m$). These two forces jointly generate a higher profit for the upstream SOE ($\frac{\partial\Pi_m}{\partial A}>0$). Note that the prediction is exactly opposite in the horizontal structure when SOEs and non-SOEs are located in horizontally substitutable sectors, as usually assumed in the resource misallocation structure (see the formal proof in Appendix **??**).

[8] Not surprisingly, the upstream SOE's profit also increases with its own TFP ($\frac{\partial\Pi_m}{\partial A_m}>0$) and the capital stock K ($\frac{\partial\Pi_m}{\partial K}>0$).

It is important to note that labour abundance is important for the mechanism in Proposition 2. Without abundant labour, the expansion of the industrial sector, induced either by an increase in productivity or by capital accumulation, would push up the wage, which in turn would cause the profit of the upstream SOE not to grow as fast. Formally, we first find the "Lewis turning point" in our model — the critical value of labour endowment, denoted by $\underline{L}$, such that the numeraire good n is marginally produced in equilibrium (i.e., $D_n = 0^+$). That is, if $L > \underline{L}$, some labour remains in the agricultural sector; if $L < \underline{L}$, all labour is absorbed in the industrial sector. We then look at how the profit of the upstream SOE is related to productivity and the capital stock before and after passing the Lewis turning point. We have the following corollary.

Corollary 1 *The monopoly profit of the upstream SOE increases faster with the productivity of the downstream POEs, its own TFP and the total capital stock before passing the Lewis turning point than after passing the Lewis turning point (*$\frac{\partial \Pi_m}{\partial A}\big|_{L=\underline{L}^+} > \frac{\partial \Pi_m}{\partial A}\big|_{L=\underline{L}^-}$, $\frac{\partial \Pi_m}{\partial A_m}\Big|_{L=\underline{L}^+} > \frac{\partial \Pi_m}{\partial A_m}\Big|_{L=\underline{L}^-}$, *and* $\frac{\partial \Pi_m}{\partial K}\big|_{L=\underline{L}^+} > \frac{\partial \Pi_m}{\partial K}\big|_{L=\underline{L}^-}$*).*

The key intuition behind Corollary 1 can be understood from the following result

$$\frac{dF\left(K, L^d\right)}{dK} = \frac{\partial F\left(K, L^d\right)}{\partial K} + \underbrace{\frac{\partial L^d}{\partial K}\frac{\partial F\left(K, L^d\right)}{\partial L^d}}_{\text{absorb more labour into industrial sector}},$$

where $Y_d = F\left(A, A_m, K, L_d\right)$ is defined as the aggregate production function of the industrial goods sector, Y_d is the output quantity of the downstream good d (in equilibrium $Y_d = D_d$), and L_d is the total industrial employment. Before passing the Lewis turning point, an increase in K increases the output of the industrial sector through two forces: a direct effect of more input K and an indirect effect of absorbing additional input L^d. After passing the Lewis turning point, the second force does not exist. Considering that the profit of the upstream SOE is proportional to the output value of the industrial sector,[9] we obtain $\frac{\partial \Pi_m}{\partial A}\big|_{L=\underline{L}^+} > \frac{\partial \Pi_m}{\partial A}\big|_{L=\underline{L}^-}$. Similarly, the results regarding the effect of A and A_m on Π_m around the Lewis turning point can also be obtained.

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 (17) 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.*

[9] Specifically, $\Pi_m = \frac{\mu-1}{\mu}\left(1-\alpha-\beta\right) Y_d p_d$, where $Y_d p_d$ is increasing in Y_d.

The intuition for Proposition 3 is the following. Eliminating the upstream monopoly lowers p_m, which in turn lowers p_d. Therefore, the output of good d increases, absorbing more labor from the agriculture sector. It, in turn, drives up R. GDP expands primarily because the elimination of the upstream monopoly facilitates structural change, moving more labor from the relatively low value-added agriculture 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, W stays unchanged, as ensured by $L > \overline{L}$. Thus, the total GDP increases from the factor income point of view.

From 2001 to 2007, China witnessed a more rapid increase in the profits of SOEs than private firms, while the aggregate GDP continued to rise steadily. As such, SOE defenders claimed that SOEs contributed significantly to China's economic exuberance and that there was no need for major reforms as SOEs performed better than non-SOEs. Our analysis stresses an opposite view: the unusual prosperity of SOEs was an undesirable symptom of the incompleteness of the SOE reforms. In particular, Proposition 1 and Proposition 2 show that both total GDP and the upstream SOE's profits would increase when the TFP of downstream private firms increases, even if the TFP of the upstream SOE remains unchanged. In other words, high profits of the upstream SOE can be merely a consequence rather than a cause of economic growth; it was the downstream private firms that were the key engine for GDP expansion. In fact, Proposition 3 makes it clear that the SOE monopoly undermines GDP and welfare.[10]

Now we examine the case with a capital subsidy to the upstream SOE ($\tau > 0$). In this case, it is easy to verify that in equilibrium the upstream SOE's profit Π_m and the total GDP (per capita) Y are still given by (18) and (19) respectively, but the total industrial employment is revised as

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

where

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

and ξ is still given by (15). Proposition 4 follows.

Proposition 4 *For a given markup level μ ($\equiv \frac{(1-\alpha-\beta)(\epsilon-1)+1}{(1-\alpha-\beta)(\epsilon-1)} > 1$), there exists a unique optimal capital subsidy rate $\tau^* = 1 - \frac{1}{\mu}$ that maximizes total GDP Y; at this optimal τ^*, total industrial*

[10] Our model also implies that privatizing upstream SOEs without eliminating their administrative monopoly does not help. Nothing would change in the model if the upstream SOE is now replaced by a politically-connected private monopolist firm. An effective way to reform is to dismantle entry barriers to upstream sectors and create a level playing field.

employment $\hat{L}$ and the upstream SOE's profit Π_m are also maximized. However, the maximum total GDP and the maximum industrial employment under the optimal capital subsidy are still lower than the first-best counterparts under no upstream monopoly.[11]

Proposition 4 shows that in the presence of the upstream monopoly distortion, the introduction of another distortion — the provision of a capital subsidy to the upstream industry — can actually improve welfare. Of course, the subsidy should not be too high, and indeed there is a unique optimal level of subsidy which is a function of the markup level μ. The underlying mechanism is that providing subsidies to upstream industries can alleviate the undersupply problem of upstream industries and thus improve welfare. However, since providing a capital subsidy per se is still a distortion (on the factor market) plus the monopoly distortion (on the market structure), the first-best efficiency under no monopoly can never be achieved. Proposition 4 may help us better understand the well-documented fact that SOEs receive more favourable loans than POEs in China. The capital subsidy to the upstream SOE may act as a mechanism to partially counter the efficiency loss caused by the upstream monopoly.

We would also note that the provision of cheap credit to upstream SOEs may in part be a market behavior response (besides a deliberate arrangement by the government). Specifically, if the financial market is plagued by contracting frictions with collateral constraints akin to **?** and **?**, then the more profitable upstream SOEs would enjoy advantages over downstream private firms in obtaining more favorable loans, *ceteris paribus*. In other words, factor market discrimination can be the consequence, rather than the cause, of the high profitability of SOEs. In this case, factor market discrimination is a market response to partially offset the inefficiency of the upstream monopoly.

[11] We still focus on the case that the labor endowment L is large enough such that in equilibrium good n is produced ($D_n > 0$).