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# Endowment Structure, property rights and reforms of large state-owned enterprises (SOEs) in China: Past, present and future<sup>☆</sup>

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## ABSTRACT

Based on the criteria of the factor endowment structure of state-owned enterprise (SOE) sectors in China between 1980 and 2018, this paper rationalizes the classified reforming of China's state sectors by constructing a Nash bargaining model to capture the dynamics of ownership restructuring, and the reduction process of policy burden on SOEs. We reveal that the interplay between policy burden bared by SOEs and the ownership restructuring process largely depends upon their factor intensities since the reform period in the 1980s. Our model identifies two Ownership Reform Irrelevance Points (ORIP), which serve as the benchmark for the dynamics of the ownership restructuring process of China's large SOEs, which saw them move from 'mixed-ownership' to 'privatization'. ORIPs demonstrate the need for a reduction in social policy burdens with regards to the state sector's comparative advantage of factor endowment structure through SOE ownership restructuring. This study theoretically analyzes existing literatures on the classified reforms of China's state sectors from 1978 to 2018. This study is the first to base such an analysis on the criteria of factor endowment structure focusing on the connection between the policy burdens bared by SOEs and their ownership restructuring process.

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## 1. Introduction and contribution of this research

It is widely acknowledged that state-owned enterprises (SOEs) still play an important role in the Chinese economy; they employ nearly 6% of China's overall population, and most are concentrated in the upstream capital intensive and high value-added industries, such as oil, telecommunication, and gas (Sheng and Zhao, 2013; Sun and Tong, 2003; Wang et al., 2013b; Zhang et al.,

2017; Naughton, 2017; Shen et al., 2020). Hence, the question of business viability arises.<sup>1</sup> The concept of SOEs was borrowed from the Soviet Union during the 1950s, and throughout several decades of economic reform under Deng Xiaoping's leadership, improvements to SOE efficiency has become an economic priority for the Chinese government.<sup>2</sup>

Many scholars argue that ending the main source of business uncertainty: government mandatory 'extra-economic policy bur-

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<sup>1</sup> The concept firm 'viability' is investigated by Lin and Tan (1999). 'Viability' means socially expected profitability in a perfectly competitive open-market economy. In this paper, we relax the assumption of a perfectly competitive open-market economy. Our viability operates in a mixed oligopoly with a certain degree of competition.

<sup>2</sup> In accordance with Lin et al. (1998), SOE inefficiency in China is an endogenous problem arising from the Soviet administratively planned economy. Symptoms include a lack of managerial autonomy in decision-making and too few profit incentives, soft budget constraints, and so on. Soft-budget constraints is the most entrenched symptom, and the causes are commonly debated in existing literature (Cao et al., 1999; Bai and Wang, 1998; Lin and Tan, 1999; Dewatripont and Roland, 2000).

dens' (e.g., externally imposed targets beyond the healthy economic function of the enterprise), is vital for SOE efficiency. Ownership reforms should be secondary.<sup>3</sup> According to Lin et al. (1996, Lin et al., 2003), 'social burdens' and 'strategic burdens' are the main government mandatory extra-economic policy burdens on SOEs. 'Social burdens' include the compulsory employment of excessive numbers of often unskilled and technically redundant workers, along with their welfare entitlement packages. 'Strategic burdens' refer to compulsory extra investment, ignoring China's comparative advantages of the factor endowment structure. Subsequently, considering its functional workforce, China's state sector is excessively capital intensive.<sup>4</sup> Meanwhile, such 'extra policy burdens' result in SOE managers not being solely responsible for enterprise performance, and aligning the performance of SOEs with government political objectives. Thus, budget constraints for SOEs are soft, which greatly impact on poor SOE performance, and in turn incites low efficiency. The highly distorted 'social and strategic burdens' contribute to low SOE efficiency, which is financed by the soft budget constraint stemming from various subsidies and loans borrowed from either the banking system or external capital markets. Despite China's much publicized managerial reforms over recent decades, such interplay between policy burdens and soft budget constraint automatically creates a vicious circle (Lin and Li, 2008). Lin and Li (2008) further contend the views that removal of the aforementioned burdens will remove distortion, and subsequently market competition will terminate the monopoly of SOEs and economic rent. In their view, rent bails out inefficient SOEs from assured bankruptcy. Hence, with market competition, SOE managers will be forced to improve efficiency with or without privatization.

Another group of scholars paid more attention to state-ownership reforms. Until the mid-1990s, such reforms were confined within managerial autonomy, i.e., power decentralization, profit retention and contractual responsibility (Bai et al., 2006). In 1998 the Premier Zhu Rongji initiated the reform to 'invigorate large enterprises and let go of small enterprises' (Wu, 2003). The main concern for a communist government is that large SOEs ultimately determine and dictate the political color of the economy. Small and medium sized firms are politically less important; their privatization causes a communist government no political harm. About 4000 small-medium SOEs were up for sale in the end of 1990s. Consequently, the number of loss-making SOEs was halved by 2000 (Li, 2001). A small number of scholars believe that market competition, or too much of it, exists in the state sector. For example, Zhang and Ma (2003) used a static Cournot Duopoly Model to argue that distorted firm ownership leads to excessive competition in SOE dominated sectors. They viewed such excessive competition as harmful and sub-optimal, and considered ownership reform as the feasible solution. It should be noted that the overall number of SOEs within the Chinese economy has seen a large decline over recent years, as shown in Fig. 1 below.

The above Fig. 1 shows that by the late 1990s, the national property right reforms of large Chinese SOEs, so called '*grasp the large, get rid of the small*', led to the privatization of most small-medium SOEs. Hence, a large drop in the number of SOEs. However, there was a notable rise again in terms of the overall number of SOEs in China in 2008. One of the main reasons for the rise was the 4 trillion-yuan stimulus investment injected by the state in 2008, with main reference to the provision of fiscal and loan assistance to large SOEs in order to prevent exposure of the Chinese economy to systematic financial risks. (Berger, 2016; Opie,

<sup>3</sup> As pointed out by Lin et al. (1998), policy burden reduction-driven reforms are particularly relevant to meg-SOEs.

<sup>4</sup> It means a considerable proportion of the state sector's workforce is technically redundant.

2019).<sup>5</sup> To empirically corroborate this stylized fact, we consider the evolution over time of the absolute number of large SOEs with annual operating income over 500 million RMB, in comparison to Fig. 1 showing the increasing number of SOEs in overall since the end of 1990s, the opposite trend of the number of large SOEs since the 2000s occurs, which is shown as the following Fig. 2

Fig. 2 indicates that since the beginning of the 2000s, the influence of large SOEs within the Chinese economy has expanded dramatically, hence the need to study how they affect the dynamic economic growth pattern and how they operate within different industries. Table 1 shows the distribution of state ownership across different Chinese industries.

Source: China Statistical Yearbook (1999 and 2018)

Notes: SOEs are either small-medium or large. The number of firms are measured in the units of 1 thousand, and both gross industrial output and total assets are measured in the units of 100 million RMB.

Table 1 shows that in 2017, most large SOEs specialized in the production of upstream and highly capital-intensive industries such as coal, tobacco, natural gas, heat power and gas supply. In part this reflects that SOEs with high levels of capital-intensiveness and a high degree of state-imposed policy burdens are far from privatization. This is significant because if we look at the state ownership distribution across the industries in 1997, most of the SOEs in the downstream labor-intensive industries, such as those producing textiles and food, had been transferred to private hands.

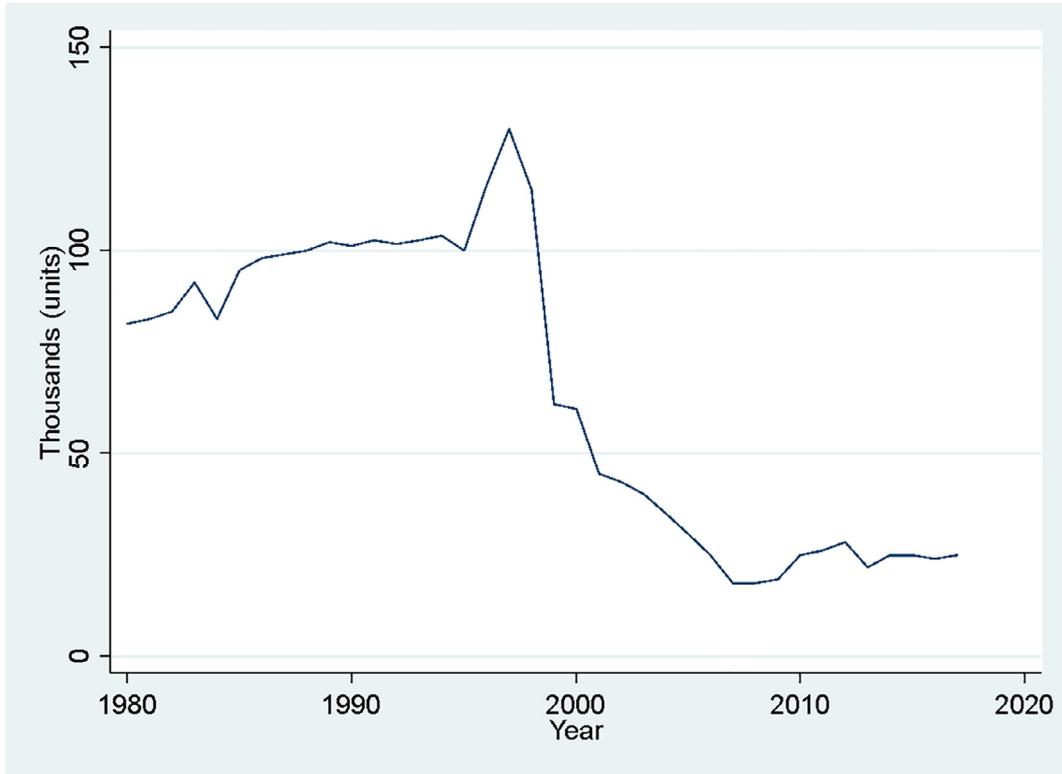
Nonetheless, it should be realized that the property rights of large SOEs remained largely undecided by the Chinese government after the massive scale of privatization programs initiated at the end of the 1990s.<sup>6</sup> It seems the state is reluctant to privatize large and capital intensive SOEs. In terms of theoretical possibilities, scholars are inclined to consider the internal factors that hinder the privatization process of large SOEs. Zhang (2006) identified large SOE managers as bureaucrats that have been selected by bureaucrats. Thus, China's state apparatus makes it difficult to guarantee retaining good managers and refusing the bad ones who are largely only accountable for the state's political objectives within the firms.

However, serious concern exists about the excessive capital intensiveness of large SOEs from the perspective of factor endowment structure.<sup>7</sup> Historically, the obsession with capital intensiveness is deeply rooted in Lenin's communist development model, which prioritizes the military and heavy industries over the light industries and final goods sectors. As Lin and Tan (1999) identified, the strategic policy burdens bared by large SOEs stem largely from the Leninist planned economy model, which prioritizes the expansions of military sectors and related heavy industries over other sectors, such as final consuming goods. Resultantly, the factor endowment structure of the industries that China's large SOEs specialize in began to deviate from that of the comparative advantage of the labor-intensive endowment structure of the overall Chinese economy. As argued by Hsieh and Klenow (2009) and Hsieh and Song (2016), the transformation of China's state sector since the '*Grasp the Large, Let Go of the Small*', has largely led to problems such as capital misallocation, low total factor productivity, which

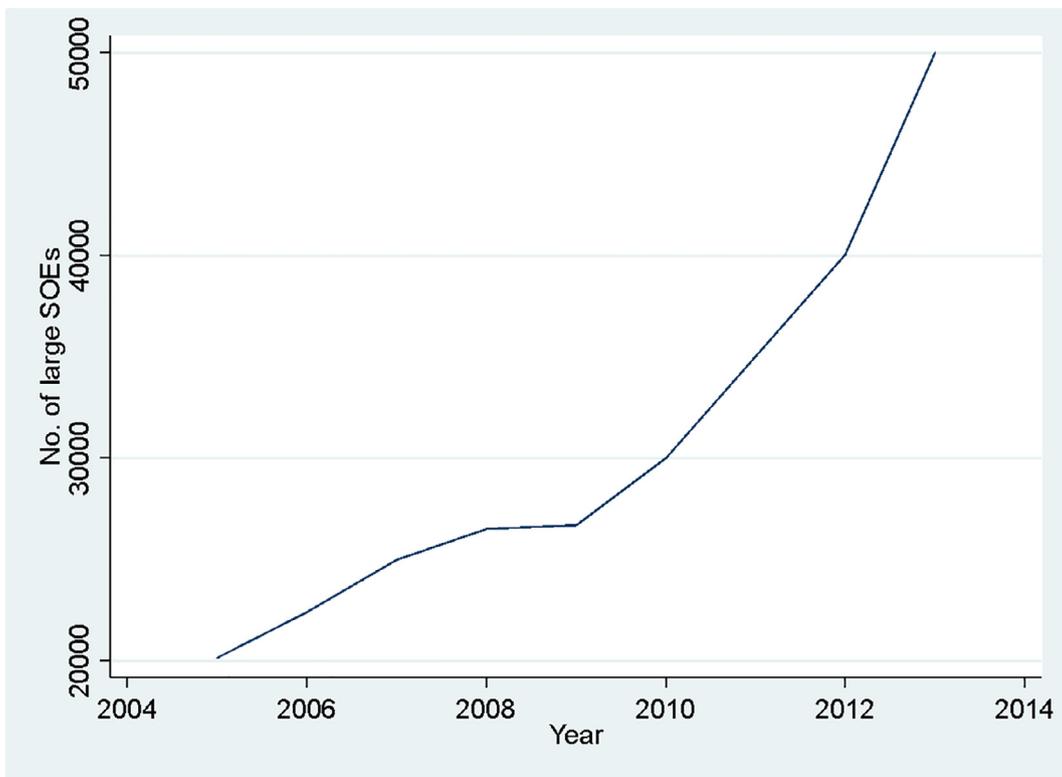
<sup>5</sup> It is also well-known that over recent years, the central government in China initiated a nationwide industrial development policy, so called '*Make SOEs grow bigger and stronger*', to provide the institutional bulwark for the persistent growth of China's SOE sectors, especially with respect to those upstream and high value-added industries endowed with the strategically developmental function for the nation's economic growth. Undoubtedly, the state pro-SOEs growth economic policy in the past decade also further accelerated the expansion of China's large SOE sectors.

<sup>6</sup> Such as those in the energy, transport, telecommunication, defence, banking and finance sectors today.

<sup>7</sup> In line with the spirit of the conventional literature, large SOEs are defined as those whose operating income is above 500 million RMB.



**Fig. 1.** The Evolution of the Number of SOEs in China (1980–2017)  
 Source: China Statistical Yearbook (1980–2017).



**Fig. 2.** Rise of the Number of Large-SOEs (2005–2013)  
 Source: China Statistical Yearbook (1980–2017).

**Table 1**  
China's SOEs in selected industries in 1998 and 2017.

	Number of Firms		Gross Industrial Output		Total Assets	
	1998	2017	1998	2017	1998	2017
Mining and Washing of Coal	49.5	18.8	81.9	64.1	92.7	75.7
Extraction of Petroleum and Natural Gas	81.7	62.9	94.5	84.3	98.9	95.0
Manufacture of Food	44.1	3.7	29.7	6.0	41.1	8.5
Manufacture of Tobacco	87.2	77.0	98.3	99.3	98.2	99.1
Manufacture of Textiles	24	0.9	32.2	2.3	46.2	5.4
Printing, Reproduction of Recording Media	58	5.0	37.9	6.6	51.2	12.8
Processing of Petroleum, Cooking and Nuclear Fuel	28.3	12.2	91.0	56.2	90.3	51.8
Manufacture of Chemical Products	32.3	5.0	50.4	18.0	69.5	29.5
Manufacture of Medicines	45.3	5.7	49.6	8.7	60.8	15.0
Manufacture of Rubber	21	1.3	34.3	3.8	50.7	7.2
Manufacture of General Machinery	29.6	3.0	38.4	9.8	60.7	20.2
Manufacture of Special machinery	40.9	3.9	41.2	12.5	63.3	24.6
Manufacture of Transport Equipment	40.1	11.1	67.0	41.8	78.2	60.5
Manufacture of Communication Equipment	29.8	3.9	37.7	9.1	51.0	17.4
Production and Supply of Electric Power and Heat Power	85.6	54.2	85.4	91.5	89.1	87.0
Production and Supply of Water	92.6	28.0	87.8	49.8	90.3	53.7
Production and Supply of Gas	84	59.3	71.6	69.0	93.7	81.6

are potentially another very important source of large SOE inefficiency.

The third plenum of the 18th Party Congress laid out principal guidelines for SOE reforms. The Chinese government had been motivated to implement changes due to increased awareness of the inefficiencies amongst large SOEs, which stemmed from low managerial incentives for SOE managers, insider control of the firms, and low total factor productivity (TFP) due to over-investment. The government embarked on a series of reforms centering on the notions of mixed-ownership aimed at improving the market-driven efficiency of large SOEs. According to [Yang et al. \(2020\)](#), [Li et al. \(2020\)](#) and [Wang and Cheng \(2020\)](#), the mixed ownership reform of China's large SOEs, which entailed adjusting the composition of the corporate board, and forming an alliance between state shareholders and externally strategic investors, has largely enhanced the commercialization of SOEs and made their investment decisions more responsive to market demand. However, since the mixed ownership reform of large SOEs is still in progress, researchers will require a longer time-period to fully examine its efficacy, especially with regards to the ex-post credibility of reform commitment, as well as ensuring the relevant protection mechanism for outside investors ([Zheng, 2014](#); [Aranoff, 2007](#); [Zhang, 2013](#)).

Since the opening-up policies, the reform path taken by China with regards to SOEs falls into three types: (1) full privatization of small-medium labor-intensive SOEs that operate within the competitive market; (2) maintenance of full state ownership over some of the military, heavy and extremely capital-intensive monopolized SOEs; (3) mixed-ownership reforms imposed upon most large SOEs with either state shares or private shareholders dominating the majority of firm shares, dependent upon the degree of external market competition. However, it ought to be aware of the fact that the existing literature that focuses mainly on the reform dynamics of Chinese large SOEs from the angle of policy burdens or ownership restructuring with its accompanied property right change of firms, does not demystify the intrinsic nature of classified SOE reforms based on the distinct level of SOEs' factor intensities. It is demonstrated in this paper that the factor endowment allocation-induced classified SOE reforms are affected by the interplay between policy burdens and their ownership restricting process. Existing literature that covers the current 'Policy Burden-Ownership Restructuring dichotomy' debate within China's large SOE has so far failed to produce a unified framework to systematically examine the rationale behind China's SOE reform paths since 1978. This paper fills that gap. We argue that 'policy burden reduction' and

'ownership restructuring' are complementary, not supplementary. This makes our paper distinct from previous and existing studies that typically assume policy burden reduction and ownership reform approach are dichotomous. This paper makes a major contribution to existing literature; it is the first paper in the literature revealing the interplay between property right structure variation that affects the optimal factor endowment allocation of large SOEs and the policy burdens they bare. Such interplay is crucially important in the unlocking of classified reform dynamics of China's contemporary SOE sectors. Surprisingly, this perspective is rarely discussed in existing literature related to China's SOE reforms, hence the deficiencies.

It could easily be derived that those labor-intensive small-medium SOEs transferred to private hands in the late 1990s were also endowed with a low degree of policy burdens, implying the feasibility of SOE ownership restructuring highly depends on their ability to bare the policy burdens, which is determined by their corresponding factor endowment structure. This is because since labor intensive SOEs and those operating within a more intense competitive market, bare a low degree of policy burdens both socially and strategically. For the state, privatization of these small firms carries no political damage, nor does it threaten the superiority of large SOEs in terms of maintaining social stability through hiring technically redundant workers and conducting strategic state investment to enhance social welfare and national industrial development. On the other hand, for those large and capital-intensive SOEs operating within the monopolized and upstream industries, since they persistently bare the high degree of policy burdens both strategically and socially. Additionally, were these large SOEs to be privatized or transferred to mixed-ownership reform with the dominance of private shareholders, there would be a reduction in social-welfare.

In terms of methodological contribution, this paper is also one of the first to provide a formalized quantitative framework by using the Nash bargaining model technique to capture China's state sector reforms in their entirety over the past several decades, including an analysis of the interaction amongst state officials, SOE managers and external investors within this period. There are four main reasons for this paper adopting the Nash bargaining model to analyze the problems associated with SOE reforms: (1) it is widely known that under a transitional economy, the SOE ownership restructuring process is closely connected to the re-allocation of power amongst SOE managers, workers, and state authority ([Blanchard, 1996](#); [Aghion and Blanchard, 1998](#)). Therefore, SOE property rights reform is intrinsically linked to stakeholder bar-

gaining in relation to control rights and firm ownership, which is in line with the mechanism behind the Nash bargaining model; (2) the re-allocation of power within SOEs, resultant of the SOE reforms following China's opening-up policy, mainly refers to the redistribution of control rights amongst SOE stakeholders, which implies an increase in asymmetrical distribution of decision-making power amongst the state authority, SOE managers, workers, and other outside private investors. The Nash bargaining model is able to capture the dynamic change in bargaining power amongst different stakeholders within SOEs by respectively assigning the bargaining power to each player in the model. For that reason, the Nash bargaining model fits in well with the theories proposed by this paper; (3) since one of the key features of SOE reforms is the privatization process (both partial and full privatization) of those SOEs operating within the non-strategic sectors of the economy, we construct a Nash bargaining model that incorporates various SOE ownership structures. Setting distinct objective functions in the model with a weighted level of private shares for players, we will be able to assess the relative efficacy, as well as compare the welfare level of ownership restructuring, ranging from partial privatization to full privatization of SOEs in the course of the period of the endowment structure driven-classified nature of reforms; (4) key factors that prevent large SOEs from fully adapting to the dynamics of market conditions are the strategic and social policy burdens, caused by hiring excessive levels of technically redundant workers, and excessively deploying capital. Therefore, the adoption of the Nash bargaining model, subject to certain conditions that characterize the production technology of SOEs, that reflect the policy burdens of SOEs, enables us to reveal the inherent interplay between the dynamics of policy burden and the ownership restructuring process throughout China's factor endowment structure-driven SOE reforms.

Our modeling framework is in line with the spirit of the cooperative game theory in the analysis of transition economics (Shleifer and Vishny, 1994, 1997). Our model captures the reform context of China's economy during the economic transition, especially with reference to the interaction between state officials and SOE managers, whose economic and political objectives significantly differ to those of western counterparts. In particular, we have mathematically derived two ORIPs that identify the SOE factor endowment allocation threshold, which captures how mixed ownership and full privatization reforms are indifferent to SOEs with regards to social planners.

The remainder of the paper is organized as follows: Section 2 offers a critical review of the relevant literature; Section 3 provides a brief institutional background of China's state sector reforms, which further motivates and outlines the contributions made by this paper; Section 4 offers a Nash bargaining modeling framework for the classified reforms of China's SOE, based on factor endowment allocation since the 1980s; Section 5 derives the policy implications of this paper; Section 6 provides concluding remarks.

## 2. A critical review of the related literature

### 2.1. Policy burden approach

The most representative works regarding government mandatory extra-economic policy burdens and SOE reform have been conducted by Lin et al. (1996, 1998, 1999, 2001), Lin and Li (2008), Berkowitz et al. (2017a), Jian et al. (2020), Lin et al. (2020), and Lin (2021). Lin's policy burden approach contends the views that a change in SOE ownership style in China is not a necessary condition to improve efficiency. They argue that even if all SOEs were privatized, the problem of soft-budget constraint would remain. Their evidence is based on the track record of SOE low-efficiency

following privatization campaigns in Eastern Europe and the former Soviet Union. Similarly, Xu et al. (2005) found that a reduction in government mandatory extra-economic control relates to policy burdens increasing SOE performance in China. However, one should note that the dynamics of the policy burdens undergone by large SOEs are endogenous to the ownership restructuring process of China's large SOEs. This makes sense because once some of the state shares of SOEs are transferred to the SOE managers, the latter would no longer have incentives to maintain the initial policy burdens and would instead remove them.<sup>8</sup> This is largely caused by the fact that SOE managers would prioritize the efficiency-enhancing of firms over the state-imposed political and national development objectives during the privatization program. Zhang (1997, 1998) formulated similar views whilst examining control deregulation in a principal-agent framework in which decisions and economic gains shifted from the government to firms, with the belief that firm autonomy increase market incentives and thus improve firm efficiency. Moreover, Shleifer and Vishny (1994) claim that any efficiency improvement requires a reduction in bureaucratic control over SOEs.

Existing literature has often focused on the shortcomings of the policy burdens approach as an explanation for SOE inefficiencies in China. Yet, little attention has been given to the mechanism through which ownership restructuring of SOEs may affect the level of policy burdens. Our paper aims to fill this gap and reveals that a change in SOE ownership structure, will correspondingly affect the factor intensity level of these firms, which in turn would affect the extent to which SOEs were willing to bear the state-imposed policy burdens. For example, as traditional studies focus on the economic transition of post-communist economies, and neglect the role of factor endowment structure in forming the interplay between policy burdens and ownership restructuring, it has been incorrectly assumed that the failure of privatization in Eastern Europe and the Soviet Union is also destined for China. It should be noted that unlike China, most privatized SOEs in Eastern Europe and the Soviet Union were large and capital-intensive firms bearing intensive levels of policy burden. Overall, the degree of industrialization of economic structure in those former communist countries had already been very high. Nonetheless, most privatized SOEs in China have been small-medium, loss-making and competitive firms that do not bear policy burdens to the same degree as large capital-intensive firms. Hence, during the ownership restructuring process amongst small-medium and competitive SOEs, the systematic risk with respect to the elimination of social welfare, such as the rising level of employment and decline in the firm output arising from the reduction in social and strategic policy burdens, will be greatly avoided. This system failed in the Soviet Union and Eastern European countries, which explains why full privatization has not yet been considered amongst large, capital-intensive and monopolized SOEs in China.

Moreover, Lin and Li (2008) adopted a Cournot Model in a free-entry market context, and argued the soft-budget SOE constraint results from external state-imposed policy burdens, which in turn disincentivizes SOE efficiency. They argue that privatization merely aggravates the soft-budget constraint predicament so long as extra-economic policy burdens remain intact.<sup>9</sup> Of greater interest would be research into why the asynchronous implementation of policy burden removal and ownership restriction may not lead to increased SOE efficiency. Our paper refutes the argument

<sup>8</sup> Such views are also corroborated by Liu and Zhang (2018) who highlighted that the degree to which SOEs are privately owned would affect the incentives of SOE managers due to more market-oriented executive evaluations on the work performance of SOE managers.

<sup>9</sup> They highlighted that those managers in private firms may demand more state subsidies *ex post* than their SOE counterparts.

that state subsidies provision stemming from the remaining policy burdens borne by SOEs were the cause of low SOE efficiency during the ownership reforms. This paper instead contends the view that leaving the policy burdens intact during ownership reforms will largely inhibit the optimal convergence of SOE factor endowment allocation. In this case, as demonstrated by our Nash bargaining model, such distorted factor endowment allocation of SOEs will lead to reduced welfare outcome from the viewpoint of social planners.

Moreover, the validity of the existing empirical studies related to the policy burdens approaches to China's SOE reforms is questionable. For instance, Li (2008) employed a panel dataset based on a survey of SOEs to investigate the sources of soft-budget constraint, and showed that government mandatory policy burdens directly cause the soft-budget constraint of SOEs. However, this approach ignores the multicollinearity that stems from the theory that initial change of SOE ownership restructuring leads to the automatic removal of policy burdens, which in turn mitigates the problem of soft-budget constraint amongst SOEs. Other studies use a panel of SOEs that identify the impossibility of SOEs unilaterally 'hardening' the budget constraint because it is indeed state imposed mandatory policy burdens that induce the soft-budget constraint (Perotti et al., 1999; Bai et al., 2000; Dong and Puterman, 2003). Subsequently, the 'soft budget constraint-poor SOE performance' causality perpetuates. These studies reveal the origin of the policy burdens, but overlook two main issues, and that is where our study differs. Firstly, they only consider the efficiency of China's SOE reforms. It should be noted that since large SOEs in China naturally bear the responsibility of promoting national industrial development, as well as maintaining social employment levels, both social and strategic policy burdens borne by large SOEs are impossibly and politically infeasibly removed by the state. If we consider this from a social welfare viewpoint, although SOE efficiency could be undermined by policy burdens issues, bearing a certain level of policy burdens could be conducive to the nation's industrial development, as well as the enhancement of overall social employment. Hence, the overall net welfare effect is not necessarily worse from the viewpoint of social planners. Secondly, these studies all fail to detect the inherent mechanism through which the dynamics of factor endowment allocation form the interplay between policy burdens and SOE ownership restructuring, one of the main criteria of China's classified state sector reforms.

## 2.2. Ownership reforms approach

Much literature has linked ownership reforms to improvements in SOE efficiency within transitional economies (Coase, 1992, 1960; Shleifer and Vishny, 1997; Zhang, 1997, 1998; Cao et al. (1999); Ma and Zhang, 1999, 2003; Estrin et al., 2009; Zhang et al., 2020; Wang et al., 2021). Most studies consider market-oriented ownership reforms as the solution to low SOE efficiency within an administratively planned economy. The empirical study by Tong (2009) established a panel dataset composed of 50,000 Chinese SOEs from 1998 to 2003. It was demonstrated that the speed and scale of privatization improved SOE performance in China. Bennet et al. (2005) also suggest that changes in state ownership do not necessarily compromise a government's revenue objectives, thus the state has little to lose. Nonetheless, the main shortcoming of these papers is their failure to classify the extent of privatization amongst different industries based on different levels of factor endowment allocation during the reforming of China's SOE sectors. In other words, most aforementioned empirical studies do not conduct the sub-samples analysis of the efficacy of privatization amongst different industries within which Chinese SOEs have operated since the late 1990s.

Existing literature has widely concluded that privatization did not improve SOE performance in post-Soviet Russia. This raises the issue of whether privatization is a necessary condition for a firm to experience better performance. There is also the issue of market nature during economic transition. For example, if the ownership restructuring process is not accompanied with increased market competition, then the ownership reform itself may not play an effective role in upgrading the economic performance of firms (Li, 2003; Li et al., 2015). One main issue regarding the validity of relevant literature is the failure to recognize the mechanism through which ownership restructuring may lead to the removal of policy burdens by inducing a change in the factor intensity level of SOEs.

## 2.3. Other approaches

There are other approaches to SOE reforms in transitional economies. Estrin et al. (2009) argued that the efficiency gained from privatization of SOEs in Eastern Europe was smaller than a benchmark of Western firms. They observed that the gain in total factor productivity from privatization was sometimes insignificant, and/or negative since the shock therapy transitional strategy was adopted in the mid-1990s. In their view, privatization with main reference to the ownership restructuring *per se* does not warrant better performance. Estrin (2002) thus saw the importance of initial conditions in transitional economies as a factor that determines the route, scale and scope of efficiency improvements. Initial conditions are very important when considering transitional strategies. Our findings highlight that the failure of mass scale privatization in Eastern Europe and Russia mainly stemmed from the failure to implement SOE reforms based on the distinct level of factor endowment allocation across industries, which could greatly affect the feasibility and efficacy of SOE ownership reform. Consequently, the privatization program aimed at increasing the efficiency of those capital intensive large SOEs endowed with a high level of policy burdens in these countries could not function as well as expected. On the contrary, China's approach to SOE privatization has differed greatly from the aforementioned countries.

Furthermore, many former studies regard SOEs as a symbol of state capitalism in China (Szamoszegi and Kyle, 2011; Wang et al., 2013a; Milhaupt, 2020). Wang et al. (2013b) developed a general equilibrium model to feature such state-capitalism, and explain why SOEs in China yield more profits than non-SOEs. They argue that SOEs monopolize 'upstream' industries whereas more labor-intensive non-SOEs are concentrated in the 'downstream' industries. 'Upstream' capital intensive SOEs extract rent from 'downstream' non-SOEs, which demonstrates exploitation of the private sector. They conclude that the current prosperity of SOEs in China reflects price distortion and unequal division of the gains under such distinct ownership structure distribution along China's vertical industrial chain. We partially agree with their views. However, such unequal distribution of the gains between SOEs and non-SOEs is also endogenous to the legacy of the Soviet extensive growth model, which was based on price distortion, commonly known as 'scissor pricing', to accumulate sufficient capital for large-scale heavy and resource-intensive industries, mainly to strengthen the national military and promote national industrial development. This indicates that price distortion arising from such ownership structure distribution and the domestic industry chain is the stick. The carrot is the government-imposed policy burden on the privileged SOEs as a way to deliver social welfare to secure social and political stability. Clearly, such a growth model has not yet been abandoned since the beginning of Deng Xiaoping's leadership in the 1980s. This directly leads to the institutional path dependency under which the legacy of the Soviet/Leninist

economic growth model still greatly exerts high influence on the operations of SOE sectors up to the present day. In other words, the state still exerts a high degree of administrative power, particularly over large SOEs, mainly in the form of imposing policy burdens.

Overall, the opinions of previous researchers on China's SOE sector fall into two camps. The first considers a change in firm ownership (hence privatization of large SOEs) as the panacea for reversing poor performance amongst large SOEs; the other sees it as a reduction of government policy burdens on large SOEs. We integrate these two views and instead develop a unified Nash bargaining model to study the interplay between ownership restructuring and policy burdens from the angle of the dynamics of factor endowment allocation of different SOEs in the context of China's classified state sector reforms. To date, few scholars have considered a change in factor allocation at the firm level, and how such change could affect the interaction between ownership restructuring and policy burdens during China's SOE reforms. This study aims to fill that gap.

### 3. Institutional backgrounds of the factor endowment allocation based classified of China's SOE sector reforms

#### 3.1. The full privatization of small-medium labor-intensive SOEs

China's central government decided to formally introduce corporate law and modern corporate institutions in 1994 following realization of the difficulties and some of the inherent institutional voids, such as the poverty of the managerial incentives during the first two rounds of SOE reforms mainly reference to the introduction of contractual responsibility system, as well as the managerial power delegation and profit retention. The formal usage of modern corporation institutions has two institutional advantages. Firstly, there is a dramatic change in the governance of SOEs; large scale commercialization and corporatization of SOEs has meant the traditional method of bureaucratic control and purely market-oriented corporate governance have been separated. In this case, the massive campaign of the ownership restructuring of Chinese SOEs was legally allowed. According to the China Economic Statistical Yearbook (2001), amongst a sample of 4371 firms, corporatization had been undertaken in 3322 (76% of the total). Secondly, the central government implemented reforms in 1998 that further deregulated political control over large SOEs (Wang, 2005). Moreover, late 2001 saw the implementation of a formal corporate governance structure and property rights reforms, following which 3118 out of a total of 3322 large SOEs have undergone reform; enterprise shareholder systems were also established in the 3118 large SOEs. One more point worth mentioning is that by the end of 2001, 1987 of the large SOEs had established shareholder boards, 3196 had set up boards of directors, and 2786 had installed boards of supervisors, accounting for 80.93%, 96.2%, and 83.9%, respectively, of the total (Shen, 2020).<sup>10</sup> Moreover, one of the main cores of the factor endowment allocation induced classified SOE reforms is that small-medium labor-intensive SOEs operating at the downstream industries are open to market competition, as unlike large SOEs they do not need to fulfill a high degree of social and strategic state-imposed policy burdens. The central government merely mounted a privatization campaign for small-to-medium SOEs, most of which were transferred to private hands

<sup>10</sup> In accordance with the corporate governance reforms, the regulation framework for large SOEs has also been developed. Large SOEs were at the time under the direct supervision of the newly established State Asset Supervision Asset Council at both the central and local state levels. More importantly, a 3-layered state-sector governance system was implemented. The SASAC operates at the top of the governance hierarchy. The middle layer is composed of various sorts of operating investment companies, and the bottom layer is made up of SOEs.

(Yang, 2017). The privatization campaign featured ten detailed policy schemes: (1) absorb other types of investment such as private investment and establish limited liability companies according to 'corporation law', but still protect the original state shareholders; (2) establish mixed-ownership structures between state and private capital; (3) promote inter-sectorial, inter-regional mergers and acquisitions; (4) transfer control rights to private hands; (5) transfer capital ownership to private hands through open auctions; (6) encourage small SOEs to form mixed-ownership arrangements with private or foreign capital, with the latter as the dominant shareholders; (7) implement bankruptcy proceedings for unprofitable SOEs; (8) delegate the right to manage some unprofitable and unproductive SOEs to other more competitive SOEs; (9) maintain the status quo if SOEs are profitable; (10) use all other means of improving the efficiency of SOEs.<sup>11</sup>

The privatization campaign substantially improved the economic performance of small-medium SOEs. For example, using the World Bank data (1996–2001) of nearly 300 SOEs as panel data samples, Hu et al. (2006) documented three stylized facts regarding the improved efficiency of small-to-medium SOEs after privatization: (1) better-performing SOEs operating under the competitive market would be given privatization priority; (2) the privatization of small-medium SOEs operating under the competitive market led to increased turnover and reduced costs, which improved profitability; (3) the fully privatized SOEs performed better in terms of profitability than those partially privatized and those still state-owned.

Similarly, Bai et al. (2006) empirically found that between 1998 and 2003, great reductions were made in agency costs faced by firms, implying that administrative costs declined following the privatization and ownership restructuring of small-to-medium SOEs. Although they found the privatization campaign to have brought certain social costs, such as a rising unemployment rate, it was not particularly high by international standards.<sup>12</sup>

#### 3.2. Rise of capital-intensive large state-owned conglomerates and mixed-ownership reforms of large SOEs operating within the competitive market

It should be noted that the corporatization and commercialization of large SOEs did not essentially reform the negative aspects of the policy burdens. This reflected the tendency of large SOEs to de-politicize as they commercialized, which resulted in considerable managerial autonomy being granted to their managers. Nevertheless, the policy burdens, including both social and strategic, are not lifted during the process. This is because social and strategic policy burdens imposed upon large SOEs represent the state's political and national developmental objectives. Despite the ownership restructuring of these firms, the policy burdens are impossible to remove, and any intentions by managers to remove these policy burdens would be opposed by the state due to the aforementioned reasons. Therefore, even though managers may have more decision-making authority, they are still obliged to carry out state-imposed duties. For instance, employing so many technically redundant workers whilst controlling excessive amounts of capital, would cause large SOEs to engage in anti-efficiency practices no matter how large the increase in managerial autonomy they were granted. Moreover, large SOE managers are also accountable for conducting strategic investment in the capital-intensive sec-

<sup>11</sup> Since the mass scale privatization campaign of China's small-medium SOEs in the late 1990s, some particular SOEs were partially privatized, which delivered a much better outcome with respect to the efficiency enhancement and access to more market opportunities (Zheng, 2014).

<sup>12</sup> Jefferson and Su (2006) and Driffield and Du (2007) empirically demonstrated a similar argument.

tors for the sake of national industrial development, and asset returns may not be as high as they would be were the investments to have been made in other non-strategic sectors.<sup>13</sup> This explains the unprecedented expansion of SOEs and the state sector in China following the 2008 financial crisis; strong financial support was provided by the central state to further assist the operations of large SOEs. Realizing this fundamental puzzle faced by large SOEs. With national industrial development and social stability being given priority by the state, the classified reforming nature of large SOEs based on the factor endowment allocation determines the illegality of ownership restructuring of state monopolized large SOEs, typically located in strategic and natural monopoly industries such as defense, military, gas, oil, and some others with the presence of high factor intensity and bearing higher degree of policy burdens. Shen et al. (2018) studied the rise of the red zaibatsu, and concluded that the SOE sector went into overdrive following the financial crisis. Two new strategies were implemented in the reform of the state sector: (1) creation of bigger and stronger SOEs to expand beyond China's borders; (2) expansion of SOEs (predominantly large SOEs), but at the expense of the private sector, concurrently benefitting from the support of a government fiscal stimulus package of 4 trillion RMB yuan. The privatization and restructuring campaign ceased after 2008, and was replaced by a re-nationalization campaign. According to Huang et al. (2014), Wei et al. (2019) and Huang et al. (2017) there was a large-scale re-nationalization of firms previously privatized between 1999 and 2007; they argued that although re-nationalization could to some degree lower the unemployment rate, its economic benefits would not be sustainable in the long term.

$$\underbrace{Max}_{Q} S = \underbrace{TR}_{\text{empire building effect}}^m \underbrace{(ps + cs)}_{\text{benevolent state effect}}^n \quad \text{where } m + n = 1$$

$$s.t \ Q = L^\alpha \bar{K}^\beta \tag{1}$$

However, it is important to note that despite bearing a high degree of policy burdens, a certain number of large SOEs locating around the local provinces in China still operate within a market where they encounter intense competition with both domestic and foreign private firms. Such intensive competition urges Chinese government at both central and local level to enact some more market-efficiency enhancing policies with main reference to the mix-ownership restructuring towards those large SOEs. Jing and Tylecote (2008); Wang and Cheng (2020) Hence, under such context, in 2014 the Chinese government adopted the mixed-ownership reform as the solution for reversing the low efficiency of large SOEs, which meant allowing the non-state externally strategic investors to own some of the SOE shares. There are three main factors driving the continuous implementation of China's mixed-ownership reforms (Wang and Han, 2020). Firstly, the Chinese government still recognizes that ownership restricts SOEs from being incentivized to become more productive and efficient. Secondly, it is better to share the control rights of firms amongst different shareholders with distinct ownership structures rather than delegating the control to a single state shareholder. Thirdly, the Chinese government still prioritizes ownership reform on the agenda of the classified reform of China's SOE sectors. There has al-

<sup>13</sup> This logic is consistent with the observations by Lin et al. (1998), who argues that viability issues affecting SOEs could not be resolved due to remaining policy burdens.

ready been some literature contending the improved performance of SOEs, especially with reference to the innovation brought by the mixed-ownership reform. For instance, Zhang et al. (2020) empirically found that China's ongoing mixed-ownership reform has largely improved the innovation performance of SOEs. Nonetheless, as mixed-ownership is still ongoing, its efficacy cannot be measured until further more comprehensive research has been undertaken.

#### 4. A Nash bargaining model of the reforming dynamics of China's SOE sectors

In order to formalize the features of Chinese state sectors with the mixture of bureaucratic control and market-orientation functions when China's SOE sectors were first established in the 1980s, we need to incorporate the payoff of both manager and state officials into the central planner optimization problem, as the managers are now given a certain amount of autonomy. Hence, we define our Nash bargaining model for this problem as the product between the payoff of the SOE manager and the payoff of the state. An SOE manager (agent) maximizes his/her benefit from his/her personal control over a firm, whereas the state (principal) maximizes the 'social welfare' of society. In this paper, we denote the private control of SOE manager benefits as the 'empire building effect', whereas the total welfare maximization by the state is the 'benevolent hand effect' under the socialist government (Baumol, 1959; Feldstein, 1964; Shleifer and Vishny, 1994).

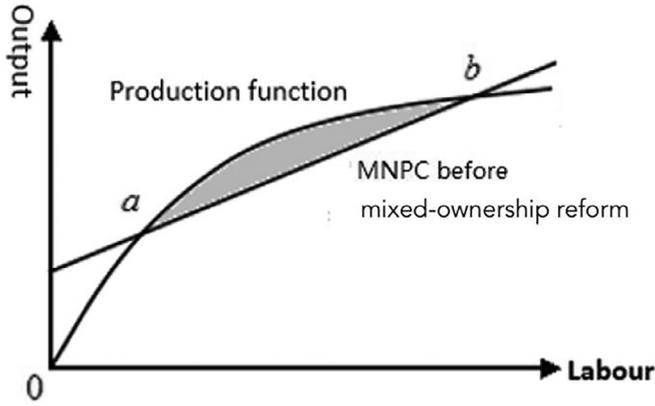
The Nash bargaining problem for the state sectors under a planned economy at the beginning of China's opening up policies can be represented as follows, with zero value of outside option:<sup>14</sup>

$$s.t \ Q = L^\alpha \bar{K}^\beta \tag{2}$$

According to (1), there is a split of bargaining power (decision making authority) between managers and the state, hence parameter 'm'. S denotes the Nash Product; TR is the total revenue of an SOE; m is the parameter of the decision-making right of the firm manager; n is the corresponding amount for the general public via the state.

The division of the power structure between the state politicians (principal) and the firm manager (agent) determines how social benefit is shared between the two parties. The Cobb-Douglas Production Function  $Q = L^\alpha \bar{K}^\beta$  is valid. This model refers to the short-term situation for the sake of excluding the possibilities of the occurrence of capital distortion effect in a transitional economy in the long-term. This is because it may affect the validity and generalizability of the model presented in this paper (Blanchard, 2018). Therefore, in our model, the capital K remains constant, and hence  $\bar{K}$ . It is assumed that labor is homogeneous in skills, but the quantity of labor can vary.

<sup>14</sup> The reason for assuming zero outside options is that under a planned economy, both state and SOE managers have some implicit contracts that do not allow them the right of exit due to the absence of imperfect labor and manager selection market under the planned economic system. For further details, please refer to Zhang (1994).



**Fig. 3.** Maximum Nash Product Curve (MNPC) and Production Function  
Notes: Points *a* and *b* represent two optimal outputs for large SOEs. The shaded area represents the efficiency loss of large SOEs. See Appendix A for details.

**Lemma 1.** If a centralized planner maximizes the Nash Product implied by (9), the following NMPC is satisfied:  $P_1 Q = (m + \frac{n}{\alpha})wL + mr\bar{K}$ , where  $P_1 = \frac{1}{2}[P(0) + P]$  and  $P$  is the regulated price set by the central state under the planned economy, so called “planned price”.

For the Proof of Lemma 1, please see the A.1 of Appendix A.

Before Point *a*, the output is below the maximum Nash Product Output. After Point *b*, the output is above the maximum Nash Product Output. The shaded area represents efficiency loss. Hence, *a* and *b* are also ‘Maximum Nash Product Curve Points’.<sup>15</sup> On the left-hand side of Point *a*, firms are inclined to increase production to stay at Point *a*. On the right-hand side of Point *a*, firms tend to increase production to stay at Point *b*. More labor input is required at Point *b*.<sup>16</sup> However, social planners are not willing to render these types of SOEs producing the output at point *b* because as indicated by Fig. 3 above, increasing the production beyond point *a* would start delivering efficiency losses to SOEs up until point *b*. Hence, it is more rational to let these types of large SOEs produce at point *a*.

It could be considered that Lemma 1 astutely reflects the nature of China’s largest monopolized SOEs responsible for providing public goods such as military armaments, gas, telecommunication, oil. For these types of highly capital intensive large SOEs operating under the natural monopolistic industries, only managerial autonomy is granted to the managers; there is no ownership restructuring. It could be derived from Lemma 1 that the main feature of these types of SOEs is that they avoid efficiency losses by employing little labor with a high degree of capital-intensiveness, such as defense, aircraft, aviation, oil, gas industries, and other capital-intensive upstream industries with strategic roles in terms of national security and national industrial development.

Furthermore, it is assumed that there is no transaction cost arising from issues such as information asymmetry amongst the state, outside investors or private shareholders. Therefore, as mixed-ownership reform leaves the state as the majority shareholder, the state share is  $a_1$ , the private share is  $a_2$ , and collectively

<sup>15</sup> We assume that all the loss-making SOEs operate within the shaded area.

<sup>16</sup> According to the Lagrange mean theorem, between Point *a* and Point *b*, there must be a point on Production Function that makes the gradient of Production Function, whose marginal product of labor equals to the gradient of the MNPC, expressed as:  $\frac{\partial Q}{\partial L} = (m + \frac{n}{\alpha}) \frac{w}{P_1} (/END)$  This logic holds true for both democratic and non-democratic regimes. In the democratic regimes, politicians will at least make some social welfare-enhancing policies in order to gain votes from the general population. For those in the non-democratic states, politicians also need to be partially if not fully accountable for the general social welfare of the population to maintain the legitimacy of their political authority.

is  $a_1 + a_2$ . After such state-dominated mixed-ownership reforms, the state remains the majority shareholder, hence  $a_1 \geq 0.5$ . The division of power between the state and firm managers remains exogenous and unchanged. The constrained optimization Nash bargaining problem infers that the state is the majority shareholder within the mixed-ownership restructuring process, which is indicated as follows:

$$\underset{Q}{\text{Max}} S = [TR^m (ps + cs)^n]^{a_1} (TR - C)^{a_2} \quad (3)$$

$$\text{s.t } Q = L^\alpha \bar{K}^\beta$$

**Lemma 2.** Before and after the mixed-ownership reform (with the state as the majority shareholder), the Maximum Nash Product Curve and Production Function intersect at the optimal level of factor endowment allocation under a mixed-ownership reform ( $L_k, Q_k$ ). At  $L_k = \frac{mr\bar{K}}{\frac{wP_1}{\alpha\beta} - (m + \frac{n}{\alpha})w}$ ,  $L_k$  is independent from the initial ownership condition ( $a_1, a_2$ ).

For the Proof of Lemma 2, please see the A.4 of Appendix A.

The rationale behind the Nash bargaining problem under the mixed-ownership reform where the state remains the majority shareholder is that on the one hand, there is an outside profit-driven investor that buys shares  $a_2$  in the large SOE. On the other hand, as the bureaucratic control over SOEs remains intact due to the incomplete market-oriented reforms, state politicians could face a multi-task problem; they have to maximize social welfare, whilst also expanding firm sizes through increasing labor employment to maintain legitimacy (Shleifer and Vishny, 1994). In other words, the nonprofit-maximizing nature of SOEs, are also endowed with the functions of enhancing social welfare, including the prevention of mass scale unemployment, abiding to the minimum wage law and others, making them compatible with politicians, who require the political legitimacy and support from the general population.<sup>17</sup> In particular, the industrial policies assisting the operations of SOEs are normally used by the state as a means of enhancing social welfare with respect to the additional hiring of redundant workers, the dominance of some naturally monopolized industries that are highly relevant to the general welfare of the population. It should be realized that there is no transfer of control rights during the process of mixed-ownership reform, where the state still acts as the majority shareholders. Initially,  $m$  measures the decision-making authority of SOE managers, but following the mixed-ownership reforms without the elimination of bureaucratic control, the decision-making authority is still centralized to the state officials, meaning that they still retain the control right of SOEs measured by  $n$ , which is shown in (3).

Overall, we could model the payoff for the state as the Cobb-Douglas production function, as shown in the constrained optimization problem in (3). After a mixed-ownership reform, the trajectory of the MNPC changes, as shown in Fig. 4.

With certain mathematical derivation, we could find the intersectional point between the two objective functions under the Nash Bargaining Solution for both prior and post mixed-ownership reform. As the state is the majority shareholder, we use the following to obtain the intersectional point regarding the optimal level of

<sup>17</sup> Nevertheless, one must realize that some SOEs may occasionally produce at the FORIP both before and after mixed-ownership reforms. For these firms, the ownership restructuring with outside strategic investors as the main shareholders is not valid, as the Maximum Nash Product Curve (MNPC) would not be affected by a change in such ownership. It should be noted that these SOE firms could be those previously discussed, including those providing public goods, and those that are naturally monopolistic. A detailed discussion about these different types of SOEs that might produce at the FORIP which are not suitable for being imposed the mixed-ownership reform with the private owners as the minority shareholders could be seen in the work by Yang(2017) and Yang.et.al (2020)

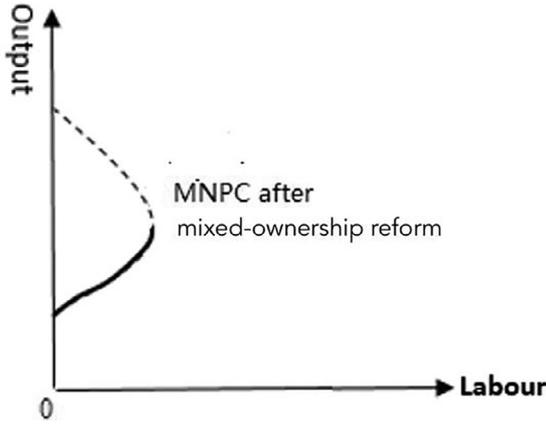


Fig. 4. Maximum Nash Product Curve (MNPC) following the mixed ownership reform

Notes: The reason for this curve being divided into dashed and solid lines is explained in A.2 of Appendix A.

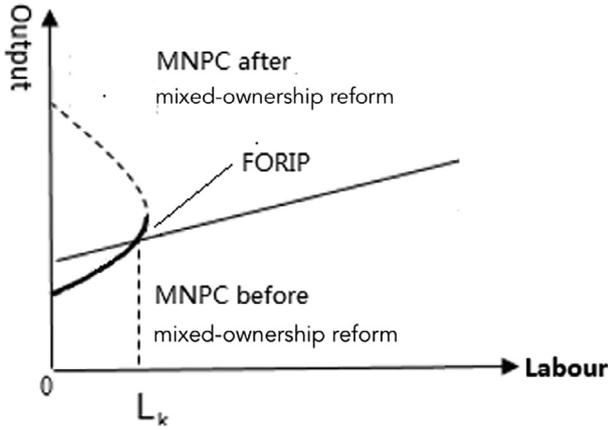


Fig. 5. Maximum Nash Product Curve (MNPC) and the First Ownership Reform Irrelevance Point (FORIP)

Notes: please see the A.3 of Appendix A for further details.

factor endowment allocation under a mixed-ownership reform:

$$L_k = \frac{mr\bar{K}}{\frac{wP_1}{\alpha P} - (m + \frac{n}{\alpha})w}, \quad Q_k = \frac{mr\bar{K}}{P_1 - mP\alpha - nP}$$

With  $L = 0$ , we plug it into the constrained optimization problem indicated by (3), a quadratic curve intersects at the  $Q$  axis with the following Fig. 5:

**Proposition 1.** *Prior and Post mixed-ownership reform, there exists a point  $(L_k, Q_k)$ , which is the First Ownership Irrelevance Point (FORIP) and indicates that the social benefit delivered by MNPC prior to and post mixed-ownership reform remains unchanged.*

**Proof of Proposition 1:**

Before the mixed-ownership reform, production function intersects with the MNPC at  $(L_k, Q_k)$ , where MNPC is maximized before any structural changes in the ownership of large SOEs. After the mixed-ownership reform, production function still intersects with MNPC post mixed-ownership reform at  $(L_k, Q_k)$ , suggesting the situation under which the post mixed-ownership reform MNPC could be reached following changes to ownership structure. In addition, as  $L_k$  is independent from the initial ownership composition  $(a_1, a_2)$ , regardless of the ownership type, this point will always be the equilibrium for use as the benchmark criteria to assess the relative efficiency of ownership reforms.

We call  $(L_k, Q_k)$  the ‘First Ownership Reform Irrelevance Point’ (FORIP) in relation to the mixed-ownership reform. Therefore, the closed-form solution for the endowment structure at the FORIP can be expressed as,  $\frac{\bar{K}}{L} = \frac{\frac{wP_1}{\alpha P} - (m + \frac{n}{\alpha})w}{mr\bar{K}}$  whereby an equilibrium level of factor endowment allocation delivers state and SOE managers the same level of joint-benefits both before and after the mixed-ownership reform.

Let us now suppose that in an economy driven by fully public enterprises, the state imposes social policy burdens on large SOEs in the form of hiring excessive labor  $L_p$ . We assume that  $L_p > L_k$  indicates that the state imposes social policy burdens upon SOEs.

Assumption 1:  $L_p > L_k$

At FORIP, large SOEs can achieve the same level of MNPC before and after ownership reforms. It is intuitive because following implementation of mixed-ownership reform, if the SOE’s actual factor allocation moves towards FORIP, the large SOE will hire fewer workers, thus improving efficiency. However, it is noteworthy that the reduction in social policy burdens is not indefinite, and only so far as the minimum level of labor employed by large-SOEs is  $L_k$ . If the SOE produces the output at the left-hand side of FORIP following mixed-ownership restructuring, then it employs too few workers, which further prevents SOEs from producing at the optimal factor endowment allocation level.

Upstream, strategic and capital-intensive industries that are under the state monopolistic control, which include oil, gas, telecommunication and others, face a trade-off between efficiency improvement through diversifying their initial state ownership structure and the high level of welfare loss brought about by the progress of full privatization caused by the private monopoly. Therefore, the corresponding classified nature of the reforms towards those monopolized SOEs is to partially privatize these firms, with the state still having dominant control. This enables partial resolution of the aforementioned trade-off between efficiency improvement and welfare loss caused by the private monopoly.

The mixed-ownership restructuring without debureaucratization is well-supported by the recently stylized equity-debt swapping of some of the large Chinese monopolized SOEs operating within the high-tech, semi-conductor, insurance, railway, banking and some other strategic capital-intensive industries. Some of the big Chinese private enterprises took over a certain level of large SOE debts (Yuan et al., 2021). However, the state maintains dominant control over large SOEs during partial privatization, and the strategic outside investors are prevented from making independent investment decisions.

**4.1. Mixed-ownership reform with outside private investors as majority shareholders**

As previously discussed, if a decline in policy burdens reduces labor numbers in large SOEs, and narrows the distance between their actual factor endowment allocation and the FORIP followed by the implementation of mixed-ownership reform, then mixed-ownership reform improves SOE efficiency. Otherwise, a mixed-ownership reform becomes optional.<sup>18</sup> This leads to our next proposition:

**Proposition 2.** *When the distance between a firm’s factor allocation post mixed-ownership reform and the FORIP is narrower, a mixed-ownership reform is justified.*

**Definition 1.** Let  $d_1 = |\frac{\bar{K}}{L_k} - \frac{\bar{K}_0}{L_0}|$  be the absolute level of factor endowment allocation deviance away from the FORIP before a mixed-

<sup>18</sup> For the proof of the existence of SORIP, please see Appendix C.

ownership reform; and let  $d_2 = |\frac{\bar{K}}{L_k} - \frac{\bar{K}_0}{L_0}|$  be the factor endowment allocation deviance away from the FORIP after the reform.

Based on **Definition 1**, we then have the following:

**Proposition 3.** *If  $d_2 < d_1$ , an SOE becomes more efficient through the mixed-ownership reform and vice versa, if  $d_1 \leq d_2$ .*

Lin et al. (1996) argued that a reform of large SOE ownership structure is not essential for efficiency gain if policy burdens remain. However, conceptually, some large SOEs may accidentally produce at FORIP. For such large SOEs, the mixed-ownership reform is unnecessary. As mentioned previously, these large SOEs may specialize in production such as heavy industry, military defense, telecommunication, oil, and gas, in which case they may have already produced at the FORIP prior to the mixed-ownership reform with outside investors as the main shareholders. Nevertheless, the reality is that a reduction in social policy burdens will always improve efficiency. For large SOEs that have not yet produced at the FORIP before mixed-ownership reform, privatization with outside private investors as the main shareholders is the logical solution. It would allow the SOE managers to own shares and maximize profits. However, corporate governance with Chinese characteristics also comes into play. On the one hand, the player with more than 50% private shares would only be interested in profits maximization; on the other hand, the state that has minority shares would only focus on welfare maximization. It is worth mentioning that in the settings of the Nash bargaining problem under the mixed-ownership reform, managers are not fully motivated by the profit-maximization objective, irrespective of whether either the state or private shareholders are the main shareholder. This is because in both cases, they are not the fully residual claimant of the private income. Moreover, under a socialist economy, such as that of China, SOEs must fulfill the function of social welfare enhancement. For instance, in some large public listed mixed-owned SOEs with more than 50% private shares, the party committee within the board of directors still largely influences the investment decisions in terms of price regulation, as well as quantity settings.

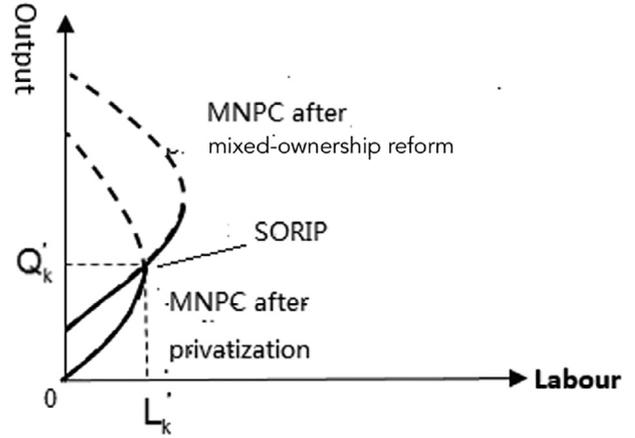
In a nutshell, with more than 50% of private shares being transferred to managers, the Nash bargaining problem and the MNPC will now be rewritten as:

$$S = (ps + cs)^{a_1} (TR - C)^{a_2} \quad (4)$$

We could derive the closed-form solution for the intersection point, which is determined by two MNPCs (one for mixed-ownership reform and the other for privatization), and is also independent of  $a_1$  and  $a_2$  (see Fig. 6). We set  $a_1 < a_2$  to reflect that more than 50% of shares are transferred to private owners.

**Lemma 3.** *The MNPC following the mixed ownership reform with the outside investors as the majority shareholders (privatization campaign reform) will intersect with the MNPC following the mixed-ownership reform, with the state acting as the majority shareholders at  $(L'_k, Q'_k)$ , where  $L'_k = \frac{\alpha}{1-\alpha} \frac{r\bar{K}}{w}$ ,  $Q'_k = \frac{r\bar{K}}{(1-\alpha)p}$ ;  $L'_k$  is independent of an ownership change. A new ownership reform irrelevance point between two curves emerges with the benchmark factor endowment allocation at  $\frac{\bar{K}}{L_k} = \frac{1-\alpha}{\alpha} \frac{w}{r}$ . This is known as the Second Ownership Reform Irrelevance Point (SORIP),<sup>19</sup> and qualifies as the 'benchmark factor endowment allocation point' for the mixed ownership with the outside investor acting as the majority shareholders (privatization campaign) (see Fig. 6 below).*

<sup>19</sup> Shen (2020) also shared such efficiency-enhancing views of China's large SOEs, as did Guan et al. (2021), who focused on the efficiency implications of China's mixed-owned SOEs.



**Fig. 6.** Maximum Nash Product Curve (MNPC) and the Second Ownership Reform Irrelevance Point (SORIP)

Notes: (1)  $L'_k$  is the optimal labor input at SORIP; (2)  $Q'_k$  is the optimal output at SORIP.

**Proposition 4.** *Prior to the privatization campaign, if an SOE's factor endowment allocation is already at  $(L'_k, Q'_k)$ , there is no need to implement further mixed ownership reform with outside investors as majority shareholders (privatization campaign). If an SOE's factor endowment allocation has not yet met the mixed ownership reform with outside investors as majority shareholders (privatization campaign) benchmark point, the SOE will become more efficient if the privatization campaign brings it closer to that benchmark point.*

**Definition 2.** *Let  $d_3 = |\frac{\bar{K}}{L_k} - \frac{\bar{K}_0}{L_0}|$  be the factor endowment allocation deviance away from the SORIP before privatization; and let  $d_4 = |\frac{\bar{K}}{L'_k} - \frac{\bar{K}_0}{L'_0}|$  be the factor endowment allocation deviance away from SORIP after privatization.*

**Proposition 5.** *If  $d_3 > d_4$ , a SOE becomes more efficient, and the privatization campaign benefits all parties due to a reduction in the level of social policy burdens.*

Both Proposition 4 and Proposition 5 deliver a very important message: for SOEs that require further efficiency improvements by removing the level of social policy burdens, the state ought to implement further mixed-ownership restructuring by transferring most of the state shares to private hands. The classified nature of China's SOE sector corroborates the above argument. Most SOEs bearing a high degree of policy burdens and operating under the competitive market structure have experienced large scale ownership diversification by introducing the outside strategic investors as the majority shareholders. Consequently, the initial problem of SOE inside control has been largely mitigated due to the improved incentive effect stemming from the ownership restructuring process (Huang, 2015).

#### 4.2. The interplay between mixed-ownership restructuring with the majority state shareholders and privatization reform

To illuminate the inherent connection between these two types of reform, we derive the following proposition:

**Proposition 6.** (1) *Regardless of the increasing or decreasing returns to scale, if an SOE's capital satisfies  $\bar{K} = (\frac{mr}{p_1 - m\beta\alpha - n\beta})^{\frac{1-\alpha}{\alpha+\beta-1}} (\alpha w p)^{-\frac{\alpha}{\alpha+\beta-1}}$ , it will produce at FORIP, which is  $(L_k, Q_k)$ ; (2) *With constant returns to scale, if an SOE's wage is set at  $w = (\frac{mr}{p_1 - m\beta\alpha - n\beta})^{\frac{1-\alpha}{\alpha}} \frac{1}{\alpha p}$ , it will also produce at the FORIP.**

#### Proof of Proposition 6:

Since the amount of capital at FORIP ( $L_k, Q_k$ ) is known, we can plug  $L_k = \frac{mr\bar{K}}{\frac{wP_1}{\alpha\beta} - (m + \frac{n}{\alpha})w}$ ,  $Q_k = \frac{mr\bar{K}}{P_1 - mP\alpha - nP}$  into Production Function  $Q = L^\alpha K^\beta$  in order to obtain,

$$\bar{K}^{\alpha+\beta-1} = \left( \frac{mr}{P_1 - mP\alpha - nP} \right)^{1-\alpha} (\alpha w P)^{-\alpha} \quad (5)$$

When returns to scale is either increasing or decreasing, i.e.  $\alpha + \beta \neq 1$  and the amount of capital is set as Formula (5), an SOE will produce at FORIP, which satisfies the following fixed capital input requirement:

$$\bar{K} = \left( \frac{mr}{P_1 - mP\alpha - nP} \right)^{\frac{1-\alpha}{\alpha+\beta-1}} (\alpha w P)^{-\frac{\alpha}{\alpha+\beta-1}} \quad (6)$$

If an SOE has constant returns to scale, i.e.,  $\alpha + \beta = 1$ , it will produce at the FORIP if the following conditions are met:

$$\left( \frac{mr}{P_1 - mP\alpha - nP} \right)^{1-\alpha} (\alpha w P)^{-\alpha} = 1 \quad (7)$$

and the wage level is thus set as follows:

$$w = \left( \frac{mr}{P_1 - mP\alpha - nP} \right)^{\frac{1-\alpha}{\alpha}} \frac{1}{\alpha P} \quad (8)$$

Similarly, we can also derive the following Proposition 7.

**Proposition 7.** (1) With increasing or decreasing returns to scale, a large SOE will produce at SORIP, if it satisfies  $\bar{K} = \left[ \frac{r}{(1-\alpha)P} \right]^{\frac{1}{\alpha+\beta-1}} \left( \frac{1-\alpha}{\alpha} \right)^{\frac{\alpha}{\alpha+\beta-1}} \left( \frac{w}{r} \right)^{\frac{\alpha}{\alpha+\beta-1}}$ ; (2) With constant returns to scale, a large SOE will produce at SORIP if its wage rate is set at  $w = \left( \frac{\beta P}{r} \right)^{\frac{1}{\alpha}} \left( \frac{\alpha^2}{\beta} \right)$ .

The proof of Proposition 7 is similar to that of Proposition 6.

The difference between FORIP and SORIP is contingent on the values of  $\frac{P_1}{P}$ ,  $m$ ,  $n$ ,  $\alpha$  (i.e., the output market price, demand curve, division of rights between the state and firm managers, and the labor output elasticity, respectively).

If capital is constantly set as  $\bar{K}$ , there are two possibilities: (1) Constant returns to scale, causes large SOE wage rate changes (see Appendix C); (2) Increasing or decreasing returns to scale (see Appendix D), will cause the wage rate to become:

$$w = \left( \frac{m}{P_1 - (m\alpha + n)P} \right)^{\frac{1-\alpha}{\alpha}} P^{-\frac{1}{2}} P_1^{\frac{1}{2\alpha}} (1-\alpha)^{\frac{1-\alpha}{2\alpha}} \quad (9)$$

That is because,

$$L'_k - L_k = \frac{r\bar{K}}{w} \left[ \frac{\alpha}{1-\alpha} - \frac{m}{\frac{P_1}{P\alpha} - (m + \frac{n}{\alpha})} \right] = \frac{r\bar{K}}{w} \frac{\frac{P_1}{P} - 1}{(1-\alpha) \left( \frac{P_1}{P\alpha} - (m + \frac{n}{\alpha}) \right)} \quad (10)$$

Since  $P_1 > P$  and  $L'_k > L_k$ , the optimal allocation of factor endowment under privatization becomes larger than that under the mixed-ownership dominated economy:  $\frac{\bar{K}}{L'_k} < \frac{\bar{K}}{L_k}$ .

**Proposition 8.** When the factor endowment allocation moves from the case of mixed ownership reform ( $L_k, Q_k$ ) to that of full privatization ( $L'_k, Q'_k$ ), given the amount of capital remains unchanged, more labor will be employed,  $L'_k > L_k$ . This is because when the perfect market competition occurs, that is  $P_1 = P$ , it will be the case that  $\frac{\bar{K}}{L'_k} = \frac{\bar{K}}{L_k} = \frac{1-\alpha}{\alpha} \frac{w}{r}$ . Since  $L'_k > L_k$ , large SOEs will reverse their capital intensiveness and become more labor intensive in the short-term.

We can derive the following theorems based on the above results:

**Theorem 1.** Both mixed-ownership reform with majority and minority private shareholders enable SOEs to adjust their factor endowment allocation as closely as possible to the benchmark factor allocation level under the case of full privatization.

**Theorem 2.** SORIP indicates a Pareto optimum point under full privatization.

**Theorem 3.** Fully Privatized SOEs can achieve Pareto optimum in the short-term so long as their capital input remains unchanged.

**Theorem 4.** Fully Privatized SOEs operating in a market of perfect competition can reach a Pareto optimum in both the short- and long-term.

**Theorem 5.** SOEs operating in perfect market competition without full privatization can achieve a Pareto optimum if they already produce at SORIP before the full privatization program.

The above several theorems with particular reference to Theorems 1 and 4 are highly in line with the spirit of the so called grasp the large, get rid of the small mass scale privatization campaign imposed upon small-medium SOEs in the late 1990s. The essential feature of these small-medium SOEs is their high labor-intensity and operation within the competitive market. Hence, the theories proposed by our paper reveal full privatization is the solution to achieving the pareto-optimality.

## 5. Policy implications derived from the results of our nash bargaining model

The theoretical results proposed by our model have the following policy implications for future SOE reforms. Firstly, with reference to Proposition 1 and Proposition 2, the feasibility of SOE ownership restructuring is largely contingent upon their distinct factor endowment structure. The FORIP indicates that the partial privatization of some naturally-monopolized SOEs that operate within highly capital-intensive and strategic industries, such as national defense, military, oil, and gas, will not be welfare-enhancing, thus it is preferential for these SOEs to remain under full state control. The giant state-owned oil companies, such as China North Industries Group Corporation Limited (CNIGC) and the China Aerospace Science and Technology Corporation (CASTC) corroborate such views. CNIGC and CASTC play a crucial role in undertaking strategic investments that are central to national defense security and the competence of national aerospace technology, respectively. Hence, since large monopolized SOEs are not allowed to be privatized, our theories may infer that large monopolized SOEs provide public goods, and remain largely accountable for maintaining national social welfare, with particular reference to employment and industrial development. Other existing literature confirms the welfare enhancing role played by large SOEs. For example, Lo (1999) demonstrate that SOEs may sustain a high level of welfare, which is crucial to the institutional transformation of China's economy. Furthermore, Gu (2001), Lee (2000), and Leung (1994), elucidated that since the economic transition began in the late 1970s, China's government has been under increasing pressure to reshape the welfare system of workplace units, with the aim of ensuring full employee welfare provision through the bulwark of SOE sectors. Similar to our findings in this paper, Shen et al. (2018) explained why the expansion of large, capital-intensive, and monopolized SOEs has been a necessary policy tool for the state to maintain social policy burdens, such as the excessive employment of technically redundant workers, and strategic policy burdens to promote national welfare-enhancing industrial development. Both types of burden may partially function as an umbrella to protect workers from unemployment, as well as maintaining the minimum required rate of economic growth through welfare-enhancing investment, which both partially reflect state social welfare provision.

Secondly, in contrast to the views of existing mainstream literatures on the efficiency of China's SOEs,<sup>20</sup> our paper contends that during the period of factor-endowment allocation induces China's SOE classified reforms, there must be some SOEs producing at the FORIP, implying it is preferable not to transfer all SOE shares into private hands due to their strategic and welfare commitments to China's economy. Instead, partial privatization, whereby the state remains the majority shareholder of SOEs, is more welfare-enhancing. According to [Proposition 2](#), those SOEs operating within the less-competitive, non-natural monopolized, and that are less-related to national defense or livelihood industries, and that do not produce at the FORIP, which are characterized by a specific level of factor intensity are suitable for being undertaken the mixed-ownership reform with the private owners as the minority shareholders. The above view is reasonable because in reference to [Yang et al. \(2020\)](#), those SOEs operating within the non-naturally monopolized and non-livelihood industries, but who are still under a certain degree of monopolistic government control and receive certain degree of developmental commitment from the state, they can behave both efficiently and welfare-enhancing via partially transferring some of the shares to the private hands by making the state still remain the dominant ownership control. China's automotive industries typically illustrate the abovementioned point. China's Faw Group formed a joint-venture with the German car giant, Volkswagen AG, at the beginning of 1990s, with Faw Group controlling the majority of shares. The joint-venture greatly enhanced the economic performance of the firm, and the growth of China's car industry and industrial capabilities have also been elevated. For example, after China's entry to the World Trade Organization (WTO), Harwit (2001) argues that the prevalence of the joint-venture between China's local automotive SOEs and other international automotive producers has largely increased regional income and employment levels, but these mixed-owned SOEs are still featured by the presence of partial bureaucratic as well as decision-making authority control by the local government.

Thirdly, [Proposition 3](#) and [Lemma 3](#) provide two clear observations with regards to relevant policy implications: (1) a large number of SOEs do not produce at the FORIP of our proposed Nash bargaining model because the majority state-owned shares of these SOEs are suitable for transferring to private ownership. In other words, SOEs that operate within the more competitive and technological-intensive industries that are open to private and foreign competitions, would benefit from having majority shares transferred to private shareholders in order to ensure greater managerial incentives to help drive innovation, and enhance their technological abilities. As demonstrated by Cai and Tylecote (2008), semi-privatized SOEs in China's mobile telecommunication industry exhibit more dynamic and competent innovation capabilities, compared with their counterparts who do not introduce the majority private shares. Hence, our paper also illustrates that the mixed-ownership SOE reform may play an important role in improving the innovation capability within certain industry sectors, which in turn could be conducive to the technological development of China's economy as a whole.

Fourthly, as aforementioned, one of the main features of China's SOE reforms is that the partial privatization of large SOEs, whereby the private owners form the majority shareholders, normally occurs within the more competitive, but technologically catching-up sectors, such as semiconductor, chips, and aerospace. Due to the presence of the ownership restructuring incentive effect, mixed ownership reform makes these newly structured mixed-owned SOEs more highly competitive through improving their innova-

tion capability. ([Zhang et al., 2020](#)). In particular, since substantial technological progress requires a large amount of capital, as well as managerial incentives to engage in innovation activities, SOEs would undoubtedly benefit from the mixed-ownership restructuring process. A further example is the internal mechanism of mixed-ownership-oriented M&As of local SOEs in Guangdong Province, which has largely enhanced the SOE innovation capabilities, and improved regional economic growth. ([Wang, 2021](#)).<sup>21</sup>

Fifthly, there are several conclusions that we could draw from [Propositions 4, 5, and 6](#), as well as [Theorems 1-5](#): (1) it is realized that there must be some SOEs that do not produce at the SOIRP, and such SOEs should be fully privatized to enable them to fully reverse their poor performance and low efficiency. Consistent with what has occurred throughout the course of China's SOE reforms, small-medium SOEs that operated within the competitive, labor-intensive and non-strategic industries in the late 1990s, have been fully privatized under the reform agenda: '*Grasp the Large, Get Rid of the Small*'. As illustrated by Chen et al. (2021), removal of the endogeneity problem of the self-selection bias, meant the privatized SOEs causally largely improved their productivity, and on average became 53% more productive than their SOE counterparts; (2) [Proposition 5](#) underlines the important effect of privatization on removing the policy burdens on SOEs, which are the main impediment to enhancing their innovation capabilities. With regards to economic growth and technological development, it is evident that the privatization of small-medium SOEs at the end of the 1990s, also significantly contributed to the elimination of the distortions of resource allocations across SOE dominated sectors, and substantially improved the total factor productivity level of the Chinese economy as a whole ([Lu et al., 2020](#); [Hsieh and Song, 2016](#)).

[Propositions 6 and 7](#) provide a mathematical proof of the conditions that some SOEs must satisfy in order to produce at the FORIP and SORIP, respectively, of our proposed Nash bargaining model. In terms of the correspondingly derived policy implications, these two propositions imply that ownership restructuring, with reference to both full- and partial- privatization, could not be applied to all SOEs in the course of factor endowment structure-driven classified SOE reforms. In other words, analogous to the previously proposed argument, and consistent with real observations, SOEs that operate in the more competitive, technological catching-up, non-livelihood, and non-monopolized industries, are either partially or fully privatized.<sup>22</sup> Subsequently, [Proposition 8](#) illustrates why full privatization of small- to medium-sized SOEs that operate within competitive industries, is key to unlocking their labor-intensiveness, which in turn provides us with a far-reaching insight into how the factor-intensity is negatively varied by the degree of privatization of SOEs given the externally competitive market structure under which these SOEs operate within. [Huang and Zhu \(2022\)](#) also conclude that privatization is more prevalent within a more competitive and market-oriented market.

Moreover, [Theorems 1-5](#) of our proposed Nash bargaining model summarize the main theoretical results of the paper. There are several points worth mentioning from these aforementioned theorems: (1) [Theorems 1 and 2](#) imply that since the opening-up policies, the privatization of SOEs is endowed with the welfare-enhancing nature of improving the status-quo of all stakeholders including SOE managers, state, employees and outside private investors involved in the process of ownership restructuring. In particular, [Theorem 2](#) indicates that for SOEs already producing at the SORIP, the state does not need to impose full privatization, as the whole economy may reach the pareto-optimality without

<sup>20</sup> The paper by [Hsieh and Song \(2016\)](#) also empirically found that there was the rise in the TFP of Chinese SOEs over the recent years.

<sup>21</sup> These views are also resembled by [Bai et al. \(2009\)](#) and [Liu et al. \(2016\)](#).

<sup>22</sup> These views are also resembled by [Bai et al. \(2009\)](#) and [Liu et al. \(2016\)](#).

privatization. This is crucial to comprehend the overall failure of the full-privatization of all state sectors amongst the former Soviet economies (Brada, 1996; Lin and Makarov, 1998; Estrin, 2009, Shen et al., 2019). As this paper suggests, when a transitional economy is experiencing mass-scale ownership restructuring, full privatization of entire SOE sectors is not a necessary condition for the whole economy to achieve pareto-optimality.

Both Theorems 3 and 4 crucially imply that without a competitive market structure, the privatization process will not deliver the first-best long-term outcome for those SOEs, even though the welfare-maximizing outcome may be realized in the short-term. Such policy implications are in line with the arguments contended by Lin et al. (1998), Lin and Tan (1999), and Lin (2021), who particularly highlight the importance of creating a competitive market structure throughout the course of China's SOE reforms. Even though the intensity of market competition may raise the efficiency levels of SOEs, existing literature commonly concludes that without creating a competitive market structure, privatization may not fundamentally resolve the problems that result in the low efficiency of SOEs, such as low managerial incentives, and ex-post moral hazard behaviours of SOE management committee boards (Naughton, 1994; Chang, 1997; Wu, 2006; Berkowitz et al., 2017b). Theorem 5 of the proposed model further demonstrates that even without full privatization, if the externally competitive market is created through eliminating the potential entry barriers, removing the administrative regulation etc., those SOEs producing at the SORIP could still achieve pareto-optimality due to the dominance of market-competition effect over ownership incentive effect.

## 6. Conclusions

This paper constructs a unified Nash Bargaining Model to identify the classified reform nature of China's SOE sectors based on the factor endowment allocation across different industries. Our model derives two ownership reform irrelevance points that correspond to the Pareto optimum level of factor endowment allocation under the mixed-ownership reforms and full privatization programs. It is realized that the traditional operational mode of SOEs during the planned economy era has created two main features of Chinese SOEs following the opening-up policies of 1978. Firstly, large SOEs subsequently still opt for a capital-intensive production model by bearing a high level of policy burdens despite China's undisputed comparative advantage of the factor endowment structure with its abundant labor *hitherto*. Secondly, state social welfare needs have forced large SOEs to hire a large amount of technically redundant labor beyond the optimal production scale requirements. These dictate that under China's SOE reforms based on the classification of firm factor endowment structure, full privatization of large capital-intensive SOEs will be impossible. The insights provided by our model are also in line with the spirit of why those relatively more labor-intensive SOEs experienced ownership restructuring at the end of 1990s. This is because from the perspective of social welfare, partial or full privatization of these relatively more labor-intensive SOEs *per se* would not harm the state's interest in terms of maintaining social employment, as well as promoting national industrial development.

Our model also demonstrates that the classified reform nature of China's SOE sectors based on the factor endowment structure allocation makes the efficiency of SOEs equal to that of private firms, as well as the welfare maximizing from the viewpoint of social planners. Therefore, it is noteworthy that as large SOEs are more capital-intensive and bear a higher degree of policy burdens, they are considered one of the key strategic players in enhancing the nation's industrial development and maintaining large scale social employment. From this point of view, privatizing large SOEs would

be welfare-reducing. Likewise, since most former small-medium SOEs were concentrated in the downstream labor-intensive industries and bore a lower degree of policy burden, privatization will be a win-win outcome for both SOE managers and the state with regards to maximizing social welfare. Hence, in terms of the policy implications of China's classified reforming dynamics of state sectors, the degree to which SOEs should be privatized largely hinges upon the factor intensity of SOEs, which is highly related to the degree of policy burdens. Large and highly capital-intensive SOEs providing public goods for the general population should not undergo ownership restructuring, since they have the strategic function of undertaking the nation's core technological innovation and industrial development. The state should partially privatize capital-intensive SOEs operating within the monopolistic market structure in order to incentivize SOE managers to increase efficiency, since they too are responsible for promoting the nation's strategic industrial development, such as the railway, banking, and insurance. Thirdly, with regards to large SOEs bearing a high degree of policy burdens, outside strategic investors as majority shareholders are a necessary means of removing policy burdens that cause low efficiency, since these shareholders operate within the competitive market and can enable competition with the SOEs counterparts. With regards to small and medium labor-intensive SOEs, privatization would be more efficient and welfare-enhancing, and they would also be opened up to market competition, since they are not endowed with a high level of social and strategic policy burdens.

## Appendix A. Nash Product Curve

### A.1. Proof of Lemma 1:

Let  $TR = PQ$ ,  $cs = \frac{1}{2}[P(0) - P]Q$ ,  $ps = TR - C = PQ - wL - r\bar{K}$  and plug these three into Eq. (1) to obtain the following:

$$S = (PQ)^m \left\{ \frac{1}{2}[P(0) - P]Q + PQ - wL - r\bar{K} \right\}^n \quad (A.1.1)$$

Since  $P_1 = \frac{1}{2}[P(0) + P]$ , the labor input can be written as  $L = \left(\frac{Q^{\frac{1}{\alpha}}}{\bar{K}^{\frac{\beta}{\alpha}}}\right)$ . We plug this into Eq. (11), and thus have NSB:

$$S = (PQ)^m \left[ P_1 Q - w \left( \frac{Q^{\frac{1}{\alpha}}}{\bar{K}^{\frac{\beta}{\alpha}}} \right) - r\bar{K} \right]^n \quad (A.1.2)$$

We take the derivative of Eq. (12) by Q:

$$\frac{\partial S}{\partial Q} = m (PQ)^{m-1} \left[ P_1 Q - w \left( \frac{Q^{\frac{1}{\alpha}}}{\bar{K}^{\frac{\beta}{\alpha}}} \right) - r\bar{K} \right]^n + n(PQ)^m \left[ P_1 Q - w \left( \frac{Q^{\frac{1}{\alpha}}}{\bar{K}^{\frac{\beta}{\alpha}}} \right) - r\bar{K} \right]^{n-1} \left[ P_1 - \frac{1}{\alpha} w \left( \frac{Q^{\frac{1}{\alpha}-1}}{\bar{K}^{\frac{\beta}{\alpha}}} \right) \right] \quad (A.1.3)$$

We let  $\frac{\partial S}{\partial Q} = 0$ . The resulting equation for the maximum value of the Nash Product is:

$$m (PQ)^{m-1} \left[ P_1 Q - w \left( \frac{Q^{\frac{1}{\alpha}}}{\bar{K}^{\frac{\beta}{\alpha}}} \right) - r\bar{K} \right]^n + n(PQ)^m \left[ P_1 Q - w \left( \frac{Q^{\frac{1}{\alpha}}}{\bar{K}^{\frac{\beta}{\alpha}}} \right) - r\bar{K} \right]^{n-1} \left[ P_1 - \frac{1}{\alpha} w \left( \frac{Q^{\frac{1}{\alpha}-1}}{\bar{K}^{\frac{\beta}{\alpha}}} \right) \right] = 0$$

Then,

$$m(P_1 Q - wL - r\bar{K}) + n \left( P_1 Q - \frac{1}{\alpha} wL \right) = 0 \quad (A.1.4)$$

When we re-arrange Eq. (6), it becomes:

$$P_1 Q = \left( m + \frac{n}{\alpha} \right) wL + m r\bar{K} \quad (A.1.5)$$

Eq. (7) defines the mathematical relationship between output Q and SOE labor under the planned economy in the short-term. This curve can be called the Maximum Nash Product Curve (MNPC).

**Proof of Lemma 1 completed.**

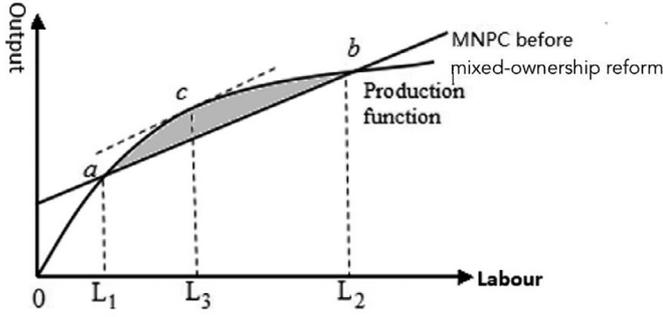


Fig. A.1. Maximum Nash Product Curve (MNPC) with Production Function.

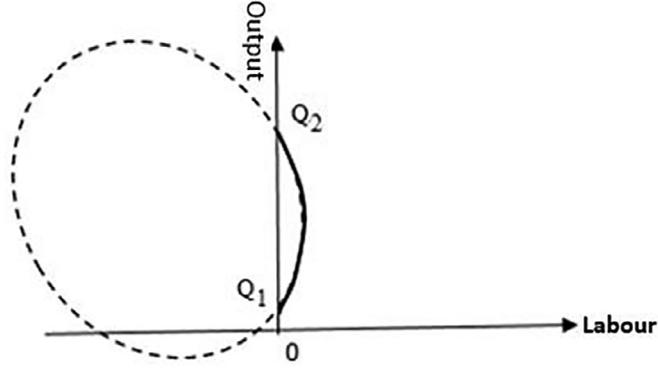


Fig. A.2. The Making of the Maximum Nash Product Curve (MNPC).

A.2. Maximum Nash Product Curve (MNPC)

Fig. A.1 illustrates the output mechanisms, Nash Product and firm efficiency. Both Points *a* and *b* intersect with production function to mark the optimal efficiency points. Point *c* is a tangential point for the maximum efficiency loss.  $L_1$  is the first optimal labor input level before a mixed-ownership reform;  $L_2$  is the second optimal labor input level before a mixed-ownership reform;  $L_3$  is the labor input corresponding to maximum efficiency loss.

Fig. A.1. Maximum Nash Product Curve (MNPC) with Production Function

A.3. Elaboration of Maximum Nash Product Curve (MNPC)

Equation (A.1.3) can be rewritten as follows:

$$ma_1(P_1Q - wL - r\bar{K})(PQ - wL - r\bar{K}) + na_1\left(P_1Q - \frac{1}{\alpha}wL\right) \quad (A.2.1)$$

$$(PQ - wL - r\bar{K}) + a_2(P_1Q - wL - r\bar{K})\left(PQ - \frac{1}{\alpha}wL\right) = 0$$

Where the coefficient for  $Q$ , which is  $(ma_1 + na_1 + a_2)pp_1$ , has a positive value, as does the coefficient for  $L$  which is  $(ma_1 + \frac{na_1}{\alpha} + \frac{a_2}{\alpha})w^2$ . If there is no interaction term for  $Q_L$ , then this quadratic curve is an ellipse.

If we let  $L = 0$ , and plug it into Equation (A.1.2), the intersectional points are  $(Q_1 = \frac{r\bar{K}}{p}, Q_2 = \frac{mr\bar{K}}{p_1} \frac{a_1 p_1}{a_1 p_1 + a_2 p})$ .  $Q_1$  and  $Q_2$  are the minimum and maximum outputs for large SOEs, respectively, after the implementation of a mixed-ownership reform with the state acting as the majority shareholder (see as Fig. A.2).

For current purposes, we enlarge the sections lying within the first quadrant (see Fig. A.3).  $L_i$  is the maximum labor input for SOEs after mixed-ownership reform;  $Q_1$  is the minimum output for SOEs after mixed-ownership reform (when  $L = 0$ );  $Q_i$  is the maximum output for SOEs after mixed-ownership reform;  $Q_2$  is the hypothetical output beyond the capacity of SOEs.

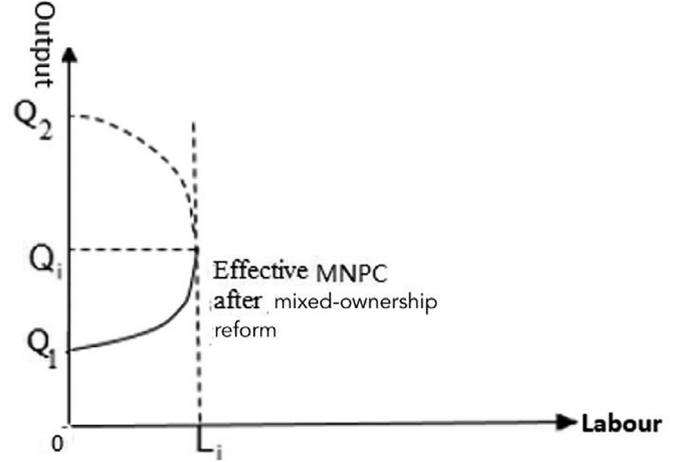


Fig. A.3. Fine-tuning the Maximum Nash Product Curve (MNPC).

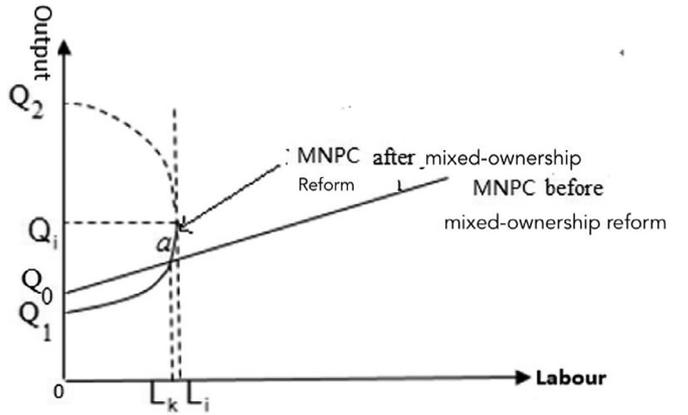


Fig. A.4. Locating FORIP.

A.4. Maximum Nash Product Curve (MNPC) and Ownership Reforms

We now divide the quadratic curve into two parts at the point  $x = L_i$ , which is the tangential point of the curve. The upper-dashed line represents an increasing output whilst  $L$  decreases, which is not meaningful. The lower solid line symbolizes Net Social Benefit.

Before the mixed-ownership reform the output is at  $Q_0 = \frac{mr\bar{K}}{p_1}$ . The location of FORIP falls where  $Q_i > Q_k$  or  $L_i > L_k$ . This is shown in Fig. A.4.

A.5. Proof of Lemma 2

After the mixed-ownership reform, the Nash bargaining problem can be rewritten as:

$$\underset{Q}{\text{Max}} S = [TR^m(ps + cs)^n]^{a_1} (TR - C)^{a_2} \quad (A.4.1)$$

s.t  $Q = L^\alpha \bar{K}^\beta$

We let  $TR = PQ$ ,  $cs = \frac{1}{2}[P(0) - P]Q$ ,  $ps = TR - C = PQ - wL - r\bar{K}$ , plug them into Equation (A.4.1) and obtain:

$$S = \{ (PQ)^m \left\{ \frac{1}{2}[P(0) - P]Q + PQ - wL - r\bar{K} \right\}^n \}^{a_1} (PQ - wL - r\bar{K})^{a_2} \quad (A.4.2)$$

Given  $P_1 = \frac{1}{2}[P(0) + P]$ , it becomes  $L = \left(\frac{Q_1 \alpha}{\bar{K} \beta}\right)$ .

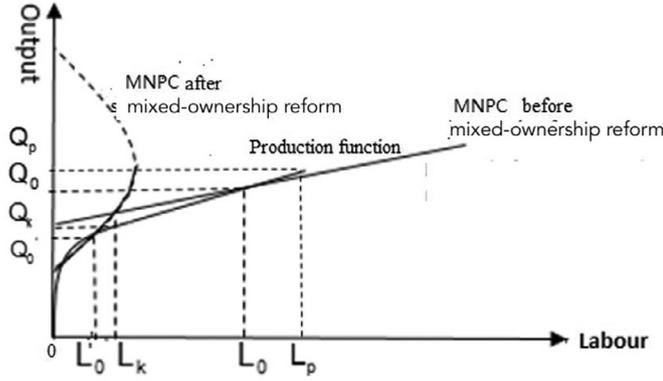


Fig. B.1. Reforms and Nash Product (1).

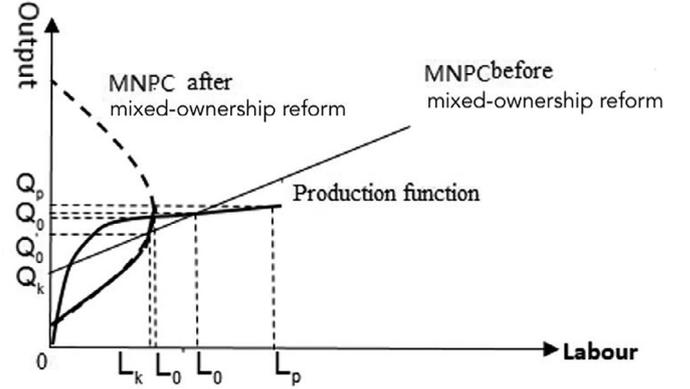


Fig. B.2. Reforms and Nash Product (2).

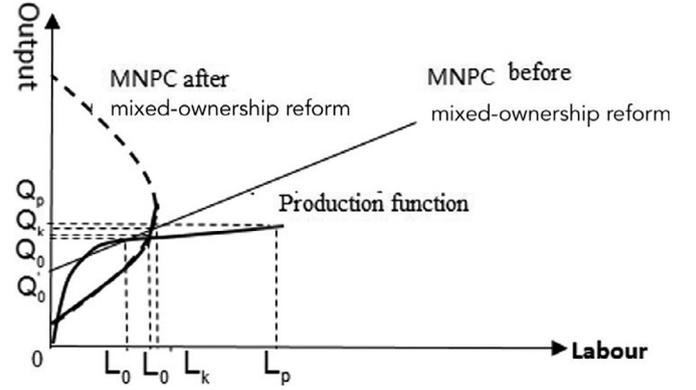


Fig. B.3. Reforms and Nash Product (3).

We then plug it into Equation (A.4.2) and obtain:

$$S = (PQ)^m \left[ P_1 Q - w \left( \frac{Q^{\frac{1}{\alpha}}}{\bar{K}^{\frac{\beta}{\alpha}}} \right) - r\bar{K} \right]^{a_1} \left[ PQ - w \left( \frac{Q^{\frac{1}{\alpha}}}{\bar{K}^{\frac{\beta}{\alpha}}} \right) - r\bar{K} \right]^{a_2} - R \quad (A.4.3)$$

We take the derivative of Equation (A.4.3) by  $Q$ , and the maximum value of the Nash Product Curve can be obtained at  $\frac{\partial S}{\partial Q} = 0$ . Therefore,

$$ma_1 (P_1 Q - wL - r\bar{K}) (PQ - wL - r\bar{K}) + na_1 \left( P_1 Q - \frac{1}{\alpha} wL \right) (PQ - wL - r\bar{K}) + a_2 (P_1 Q - wL - r\bar{K}) \left( PQ - \frac{1}{\alpha} wL \right) = 0 \quad (A.4.4)$$

We plug Equation (A.4.2) into Equation (A.4.4) and obtain:

$$a_2 (P_1 Q - wL - r\bar{K}) \left( PQ - \frac{1}{\alpha} wL \right) = 0$$

We also know that at the equilibrium market price,  $P_1 Q - wL - r\bar{K} = 0$

$$\text{Hence, } PQ - \frac{1}{\alpha} wL = 0 \quad (A.4.5)$$

## Appendix B

### B.1. Proof of Lemma 3

In Fig. B.1,  $Q_0$  and  $Q'_0$  are optimal outputs before and after the mixed-ownership reform, respectively;  $Q_p$  is the optimal output with policy burdens;  $Q_k$  is the optimal output at FORIP;  $L_0$  and  $L'_0$  are the optimal labor inputs by SOEs before and after the mixed-ownership reform, respectively;  $L_k$  is the optimal labor input at FORIP;  $L_p$  is excessive labor employment imposed on SOEs by the state.

Before the mixed-ownership reform, the optimal labor input  $L_0$  is bigger than the optimal labor input  $L_k$  at the FORIP. The optimal labor input  $L'_0$  after the reform is smaller than the optimal labor input  $L_k$  at FORIP. Two MNPCs move in opposite directions because one is a quadratic function (after the mixed-ownership reform), and the other a linear function with a gradient of  $(m + \frac{n}{\alpha})w$ .

Fig. B.2 illustrates that before the reform the optimal labor input  $L_0$  is bigger than the optimal labor input  $L_k$  at the FORIP. The optimal labor input  $L'_0$  after the reform is bigger than the optimal labor input  $L_k$  at FORIP.

$Q_0$  and  $Q'_0$  are the optimal outputs before and after the mixed-ownership reform, respectively;  $Q_p$  is the optimal output with social policy burdens;  $Q_k$  is the optimal output at FORIP;  $L_0$  and  $L'_0$  are the optimal labor inputs before and after the reform, respectively;  $L_k$  is the optimal labor input at FORIP;  $L_p$  is the excessive state-imposed labor employment.

Fig. B.3 shows that before a mixed-ownership reform the optimal labor input  $L_0$  is smaller than the optimal output  $L_k$  at FORIP.

The optimal labor input  $L'_0$  after the reform is smaller than the optimal labor input  $L_k$  at FORIP. All labels are the same as in Fig. B.2.

## Appendix C

### C.1. Proof of Lemma 4

Let  $TR = PQ$ ,  $cs = \frac{1}{2}[P(0) - P]Q$ ,  $ps = TR - C = PQ - wL - r\bar{K}$ , plug into Eq. (4), and we obtain:

$$S = \left\{ \frac{1}{2}[p(0) - p]Q + pQ - wL - r\bar{K} \right\}^{a_1} (pQ - wL - r\bar{K})^{a_2} - R \quad (C.1.1)$$

As  $P_1 = \frac{1}{2}[P(0) + P]$ , we obtain  $L = \left( \frac{Q^{\frac{1}{\alpha}}}{\bar{K}^{\frac{\beta}{\alpha}}} \right)$ , then,

$$S = \left[ P_1 Q - w \left( \frac{Q^{\frac{1}{\alpha}}}{\bar{K}^{\frac{\beta}{\alpha}}} \right) - r\bar{K} \right]^{a_1} \left[ PQ - w \left( \frac{Q^{\frac{1}{\alpha}}}{\bar{K}^{\frac{\beta}{\alpha}}} \right) - r\bar{K} \right]^{a_2} - R \quad (C.1.2)$$

If we take derivative of Equation (C.2) by  $Q$ , the MNPC Equation can be obtained if  $\frac{\partial S}{\partial Q} = 0$ . Hence,

$$a_1 (PQ - wL - r\bar{K}) \left( P_1 Q - \frac{1}{\alpha} wL \right) + a_2 (P_1 Q - wL - r\bar{K}) \left( PQ - \frac{1}{\alpha} wL \right) = 0 \quad (C.1.3)$$

Equation (C.3) represents the MNPC Equation. If we plug Equation (D.3) into Equation (A.4.1), we obtain,

$$a_1 (P_1 Q - wL - r\bar{K}) (PQ - wL - r\bar{K}) + a_2 (P_1 Q - wL - r\bar{K}) \left( PQ - \frac{1}{\alpha} wL \right) = 0 \quad (C.1.4)$$

According to Equations (C.3) and (C.4), the intersectional point is at  $L'_k = \frac{\alpha}{1-\alpha} \frac{r\bar{K}}{w}$ ,  $Q'_k = \frac{r\bar{K}}{(1-\alpha)P}$ . When  $Q = 0$ , plug into Equation (C.4), and this quadratic function intersects with the L axis at  $L_1 = 0, L_2 = -\frac{r\bar{K}}{w}$ .

Moreover, when  $L = 0$ , and is plugged into Equation (C.4), this quadratic curve intersects with the Q axis at  $Q'_1 = 0, Q'_2 = \frac{a_1 p_1 + a_2 p}{p_1} \frac{r\bar{K}}{p_1}$ , and  $Q'_2 < Q_2$ .

**Appendix D. Proof of Proposition 8**

Plug  $L'_k, Q'_k$  into production function to obtain  $\bar{K}'$ . Plug  $L'_k = \frac{\alpha}{1-\alpha} \frac{r\bar{K}}{w}$ ,  $Q'_k = \frac{r\bar{K}}{(1-\alpha)w}$  into  $Q = L^\alpha \bar{K}^\beta$  to obtain,

$$\bar{K}'^{\alpha+\beta-1} = \frac{r}{(1-\alpha)P} \left(\frac{1-\alpha}{\alpha}\right)^\alpha \left(\frac{w}{r}\right)^\alpha \tag{D.1.1}$$

$$\bar{K}' = \left[\frac{r}{(1-\alpha)P}\right]^{\frac{1}{\alpha+\beta-1}} \left(\frac{1-\alpha}{\alpha}\right)^{\frac{\alpha}{\alpha+\beta-1}} \left(\frac{w}{r}\right)^{\frac{\alpha}{\alpha+\beta-1}} \tag{D.1.2}$$

Equation (D.1) indicates that when SOEs have increasing or decreasing return to scale,  $\alpha + \beta \neq 1$ , and when the initial capital satisfies Equation (D.2), production function interests FORIP. SOEs will produce at the Coase Point ( $L'_k, Q'_k$ ).

If SOEs have constant return to scale,  $\alpha + \beta = 1$ , and if the following is satisfied:

$$w = \frac{\alpha^2}{\beta} \left(\frac{\beta p}{r}\right)^{\frac{1}{\alpha}} \tag{D.1.3}$$

SOEs will always produce at CPRP ( $L'_k, Q'_k$ ), regardless of the initial capital.

Equation (D.3) also indicates that the amount of labor input can be determined when  $P, r, \alpha$  remain unchanged. Regardless of the capital, SOEs will always produce at ( $L'_k, Q'_k$ ). The output  $Q_k$  still depends on the amount of capital.

Letter of Statement My Coauthors and myself declare that this paper has no conflict of the interests with any third party

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