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and Economic Development**

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1 Introduction

In the last decade, China's economy has been growing at a rapid rate of nearly 9.8% annually. At the same time, accompanying the economic growth is the high occurrences of accidents. According to the reports of the State Administration of Work Safety (SAWA), from 2001 to 2003, there were about 1,000,000 accidents of all kinds annually with average death toll of 130,000 with an ascending tendency.¹ The environmental deterioration doesn't allow optimism, either. Experts estimate 4-6 percent of the GDP' growth is the environmental costs, including natural resources reducing, zoology destroy and pollution.² Consuming too much energy is often considered as the bottleneck of economic growth of today's China. In addition, the bubbles of the real estate are also becoming a major concern of the public. There will be problems such as the reoccurrence of mine accidents, serious environmental pollution, large areas of power shortage, large-scale appellations to the higher authorities and the exposition of corruption by the media when these above phenomena accumulate to some extent. We call these problems "accidents". All the four types of accidents have a common character: they are all related to the high cost as well as GDP.

What is the institutional cause behind these phenomena is the theme of this paper. Under the fiscal sharing system and with the practice of assessing the officials' performance based on GDP, due to the asymmetry information of the production cost, the collusion between the local

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¹ The data come for the official websites of SAWA (<http://www.chinasafety.gov.cn>).

² "How to deter the environmental costs from increasing", *Economic References*, July 2nd, 2005.

government and the firm is the cause of coincidence of high growth and high occurrences of accidents. Under the fiscal sharing system, the officials of the local government have strong incentives to develop the local economy (Qian and Weingast, 1996; Yang, 1998; Lin and Liu, 2001; Jin *et al*, 2004). Meanwhile, under the existing political institutions, the GDP is taken as an important yardstick for promotion of officials (Li and Zhou, 2005). These economic and political arrangements both give officials strong incentives to develop their local economy. But little attention is paid by the existing literatures to the adverse effect of these institutions. Only several authors (Shen and Dai, 1990; Zhou, 2004; Nie, 2006) noticed the induced fierce competition, repeated construction and the distorted fiscal system, but they didn't analyze the collusion phenomena between the local government and the firm. In fact, for the time-lag problem, the central government can't exactly and immediately observe the real cost of local economic development. The information asymmetry between the central government and the local government may induce the local government to monitor the local firm to adopt a relatively more safe, energy-saving, environment-friendly production manner, which is the "good" manner, or may induce them to collude with the local firm to adopt a less safe or excess energy-consuming manner, which is the "bad" manner. Further, the interest conflict is also an important reason for collusion.

When can we prevent the collusion? Why does there abound the collusion in reality? The purpose of the paper is to try to depict an optimal collusion-proof contract theoretically and explain the collusion existing as equilibrium. Based on Tirole (1986), we build a Principal (the central government)-Supervisor (the local government)-Agent (the firm) model. In this model, both the supervisor and the agent have the complete information about the production type. Ex ante, the supervisor can allow the agent to adopt the good manner which induces a higher private cost, or can collude with the agent allowing it to adopt the bad manner which has a lower private cost but with a higher social cost. The bad manner will cause accidents ex post with some probability. The fourth party such as the media can learn the accidents with some probability ex post and report to the principal. Once exposed by the fourth party, say, the media, the supervisor and the agent will be punished.

Our analysis indicates that in the optimal collusion-proof mechanism, the supervisor and the agent will obtain a positive information rent and their incentive compatibility constraints and limited liabilities constraints are binding. Contrasting with the case of collusion-free, the optimal collusion-proof contract will bring about extra cost to the principal. The optimal punishment will give the colluding supervisor and agent zero utility. The optimal collusion-proof contract and its comparative statics show that strengthening supervision of the fourth party will improve the welfare of the central government and deter the abuse of local officials. The interest distribution between the central government, local government and the firm will influence the formation of collusion. Further, we find that the legal damages of accident play the role of supervision and punishment. Taken the optimal collusion-proof contract as a benchmark, we disclose five causes for the ubiquitously existing collusion: (1) The cost for the central government to prevent collusion is too high; (2) The myopia of the local government; (3) The over-taxation on the firm; (4) The inability of supervision by the fourth party; (5) The commitment problem of the central government to implement the punishment.

The related literature are mostly concerned with how to prevent the collusion, such as Tirole(1986), Kofman and Lawarree(1993), Laffont and Tirole(1991, 1993), Laffont and

Martimort(1998), and Faure-Grimaud, Laffont and Martimort(2001, 2002), and so on. Little literature deal with the equilibrium collusion, such as Tirole(1992) and Kofman and Lawarree (1996). We differ from them in three ways: the first as well as the most important is that the supervisor is the local government who bears double responsibilities: one is to develop the local economy and the other is to monitor the firm to supply output in the good manner. So here the supervisor is faced with a trade-off while in other models on collusion the supervisor is just a supervisor. Second, different from other models which take the variance of wage as a manner of punishment, here we keep the wage as an incentive tool to encourage output and discuss the optimal punishment separately.³ Third, our model introduces the fourth party, and depicts the relation between his monitoring ability and the interests of the principal, supervisor and agent.

Different from the existing literature which is mainly concerned with Chinese local governments, we apply the modern incentive theory to analyze the adverse effects of the current fiscal and personnel system and try to study the possible mechanisms to cope with them. But our framework is not limited to the safe production problems, it also applies to the environmental protection, energy-consuming, and economic bubbles. We try to comprehend the general and internal relations between institutions and economic growth from the micro-perspectives of local governments and the firm.

The paper is organized as follows. Section 2 builds a classical three-tier principal-agent model; Section 3 investigates the characteristic of the optimal collusion-proof contract; Section 4 relaxes some assumptions and gives an answer to the existing collusion phenomena; Section 5 concludes.

2 Model

2.1 The Grand Contract

Suppose there is a formal grand contract among the central government (CG), the local government (LG) and the firm. As the principal, the CG authorizes the LGs as the supervisor to monitor the firm (the agent) to develop the local economy. The CG includes central agencies which are not the owner of the firm, but according to the law, they are responsible for regulating the activities of the firm on the macro-level. The LGs, as the agency of the CG, are responsible for monitoring the production activities of the firm under the leadership of the CG and are paid for their efforts. The LGs, including local CCP authorities of all levels, local governments and all other agencies responsible for safe production, such as Administration of Work Safety, Environmental Protection Administration, and Administration of Quality Supervision, Inspection and Quarantine, and so on. The firm organizes their production activities and receives its profits under the regulation of the CG. Actually, the three-tier principal-agent relation exists in the areas of general economy as well as the supply of public goods.

³ Kofman and Lawarree(1993) also detached the wage from punishment, but they took the outside auditor who receives payment as an endogenous tool of preventing the collusion between the inside auditor and the manager. In our model, the fourth party is exogenous and receives no payment, and the supervisor can decide the production type.

Suppose the principal's aimed output (GDP⁴) is x and x is standardized to be 1. From 1 output t is taxed by the principal, among which $w = \alpha t$ is paid to the supervisor and $(1 - \alpha)t$ is kept for herself, where $\alpha, t \in (0, 1)$. Here the tax t should be taken as the taxes and charges within the law, and αt denotes the fiscal revenue of the LGs under the system of tax-sharing. There are two kinds of production technologies by the agent: One is the "good" manner with the cost of \bar{c} having no externalities; and the other is the "bad" manner with the private cost of \underline{c} which may cause some accident I . The accident I is defined as the event which exceeds the limitation value declared by the principal. It is ex post verifiable and it will induce an extra social cost of C . C includes direct costs and indirect costs. The former mainly includes wealth or life losses while the latter involves the political pressures driven by public opinions, such as the complaints from the media, the non-cooperative activities toward the government by the voters and so on. These indirect costs are assumed by the principal. Let $0 < \underline{c} < \bar{c} < 1$ and $\Delta c = \bar{c} - \underline{c}$. Δc denotes the quasi-rents from the adoption of the "bad" manner. In reality, the "good" manner is the manner of adoption of enough safety precautions, such as installation of aeration and drainage system when excavating coal, while the "bad" manner is that without safety precautions. So the "good" manner will cause higher cost to the firm. The accident I may be those with the death toll of more than 10 or 30, which should be reported to the CG. As far as the environmental damage, resources over-depletion and economic bubbles are concerned, although the definitions of accidents are different, the principles this paper derives also apply.

2.2 Information Structure

For the principal, though both costs are common knowledge, but the type of the agent (A) is assumed to be unobservable (or the cost of detection the type of the agent is too high for the CG). So with the incomplete information, the grand contract without collusion-proof is always a pooling equilibrium. Suppose the agent should acquire the sanction of the supervisor (S) before his production activity. Then the supervisor knows the type of the agent.⁵ The agent can ex ante adopt the "good" manner (\bar{c}) without the accident I ex post, or collude with the supervisor and take the "bad" manner (\underline{c}) but with the probability of p for accident I ex post. After the accident, the fourth party (the media) can discover and report it to the CG with the probability of ρ . All the four states are summarized as follows:

- (1) A chooses \bar{c} without I ;
- (2) A chooses \underline{c} and the accident I doesn't occur with the probability of $1 - p$;

⁴ As for the central government, it may be cheaper to base the performance evaluation on GDP. It can also be understood as it reflects the preference of most voters.

⁵ The assumption is different from standard collusion model, but is realistic in our context. For example, the start-up of a coalmining firm at least need the license of mining, safety production, mine production, and operation from local government. In practice, local governments, especially municipal or county governments often fully know the safe conditions of local firms. However, the central or provincial governments don't. The earlier version of this paper (Nie and Li, 2005) discussed the state that supervisor is with asymmetric information, and distinguished interim punishment and ex post punishment, but the outcome was not essentially different from this paper.

(3) A chooses \underline{c} and the accident I occur with the probability of p . The fourth party discovers it with the probability of ρ ;

(4) A chooses \underline{c} and the accident I occur with the probability of p . The fourth party doesn't discover it with the probability of $1 - \rho$.

The probability $p, \rho \in (0,1)$ and are common knowledge. Under state (2), (3), (4), the supervisor colludes with the firm. Because the accident is ex post verifiable, if the principal learns I from the fourth party, she can realize there is collusion between the supervisor and the agent.

2.3 Utility

The principal, supervisor and agent are all self-interest. The principal is risk-neutral and aims to maximize her total revenues $(1 - \alpha)t$. The grand contract relies on the monitoring of the supervisor and the report from the fourth party. In the grand contract, within the contract period, if there is no accident I or the accident occurs but the fourth party doesn't discover it, then the supervisor gets his normal wage w from the principal; if the accident I does occur and also is reported by the fourth party, the supervisor and the agent will receive their punishment F_S and F_A respectively from the principal. For convenience, we can suppose the punishment can be quantified in money. In reality, the punishment to the supervisor can be in the form of dismissing from their job with zero payoff, or demotion with decreased revenues. The punishment to the supervisor and the agent should not exceed their own income, which means that they only assume limited responsibility. So we can suppose they are all risk-neutral.⁶ The agent can sign an informal side contract with the supervisor to collude: if the supervisor allows the agent to choose \underline{c} , the agent should give the supervisor a bribe b no matter whether the possible accident is discovered by the fourth party. Suppose $b = k\Delta c$, where k denotes the division proportion. We also suppose the side contract between the supervisor and the agent is Pareto-improving and self-enforcing, so we can neglect the transaction costs between them. The expected utility of the supervisor and the agent are respectively EU_S and EU_A with a standardized reservation utility of zero.⁷

2.4 Time Line

⁶ Or the supervisor and agent is risk-averse below the zero wealth and is risk-neutral above the zero wealth (Faure-Grimaud, Laffont and Martimort, 2001). Such an assumption is different from the general agency model, but coincide with Kofman and Lawarree(1993) and Laffont and Martimort (1998, 2000). In reality, after the accidents, the manager of the firm suffers pecuniary punishment and receives little criminal penalties, which justifies our assumption. For instance, "The Regulations of Coal Safety Supervision" in China say, anyone who conceals the fact, destroys the locale, or embarrass investigation after the mining accidents will be fined from 30 to 150 thousands RMB by the authority of the local government.

⁷ In the following model, it is very easy to prove that the assumption doesn't influence our conclusions.

The time line of the game is as follows: (1) the principal offers a take-it-or-leave-it grand contract to the supervisor and the agent. If both the latter accept it simultaneously, the game goes to the next step or it ends up; (2) the supervisor and the agent negotiate in private. If they reach a side contract, they collude with each other, or action non-cooperatively; (3) the agent chooses the manner of production. If it chooses \underline{c} , it is up to the nature to determine the probability of accidents; (4) the side contract is implemented by the supervisor and the agent if possible; (5) the fourth party reports to the principal if he discovers the accident I ; (6) the principal implements the grand contract. Here we only consider the static model, so the timing of side contract and the payment of the wage and punishment are irrelevant.

3 The optimal collusion-proof contract: normative perspective

3.1 Optimal contract

According to the Revelation Principle, we can only consider the direct revelation mechanism under which the agent chooses the “good” manner. An optimal collusion-proof contract should meet the following constraints:

First of all, the individual rationality constraints (IR) of the agent and the supervisor should be satisfied:

$$(AIR) \quad EU_A = 1 - \bar{c} - t \geq 0 \text{ and } EU_S = \alpha t \geq 0.$$

Then we consider the incentive compatibility constraint of the agent (AIC) which make the expected payoff from the good manner no less than that from the bad manner, that is,

$$(AIC) \quad 1 - \bar{c} - t \geq 1 - \underline{c} - t - k\Delta c - p\rho F_A$$

The supervisor’s incentive compatibility constraint (SIC) assures him lower expected payoff when colluding with the agent than that without collusion, that is,

$$(SIC) \quad \alpha t \geq \alpha t + k\Delta c - p\rho F_S$$

Further, we should consider the coalition incentive compatibility constraint (CIC) between the supervisor and the agent. This constraint assures the supervisor and the agent’s joint surplus without collusion no less than that with collusion. But it is exactly the sum of AIC and SIC, so we can neglect it.

Finally, we should consider the constraint of the agent’s limited liability (ALL) as well as the constraint of the supervisor’s limited liability (SLL). The punishment they receive when possible should not exceed their actual revenues, that is,

$$(ALL) \quad F_A \leq 1 - \underline{c} - t - k\Delta c$$

and

$$(SLL) \quad F_S \leq \alpha t + k\Delta c.$$

According to our assumptions, SIR is satisfied automatically. We rearrange the other conditions as follows:

$$\text{Max}_{\{\alpha, t, F_A, F_S\}} (1 - \alpha)t$$

s.t.

$$(AIR) 1 - \bar{c} - t \geq 0$$

$$(AIC) k\Delta c + p\rho F_A \geq \Delta c$$

$$(SIC) p\rho F_S \geq k\Delta c$$

$$(ALL) 1 - \underline{c} - t - k\Delta c \geq F_A$$

$$(SLL) \alpha t + k\Delta c \geq F_S$$

According to the collusion-proof principle (Tirole, 1986), the optimal contract satisfying the above constraints should be collusion-proof and the principal can't be better off than that. Construct the Lagrange function and apply the Kuhn-Tucker theorem, we can solve the maximizing problem and obtain the Proposition 1 (The detailed proof is in the appendix 1.)

Proposition 1: Assumptions hold, the optimal collusion-proof contract has the following characteristics:

- (1) Both AIR and SIR are slack and all other constraints are binding;
- (2) All endogenous variables are determined by the following formula:

$$t^* = 1 - \underline{c} - k\Delta c - \frac{(1-k)\Delta c}{p\rho} < 1 - \bar{c}$$

$$\alpha^* = \frac{(1-p\rho)k\Delta c}{p\rho(1-\underline{c}) - (1+p\rho)k\Delta c}$$

$$F_A^* = \frac{(1-k)\Delta c}{p\rho}$$

$$F_S^* = \frac{k\Delta c}{p\rho}$$

$$(3) R = 1 - \bar{c} - t^* = (1-k)\left(\frac{1}{p\rho} - 1\right)\Delta c > 0$$

Proposition 1 indicates that the expected payoff of both the supervisor's and the agent's will exceed their reservation level, that is, they will obtain a positive information rent. This conclusion is obvious. Because the CG don't know the actual type of the firm's cost, to encourage the firm to adopt the good manner while prevents it colluding with the LGs, she should give them a positive information rent. Contrasting with the case of collusion-free, the collusion-proof contract reduces the welfare of the CG, otherwise it is not necessary to prevent the collusion. The expression (2)

shows that the optimal taxation rate is t^* , the optimal proportion the LGs get from the sharing system is α^* and the optimal punishments to the supervisor and the agent are respectively F_A^* and F_S^* . It's very intuitive for the expression of optimal punishment: the punishment should equal to their expected quasi-rents. In other words, under the limited liability constraint, once the collusion between the LGs and the firm happen, they will get nothing. If the punishment is lower than the optimal value, the expected payoff from collusion will be positive. Then the punishment will not deter any collusion. The expression (3) denotes that the firm's information rent is R , that is, if the firm chooses the good manner, he will get an extra bonus.

Proposition 2: The optimal collusion-proof contract has the following comparative statics:

- (1) $\frac{\partial t^*}{\partial \rho} > 0, \frac{\partial \alpha^*}{\partial \rho} < 0, \frac{\partial F_A^*}{\partial \rho} < 0, \frac{\partial F_S^*}{\partial \rho} < 0, \frac{\partial R}{\partial \rho} < 0;$
- (2) $\frac{\partial t^*}{\partial \Delta c} < 0, \frac{\partial \alpha^*}{\partial \Delta c} > 0, \frac{\partial F_A^*}{\partial \Delta c} > 0, \frac{\partial F_S^*}{\partial \Delta c} > 0, \frac{\partial R}{\partial \Delta c} > 0;$
- (3) $\frac{\partial t^*}{\partial k} > 0, \frac{\partial R}{\partial k} < 0.$

Proof is omitted. The meaning of Proposition 2 is intuitive. The expression (1) shows that the stronger the fourth party's monitoring ability, the higher the taxation rate, and the lower the firm's rent. It indicates that it will do better to the CG to improve the monitoring ability of the fourth party because a higher ability of the fourth party will reduce the reliance of the CG on the LGs to supervise the firm. So, when it is possible for the LGs to malpractice, the CG should protect the monitoring function of the media vigorously and encourage them to discover and expose the accidents. The expression (2) illuminates that the higher quasi-rent from different production manner, the lower the taxation rate for fear that the firm adversely chooses the production manner. At the same time, the punishment to the LGs and the firm should be leveled higher. Of course, a higher quasi-rent will induce a higher sharing proportion of the LGs and a higher information rent of the firm. The expression (3) indicates, the higher sharing proportion of the LGs in the total quasi-rent, the higher the taxation rate while the firm gets the lower information rent. Because the sharing proportion k the LGs get from the side contract with the firm is generally determined by his bargaining power, the less restricted are the LGs, the higher the taxation rate should be and the less the firm will get, which lowers the incentives of the firm to choose the good manner.

According to Proposition 2, there is a trade-off for the CG to rely on the LGs and the fourth party to monitor the firm. The stronger the fourth party's monitoring ability, the less will the CG rely on the LGs, and the more the CG will get. In another way, the more the CG gets, the less will the LGs get, and the lower will be the incentives of the LGs to monitor the firm. So, on one hand, to reduce the accidents, it is necessary to protect the media's legal rights to supervise especially to the extent of keeping insulated from the intervention of the LGs. On the other hand, the inappropriateness of revenue-sharing between the CG and the LGs will distort the incentives of the LGs. We will discuss it in the following section.

3.2 The role of damages

In the previous analysis we implicitly presumed that the damages to direct victim (e.g. coal miner) of accidents are trivial to the plentiful profits of the firm after the accidents happen. Actually the presumption is reasonable. Take the coal mines as an example. Data indicate that the average death tolls per 1 million ton coal are 4.46 during year 2000 to 2005. If the damages for a dead coalminer are 0.2 million RMB, the total damages per 1 million ton coal are 0.9 million RMB. The gross profits per ton are at least 100 million RMB, so the gross profits per 1 million ton coal are least 100 million RMB!⁸ Those workers of coal mining or firecracker industries are almost poor peasantry, whose reversion utilities are very low due to excess supply, so we can ignore their participation constraints theoretically. Assuming the damages of the accident is decided by law, what is the effect of the damages to optimal collusion-proof mechanism?

We still suppose the probability of accident per unit output is p , and the damages that the firm must pay for after the accident is m . Let we simply modify the optimal collusion-proof contract. The agent must pay for extra m under the condition (3) and (4), so accordingly the incentive compatibility constraint (AIC) and limited liability constraint (ALL) also change. After adding the damages, we get the following proposition 3.

Proposition 3: When the damages are below the critical value $\bar{m} = \frac{(1-k)(1-p\rho)\Delta c}{p(1-\rho)}$, the

optimal collusion-proof mechanism holds, and $\frac{\partial \alpha^*}{\partial m} < 0$, $\frac{\partial t^*}{\partial m} > 0$, $\frac{\partial F_A^*}{\partial m} < 0$.

The proof is in the appendix 2. The implication of Proposition 3 is that facing the damages over the critical value the agent will lost information rents and hence has no incentive to adopt the “good” manner, which invalidates the optimal collusion-proof mechanism. Below the critical value, the optimal collusion-proof mechanism holds, and the damages of accidents play the role of supervision and punishment to some extent. The higher the damages, the higher will be the firm’s actual costs to choose “bad” manner, and the heavier can be the tax, which are the supervision effect of damages; the higher the damages, the lower should be the punishment to the firm under limited liability constraint, which is the punishment effect of damages. We argue that if the actual damages are too low, the government can lift up the legal damages to give a positive incentive to the firm. However, although the damages have the supervision effect and punishment effect, the CG can’t depend on the damages too heavily. On one hand, too high damages will lead to too high risk to the firm, for in reality it is hard to avoid the accident for the firm even under normal conditions and the costs of legal enforcement are too high in transitional China; on the other hand, too high damages will induce the firm to conceal the accidents, and the collusion between the government and the firm will be more severe. Besides, the higher the damages, the more incentive will the victims or their kins have to conceal the accident together with the firm, which leads to the invalidation of official punishment.⁹ In fact, it is very important for the CG or the

⁸ Data from the website <http://www.coalworld.net.cn> and the related materials of China News Agency.

⁹ What the safety accidents (e.g. explosion) bring about are not only the direct damages of life or property to workers, but also polluted environment. If the direct victims (e.g. workers) don’t provide the evidence of the accidents, it will be hard for the indirect victims (e.g. local residents) to protect their interest.

media as the forth party to prevent the collusion that they get the evidence of the accidents from the victims or their kins. Given the too low reservation utilities of workers, how to establish appropriate damages is a delicate problem. Theoretically, the optimal damages are the function of the incentive of the firm choosing the production manner, the incentive of impeachment of the victim or their kin, the difference of the living standard in regions, and the costs of legal enforcement, and etc.

4 Equilibrium collusion: a further explanation of the reality

An obvious question is why there are still reoccurring accidents though the CG issued many orders to regulate production safety. The public media point their guns at collusion between the LGs and the firm. It indicates that the collusion between the government and the firm is exactly the main cause of accidents. They exist ubiquitously in today's China.¹⁰ Why doesn't the optimal collusion-proof contract apply? Here we relax some assumptions to explain the collusion in reality. After all, the above characterization is just a theoretical framework.

The following factors account for the existence of collusion:

(1) The cost for the CG to prevent collusion is too high.

We've implicitly assumed that preventing collusion will improve the social total welfare, but in fact it is not always. Supposed the principal does not consider preventing the collusion, then the self-interest supervisor and agent will collude with total social welfare $U^C = p(1 - \underline{c} - C) + (1 - p)(1 - \underline{c})$. Suppose the principal does try to prevent the collusion, then the total welfare is $U^{NC} = 1 - \bar{c}$. Obviously, if $U^C > U^{NC}$, that is $\Delta c > pC$, then allowing collusion is optimal. In other words, if the cost from the good manner is so high, compared with that from the bad manner, that it exceeds the extra social cost from the bad manner, and then it is optimal to allow collusion. Actually C is related with the period of social development and political environment. The lower the political pressure or the less the economic loss the accidents cause to the CG, the more will the CG tolerate the bad manner and the collusion.

(2) The myopia of the LGs.

We've implicitly assumed that the production cycle accords with the government tenure. But in fact, the tenure of the LGs officials is determined by multi-factors with some randomness. Suppose the LGs officials' discount rate is $\delta \in (0, 1]$, where $\delta = 1$ denotes they have long-lasting tenure. Then SIC turns out to be $\delta \alpha t \geq \delta(\alpha t + k\Delta c) - p\rho F_s$. It is also binding, so

¹⁰ We learn a typical case from the Chinese media. The Xinfu Coalmining factory in Qitaihe city of Heilongjiang province of China got a fire damp explosion in March 14, 2005, which killed 18 coal miners. What is startling is that the boss of the unqualified factory is actually the deputy director of SAWA of a district of Qitaihe city.

we obtain the optimal discount rate $\delta^* = \frac{p\rho F_s}{k\Delta c}$. If the tenure of the LGs is too short, or is broken up by an unexpected redeployment, then it will violate the incentive compatibility mechanism. Below the optimal value, the lower δ is, the lower will be the proportion the LGs get from the taxation. So they will have stronger incentives to collude with the firm.¹¹ Or they can realize their expected revenues from improving the bribe proportion k , which will violate the incentive of the firm to choose the good manner. Obviously it is not easy to reform the personnel system.

(3) The over-taxation on the firm.

In the optimal collusion-proof contract, we obtain the optimal taxation rate t^* , which considers the quasi-rents, the probability of accidents, the monitoring ability of the fourth party, and so on. But in fact, the taxation system is not established according to these factors. Once instituted, they should be kept for a long time for consistency. If $t > t^*$, the firm has no enough surplus to adopt the good manner.¹² As for the SOEs, deregulation is necessary to obtain their deserved information rents.

(4) The inability of supervision by the fourth party.

Because the CG doesn't know the type of the firm, to prevent collusion she should rely on the fourth party. Proposition 2 analyses the function of strengthening the fourth party to reduce the CG's dependence on the LGs monitoring ability. But under current systems, the media are often suppressed by the LGs. Those exposed are just a corner of an island. How to protect the legal rights of the media is a problem facing us.

(5) The commitment problem of the CG.

The commitment problem of the CG is manifested in the following two ways. On one hand, the officials dismissed for the safety production are redeployed in another position which nullifies the punishment. Anticipating sometimes CG's commitment of punishment is not credible, the LGs have no sufficient incentive to carry through CG's policies.¹³ On the other hand, once accidents occur, facing the pressures of the public, the CG often closes all firms of the same kind even the whole industry. This often causes the inconsistency problem which hurts the incentives of the firm to make long-term investments (Nie, 2005). To strengthen the reliability of the commitment problem, it is an important approach to improve the monitoring ability of the fourth party. It's fortunate that some authorities related to safety production supervision of CG have make promise

¹¹ To some extent, it is the reason that local governments connive those small coal kilns, small mines, and small firecracker factories. Because low-provincial local governments impossibly can benefit from the state-owned mine enterprises, but can benefit from the non-state-owned. However, due to the instable tenure, the local officials have not adequate incentive to adopt the good manner even they have stocks in the firm.

¹² The reason that many SOEs didn't adopt good manner is that SOEs lack necessary capital for technical and safe reconstruction due to the business recession before 1989. Meanwhile, the other reason is the regulation of "the coal subsidizing the power plants" by the state. According to the influential report of the investigation of 54 big coalmining factories and 462 coalmining wells by SAWA in 2005, about 68.9 billions RMB is needed to fill up the vacancy of safety production of all the key state-owned coalmining firms. (The Beijing News, Feb 8, 2006).

¹³ For example, the State Council of China required that all the staffs and the SOE's managements who had stock in coalmining firms draw back all their stocks before Sep 22 of 2005. However, there was even nobody to draw back until the deadline, and the majorities of provinces have to put off the deadline.

by central medias. For instance, the State Administration of Coal Mine Safety has published the process of closing those illegal coalmining firms on the People's Daily.

Actually, there are still other factors contributing to the collusion. What's more, the above factors are often interacting with each other, which make it more difficult to prevent collusion. Our analysis just offers an invoking reflection on the collusion problem.

5 A concluding remark

In this paper, we argue that it is the collusion between the local government and the firm that leads to both high rates of economic growth and accidents in China. In a Principal-Supervisor-Agent framework, we investigate an optimal collusion-proof mechanism. Our main conclusion is that strengthening the fourth party can effectively improve the welfare of the CG's and deter the abuse of the LGs. The interest distribution between the CG, LGs and the firm will influence the collusion. Our analysis offers a new micro-perspective to explain the relation between China's economic growth and institution evolution. In addition, because our model doesn't rely on the assumption that the principal is owner of the vertically structure, we can explain all collusion phenomena in the area of macro-control and micro-regulation, not limited in the agencies or public-operated firms.

The reality is always more complex than theories. In this paper, we didn't consider the unlimited liabilities or the criminal penalties which may perplex the analysis. We didn't consider the empowerment problem, either. Because social costs C can't be internalized, the empowerment can't improve social welfare except that the LGs are responsible for all costs in the long-run. How to analysis the commitment problem and the LGs tenure simultaneously needs future work.

Appendix 1: Proof of Proposition 1.

Construct the Lagrange function as follows,

$$L = (1 - \alpha)t + \lambda_1(1 - \bar{c} - t) + \lambda_2(k\Delta c + p\rho F_A - \Delta c) + \lambda_3(p\rho F_S - k\Delta c) + \lambda_4(1 - \underline{c} - t - k\Delta c - F_A) + \lambda_5(\alpha t + k\Delta c - F_S)$$

The first order conditions are:

$$\frac{\partial L}{\partial \alpha} = -t + \lambda_5 t = 0 \quad (1)$$

$$\frac{\partial L}{\partial t} = 1 - \alpha - \lambda_1 - \lambda_4 + \alpha \lambda_5 = 0 \quad (2)$$

$$\frac{\partial L}{\partial F_A} = \lambda_2 p \rho - \lambda_4 = 0 \quad (3)$$

$$\frac{\partial L}{\partial F_S} = \lambda_3 p \rho - \lambda_5 = 0 \quad (4)$$

We get:

$$\lambda_3 = \frac{1}{p\rho} > 0 \quad (5)$$

$$\lambda_5 = 1 \quad (6)$$

$$\lambda_1 + \lambda_4 = 1 \quad (7)$$

$$\lambda_4 = p\rho\lambda_2 \quad (8)$$

$$\lambda_5 = p\rho\lambda_3 \quad (9)$$

According to Kuhn-Tucker Theorem, all Lagrange multipliers $\lambda_i(\cdot) \geq 0$. When $\lambda_i > 0$, the respective constraints are binding; when $\lambda_i = 0$, the respective constraints are satisfied automatically.

Here is the discussion:

(1) If $\lambda_4 = 0$, we have $\lambda_1 = 1$, $\lambda_2 = 0$, and all constraints can be rearranged as follows:

$$t = 1 - \bar{c} \quad (10)$$

$$F_A > \frac{(1-k)\Delta c}{p\rho} \quad (11)$$

$$F_S = \frac{k\Delta c}{p\rho} \quad (12)$$

$$F_A < (1-k)\Delta c \quad (13)$$

Obviously expression (11) contradicts with expression (13), so we have $\lambda_4 > 0$, $\lambda_2 > 0$.

(2) If $\lambda_1 > 0$, the constraint can be organized as:

$$t = 1 - \bar{c} \quad (14)$$

$$F_A = \frac{(1-k)\Delta c}{p\rho} \quad (15)$$

$$F_S = \frac{k\Delta c}{p\rho} \quad (16)$$

$$F_A = (1-k)\Delta c \quad (17)$$

Obviously expression (15) contradicts with expression (17), so we have $\lambda_1 = 0$,

$\lambda_2 = \lambda_3 = \frac{1}{p\rho} > 0$ and $\lambda_4 = \lambda_5 = 1$, which means AIR is slack and all other constraints are binding. *QED*.

Appendix 2: Proof of Proposition 3.

After adding the damages, the new Lagrange function is:

$$L = (1 - \alpha)t + \lambda_1(1 - \bar{c} - t) + \lambda_2(k\Delta c + p\rho F_A + pm - \Delta c) + \lambda_3(p\rho F_S - k\Delta c) + \lambda_4(1 - \underline{c} - t - k\Delta c - F_A - m) + \lambda_5(\alpha t + k\Delta c - F_S)$$

First order conditions and Lagrange multipliers are same as those of the original equation in appendix 1.

Let us discuss the following cases:

(1) If $\lambda_4 = 0$, $\lambda_1 = 1$, $\lambda_2 = 0$, so the constraint conditions can be written as follows:

$$t = 1 - \bar{c} \tag{18}$$

$$F_A > \frac{(1-k)\Delta c - pm}{p\rho} \tag{19}$$

$$F_A < 1 - \underline{c} - t - k\Delta c - m \tag{20}$$

$$F_S = \frac{k\Delta c}{p\rho} \tag{21}$$

Let we rearrange the constraint conditions. Equation (19) turns to be $p\rho F_A + pm > (1-k)\Delta c$, equation (20) is $F_A + m < 1 - \underline{c} - t - k\Delta c = 1 - \bar{c} - t + (1-k)\Delta c$. According to our assumption, we know $p\rho < 1$, $p < 1$ and $1 - \underline{c} - t \geq 0$, so equation (19) and

(20) can't hold simultaneously. The case can't hold. So we have $m > \frac{(1-k)(1-p\rho)\Delta c}{p(1-\rho)}$.

(2) If $\lambda_4 > 0$, there are two cases:

(a) If $\lambda_1 > 0$, all the Lagrange multipliers exceed 0, and namely all the constraint conditions are binding. According to above analysis, we know equation (19) and (20) can't hold simultaneously, so the assumption can't hold. Meanwhile $m = \frac{(1-k)(1-p\rho)\Delta c}{p(1-\rho)}$.

(b) If $\lambda_1 = 0$, all the other Lagrange multipliers exceed 0. That is to say, all the constraints are binding except for condition (AIR).

We get:

$$\alpha^* = \frac{(1-p\rho)k\Delta c}{(1-\underline{c}-m)p\rho - (1-k+p\rho k)\Delta c + pm} \quad (22)$$

$$t^* = 1 - \underline{c} - k\Delta c - m - \frac{(1-k)\Delta c - pm}{p\rho} \quad (23)$$

$$F_A^* = \frac{(1-k)\Delta c - pm}{p\rho}$$

(24)

$$F_A^* = \frac{k\Delta c}{p\rho} \quad (25)$$

Combining condition (AIR) and equation (23), we have $m < \bar{m} = \frac{(1-k)(1-p\rho)\Delta c}{p(1-\rho)}$.

Intuitively, with the asymmetrical information, the agent have incentives to adopt the “good” manner only when he can attain positive information rents. Hence the optimal collusion-proof mechanism holds when the damages are below the critical value \bar{m} . It is easy to show

that $\frac{\partial \alpha^*}{\partial m} < 0$, $\frac{\partial t^*}{\partial m} > 0$, $\frac{\partial F_A^*}{\partial m} < 0$. **QED.**

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