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Causes, effects, and prevention of agent corruption in Chinese SOEs†

DAPENG CAI* & JIE LI**

Abstract: This article analyzes agent corruption in a state-owned enterprise (SOE) in a duopoly model, in which an SOE competes with a private enterprise. The manager of the SOE contemplates to embezzle, and is caught and subject to punishment at a probability. The comparative statics of the compensation to the manager, the legal loopholes in the SOE, the unit transaction cost of corruption, and the government's concern for employment are examined, and their effects on outputs, social welfare and the value of the government's objective function are considered. The conditions under which corruption may be socially good are also presented.

Keywords: Agent corruption; Information asymmetry; State-owned enterprises (SOEs); Transitional economy

JEL classification code: P20; L32; L13

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1. Introduction

The severest problem encountered during the state-owned enterprise (SOE) reform in China has been increasingly pervasive corruption by SOE managers, especially in large- and medium-sized SOEs. As more and more Chinese SOEs start to meet their massive capital demands by accessing global capital markets, corruption in SOEs is an issue of abundant political and economic implications not only to China, but also to the global economy.[1] In this article, we intend to examine the causes, consequences and the prevention of corruption in SOEs, from the perspectives of both a social planner that aims at maximizing social welfare and a government that is pressured to provide employment opportunities.

Corruption, defined as illegitimate use of public office for private gains, has been more rampant and endemic in transitional economies due to the withdrawal or absence of government authority, economic collapse and political instability, underdeveloped legislature and legal loopholes, inefficiency of state institutions, and weakly established civil society, democratic political traditions, and judiciary (He, 2000; Levin and Satarov, 2000). There has been a proliferation of literature on corruption in transitional economies.[2] Corruption in transitional economies can be roughly classified into the following types: The administrative monopoly, the state capture, influence, and the administrative corruption (Abed and Davoodi, 2000; Hellman et al., 2000; Guo and Hu, 2004). The first three are "grand" corruption, in that they capture the situation in which the formation of legislation and ordinances, or public policies is influenced through bribes to public officials.[3] Undervalued sales of SOEs by managers and officials to friends and family belong to this category. On the other hand, the administrative corruption is rather "petty," as it denotes the situation in which public officials extract dirty money from the abuse of their daily discretionary power. The agent corruption we consider in this paper belongs to this category: The managers of SOEs, being agents dispatched by the government, corrupt in the forms of the embezzlement of the firms' assets, or kickbacks in procurement.

It has long been suggested in the literature that corruption could conceivably be

[1] According to China Securities Regulatory Commission, by December 2005, there are 100 Chinese firms listed in Hong Kong Stock Exchange, 12 jointly in US and Hong Kong Stock Exchange, 5 jointly in London and Hong Kong Stock Exchange, and 2 in Singapore Stock Exchange (www.csrc.gov.cn). With a few exceptions, Chinese firms listed overseas are all SOEs.

[2] He (2000), Nakagane (2003), and Guo and Hu (2004) contain good reviews of the literature.

[3] Recent theoretical analyses on the grand corruption include Ventelou (2002) and Damania et al. (2004). Ventelou (2002) incorporates the grand corruption into the analysis of economic growth, whereas Damania et al. (2004) considers the persistence of corruption in a model in which a firm seeks to evade regulation through either bribery or lobbying.

socially good (Leff, 1964; Huntington, 1968).[4] However, the vast empirical studies in the literature seem to confirm that corruption damages economic development, reduces social welfare, and induces social polarization (Treisman, 2000; Hu and Guo, 2001; Vinod, 2003).[5] The fact that China has been able to grow fast while being ranked among the most corrupt countries then appears to be an apparent paradox, leading Svensson to ask "Is corruption less harmful in China?" in his survey article on corruption (Svensson, 2005). Corruption may take a variety of different forms, and there is no reason to believe that similar types of corruption may exert equal impact on the economy.[6] In this paper, we focus on agent corruption in SOEs, and examine its effects and prevention in the Chinese context. Questions we intend to address include: Will the Leff-Huntington hypothesis that agent corruption may be socially good be espoused when it is "costly," in the sense that it is accompanied by a transaction cost and a penalty? And if so, under what conditions? Moreover, do higher salaries for managers reduce corruption? We also consider the impacts of corruption from the perspective of a government like that of China, whose objective differs substantially from that of a social planner as it tends to value employment opportunities. Will such a government tend to prefer a different level of law enforcement to fight corruption than that of a social planner? How will such difference, if it ever exists, affect social welfare? Furthermore, we also investigate the effects of the anti-corruption measures on both government payoffs and social welfare and ponder their implications for the prevention of corruption.

There has been a sizeable theoretical literature on corruption using game-theoretic, imperfect information and principal-agent models (see, for example, Klitgaard, 1988; Laffont and Tirole, 1991; Murphy et al., 1991; Mauro, 1995; Laffont and N'Guessan, 1999; Fisman, 2001; Polinsky and Shavell, 2001; Rauch, 2001; Celetani and Ganuza, 2002; Li, Smyth, and Yao, 2005). The literature mainly characterizes the cases of grand corruption, in which a bribe is contributed to change the rules of the game. This paper expands the literature by applying a game-theoretic duopoly competition model to address the effects of the petty corruption by examining the agent corruption in Chinese SOEs. Specifically, we consider a duopolistic market, in which an SOE coexist with a

[4] Leff (1964) stresses the grease effect of corruption and argues corruption can be socially good as it may improve efficiency. Hunington (1968) also maintains similar views and argues that corruption may surmount obstacles that hamper economic expansion. The grease effect is later verified by Lui (1985) with a queuing model of bribery. However, as Myrdal (1968) argues, corruption may instead lead to more inefficiency. Klochko and Ordeshook (2003) also show that corruption may lead to under-investment.

[5] There has been a vast empirical literature that contemplates to test the Leff-Huntington hypothesis. The hypothesis has been largely reputed at the micro level, however, the marco evidence seems to be inconclusive (thorough reviews of the empirical studies can be found in Davoodi, 2001; Nakagane, 2003; and Svensson, 2005).

[6] There is a surging literature that considers various aspects of corrtuption in the Chinese context (see, for example, Liew, 1993; Manion, 1996; Yao, 1997; Chen, 2004; Chow, 2005; Li, Smyth, and Yao, 2005).

private firm, where the manager of the SOE has the opportunity to embezzle. We examine a two-stage model, where in the first stage the government or the social planner chooses the appropriate level of anti-corruption measures to maximize its own payoff. In the second stage, the SOE competes against a private firm in the product market, *á la* Cournot. While the private firm is a pure profit maximizer, the manager of the SOE maximizes her expected illicit gains. We find that at least under our formulation of the model, under certain conditions, the Leff-Huntington hypothesis that corruption may increase social welfare is espoused even when it is "costly." This is so as corruption generates a pro-competitive effect that induces the SOEs to increase production, which partially corrects the oligopoly distortion. When the pro-competitive effect dominates the deadweight loss associated with the transaction cost, corruption is socially good, and vice versa. Moreover, a government under the pressure to provide employment opportunities tends to prefer a different level of law enforcement from that of a social planner, with the difference of the two depends on a comparison between the exaggerated average cost of SOE and the sum of the employment effect and the marginal transaction costs of corruption. Finally, we also present the comparative static effects of changes in the parameters on social welfare and the government's payoff.

The rest of the article is organized as follows. In the next section, we first provide a brief background of the agent corruption in Chinese SOEs. In Section 3, we set up the basic model. In Section 4, we characterize the comparative static properties of the model. In Section 5, we examine the government's and the social planner's optimal levels of law enforcement and their impacts on social welfare. Our concluding remarks are given in Section 6, in which we ponder the implications of our findings for China's crusade against corruption. The proofs of our results are collected in Appendix.

2. The SOE reform and the agent corruption in SOEs

Our model formulation intends to capture the following features of the contemporary Chinese economy: First, after a series of reform, SOEs emerge as profit-maximizing enterprises with modern corporate governance; second, corruption by SOE managers are pervasive as there lacks sufficient supervision over their discretionary power, due to the *de facto* none-existence of principals; third, the prevalent market structure may be an oligopoly in which state firms and private ones compete with each other; and fourth, the government may confront an employment pressure.

2.1 *The SOE reform*

The reform of the state-owned enterprises (SOEs) has been at the core of social agendas in China. Under the previous central planning system, the industrial sector was dominated by SOEs, which served mainly as cost centers to fulfill government-specified production quotas and to provide lifelong employment. The aim of the initial reforms was to "revitalize" SOEs through decentralization, improvement of internal managerial and incentive systems, and introduction of market competition, with the aim to transform SOEs to economic units responsible for profit targets (Wu, 1999). Starting from the mid-1990s, through a policy termed *zhuada fangxiao*, or "retain control of the large and let loose of the small," small and medium-sized SOEs were transformed into largely private share-holding companies and the shares were sold to the management, staff, and workers of the enterprises, whereas large enterprises were restructured into limited liability companies or joint stock companies in which the shares are mostly held by government organizations. The "successful" large enterprises are listed in stock markets, with the corporate governance within which closely resembles that of their western counterparts. The shareholder conference, the board of directors, and the board of supervisors have been introduced as new governance structures into SOEs.[7]

Meanwhile, the heavy ideological and social burdens once shouldered under the previous central planning system have been gradually peeled off from the SOEs through the implementation of a policy termed *xiagang fenliu*, or "rearrange layoffs." Together with the reform measures such as bankruptcies, sales, and acquisitions and mergers, remaining SOEs are increasingly like free market players, with the ratio of profit-making SOEs improving over the years.[8]

Despite intensive reforms, SOEs are still intrinsically different from private enterprises (Zhang, 1999; Zhou and Wang, 2000; Garnaut, et al, 2005). First, the incentive system within SOEs to reward managerial achievements remains to be largely inflexible and insufficient. Although the managers' incomes have been linked to the performance of the firms, they are still at relatively low levels as compared to those with similar positions in private enterprises. Moreover, to SOEs, the principal is virtually none-existent. As noted in Zhou and Wang (2000), the principal is the government that represents people, but there lacks sufficient incentives for the government to ensure that

[7] Chow (2005) points out that good corporate governance "may be good on paper, but it may not govern actual behavior," and as exemplified by the Enron case, "smart managers and accountants can cook the books even in the US."

[8] Although SOEs' performance is still in inferiority as compared with those of foreign funded and private enterprises. SOEs' rate of return on net fixed assets is 12% in 2004, whereas the same index is 21.9% to foreign funded enterprises and 15.8% to all large and medium sized enterprises, the ratio of loss-suffering enterprises to all state-owned and state-controlled industrial enterprises was 41.5% in 1998, which declined to 35.0% in 2004 (2005 China Statistical Yearbook).

SOEs pursue profit maximization. The property rights of SOEs remain largely ambiguous and under state-dominance, and the control rights rest with bureaucrats who have only an indirect interest in profit (World Bank, 1992; Schleifer and Vishny, 1997; Zhang, 1997; Zhang, et al., 2002).

On the other hand, managers, being agents appointed by the government to be in charge of daily management, have considerable discretionary power. According to a survey conduced by Garnaut, et al. (2005), managers are placed in strong positions in the new governance structures: "Not only was the firm's manager often the board chairman, but, on the average, the top management took 53 percent of the seats on the board and the middle management took another 17 percent" (p. 122). Moreover, "the manager played the most important role in decisions related to employment and the daily operation of the firm" (p. 134).

2.2 *Agent corruption in SOEs*

It has been widely argued that corruption in SOEs originated from the aforementioned characteristic structure of SOEs. Under the previous central planning system, the managers' main task was the management of the production process. As both the procurement of raw materials and the sales of outputs were taken care of by the government via means of orders, there is little room for them to embezzle.[9] Contemporary Chinese SOEs, however, have a relatively high degree of autonomy to participate in the market process. As independent accounting, auditing, and property evaluation institutions are still underdevelopment in China, there is a high moral hazard that agents may take advantage of the information asymmetry by abusing their discretionary power for personal benefits by for example, entering into contracts that maximizes their personal interests (Lin, et al., 2002). These factors have combined to aggravate corruption in SOEs, and have transformed SOEs into "corruption centers." In March 2005, in his annual work report delivered to the China's National People's Congress, China's top prosecutor of Supreme People's Procuratorate reported that during 2004, cases involving SOEs' managers account for 41.5% of all cases of corruption under investigation, exemplifying the graveness of corruption in Chinese

[9] As noted in Chow (2005), corruption does not exist in the initial stage of the reform, the introduction of the "responsibility system," as the responsibility system is essentially a leasing arrangement and there is no principle-agent problem. The privatization of small and medium sized SOEs also leads to no corruption as by definition, "a manager of a private enterprise cannot be called corrupt if he takes his own money" (Chow, 2005, p.13). In the reform of the large and medium-sized SOEs, however, the problem of agent corruption emerges as there exists opportunities for corruption in the institutional framework.

SOEs (Supreme People's Procuratorate of China, www.spp.gov.cn).[10]

Common practices of agent corruption include *zuo jiazhang*, or "cook the books," in which the manager directly embezzles resources from SOEs by either overstating the costs of raw materials or under-reporting the sales revenue in accounting documents; and *chi huikou*, or "acquire kickbacks or bribes in public biddings, procurement, or sales," in which the manager colludes with the bidders, suppliers, or buyers, to enter into contracts that are unfavorable to the firm (for example, overpricing the costs of the raw materials or under-pricing the firm's products). A portion of the price differences is later (or beforehand) remitted back to the manager's private accounts by the accomplices.[11] Arguably, these types of misuse of corporate assets by managers can also be spotted in private firms, however, reflecting an underlying institutional framework aforementioned, they are routine in SOEs. Hence, the objective of the managers of SOEs may be different from those of the government and the private enterprises: Rather than profits, the managers value the public assets that can be embezzled, as well as the size of the sales volume, which contributes to the increment of her embezzlement revenue.

2.3 *Market structure in China*

Private-owned firms have emerged to serve the deregulated domestic markets, and have experienced rapid growth for the past two decades. By the end of 2004, only 35.2% of the gross national industrial value was produced by the state-owned and state-controlled enterprises, whereas the rest are attributable to the private sector (2005 China Statistical Yearbook).

2.4 *Chinese government's concern for employment*

The employment pressure has been particularly striking in China due to its huge population, abundant labor resources, and economic restructuring. Research conducted by the RAND Corporation shows that when taken into account of the "disguised" rural unemployment and the "unregistered" urban unemployment, China's actual unemployment rate is estimated to be as high as 23% of the total labor force (Wolf, 2004). For political and social as well as economic reasons maintaining a high rate of

[10] China's national ranks in the annual corruption perceptions index, issued by Transparency International, have also been declining steadily from 58 in 2001 to 78 in 2005 (www.transparency.org).

[11] It may also be provided to the managers or their relatives in other forms of favors such as free trips or meals.

job creation is no less important than achieving a high rate of economic growth (Wolf, 2004). According to the Ministry of Labor and Social Security, Chinese government regards generating ample employment opportunities as a major strategic task in economic and social development, and controlling the rate of unemployment as a main target in macro-economic regulation and control (Ministry of Labor and Social Security, www.molss.gov.cn).

On the other hand, as a result of the SOE reform, SOEs' ability to assimilate employment has diminished dramatically. By the end of 2004, a large portion of the employment positions were provided by the private sector, for example, in the mining, manufacturing, and electricity industries, SOEs employees only account for 32.2% of the labor employed (2005 China Statistical Yearbook).

3. The model formulation

The market we consider consists of an SOE and a private firm, both produce a homogenous product with output being Q_1 and Q_2, respectively. The market's inverse demand function is given by $P(Q)$, where $Q = Q_1 + Q_2$ and $P'(Q) < 0$. We assume that the real marginal cost of both the SOE and the private firm to be zero so as to exclude the effects of the discrepancy of productive efficiency on corruption. We consider the case in which an SOE's manager contemplates to embezzle the SOE's assets by exaggerating the average cost of production.

The reform on SOEs has so far succeeded in introducing into SOEs a management compensation scheme that consists of both a basic salary and a performance-based bonus.[12] As aforementioned, due to a lack of sufficient incentives to monitor management performance and a shortage of information on the SOE's daily operation, the government's supervision is inadequate and the SOE managers can easily allocate the firm's internal assets according to their own interests. As incentive contracts only work when there are "measurable targets used and performance information is easily available, corruption occurs even in their presence (World Bank, 1997, p. 55)." Hence, as argued in Zhang (1999) and Wen (2004), the real income and other benefits of the SOEs' managers come from three sources: First, a fixed basic salary; second, *ticheng*, or "a bonus that is a proportion, t $(0 < t < 1)$, of the accounting profit;" and finally, an exaggeration of average cost by γ $(\gamma > 0)$. Here *ticheng* represents an incentive contract that is used to induce the managers to focus on profits, whereas γ is the ratio of

[12] As noted in Garnaut, et al. (2005), legal and regulatory barriers to the introduction of modern compensation mechanisms still persist. For instance, there is no juridical basis for the issuance of share options to the managers.

embezzlement to the accounting profit. We assume that the manager embezzles to the maximum extent possible, so γ also represents the magnitude of legal loopholes within the SOE. To simplify the analysis, we normalized the fixed salary income into zero. Hence, the manager's income is $t(PQ_1 - \gamma Q_1) + \gamma Q_1$, with $t(PQ_1 - \gamma Q_1)$ denotes her legal income and γQ_1 her illicit income.

In reality, due to its secretive and uncertain nature, corruption can be costly as the embezzlement of public assets always mandates lobbying, bribing, and in many cases, money laundering. We assume such transaction costs are proportional to the manager's illicit income and equal $\tau\gamma Q_1$, where τ is a constant that measures the unit transaction cost. These transaction costs generate a deadweight loss for the whole society, as they are often simply squandered, or like the money laundering case, paid to foreign brokers. Finally, on the basis of Martin and Panagariya (1984) and Klittgaard (1988), there exists a risk for the managers of SOEs to be caught and subject to punishment, captured as the probability of being caught α ($0 \le \alpha \le 1$) and the associated punishment is represented by a twice continuously differentiable function $\varphi(\gamma Q_1)$, with $\varphi'(\cdot) > 0$, $\varphi''(\cdot) > 0$ and $\varphi(0) = 0$. The punishment function $\varphi(\cdot)$, being an increasing convex function of the amount embezzled, can be any combination of confiscation and imprisonment. Furthermore, to ensure that the manager of the SOE does not corrupt when $\alpha = 1$, we impose the following assumption: $\varphi(x) > (1-\tau)x$, which is equivalent to assume that the net illicit income of the SOE's manager is smaller than the punishment, in the case when corruption is detected at possibility 1. On the other hand, we assume that $t < 1-\tau$, i.e., the incentive system within SOEs to reward managerial achievements remains to be largely insufficient, and the manager of the SOE has a strong incentive to corrupt when $\alpha = 0$. The objective function of the manager in SOE is then specified as follows:

$$S_1 = (1-\alpha)[t(PQ_1 - \gamma Q_1) + \gamma Q_1] + \alpha[t(PQ_1 - \gamma Q_1) + \gamma Q_1 - \varphi(\gamma Q_1)] - \tau\gamma Q_1, \qquad (1)$$

which can be simplified as

$$S_1 = t(PQ_1 - \gamma Q_1) + \gamma Q_1 - \alpha\varphi(\gamma Q_1) - \tau\gamma Q_1. \qquad (1')$$

It should be noted that when $\gamma = 0$ or $\alpha = 1$, equation (1') is reduced to $S_1 = tPQ_1$, which implies that the objective of the SOE's manager is equivalent to that of a profit maximizer. This formulation of the SOEs's objective function differs substantially from those in the literature of mixed oligopoly markets, in which SOEs also taken into account government's concerns, such as employment pressure.[13] We argue that after the intensive SOE reform, especially reform like "corporatization," SOEs have been restructured to profit-maximizing limited liability companies or joint stock companies

[13] Sun, et al. (2005) contains a good reference to the literatures concerning mixed oligopolies.

that have internal organizations closely resembles those of their western counterparts.[14] However, due to a lack of the principal and insufficient supervision over the managers' discretionary power, they do retain a salient feature of abundant legal loopholes that the managers can take advantage of. More precisely, we argue that modern Chinese SOEs, especially large- and medium-sized ones, are better labeled as "distorted" profit-maximizing firms, distorted by the manager's routine corruption.

On the other hand, the private firm simply maximizes its profit,

$$\pi_2(Q_1, Q_2) = PQ_2. \tag{2}$$

As usual, the social welfare function W, defined as the sum of producer surplus (the real profits of the two firms) and consumer surplus, is used to measure the economic efficiency of the whole society. Managers' corruption incurs a transaction cost, which is a deadweight loss to the society. The social planner takes into account such a loss, and the social welfare is defined as

$$W(Q_1, Q_2) = \pi_1 + \pi_2 + CS - \tau\gamma Q_1 = \int_0^{Q_1+Q_2} P dq - \tau\gamma Q_1 .\text{[15]} \tag{3}$$

However, the governments in transitional economies may not be social-welfare maximizers as they are pressured by heavy employment burden. To reflect the government's concern for employment, we incorporate the total output of the SOE and the private firm as an argument into the government's objective function, denoted by $\theta(Q_1 + Q_2)$, where θ $(0 \le \theta \le 1)$ is a constant that measures the degree of employment pressure.[16] Furthermore, we assume that when the government determines the optimal level of law enforcement, she also cares about the nominal social welfare. Moreover, since the transaction costs of corruption is less visible and is not explicitly promulgated by the government, we excluded such a cost from the government's objective function. Hence, the government's payoff has as arguments the nominal social surplus, as well as total output of the SOE and the private firm. It equals the sum of the SOE's reported nominal profit, $PQ_1 - \gamma Q_1$, the private firm's profit, PQ_2, consumer surplus, $\int_0^{Q_1+Q_2} P dq - P(Q_1 + Q_2)$, and the employment pressure, $\theta(Q_1 + Q_2)$, i.e.,

[14] As aforementioned, the reform has separated SOEs from the governmental bureaucracy and reorganized them into private capitalist corporations. Recognizing this transformation, the 8th National People's Congress (1993) changed the appellation used to describe SOEs from *guoying qiye*, or "state-run enterprises" to *guoyou qiye*, or "state-owned enterprises." During the report delivered by former Prime Minister LI Peng to that congress, the objective of the reform on SOE has been proclaimed to be "transforming SOEs into self-managed, self-developing, and self-restrictive market players responsible for both profits and losses."

[15] Here $\pi_1 = PQ_1$ is the real profit of the SOE.

[16] In our model formulation, to better reflect the fact that in China, private sector has becoming increasingly important in absorbing labors, the government takes into account of the whole output. This differs from the government's objective specified in Sun, et al. (2005), which uses the SOE's output to denote the government's concern for employment. Moreover, it is assumed that in the industry under consideration, the employment opportunities are increasing in the total output.

$$G(Q_1,Q_2) = \int_0^{Q_1+Q_2} P dq - \gamma Q_1 + \theta(Q_1+Q_2). \quad (4)$$

We consider a two-stage game among the government, the SOE and the private firm: In the first stage, the government chooses α (at no cost) to maximize its own payoff; whereas in the second stage, the two firms engage in quantity competition, *á la* Cournot, by choosing their outputs, respectively.[17]

Let us first analyze the second stage of the game, taken as given the level of law enforcement, α. Firms simultaneously choose their outputs to maximize their payoffs. The Cournot equilibrium is determined by the following first-order conditions,

$$\underbrace{t(P'Q_1 + P - \gamma)}_{\text{Marginal Legal Income}} + \underbrace{(1-\tau)\gamma}_{\text{Net Marginal Illicit Income}} \underbrace{-\alpha\gamma\varphi'(\gamma Q_1)}_{\text{Expected Marginal Punishment}} = 0, \quad (5)$$[18]

$$P'Q_2 + P = 0, \quad (6)$$

and the second-order conditions $\partial^2 S_1/\partial Q_1^2 < 0$ and $\partial^2 \pi_2/\partial Q_2^2 < 0$. We assume that the stable equilibrium condition is satisfied, i.e., $\Delta \equiv \begin{vmatrix} \partial^2 S_1/\partial Q_1^2 & \partial^2 S_1/\partial Q_1 \partial Q_2 \\ \partial^2 \pi_2/\partial Q_2 \partial Q_1 & \partial^2 \pi_2/\partial Q_2^2 \end{vmatrix} > 0$. Equations (5) and (6) implicitly define the reaction functions for the SOE and private firms, denoted by $R_1(Q_2)$ and $R_2(Q_1)$:

$$R_1(Q_2) \equiv \arg\max_{Q_1 \geq 0} S_1(Q_1,Q_2;\alpha,\gamma,t,\tau), \quad R_2(Q_1) \equiv \arg\max_{Q_2 \geq 0} \pi_2(Q_1,Q_2;\alpha,\gamma,t,\tau).$$

As is common in the literature (see, for example, Dixit, 1986), the outputs of the two firms are assumed to be "strategic substitutes," i.e., one firm's marginal revenue declines when the output of the other firm rises, which is equivalent to the holding of the following two inequalities

$$P' + P''Q_2 < 0, \quad P' + P''Q_1 < 0, \quad (7)$$

for $0 < \alpha < 1$ and $0 < t < 1$. Condition (7) ensures that the slope of each firm's reaction function is negative, i.e., $R_i'(Q_j) < 0$ and $|R_i'(Q_j)| < 1$, here $i = 1,2$, and $j = 1,2$. For example,

[17] As in Martin and Panagariya (1984), the "costless law enforcement" can be interpreted in two ways. Either "the machinery for law enforcement already exists, and all that is required to make enforcement more vigorous is a decision by the authorities to *'get tough'*", or, it is the result of a "technological improvement in the enforcement activity" (Martin and Panagariya 1984, pp. 210-211).

[18] Under our formulation of the model, the book profit of the SOE is positive when $P > \gamma$, and negative when $P < \gamma$. From equation (5), it is easy to see that depending on the values of t, τ, α, and $\varphi(\cdot)$, it is possible for the manager to embezzle to a certain extent even when the book profit is negative. It should be noted that under such a circumstance, the first term of equation (5) is negative, which implies that the manager has to shoulder part of the nominal loss of the SOE. However, in reality, although the managers are rewarded for their successes, they are not credibly punished for their failures, and normally, when $P < \gamma$, t equals zero.

$$-1 < R_2^{'}(Q_1) = -\frac{P^{'} + P^{''}Q_2}{2P^{'} + P^{''}Q_2} < 0\,, \tag{8}$$

as $2P^{'} + P^{''}Q_2 < 0$ by the second-order condition, and $P^{'} + P^{''}Q_2 < 0$ by (7).

4. A comparative static analysis

We first consider the condition under which the manager corrupts.

Lemma 1. *Given the* ticheng, t*, the legal loopholes in SOE,* γ*, the unit transaction cost,* τ*, and the punishment function,* $\varphi(\cdot)$*, there exists some* $\alpha^* \in (0,1)$ *such that the manager of the SOE embezzles when* $\alpha < \alpha^*$*; otherwise, she chooses not to corrupt.*

Lemma 1 shows that under certain circumstances, corruption indeed occurs under our model formulation. To make the analysis more interesting, in what follows, we restrict our focus to the case in which corruption occurs, i.e., $\alpha < \alpha^*$. Based on the first order conditions specified by equations (5) and (6), we first consider the comparative static effects of a change in the probability of detection, α, on the equilibrium outputs, denoted $E_1(\alpha)$ and $E_2(\alpha)$, and the price, which are summarized as Proposition 1:

Proposition 1. *An increase in the probability of detection decreases the SOE's output, increases the private firm's output, but nevertheless decreases total output and, hence, increases price. Formally,* $\frac{\partial E_1}{\partial \alpha} < 0$, $\frac{\partial E_2}{\partial \alpha} > 0$, $\frac{\partial (E_1 + E_2)}{\partial \alpha} < 0$*, and* $\frac{\partial P}{\partial \alpha} > 0$.

There is a straightforward interpretation to Proposition 1. From the first order condition (5), we see that a decline in α generates a positive effect on the manager's payoff as it reduces her expected marginal punishment. Output should then rise to restore the equilibrium. Given that the firms' products are strategic substitutes, such a commitment would induce a decrease in the private firm's output. However, as $|dR_2 / dQ_1| = |R_2^{'}(Q_1)| < 1$, the output decrease of the private firm is smaller than the output increase of the state firm, thus leading to a rise in total output, and hence, a decline in price. As augmented output intensifies competition and partially corrects the distortions that accompany the duopoly market structure, it is not surprising to see that the manager's corruption generates a pro-competitive effect, or more specifically, a rise in consumer surplus.

The effect of law enforcement level on output has important implications for the equilibrium book profit of the SOE, π_1^*, as the well-being of the SOE's employees is positively correlated to the book profit. Specifically, we have:

$$\frac{\partial \pi_1^*}{\partial \alpha} = \frac{\partial[(P-\gamma)E_1]}{\partial \alpha} = \frac{\partial P}{\partial \alpha}E_1 + (P-\gamma)\frac{\partial E_1}{\partial \alpha}.$$

From Proposition 1, we see that $\frac{\partial P}{\partial \alpha}E_1 > 0$, whereas $\text{sign}[(P-\gamma)\frac{\partial E_1}{\partial \alpha}]$ depends on $\text{sign}(P-\gamma)$. If $P-\gamma<0$, $\frac{\partial \pi_1^*}{\partial \alpha} > 0$; otherwise, $\text{sign}(\frac{\partial \pi_1^*}{\partial \alpha})$ is ambiguous. When $P-\gamma<0$, the book profit of the SOE is negative, and a severer law enforcement level improves the well-being of the SOE employees. On the other hand, when the book profit of the SOE is positive, the effect of a severer law enforcement level on the welfare of the SOE's employees remains ambiguous. Moreover, the effect of severer law enforcement level on the profit of the private firm is quite straightforward. From Proposition 1, $\frac{\partial \pi_2^*}{\partial \alpha} = \frac{\partial P}{\partial \alpha}E_2 + P\frac{\partial E_2}{\partial \alpha} > 0$, i.e., a stricter law enforcement level is beneficial to the private firm, as both the price and her output increase as a result. The above findings can be summarized as the following corollary:

Corollary 1. *A stricter level of law enforcement benefits the employees of the loss-suffering SOEs and private firms, whereas its effect on the nominally profit-making SOEs remains ambiguous. Formally,* $\frac{\partial \pi_1^*}{\partial \alpha} > 0$ *if* $P-\gamma<0$, *otherwise, it is ambiguous;* $\frac{\partial \pi_2^*}{\partial \alpha} > 0$.

Next, we consider the comparative static effects of changes in *ticheng*, t, the abundance of legal loopholes in SOE, γ, and the unit transaction cost, τ, on the equilibrium outputs, which are given as Propositions 2, 3 and 4, respectively.

Proposition 2. *When the marginal revenue is larger than the exaggerated average cost, or when the expected marginal punishment is larger than the net marginal illicit income, a rise in* ticheng *augments the SOE's equilibrium output, decreases the private firm's output, but nevertheless increases the total output and hence, lowers price, and vice versa. Formally, when* $P'E_1 + P > \gamma$ *(or* $\alpha\gamma\varphi'(\gamma E_1) > (1-\tau)\gamma$ *),* $\frac{\partial E_1}{\partial t} > 0$, $\frac{\partial E_2}{\partial t} < 0$,

$\frac{\partial(E_1+E_2)}{\partial t}>0$, *and* $\frac{\partial P}{\partial t}<0$. *Otherwise,* $\frac{\partial E_1}{\partial t}<0$, $\frac{\partial E_2}{\partial t}>0$, $\frac{\partial(E_1+E_2)}{\partial t}<0$, *and* $\frac{\partial P}{\partial t}>0$.

Proposition 2 can be interpreted in a similar manner as Proposition 1. From the first order condition (5), we see that when the marginal revenue, $P'E_1+P$, is larger than the exaggerated average cost (which is also the marginal loss of being dishonest), γ, i.e., $P'E_1+P>\gamma$ (or $\alpha\gamma\varphi'(\gamma E_1)>(1-\tau)\gamma$), a rise in t generates a positive effect on the manager's payoff as it raises her expected marginal legal income, $t(P'E_1+P-\gamma)$. To maintain the expected payoff unchanged, SOE's output should rise to raise the expected marginal transaction cost of corruption and lower her marginal legal income. Moreover, as indicated above, the output decrease of the private firm is smaller than the output increase of the SOE, thus leading to a rise in total output, and hence, a fall in price. In sum, a rise in t also generates a pro-competitive effect as it induces a rise in consumer surplus.

One message arising from Proposition 2 is that when the marginal revenue is smaller than the exaggerated average cost, increasing t may reduce the embezzlement of the manager. This is so as given γ, the manager's embezzlement is denoted by γE_1. When E_1 decreases, the illicit income also falls.

Proposition 3. *When the sum of* ticheng, t, *and the marginal impact of the legal loopholes on the marginal punishment in the case of detection,* $\partial[\alpha\gamma\varphi(\gamma E_1)]/\partial\gamma$, *is larger than the net marginal illicit income, a rise in the availability of legal loopholes inside SOE decreases the SOE's output, increases the private firm's output, lowers the total output and hence, raises the price, and vice versa. Formally, when* $t+\partial[\alpha\gamma\varphi(\gamma E_1)]/\partial\gamma>1-\tau$, $\frac{\partial E_1}{\partial\gamma}<0$, $\frac{\partial E_2}{\partial\gamma}>0$, $\frac{\partial(E_1+E_2)}{\partial\gamma}<0$, *and* $\frac{\partial P}{\partial\gamma}>0$. *Otherwise,* $\frac{\partial E_1}{\partial\gamma}>0$, $\frac{\partial E_2}{\partial\gamma}<0$, $\frac{\partial(E_1+E_2)}{\partial\gamma}>0$, *and* $\frac{\partial P}{\partial\gamma}<0$.

Proposition 3 can be interpreted in the following manner. The first order condition (5) characterizes the state in which the manager's expected marginal revenue equals her marginal cost of corruption. When $t+\partial[\alpha\gamma\varphi(\gamma E_1)]/\partial\gamma>1-\tau$, we see that a rise in γ breaks the equilibrium and marginal illicit income is smaller than the sum of marginal legal income and expected marginal punishment. Accordingly, SOE's output has to decrease to restore the equilibrium, i.e., $\frac{\partial E_1}{\partial\gamma}<0$. The rest of Proposition 3 can be explained in a similar manner as that of Proposition 1 and 2.

Proposition 4. *An increase in the unit transaction cost contributes to a fall in SOE's output, a rise in the private firm's output, a decrease in total output, and a rise in price. Formally,* $\frac{\partial E_1}{\partial \tau} < 0$, $\frac{\partial E_2}{\partial \tau} > 0$, $\frac{\partial (E_1 + E_2)}{\partial \tau} < 0$, *and* $\frac{\partial P}{\partial \tau} > 0$.

The intuition behind Proposition 4 can be given in a similar way as that of Proposition 3 by exploring the first order condition (5).

Next, we move back to the first stage of the game and analyze the determination of the optimal levels of law enforcement chosen by the social planner and the government. We take as a benchmark a situation in which a social planner chooses the optimal level of law enforcement. Taking the second stage equilibrium outputs into account, the social planner selects an optimal α^* that maximizes her payoff $W^E(\alpha) \equiv W(E_1(\alpha), E_2(\alpha))$. With the assumption of the existence of an interior solution, i.e., $W_{\alpha\alpha} \equiv \partial^2 W / \partial \alpha^2 < 0$, some derivations lead to the following lemma:

Lemma 2. *The optimal level of law enforcement chosen by the social planner,* α_w^*, *should satisfy the following condition*

$$\underbrace{P(1+R_2')}_{\textit{Margianl Consumer Surplus Effect}} = \underbrace{\tau\gamma}_{\textit{Marginal Corruption Deadweight Loss Effect}} . \tag{9}$$

Lemma 2 shows that the social planner's optimal choice involves balancing two effects. First, there is a consumer surplus effect (the LHS of equation (9)), which represents the impact of the law enforcement level on consumers. A looser level of law enforcement generates a positive pro-competitive effect that is beneficial to the consumers. However, there is also a marginal corruption deadweight loss effect (the RHS of equation (9)), as the looser level of law enforcement also induces the manager to embezzle more, which leads to a higher level of transaction costs, and hence, more social welfare loss. Lemma 2 shows that it is optimal for the social planner to choose a level of law enforcement that equalizes these two effects.

Next, assuming the existence of an interior solution, i.e., $G_{\alpha\alpha} \equiv \partial^2 G / \partial \alpha^2 < 0$, we get the following result regarding the government's optimal choice:

Lemma 3. *The optimal level of law enforcement* α_G^* *that maximizes the government's payoff* G^E *should satisfy the following condition:*

$$\underbrace{P(1+R_2')}_{\text{Marginal Consumer Surplus Effect}} + \underbrace{\theta(1+R_2')}_{\text{Employment Effect}} = \underbrace{\gamma}_{\text{Nominal Productivity Efficiency}} . \qquad (10)$$

Lemma 3 characterizes how the government determines the optimal level of law enforcement by balancing three effects. First, like the choice of the social planner, there is a consumer surplus effect (the first term of the LHS of equation (10)). Second, there is an employment effect (the second term of the LHS equation (10)), as the government values employment opportunities. A looser level of law enforcement creates a pro-competitive effect, and the augmented output as a result implies a higher consumer surplus level and more employment opportunities. Third, there is a nominal productivity effect (the RHS of equation (10)), since the government also cares about the average cost reported by the manager. Lemma 3 shows that when choosing the optimal level of law enforcement, the government should balance in such a way that the sum of the consumer surplus effect and the employment effect exactly matches the nominal productivity of the SOE.

It should be noted that the condition listed in Lemma 2 differs substantially from that in Lemma 3. This is so precisely because of the difference in the objectives of the two: Unlike the government, the social planner does not consider the employment burden. A comparison of Lemma 2 and 3 immediately leads to the following proposition:

Proposition 5. *Whether the government prefers a severer level of law enforcement than the social planner depends on the comparison between* $(1-\tau)\gamma$ *and* $\theta(1+R_2')$, *namely, the expected marginal illicit income of the manager and the employment burden effect. When the former dominates the latter, the government prefers a severer level of law enforcement, and vice versa. Formally,* $\alpha_G^* > \alpha_W^*$ *if* $(1-\tau)\gamma > \theta(1+R_2')$ *; otherwise,* $\alpha_G^* \le \alpha_W^*$.

The mechanism behind Proposition 5 can be explained as follows. Condition $(1-\tau)\gamma > \theta(1+R_2')$ implies $P(1+R_2') - \tau\gamma > P(1+R_2') + \theta(1+R_2') - \gamma$. In such a case, applying the optimal α_G^* chosen by the government to the optimal problem of the social planner generates a positive net effect to the social planner. The maximization of social welfare mandates the social planner to loosen the level of law enforcement, until $P(1+R_2')-\tau\gamma$ reaches zero, hence $\alpha_G^* > \alpha_W^*$. As aforementioned, Chinese government confronts a heavy employment pressure. Proposition 5 thus implies that there is a possibility that the government may adopt a less severe law enforcement level than that of the social planner. In what follows, we explicitly characterize the impacts of optimal levels of law enforcement on social welfare.

5. Optimal levels of law enforcement and their impacts

In this section, we further explore the properties of the model and show how changes in *ticheng*, legal loopholes in SOEs, and the unit transaction cost affect the government's and social planner's optimal choices of law enforcement. In addition, we consider the impact on social welfare of the optimally levels of law enforcement chosen by the government and the social planner. Our discussion is based on the following linear demand function:

$$P = 1 - Q_1 - Q_2, \tag{11}$$

and the punishment function:

$$\varphi(\gamma Q_1) = \frac{1}{2}(\gamma Q_1)^2. \tag{12}$$

From first-order conditions (5) and (6), the equilibrium outputs can be calculated as $E_1(\alpha) = \frac{(1-2\gamma)t + 2(1-\tau)\gamma}{3t + 2\alpha\gamma^2}$, and $E_2(\alpha) = \frac{t(1+\gamma) + \alpha\gamma^2 - (1-\tau)\gamma}{3t + 2\alpha\gamma^2}$, respectively. The equilibrium price, on the other hand, is $P^E = \frac{t(1+\gamma) + \alpha\gamma^2 - (1-\tau)\gamma}{3t + 2\alpha\gamma^2}$.[19]

We first analyze how the government chooses her optimal level of law enforcement. Taking $E_1(\alpha)$ and $E_2(\alpha)$ into account, the government maximizes $G^E(\alpha) \equiv G(E_1(\alpha), E_2(\alpha))$, giving rise to:

$$\alpha_G^* = \frac{(5\gamma - 1 - 3\theta)t + (1-\tau)\gamma}{\gamma^2(1+2\theta)}. \tag{13}$$

On the other hand, the optimal level of law enforcement that maximizes social welfare, denoted as α_W^*, can be expressed as

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[19] In this numerical example, the critical point α^* where the manager is indifferent between corruption and being integrity is implicitly determined by the following function:

$$t[t(1-2\gamma) - \alpha\gamma^2 + (2+\tau)\gamma] + 2\alpha\gamma^3 - \frac{\alpha\gamma^2}{2}[(1-2\gamma)t + 2(1-\tau)\gamma] - \tau\gamma(3t + 2\alpha\gamma^2) = \frac{t(3t+2\alpha\gamma^2)^2}{9[(1-2\gamma)t + 2(1-\tau)\gamma]}.$$

As in Section 3, we only consider the case where $\alpha < \alpha^*$.

$$\alpha_w^* = \frac{(1+\gamma-3\tau\gamma)t-(1-\tau)\gamma}{\gamma^2(2\gamma\tau-1)}. \tag{14}$$

Next, we turn to analyze how changes in *ticheng,* the unit transaction cost and legal loopholes affect the government's and social planner's optimal choices of law enforcement. In addition, the effect of the employment pressure on government's optimal choice is also considered.

The comparative static properties of government's optimal law enforcement level can be summarized as follows:

Result 1. *Given the demand and the punishment specifications in equations (11) and (12), we have (1)* $\frac{\partial \alpha_G^*}{\partial t} > 0$ *if* $\gamma > \frac{1+3\theta}{5}$*, otherwise,* $\frac{\partial \alpha_G^*}{\partial t} \le 0$*; (2)* $\frac{\partial \alpha_G^*}{\partial \tau} < 0$*; (3)* $\frac{\partial \alpha_G^*}{\partial \gamma} > 0$ *if* $t > \frac{(1-\tau)\gamma}{2(1+3\theta)-5\gamma}$*,* $\frac{\partial \alpha_G^*}{\partial \gamma} > 0$*, otherwise,* $\frac{\partial \alpha_G^*}{\partial \gamma} < 0$*; (4)* $\frac{\partial \alpha_G^*}{\partial \theta} < 0$.

Result 1 is easy to interpret. Noting that $\gamma > \frac{1+3\theta}{5}$ implies $P'E_1 + P > \gamma$, from Proposition 2, we see that a rise in t leads to a rise in P, resulting a fall in marginal consumer surplus effect (the first term of the LHS of equation (10)). As shown in the Proof of Lemma 3, $\frac{\partial E_1}{\partial \alpha} < 0$ implies that $P(1+R_2') + \theta(1+R_2') - \gamma$ is an increasing function in α_G^*, a larger α_G^* is then mandated to restore the equilibrium. The case for $\gamma \le \frac{1+3\theta}{5}$ can be explained conversely. Similarly, from Proposition 4, we see a rise in τ increases P, which leads to a rise in marginal consumer surplus effect in equation (10), calling for a fall in α_G^* to restore the equilibrium. On the other hand, noting that $t > \frac{(1-\tau)\gamma}{2(1+3\theta)-5\gamma}$ implies $t + \partial[\alpha\gamma\varphi(\gamma E_1)]/\partial\gamma > 1-\tau$, from Proposition 3, we see that a rise in γ leads to a rise in P and results in an increase in marginal consumer surplus effect, as can been seen from equation (10), which generates a negative impact on the government's payoff, and to restore the equilibrium, the government is forced to strengthen the law enforcement. The case for $t \le \frac{(1-\tau)\gamma}{2(1+3\theta)-5\gamma}$ can be explained in an opposite manner. In addition, a rise in θ increases the employment effect in equation

(10), which mandates a smaller α_G^* to restore the equilibrium. Intuitively, as the employment pressure increases, the government has to resort to a less severe law enforcement level as it generates a pro-competitive effect to increase total output, resulting in more employment opportunities.

Next, we consider the comparative static properties of the optimal law enforcement level chosen by the social planner. Although we cannot prove theoretically, the following result shows these effects within our choice of the relevant parameters.

Result 2. *Given the demand and the punishment specifications in equations (11) and (12), and choosing* $t = 0.2,\ \gamma = 0.4,\ \tau = 0.5,$ *then the comparative static effects of a change of* $t,\ \gamma,\ or\ \tau$ *on* α_W^* *can be obtained by fixing the rest two:* $\frac{\partial \alpha_W^*}{\partial \tau} < 0$, $\frac{\partial \alpha_W^*}{\partial \gamma} > 0$, *and* $\frac{\partial \alpha_W^*}{\partial t} < 0$.

Result 2 can be interpreted by resorting first order condition (9) and Proposition 2, 3, and 4, similarly to that of Result 1.

Next, we move on to consider the effects of *ticheng,* the unit transaction cost and legal loopholes on the government payoff and that of the social planner. In addition, the effect of the employment pressure on government's optimal choice is also explored. Using G^* and W^* to denote the equilibrium government payoff and social planner's payoff, respectively, we have the following two results:

Result 3. *Given the demand and the punishment specifications in equations (11) and (12) and choosing* $t = 0.2,\ \gamma = 0.4,\ \tau = 0.5,\ \theta = 0.5,$ *the comparative static effects of a change of* $t,\ \gamma,\ \tau,\ or\ \theta$ *on* G^* *can be obtained by fixing the rest three: (1)* $\frac{\partial G^*}{\partial \theta} > 0$; *(2)* $\frac{\partial G^*}{\partial t} > 0$ *if* $t < 0.4$, *otherwise,* $\frac{\partial G^*}{\partial t} \le 0$; *(3)* $\frac{\partial G^*}{\partial \tau} < 0$; *(4)* $\frac{\partial G^*}{\partial \gamma} > 0$ *if* $\gamma < \frac{1}{9}$, *otherwise,* $\frac{\partial G^*}{\partial \gamma} \le 0$.

The effect of θ on G^* can be directly explained from the objective function of the government. Noting that $t < 0.4$ corresponds to $P(1 + R_2') + P > \gamma$ in Proposition 2, we see that when $t < 0.4$, an increase in t generates a pro-competitive effect, resulting a rise in the government's payoff. On the other hand, when $t \geq 0.4$, a rise in t leads to a competition reduction effect, and the total payoff of the government falls as a result. From Proposition 4, we see a rise in τ generates a competition reduction effect, which lowers the payoff of the government. Finally, noting that $\gamma < \frac{1}{9}$ corresponds to $t + \partial[\alpha\gamma\varphi(\gamma E_1)]/\partial\gamma < 1 - \tau$ from Proposition 3, we see that a rise in γ generates a pro-competitive effect, which dominates the productivity efficiency loss, γE_1, resulting in a rise in government's payoff. Conversely, in the case $\gamma \geq \frac{1}{9}$, an increase in γ leads to a fall in the government's payoff.

Result 4. *Given the demand and the punishment specifications in equations (11) and (12) and choosing* $t = 0.2,\ \gamma = 0.4,\ \tau = 0.5,$ *the comparative static effects of a change of* $t,\ \gamma$ or τ, *on* W^* *can be obtained by fixing the rest two: (1)* $\frac{\partial W^*}{\partial \tau} < 0$; *(2)* $\frac{\partial W^*}{\partial t} > 0$ *if* $t < 0.5349$, *otherwise* $\frac{\partial W^*}{\partial t} \leq 0$; *and (3)* $\frac{\partial W^*}{\partial \gamma} < 0$.

Result 4 can be interpreted by resorting to Proposition 2, 3, and 4, similarly to that of Result 3.

Finally, we consider the validity of the Leff-Huntington hypothesis that corruption may augment social welfare. It can be easily shown that the social welfare under no corruption is $\frac{4}{9}$. We use W_G^* to denote the social welfare achievable under the optimal level of law enforcement chosen by the government. We find that there exists a possibility that corruption can be socially good, even for a government facing heavy employment burden. This argument is illustrated by the following two results:

Result 5. *Given the demand and the punishment specifications in equations (11) and (12) and choosing* $t = 0.2,\ \gamma = 0.4,\ \theta = 0.5,$ *there exists some* $\tau^* \in (0,1)$ *such that* $W_G^* > \frac{4}{9}$ *if* $\tau < \tau^*$.

Result 6. *Given the demand and the punishment specifications in equations (11) and (12)* *and choosing* $t = 0.2,\ \tau = 0.5,\ \theta = 0.5,$ *there exist* γ_1^*, $\gamma_2^* \in (0,1)$ *with* $\gamma_1^* < \gamma_2^*$, *such that* $W_G^* > \frac{4}{9}$ *if* $\gamma \in (\gamma_1^*, \gamma_2^*)$.

Result 5 and Result 6 specify two cases under which corruption can be socially good, for a government that faces employment pressure. Specifically, when the unit transaction cost is small, or when there are moderate legal loopholes in the SOE, corruption can be socially good. The underlying mechanism of the above two results is attributable to the tradeoff between the pro-competitive effect and the deadweight loss effect. When the pro-competitive effect generated from corruption dominates the deadweight loss effect, as the conditions given above, corruption can be socially good by increasing social welfare.

6. Concluding remarks

Out of the above analysis, there are a couple of messages worth to be stressed. First, at least under our formulation of the transaction costs, under certain conditions, the pro-competitive effect of corruption is verified, and hence, the Leff-Huntington hypothesis is espoused even when corruption is "costly." Second, the literature has examined the relationship between the competitiveness of the economy and the corrupt incentives. Rose-Ackerman (1996) maintains that a rise in competitiveness reduces the corrupt incentives, whereas Celentani and Ganuza (2002) argue that corruption may be increasing in competition. Our results show that competition and corruption are also related in a reverse fashion: Under certain conditions, corruption may also increase competition. In particular, corruption may generate a pro-competitive effect in an oligopolistic market, which partially corrects the market distortion. Third, a government under the pressure to provide employment opportunities tends to prefer a different level of law enforcement from that of a social planner, with the difference of the two depends on the comparison between the exaggerated average cost of SOE and the sum of the employment burden effect and the marginal transaction cost of corruption. Fourth, as shown in Proposition 2, under certain conditions, higher wages for managers may reduce corruption. These insights, we believe, are highly relevant to the ongoing discourse on SOE reform and the anti-corruption campaign in transitional economies.

Without a doubt, the way we conceptualize and model agent corruption in Chinese SOEs is not the uniquely best approach. Our approach may not capture all the essential features of agent corruption and the Chinese SOEs. For example, we have used the equilibrium book profit of the SOE as a proxy for the well-being of the employees. An arguably more satisfactory indicator for this purpose might be the labor cost. However, the examination of labor cost mandates the introduction of a production function that allows both labor and capital as inputs, which may complicate analysis, but nevertheless remains to be an interesting topic for future research. Moreover, to emphasize the fact that after a series of reform, many Chinese SOEs have been transformed into largely profit-maximizers, we have excluded the government's concerns from the SOE's objective. However, in reality, the government does retain certain control powers over the SOEs, and our specification is admittedly rather shortcut. A promising extension would be to reformulate the present specification of the SOE's objective into a weighted average of the present setting and the government's payoff. It would be interesting to see under which conditions the pro-competitive effect might be stronger. In addition, it would also be interesting to consider the case in which both firms engage in price competition, *á la* Bertrand. As the reaction functions are upward sloping in a price game (rather than downward sloping in a quantity game), the results may be reversed. Finally, we have assumed that *ticheng*, t, the legal loopholes, γ, and the unit cost of corruption, τ, are exogenously given in our model. It is also necessary to examine the cases in which they are endogenously determined.

The most natural way to advance the current analysis would be to study an extended model in which these insufficiencies are addressed. It would be interesting to examine whether our conclusions could be carried over to such an extended model.

Appendix

Proof of Lemma 1. Given α, equations (5) and (6) jointly determine the equilibrium outputs E_1 and E_2. Substituting E_1 and E_2, back into equation (1'), we get the equilibrium expected payoff for the SOE's manager, s_1^*. By the envelope theorem, $\partial s_1^* / \partial \alpha = -\varphi(\gamma E_1) < 0$. From the manager's objective function, we know that when $\alpha = 0$, the manager inevitably embezzles the public assets, whereas she chooses to be integrity when $\alpha = 1$. Therefore, there exists some $\alpha^* \in (0,1)$ such that the manager of the SOE embezzles if $\alpha < \alpha^*$; otherwise, she chooses not to corrupt. □

Proof of Proposition 1. By differentiating the first-order conditions (5) and (6) with respect to α and collecting the terms, we obtain:

$$\frac{\partial E_1}{\partial \alpha} = \frac{\gamma\varphi'(\gamma E_1)\left[P''E_2 + 2P'\right]}{\Delta}, \tag{A1}$$

$$\frac{\partial E_2}{\partial \alpha} = -\frac{\gamma\varphi'(\gamma E_1)\left[P''E_2 + P'\right]}{\Delta}, \tag{A2}$$

where $K \equiv t(P''E_1 + 2P') - \alpha\gamma^2\varphi''(\gamma E_1)$, $H \equiv t(P''E_1 + P')$, and $\Delta \equiv \begin{vmatrix} K & H \\ P''E_2 + P' & P''E_2 + 2P' \end{vmatrix}$.

From the second-order conditions and the stability condition, $P''E_2 + P' < 0$, $P''E_2 + 2P' < 0$ and $\Delta > 0$. Together with the assumption of $\varphi'(\cdot) > 0$, $\frac{\partial E_1}{\partial \alpha} < 0$ and $\frac{\partial E_2}{\partial \alpha} > 0$. Furthermore, from equation (8), $\left|\frac{\partial E_1}{\partial \gamma}\right| > \frac{\partial E_2}{\partial \gamma}$, hence, $\frac{\partial E}{\partial \alpha} < 0$. With a downward-sloping demand curve, $\frac{dP}{d\alpha} = P'\frac{\partial E}{\partial \alpha} > 0$. □

Proof of Proposition 2. By differentiating the first-order conditions (5) and (6) with respect to t and collecting the terms, we obtain:

$$\frac{\partial E_1}{\partial t} = \frac{\left[\gamma - (P'E_1 + P)\right]\left[P''E_2 + 2P'\right]}{\Delta}, \tag{A3}$$

$$\frac{\partial E_2}{\partial t} = -\frac{\left[\gamma - \left(P'E_1 + P\right)\right]\left[P''E_2 + P'\right]}{\Delta}. \tag{A4}$$

From (5), $P'E_1 + P - \gamma = -\frac{1}{t}[(1-\tau)\gamma - \alpha\gamma\varphi'(\gamma E_1)]$, so we have two cases: $P'E_1 + P > \gamma$ (or

$(1-\tau)\gamma < \alpha\gamma\varphi'(\gamma E_1)$) and $P'E_1 + P < \gamma$ (or $(1-\tau)\gamma > \alpha\gamma\varphi'(\gamma E_1)$). Similar derivations like Proposition 1 yield the result. □

Proof of Proposition 3. By differentiating the first-order conditions (5) and (6) with respect to γ and collecting the terms, we obtain:

$$\frac{\partial E_1}{\partial \gamma} = \frac{[t-(1-\tau)-\partial[\alpha\gamma\varphi'(\gamma E_1)]/\partial\gamma]\left[P''E_2 + 2P'\right]}{\Delta}, \tag{A5}$$

$$\frac{\partial E_2}{\partial \gamma} = -\frac{[t-(1-\tau)-\partial[\alpha\gamma\varphi'(\gamma E_1)]/\partial\gamma]\left[P''E_2 + P'\right]}{\Delta}. \tag{A6}$$

Similar to the proof of Proposition 2, sign($\frac{\partial E_1}{\partial \gamma}$) and sign($\frac{\partial E_2}{\partial \gamma}$) depend on $\text{sign}[t-(1-\tau)-\partial[\alpha\gamma\varphi'(\gamma E_1)]/\partial\gamma]$.

Similar arguments like the proof of Proposition 1 and 2 yield the result. □

Proof of Proposition 4. By differentiating the first-order conditions (5) and (6) with respect to τ and collecting the terms, we obtain:

$$\frac{\partial E_1}{\partial \tau} = \frac{\gamma\left[P''E_2 + 2P'\right]}{\Delta}, \quad \frac{\partial E_2}{\partial \gamma} = -\frac{\gamma\left[P''E_2 + P'\right]}{\Delta}.$$

Similar arguments like Proposition 1 generate the result. □

Proof of Lemma 2. By differentiating $W^E(\alpha) \equiv W(E_1(\alpha), E_2(\alpha))$ with respect to α at E_1 and E_2, we get $\frac{dW^E}{d\alpha} = \frac{\partial E_1}{\partial \alpha}\left[\frac{\partial W}{\partial Q_1} + \frac{\partial W}{\partial Q_2}\frac{\partial E_2/\partial\alpha}{\partial E_1/\partial\alpha}\right] = \frac{\partial E_1}{\partial \alpha}[P(1+R_2') - \tau\gamma]$. Since $\frac{\partial E_1}{\partial \alpha} < 0$, it follows that $P(1+R_2') - \tau\gamma = 0$. □

Proof of Lemma 3. By differentiating $G^E(\alpha) \equiv G(E_1(\alpha), E_2(\alpha))$ with respect to α at E_1 and E_2, we get:

$$\frac{dG^E}{d\alpha} = \frac{\partial E_1}{\partial \alpha}\left[\frac{\partial G}{\partial Q_1} + \frac{\partial G}{\partial Q_2}\frac{\partial E_2/\partial\alpha}{\partial E_1/\partial\alpha}\right] = \frac{\partial E_1}{\partial \alpha}[P(1+R_2') + \theta(1+R_2') - \gamma].$$

Since $\frac{\partial E_1}{\partial \alpha} < 0$, it follows that $P(1+R_2') + \theta(1+R_2') - \gamma = 0$. □

Proof of Proposition 5. When $(1-\tau)\gamma > \theta(1+R_2')$, we have

$$P(1+R_2')-\tau\gamma > P(1+R_2')+\theta(1+R_2')-\gamma\ ,\quad \forall\alpha\in(0,1)\ .$$

$\frac{\partial E_1}{\partial\alpha}<0$ implies that $\frac{\partial E_1}{\partial\alpha}[P(1+R_2')-\tau\gamma]<\frac{\partial E_1}{\partial\alpha}[P(1+R_2')+\theta(1+R_2')-\gamma]$, $\forall\alpha\in(0,1)$.

Inserting $\alpha=\alpha_G^*$ into the above inequality and from Lemma 1, we get

$$\frac{\partial E_1}{\partial\alpha}[P(1+R_2')-\tau\gamma]\bigg|_{\alpha=\alpha_G^*}<0\ .$$

From Lemma 2, $W_\alpha(\alpha_W^*)\equiv\frac{\partial E_1}{\partial\alpha}[P(1+R_2')-\tau\gamma]\bigg|_{\alpha=\alpha_W^*}$ =0.

Therefore, $\frac{\partial E_1}{\partial\alpha}[P(1+R_2')-\tau\gamma]\bigg|_{\alpha=\alpha_G^*}<\frac{\partial E_1}{\partial\alpha}[P(1+R_2')-\tau\gamma]\bigg|_{\alpha=\alpha_W^*}$.

Since $W_{\alpha\alpha}<0$, we have $\alpha_G^*>\alpha_W^*$.

When $(1-\tau)\gamma\le\theta(1+R_2')$, $\alpha_G^*\le\alpha_W^*$ can be shown in a similar way. □

Proof of Result 1. Differentiating equation (13) with respect to $t,\ \tau,\ \gamma$ and θ, respectively, we have:

$$\frac{\partial\alpha_G^*}{\partial t}=\frac{(5\gamma-1-3\theta)}{\gamma^2(1+2\theta)},\quad \frac{\partial\alpha_G^*}{\partial\tau}=-\frac{1}{\gamma(1+2\theta)}<0,\quad \frac{\partial\alpha_G^*}{\partial\gamma}=\frac{2(1+3\theta)t-5t\gamma-(1-\tau)\gamma}{\gamma^3(1+2\theta)},$$

$$\frac{\partial\alpha_G^*}{\partial\theta}=-\frac{2[(5\gamma-1-3\theta)t+(1-\tau)]}{\gamma^2(1+2\theta)^2}-\frac{3t}{\gamma^2(1+2\theta)}=-\frac{2\alpha_G^*}{(1+2\theta)}-\frac{3t}{\gamma^2(1+2\theta)}<0\ .$$

Obviously, $\frac{\partial\alpha_G^*}{\partial t}>0$ if $\gamma>\frac{1+3\theta}{5}$; otherwise, $\frac{\partial\alpha_G^*}{\partial t}\le 0$. It is also obvious if $t>\frac{(1-\tau)\gamma}{2(1+3\theta)-5\gamma}$, $\frac{\partial\alpha_G^*}{\partial\gamma}>0$; otherwise, $\frac{\partial\alpha_G^*}{\partial\gamma}<0$. □

Proof of Result 2. Differentiating equation (14) with respect to t by choosing $\gamma=0.4,\tau=0.5$ we have $\frac{\partial\alpha_W^*}{\partial t}=\frac{(1+0.4-3\times0.5\times0.4)}{0.16(2\times0.4\times0.5-1)}=-\frac{25}{3}<0$.

Similarly, differentiating equation (14) with respect to τ by choosing $t=0.2,\gamma=0.4$, we have $\frac{\partial\alpha_G^*}{\partial\tau}=-\frac{0.01246}{(0.108\tau-0.16)^2}<0$.

Differentiating equation (14) with respect to γ by choosing $t=0.2,\tau=0.5$, we get:

$$\frac{\partial\alpha_W^*}{\partial\gamma}=\frac{2(3\gamma^2-3\gamma+1)}{5\gamma^3(1-\gamma)^2}\ .$$

Since $3\gamma^2 - 3\gamma + 1 > 0$, $\frac{\partial \alpha_W^*}{\partial \gamma} > 0$. □

Proof of Result 3. Choosing $t = 0.2, \gamma = 0.4, \tau = 0.5$, then $\alpha_G^* = \frac{0.04 - 0.06\theta}{0.16(1+2\theta)}$.

Substituting it into the expressions for $E_1(\alpha)$ and $E_2(\alpha)$, we have

$$E_1(\alpha_G^*) = \frac{0.44}{0.6 + 0.32\alpha_G^*},\quad E_2(\alpha_G^*) = \frac{0.08 + 0.16\alpha_G^*}{0.6 + 0.32\alpha_G^*},\quad E_1(\alpha_G^*) + E_2(\alpha_G^*) = \frac{0.56 + 0.44\theta}{0.68}.$$

Hence,

$$G^*(\alpha_G^*) = \frac{0.384 + 0.648\theta + 0.44\theta^2}{0.68} - \frac{1}{2}\left(\frac{0.56 + 0.44\theta}{0.68}\right)^2,\quad \frac{\partial G^*}{\partial \theta} = 0.591 + 1.01\theta > 0.$$

Similarly, choosing $\theta = 0.5, \gamma = 0.4, \tau = 0.5$, we have

$$G^*(\alpha_G^*) = \frac{0.29 + 1.945t}{0.2 + 2.5t} - \frac{1}{2}\left(\frac{0.3 + 1.35t}{0.2 + 2.5t}\right)^2,\quad \frac{\partial G^*}{\partial t} = \frac{0.192(0.4 - t)}{(0.2 + 2.5t)^3}.$$

Hence, when $t < 0.4$, $\frac{\partial G^*}{\partial t} > 0$; Otherwise, $\frac{\partial G^*}{\partial t} \le 0$.

By choosing $\theta = 0.5, \gamma = 0.4, t = 0.2$, the expression of G^* is denoted as

$$G^*(\alpha_G^*) = \frac{0.969 - 0.58\tau}{0.9 - 0.4\tau} - \frac{1}{2}\left(\frac{0.87 - 0.6\tau}{0.9 - 0.4\tau}\right)^2,\quad \frac{\partial G^*}{\partial t} = -\frac{(0.1921 + 0.232\tau)(0.03 + 0.2\tau)}{(0.9 - 0.4\tau)^3} < 0.$$

Choosing $\theta = 0.5, \tau = 0.5, t = 0.2$, we have

$$G^*(\alpha_G^*) = \frac{1.5(0.15 + 1.05\gamma)}{1.5\gamma + 0.1} - \frac{(0.2\gamma + 0.6\gamma^2)}{1.5\gamma + 0.1} - \frac{1}{2}\left(\frac{0.15 + 1.05\gamma}{1.5\gamma + 0.1}\right)^2,$$

$$\frac{\partial G^*}{\partial \gamma} = -\frac{(0.9\gamma^2 + 3.2625\gamma + 0.1945)(0.45\gamma - 0.05)}{(1.5\gamma + 0.1)^3}.$$

Here, $\mathrm{sign}(\frac{\partial G^*}{\partial \gamma})$ depends on the sign of the term $(0.45\gamma - 0.05)$. Obviously, when $\gamma < \frac{1}{9}$, we have $\frac{\partial G^*}{\partial \gamma} > 0$; when $\gamma \ge \frac{1}{9}$, we have $\frac{\partial G^*}{\partial \gamma} \le 0$. □

Proof of Result 4. Choosing $t = 0.2, \gamma = 0.4$, then $\alpha_W^* = \frac{20\tau - 15}{16\tau - 20}$.

Substituting it into the expressions for $E_1(\alpha)$ and $E_2(\alpha)$, we have

$$E_1(\alpha_W^*) = \frac{0.44}{0.6 + 0.32\alpha_W^*},\quad E_2(\alpha_W^*) = \frac{0.08 + 0.16\alpha_W^*}{0.6 + 0.32\alpha_W^*},\quad E_1(\alpha_W^*) + E_2(\alpha_W^*) = \frac{71\tau - 52.5 - 20\tau^2}{50\tau - 52.5}.$$

Hence,

$$W^*(\alpha_w^*) = \frac{(71\tau - 52.5 - 20\tau^2)^2}{2(50\tau - 52.5)^2},$$

$$\frac{\partial W^*}{\partial \tau} = -\frac{(71\tau - 52.5 - 20\tau^2)(50\tau - 52.5)(1000\tau^2 - 2100\tau + 1102.5)}{(50\tau - 52.5)^4}.$$

Since $\tau \in [0,1]$, it can be easily shown that

$$(71\tau - 52.5 - 20\tau^2)(50\tau - 52.5)(1000\tau^2 - 2100\tau + 1102.5) > 0.$$

Therefore, $\frac{\partial W^*}{\partial \tau} < 0$.

Similarly, when choosing $\tau = 0.5, \gamma = 0.4$, we have

$$W^*(\alpha_w^*) = \frac{(65t + 29)(76 - 44t)}{625(5+t)}, \quad \frac{\partial W^*}{\partial t} = \frac{16116 - 28600t - 2860t^2}{625(5+t)^2}.$$

It can be shown that $\frac{\partial W^*}{\partial t} > 0$ if $t < 0.5349$, otherwise $\frac{\partial W^*}{\partial t} \le 0$.

When choosing $\tau = 0.5, t = 0.2$, we get

$$W^*(\alpha_w^*) = \frac{(5\gamma + 2 - 3\gamma^2)^2}{8(3\gamma+1)^2}, \quad \frac{\partial W^*}{\partial \gamma} = -\frac{(5\gamma + 2 - 3\gamma^2)(3\gamma+1)^3}{4(3\gamma+1)^4} < 0. \qquad \square$$

Proof of Result 5. Choosing $\theta = 0.5, \gamma = 0.4, t = 0.2$, we have

$$E_G^* = E_1(\alpha_G^*) + E_2(\alpha_G^*) = \frac{87 - 60\tau}{90 - 40\tau}, \quad W_G^* = E_G^*(1 - \frac{1}{2}E_G^* - \tau\gamma) = \frac{(87 - 60\tau)(93 - 92\tau + 32\tau^2)}{2(90 - 40\tau)^2}.$$

Hence, $W_G^* - \frac{4}{9} = \frac{8019 - 64656\tau + 61936\tau^2 - 17280\tau^3}{18(90 - 40\tau)^2}$.

Let $F(\tau) \equiv 8019 - 64656\tau + 61936\tau^2 - 17280\tau^3$, we can show that

$$F(0) > 0, F(1) < 0, F'(0) < 0, F'(1) > 0, F''(\tau) > 0.$$

Thus there exists some $\tau^{**} \in (0,1)$, such that $F'(\tau) < 0$ if $\tau < \tau^{**}$ and $F'(\tau) > 0$ if $\tau > \tau^{**}$. Since $F(0) > 0$ and $F(1) < 0$, there must exists some $\tau^* \in (0, \tau^{**})$ such that $F(\tau) > 0$ if $\tau < \tau^*$. $\square$

Proof of Result 6. Choosing $\theta = 0.5, \tau = 0.5, t = 0.2$, we have

$$E_G^* = E_1(\alpha_G^*) + E_2(\alpha_G^*) = \frac{3 + 21\gamma}{2 + 30\gamma}, \quad W_G^* = E_G^*(1 - \frac{1}{2}E_G^* - \tau\gamma) = \frac{3 + 132\gamma + 597\gamma^2 - 126\gamma^3}{2(2 + 30\gamma)^2}.$$

Hence, $W_G^* - \frac{4}{9} = \frac{700\gamma - 5 - 1827\gamma^2 - 1134\gamma^3}{18(2 + 30\gamma)^2}$.

Let $G(\gamma) \equiv 700\gamma - 5 - 1827\gamma^2 - 1134\gamma^3$, we can show that

$$G(0) < 0, G(1) < 0, G'(0) > 0, G'(1) < 0, G''(\gamma) < 0.$$

Thus there exists some $\gamma^{**} \in (0,1)$, such that $G'(\tau) > 0$ if $\gamma < \gamma^{**}$, $G'(\tau) < 0$ if $\gamma > \gamma^{**}$

and $G'(\gamma^{**}) = 0$. By solving the equation $G'(\gamma^{**}) = 700 - 3654\gamma - 3402\gamma^2 = 0$, we get $\gamma^{**} = 0.166$. Since $G(\gamma^{**}) = G(0.166) = 55.623 > 0$, there exist γ_1^*, $\gamma_2^* \in (0,1)$ with $\gamma_1^* < \gamma_2^*$, such that $G(\gamma) > 0$ if $\gamma \in (\gamma_1^*, \gamma_2^*)$. As $\text{sign}(W_G^* - \frac{4}{9})$ depends on $\text{sign}(G(\gamma))$, we immediately get the result. □

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