SOE Inspections and Firms' Policies in China

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Abstract

This paper examines how inspections of central State-Owned Enterprises (SOEs) in China affected the corporate decisions and performance of companies controlled by the inspected SOEs. Using Chinese firm-level data, we find that companies controlled by indicted SOEs experienced lower performance and reduced investments in the aftermath of the inspections, compared with companies controlled by non-indicted SOEs. We also find that, after the inspections, companies controlled by indicted SOEs increased expenditures in environmental protection and poverty alleviation, and received higher Environmental, Social, and Governance (ESG) ratings. We propose a principal-agent model with repeated moral hazard that can capture the empirical findings and use the model to show how changes in monitoring, inspections, and tenure limits affect allocation efficiency.

JEL: D82, E22, G32

Key words: Optimal contracts, SOEs policies, firm dynamics

1 Introduction

As part of the anti-corruption campaign, the management of the most prominent State Owned Enterprises (SOEs) have been inspected and some of the inspections resulted in management indictments. In this paper we ask how the outcome of the inspections impacted the performance and corporate policies of companies controlled by the inspected SOEs. Using firm-level data for the public traded companies controlled by the inspected CEO we find that:

1. Post-inspection investment and corporate performance in companies controlled by SOEs with indicted officials declined compared to companies controlled by non-indicted SOEs.
2. Post-inspection expenses in environmental protection, poverty alleviation and ESG score, all increased in companies controlled by indicted SOEs compared to companies controlled by non-indicted SOEs.
3. A significant number of managers of non-indicted SOEs received some promotion such as higher management position, more job titles or election to board membership.

These findings suggest that the anti-corruption campaign impacted corporate policies in ways that enhanced the social goals set by the central authority. But why did inspections affect corporate policies in the ways we observed in the data? Why did corporate performance worsen after the indictment? If there was mismanagement in central SOEs, the replacement with new managers should affect positively, if at all, the performance of the controlled companies. Perhaps, the replacement of the indicted managers was done inexperienced managers. The consequent loss of management skills then, could explain lower investments and performance.

This interpretation, however, is unlikely to be the primary channel. The corporate investments and performance observed in thet data are for companies that are controlled by the inspected SOE, not for the controlling SOE. Even if the new managers of indicted SOEs might be less experienced, it is unlikely that this will have such an immediate and significant impact on the productivity of the controlled companies. The replaced managers are very high officials and do not typically deal with day-to-day operations of the controlled companies. Also, it is not obvious why the controlled companies would spend more in environmental and other social programs after the indictment of the controlling SOE. Even if we could attribute the lower corporate performance to the inexperience of the newly appointed managers, it is still difficult to explain why unexperience managers would pay more attention to social policies. Instead, we propose a theory with conflicts of interest and agency frictions between the central government and the managers of central SOEs. The different policies chosen by companies controlled by indicted and non-indicted SOEs are then just the results of optimal and incentive-compatible contracts.

The theory is based on a principle-agent model with two types of agency frictions. The first is a standard moral hazard problem: due to information asymmetry, managers can divert some of the firm's resources for their own personal gain. This friction is important for generating a managerial compensation that increases with corporate performance.

The second agency friction is in the unobserved allocation of managerial skills between market and social activities. We assume that managers benefits more than the central authority by focusing on market activities rather than social activities. Corporate inspections could reveal the allocation of skills between market and social activities, but only with some probability. The only way to mitigate these conflict of interest is for the central government to design a contract that maximizes its value taking into account the constraints imposed by the agency frictions.

The optimal structure of the contract captures the empirical properties found in the data. In particular, following an indictment for corruption, corporate investment and performance decline compared to firms without indictment. Also, following an indictment, firms spend more on social programs compared to firms without managerial indictment. Although the model does not have a formalized system of managerial promotion, it does predict that the compensation of managers increases, on average, if there is not indictment. To the extent that the increase in compensation could be related to career promotion, the prediction of our model is consistent also with the third fact, that is, the observation that a significant number of managers are promoted if the controlling SOE is not indicted.

Our theory relates to contributions that study a dynamic principal-agent model with information frictions and moral hazard starting with Spear and Srivastava (1987) and Thomas and Worrall (1990). These papers provided a methodology that has been applied to characterize various problems such as executive compensation, investment and firm dynamics (e.g., Wang (1997), Quadrini (2004), Clementi and Hopenhayn (2006), DeMarzo and Fishman

(2007)).[1]

Most of these studies, however, focused on the principal-agent problem in typical 'private firms' where the principle (for example, shareholders) cares only about the market value of the firm. In contrast, SOEs have a broader objective which includes a variety of social responsibilities.[2] Because of the social objectives, which are additional to the typical market objectives, the performance of SOEs is difficult to assess and verify. This greatly complicates the agency problem between the principle (government) and the agent (SOEs' managers). We also study how monitoring and inspections could alleviate the contractual frictions in SOEs.[3]

Another difference with the more traditional literature, is that our model features two types of moral hazard. The first is the ability of the manager to divert resources for personal benefit. The second is the ability to allocate more effort or skills toward SOE's market activities as opposed to social activities, which also benefits the the manager. We will see that both types of moral hazard are necessary for the optimal contract to capture the key empirical finding described above.

The empirical analysis of the paper is also related to studies that investigate the effects of the recent China's anti-corruption campaign. Xu (2018) finds that anti-corruption regulation reduces firm value through a disincentive channel. Chen, Xie, You, and Zhang (2018) find that stock market investors react negatively to the release of corruption scandals. However, the crackdown of corruption also lowers the risk of future stock price crashes. Ding, Fang, Lin, and Shi (2020) find that the Chinese stock market responded positively to the announcement of strong anti-corruption actions, with stronger effects on private, small-sized, and non-politically connected firms. Our pa-

[1] DeMarzo and Sannikov (2006) and Sannikov (2008) provided a continuous-time version of dynamic principal-agent model with hidden actions, which is also widely used in the literature. Examples include Zhang (2009), DeMarzo, Fishman, He, and Wang (2012), Miao and Rivera (2016), Ling, Miao, and Wang (2021).

[2] Lin, Cai, and Li (1998), Lin and Tan (1999) and Bai, Li, Tao, and Wang (2000) study the moral hazard problems of SOEs that take many 'policy burdens' during the economic transition of China in the mid 1990s. The 'policy burden' during the economic transition considered in these papers are in the form of employment and social stability. After the economic transition, the size of SOEs significantly declined relative to private firms and the 'policy burdens' of remaining SOEs were also reduced (Fan, Kanbur, Wei, and Zhang (2014), Iyer, Meng, Qian, and Zhao (2019) and Fang, Li, Wu, and Zhang (2023)).

[3] Chen, Sun, and Xiao (2020) studies the optimal monitoring schedule using a dynamic contracting model based on Sannikov (2008).

per looks beyond the stock market reaction and focuses on the impact of inspections on specific corporate policies such as sales and investment, and also on social indicators such as ESG rating, expenditures on environmental protection, and donations for poverty alleviation.[4]

The paper is organized as follows. In Section 2 we describe the institutional environment in which political inspections take place. This sets the stage for the empirical and theoretical analyses. Section 3 conducts the empirical analysis and documents the main empirical facts. Section 4 describes the basic structure of the model and characterizes its properties. Section 5 extends the model and shows that the model can capture the empirical observations characterized in the empirical section of the paper. Section 6 discusses possible normative mechanisms that could improve allocations and Section 7 concludes.

2 Institutional environment

Before the presentation of the empirical and theoretical analyses, we describe here the institutional environment which is important for understanding the level of the organization in which agency frictions arise and how the outcome of inspections could affect corporate policies. This is also important for the design of the empirical analysis.

State Owned Enterprises (SOEs) conduct commercial activities on behalf of the Chinese government and the Communist Party of China (CPC). They are dominant in some key industries such as energy, telecom, transportation, and finance. According to the latest economic census in 2018, SOEs' total assets account for approximately 56.3% of the whole country's assets. Because of the strategic sectors in which they operate, SOEs are often solicited to pursue social objectives that differ from those of purely market-oriented corporations. This could generate conflicts of interest between the management of the SOEs and the central authority. These conflicts are additional to the typical agency frictions that emerge in private corporations between managers and other stakeholders. To the extent that managerial decisions cannot be verified, managers have the ability to choose policies that are not fully aligned with the objectives of the central authority. Since deviations

[4] Chen, Chen, Liu, Suárez Serrato, and Xu (2021) study the effects of energy regulation on firms in China and find that regulated firms not only reduce output but also shifted some production to unregulated firms.

from the recommended policies could bring personal gains to managers, they can be classified as corruption cases.

The Chinese Central Commission for Discipline Inspection (CCDI) has conducted discipline inspections in many SOEs as part of the anti-corruption campaign initiated by President Xi Jinping. The aim of the inspections was to reinforce the leadership of the CPC and improve SOEs' implementation of CPC's policies and directives. President Xi placed significant effort in building a disciplined, ideologically committed, and politically loyal organization. Because of high-profile and large-scale investigations and arrests, the campaign was considered the largest anti-corruption campaign in the history of China.

In addition to detecting corruption, the goal of the CCDI is also to provide instructions to central SOEs on how to align their business strategies with the state-led development vision, and improve the implementation of the administration's political and economic reform agenda. This includes financial reform, environmental protection, and poverty alleviation. An example is the "Eight Rules" formulated by President Xi in December 2012, then extended in October 2017.

CCDI started the inspections in May 2013 and targeted 55 central SOEs. As of year 2019, there were 128 central SOEs in China. However, the inspected SOEs were only those in which the management included officials at the rank of 'ministry'. The top management of the other central SOEs was at the lower rank of general bureau or department. In 10 of the 55 inspected SOEs, the chairmen and top leaders were indicted for corruption. The appendix provides the complete list of the inspected central SOEs. We will use the indictment of a central SOE as an external shock to companies controlled by convicted SOE, and investigate how this shock affected the corporate policies of these companies.

Figure 1 illustrates the governance structure of State-Owned Enterprises. At the top there is the central government which provides general directions to the central SOE. The central SOE is, effectively, a holding company managed by government appointed officials. Being a holding company, the SOE controls many firms whose policies should also be aligned to the general government directives. But the implementation of these directives relies on the action of the central SOE. Although there could be distinct agency frictions in both layers of the organization (central government with central SOE and central SOE with controlled firms), in this study we focus on the agency frictions that emerge in the first layer of the organization, that is, between

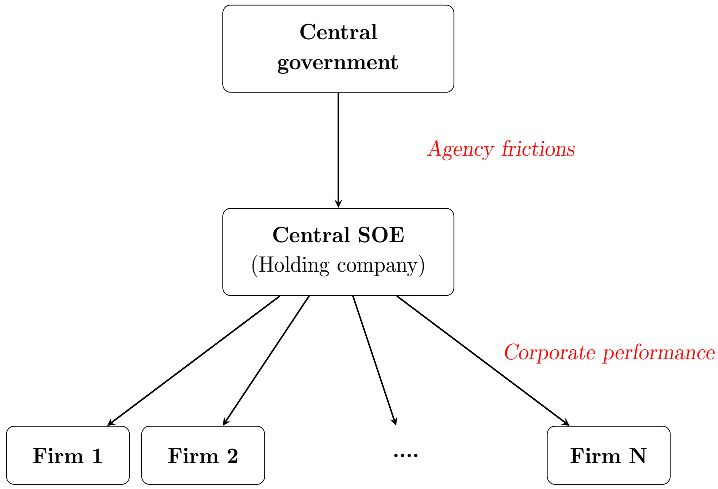

Figure 1: Governance structure of Chinese SOEs.

the central government and the central SOE. Because of the agency frictions, the corporate policies of the firms located at the bottom of the organization may not be perfectly aligned with the objectives of the central government. Indicted SOEs are probably less observant of the central government's directives. An indictment then should lead to a change in the corporate policies of firms controlled by the indicted SOEs, compared to firms controlled by SOEs that are not indicted. This is the key insight underlying our empirical analysis.

3 Empirical analysis

We collect data on public traded firms that are controlled by inspected central SOEs. Effectively, these firms are subsidiaries of the inspected central SOEs. We find 173 public traded firms that are controlled by (they are subsidiaries of) central SOEs. For each of these firms we have data for operational activities and balance sheet at the quarterly frequency, as well as management's background.

We use mainly two firm-level databases. The first is the China Stock Market and Accounting Research (CSMAR) from which we obtain firm-level information on balance sheet, investment, labor, ownership structure and so on. We use that the Chinese Business Registration System and public listed firms' shareholding disclosure statement to determine the listed firms that are controlled by central SOEs. After selecting the sample of controlled firms, the empirical analysis will use the quarterly firm-level data from CSMAR. Since the anti-corruption campaign started in 2012, we restrict our sample to the five years before and after the starting year of the campaign. Thus, our sample is a quarterly panel over the period 2007-2017.

The second database is the ESG (Environmental, Social, and Governance) rating of Chinese public listed firms provided by Bloomberg. This is available at an annual frequency. The ESG rating evaluates a company's performance in sustainability and social responsibility, and results from the aggregation of various indicators such as environmental impact, innovation, labor relations, board structure, charity and social media reports.

3.1 Inspections and corporate performance

The goal of the empirical analysis is to investigate how the outcome of the inspections conducted on the 55 controlling SOEs impacted on the corporate performance of the companies controlled by the inspected SOEs. We do that by estimating the following regression equation:

$$Y_{i,t} = \alpha + \beta_1 Post_{i,t} + \beta_2 Corrupt_{i,t} + \beta_3 Post_{i,t} \cdot Corrupt_{i,t} + \gamma X_{i,t} + \varphi_i + \theta_t + \varepsilon_{i,t}. \tag{1}$$

The subscript i is the index for the firm included in the sample (a firm controlled by the inspected SOE) and the subscript t is for time (a quarter). The dependent variable $Y_{i,t}$ is a firm-level measure of corporate performance. We consider five measures: (i) investment, (ii) total factor productivity (TFP), (iii) Tobin's Q, (iv) return on equity (ROE), and (v) return on asset (ROA).

On the right-hand-side of the regression equation we have the variable $Post_{i,t}$ which is a firm-level dummy taking the value of 1 if the central SOE that controls company i has been inspected by the CCDI. The variable $Corrupt_{i,t}$ is a dummy that takes the value of 1 if the chairman or managers of the central SOE that controls company i have been indicted for corruption. The term $X_{i,t}$ contains firm-level controls, including leverage ratio, cash flow, age, and size. We include firm fixed effects, ε_i, and time fixed effects, θ_t, to control for unobserved omitted variables. The last variable $\varepsilon_{i,t}$ is the error term.

We allow for clustering at the level of central SOEs to account for the presence of serial correlation in the data. Remember that the data contains information for each firm controlled by a central SOE that is subject to inspections. This implies that some firms included in the sample are controlled by the same central SOEs.

Table 1 presents the results from the estimation of Equation (1). A key parameter is β_3, that is, the coefficient for the interaction between the dummies $Post_{i,t}$ and $Corrupt_{i,t}$. The coefficient measures the impact that the indictment of a controlling SOE has on the performance of the controlled companies, relatively to companies with controlling SOE that has not been indicted (either because the controlling SOE has not been inspected or the inspection did not find evidence of corruption). We can see that the estimated parameter is negative and statistically significant at 5 percent confidence interval (except for ROA where the significance is at 10 percent). This shows that the indictment of the controlling SOE has a negative impact on corporate investment and performance.

3.2 Inspections and social policies

The purpose of inspections is to ensure that the corporate policies of the controlled companies align with the main goals of the Chinese government. The government goals are broader than the typical corporate objectives and they have a stronger emphasis on social considerations. The goal of central SOEs is to insure that the corporate policies of the controlled companies are more aligned with the government objectives. Still, the central SOEs may not be effective in shaping the corporate policies of the controlled companies consistently with the social goals of the government. Then inspections could be important for reshaping their policies toward more active social objectives. We would like then to test whether inspections affect the social policies of the corporate sector.

During the anti-corruption campaign, President Xi initiated two important domestic policies. The first was the poverty alleviation program, announced in 2015, with the goal of eradicating absolute poverty in China by the end of 2020.[5] The second initiative was the anti-pollution program, which aimed to address the environmental impact of China's rapid economic

[5]The original articles can be found in the government official public media web sites: `http://www.xinhuanet.com/politics/2015-11/28/c_1117292150.htm`, and `http://politics.people.com.cn/n/2015/1124/c1001-27849715.html`

Table 1: Impact of indictment on corporate investment and performance of companies controlled by inspected SOE.

	Investment	TFP	TobinQ	ROE	ROA
	(1)	(2)	(3)	(4)	(5)
Post	-0.003**	0.047	-0.180	-0.004	-0.003
	(-2.18)	(0.68)	(-1.40)	(-0.51)	(-1.31)
Post×Corrupt	**-0.005****	**-0.210****	**-0.432****	**-0.035****	**-0.008***
	(-2.10)	**(-2.65)**	**(-2.49)**	**(-2.44)**	**(-1.68)**
Leverage	-0.003	0.673**	-2.538**	-0.169***	-0.068***
	(-1.11)	(-2.50)	(-4.45)	(-5.00)	(-7.88)
Cash Flow	0.014**	2.024***	0.635*	0.261***	0.112***
	(2.54)	(8.71)	(1.73)	(4.89)	(5.01)
Age	-0.013***	-0.017	-0.064	0.003	-0.006
	(-4.38)	(-0.15)	(-0.21)	(0.18)	(-1.19)
Size	0.002***	-0.293	-0.257	0.003	0.001
	(4.17)	(-7.59)	(-2.98)	(0.98)	(0.66)
Constant	0.040**	1.959***	3.711***	0.074*	0.051***
	(6.27)	(5.49)	(6.07)	(1.90)	(3.49)
Firm F.E.	Yes	Yes	Yes	Yes	Yes
Time F.E.	Yes	Yes	Yes	Yes	Yes
Observations	7,062	7,714	7,062	7,073	7,062
R^2	0.384	0.740	0.704	0.363	0.513

Note: This table presents results from panel regressions on firm-level quarterly Investment, TFP, Tobin's Q, ROE and ROA from 2007Q1 to 2017Q4. $Post_{i,t}$ is a dummy equal to 1 if the SOE that controls firm i has been inspected in any of the quarters before t. $Corrupt_{i,t}$ is a dummy equal to 1 if the chairman or managers of the controlling SOE have been indicted in any quarter before t. $TFP_{i,t}$ is total factor productivity. $TobinQ_{i,t}$ is ratio of market value to book value of assets. $ROA_{i,t}$ is the ratio of net income to total assets. $ROE_{i,t}$ is the ratio of net income to book value of equity. $Leverage_{i,t}$ is the ratio of total debt to total assets. $CashFlow_{i,t}$ is the ratio of net operating cash flow to total assets. $Age_{i,t}$ is the natural logarithm of one plus the number of years listed. $Size_{i,t}$ is the natural logarithm of total employment. t-statistics are shown in parentheses. The superscript ***, **, or * indicates statistical significance at the 1%, 5% or 10% level, respectively.

expansion in the 1990s and 2000s. This period of growth was characterized by intensive energy use and a consequent rise in carbon emissions.

To examine the impact of the inspections on the social policies of the controlled firms, we use the Environmental, Social and Governance (ESG) score for these companies.We re-estimate equation (1) but using the ESG score as the dependent variable. The regression results, reported in the first column of Table 2, show that firms controlled by indicted SOEs received a higher ESG score after the indictment, compared to firms controlled by non-indicted SOEs. The other columns in the table show that the rise in the ESG score derives, mainly, from the rise in the Environmental and Social components of ESG. The change in the Governance is not statistically significant.

Table 2: The impact of indictment on firm ESG rating.

	ESG.	Environmental	Social	Governance
	(1)	(2)	(3)	(4)
Post	-0.710	-1.391***	0.130	-0.119
	(-1.55)	(0.68)	(0.18)	(-0.18)
Post×Corrupt	**2.214*** **	**2.529** **	**3.476*** **	**-0.089**
	(2.92)	**(2.65)**	**(2.85)**	**(-0.07)**
Leverage	2.643	3.976	1.913	-0.746
	(0.91)	(1.18)	(0.51)	(-0.44)
Cash Flow	0.889	1.086	0.050	1.010
	(0.71)	(0.72)	(0.03)	(0.88)
Age	-0.833	-1.052	1.799	-4.367**
	(-0.40)	(-0.47)	(0.70)	(-2.44)
Size	0.002	-0.881	-0.781	-0.045
	(-1.57)	(-1.57)	(-0.94)	(0.254)
Constant	27.779***	19.513***	26.027***	0.074*
	(5.24)	(3.45)	(3.61)	(1.90)
Firm F.E.	Yes	Yes	Yes	Yes
Time F.E.	Yes	Yes	Yes	Yes
Observations	3,049	2,842	2,978	3,049
R^2	0.839	0.785	0.849	0.764

Note: This table presents results from panel regressions on firm-level yearly ESG rating scores from 2011 to 2017. ESG refers to the ESG (Environmental, Social and Governance) score. Post is an indicator equaling one if a firm has been inspected by the end of the quarter. Corrupt is a dummy variable equaling one if a chairman or manager of the inspected central SOE was indicted for corruption after the inspections. TFP is total factor productivity. Tobin's Q is ratio of market value of assets to book value of assets. ROA is the ratio of net income to total assets. ROE is the ratio of net income to book value of equity. Leverage is the ratio of total debts to total assets. Cash Flow is the ratio of net operating cash flow to total assets. Age is the natural logarithm of one plus the number of years listed. Size is the natural logarithm of total employment. T-statistics values are shown in parentheses. The superscript ***, **, or * indicates statistical significance at the 1%, 5% or 10% level, respectively.

3.3 Empirical evidence on environmental protection and donations

To further investigate the impact of SOEs indictment on the change in social policies of the controlled companies we use expenditures data on environmental protection and donations to reduce poverty (a category called Targeted Poverty Alleviation) provided in the annual report. Firms reported their expenditures on environmental protection in the years 2009-2017, and donations to reduce poverty since 2016. We use these variables to assess the statistical difference between two groups of firms: those controlled by central SOEs where the top management was convicted with corruption and those controlled by central SOEs without management conviction. Since data on environmental protection expenditures and donations is available only annually, the analysis will now be conducted at an annual frequency.

Table 3 reports the average expenditures in environmental protection for the two groups of firms. The comparison is based on firm-level averages over the period of 2016-2020. The result suggests that firms controlled by indicted SOEs donated more to reduce poverty and invested more in environmental protections, compared to firms controlled by non-indicted SOEs.

Table 3: The impact of inspection outcome on environmental protection and poverty alleviation expenditures.

	Companies controlled by indicted SOEs	*Companies controlled by non-indicted SOEs*
Investment in environmental protection	144.7	573.8
Donations to reduce poverty	7.49	21.45

Note: The table reports averages of yearly firm-level donations to reduce poverty and expenditures on environmental protection over the period of 2016-2020, in millions of RMB.

Figure 2 presents the change in firm expenditures on environmental protection and shows that the expenditures made by firms controlled by indicted SOEs increased sharply after 2015, that is, after the inspection period. For firms controlled by non-indicted SOEs, instead, we do not see a significant change.

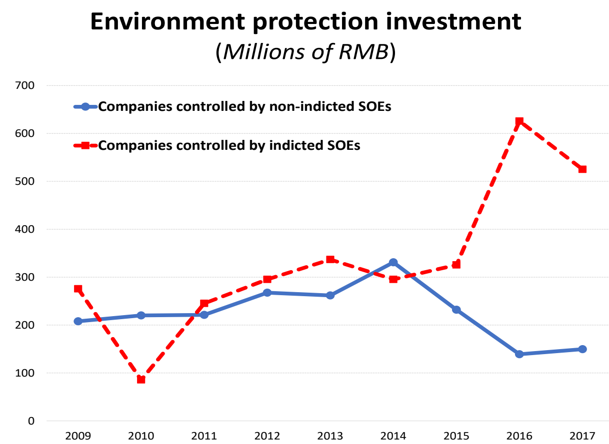

Figure 2: The impact of the inspection outcome on environmental protection investment.

3.4 Inspections and promotions

Does indictment affect the promotion prospect of managers in companies controlled by inspected SOEs? To address this question we manually collect all public announcements made by listed companies during the sample period. We identify 136,796 announcements from 173 listed companies. On these announcements we apply text analysis techniques to extract specific information pertaining to changes in management roles by using keywords such as “promotion”, “joining the board”, “appointment as board member”, and “concurrent positions”.

To determine whether managers have been promoted, we also use historical data regarding their position and compare the original job title(s) with the changes in job positions stated in the public announcements. We categorize promotions into three types. The first type is a vertical promotion. For example, a deputy manager is promoted to the position of chief manager. The second type occurs when a manager is elected to a board position, such as a regular board member or an executive director. The third type features addition of job titles. For instance, a manager may receive additional titles such as chief financial officer, chief accountant, or party secretary.

We find that managers of companies controlled by SOEs that were not indicted received more promotions compared to companied controlled by indicted SOEs. Figure 3 illustrates the number of managers who received promotions in each year in companies controlled by non-indicted SOEs and in companies controlled by indicted SOEs. The graph shows a notable promotion surge in 2016 and 2017 but only in companies controlled by non-indicted SOEs.

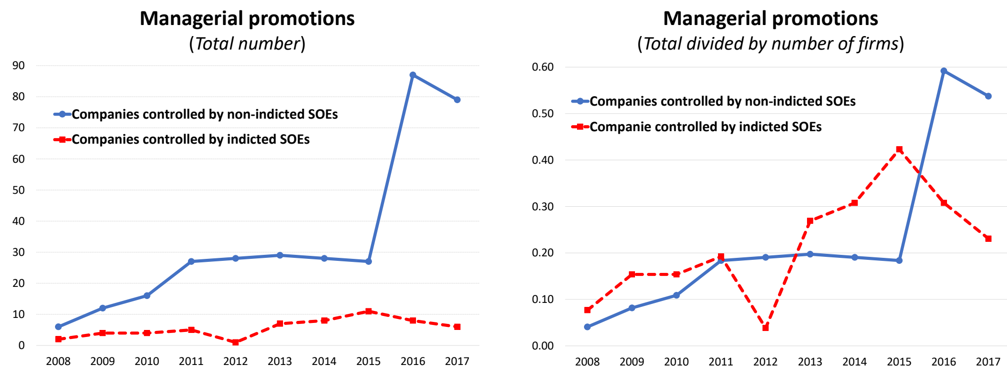

Figure 3: The impact of the inspection outcome on managerial promotions.

3.5 Discussion

The empirical analysis provides evidence that indictment of central SOEs' management affected adversely the investment and performance of the controlled companies. At the same time, the affected companies allocate more resources to social objectives like pollution abatement and poverty reduction—policies that appear to be more aligned to the objectives of the central government. As discussed in the introduction, it might be presumed that the lower corporate performance is the direct consequence of replacing skilled and experienced managers with new and less experienced management. We question whether this is the primary explanation.

First, the replaced managers are those operating in central SOEs, not in the controlled companies where we observed the decline in corporate performance. These managers are unlikely to be directly involved in the ordinary management of the controlled firms. It seems implausible then that their removal could have such a significant impact on the operational efficiency of the controlled firms. Rather, the decline in investment and performance could be the consequence of a shift in corporate policies towards different objectives, something that the top managements of central SOEs can clearly impose on the controlled firms.

The shift in objective is consistent with the second evidence presented in this section, that is, the fact that expenditures on pollution abatement, poverty reduction and ESG score all rise following the indictment of the controlling SOE. Clearly, these are important objectives for the central authorities and, perhaps, an event of corruption could be interpreted as evidence that the indicted management did not fully abide to the objectives of the central government.

In the next section we propose a theoretical model that can generate the empirical findings presented here as a result of optimal arrangements between the central government and central SOEs. The theoretical model formalizes the idea that there are conflicts of interest between the central authority and the top management of central SOEs. Because of limited enforceability, the actual policies implemented by the SOEs could deviate from the mandate of the central government and the only way to check this is through inspections. But inspections could also fail to reveal whether central SOEs truly deviated from the mandates. Because of the imperfect nature of inspections, managers may chose to deviate from the recommended policy since they will not be disciplined with certainty if they choose to deviate. This, in turn, allow for equilibria in which inspections could result in indictments.

4 The Model

Consider a manager running a SOE. The SOE uses capital and managerial inputs to produce market output and social services. Market output is $y_t^M = z_t k_t$, where $z_t \in \{z_L, z_H\}$ is stochastic productivity (shock). The realization of productivity z_t is private information since it is observed only by the manager. This introduces the first source of moral hazard in the model. As we will see, this implies that in an optimal arrangement the compensation of the manger must increase with the size of the firm, that is, the input of capital k_t.

The second source of moral hazard derives from the assumption that the probability distribution of the shock z_t depends on the allocation of managerial skills. The manager has the option to allocate the discretionary part of his/her skills to two activities: market or social activities. The allocation of skills is also private information. By allocating the discretionary skills to market activities, the manager increases the probability that the realization of productivity is high, that is, $z_t = z_H$. For notational convenience we denote the probability distribution of z_t by $\varphi(z_t|e_t)$, where e_t is the dummy variable that takes the value of 1 if the manager allocates the skills to market activities and zero otherwise. We can then indicate the impact of skill allocation on the probability distribution of the shock as $\varphi(z_H|e = 1) > \varphi(z_H|e = 0)$.

The production of social services is $y_t^S = A + s(e_t)k_t$. The term $s(e_t)$ denotes the productivity of capital in social services as a function of the allocation of managerial skills e_t. The assumption is that $s(e_t = 1) < s(e_t = 0)$, meaning that productivity in social services decreases when the manager allocates the skills to market activities (remember that $e_t = 1$ means that skills are allocated to market activities).

The assumption that the whole skills are allocated either to market activities or social services is without loss of generality. What matters is that the manager has some discretion in choosing the allocation of some skills between the two activities and the dummy e_t represents the discretionary portion. Adopting this interpretation, the manager always allocates some skills in both activities but the exact proportion can be changed within a certain range.

An important assumption is that e_t and the production of social services are not publicly observable. This implies that the principle—which in the model is the central authority—is unable to infer the allocation of managerial skills e_t from the production of social services. As observed above, this introduces a second source of moral hazard additional to the one created by the non-observability of z_t.

For notational convenience we denote the sum of social services and market output, $y^S + y^M$, with the function

$$F(k_t, z_t, e_t) = A + \Big[s(e_t) + z_t\Big]k_t.$$

Total production is linear in capital k_t with a constant $A > 0$. The linearity simplifies the characterization of the optimal contract while the constant A ensures that the initial value of the contract for the principle is positive. We will discuss the importance of adding A when we characterize the optimal contract.

Assumption 1 *Total production (sum of social and market output) is bigger when skills are allocated to social services, that is,*

$$\sum_z F\Big(k_t, z, e_t = 0\Big)\varphi(z|e_t = 0) > \sum_z F\Big(k_t, z, e_t = 1\Big)\varphi(z|e_t = 1).$$

This assumption implies that it is socially optimal to allocate managerial skills to the production of social services. However, the central authority does not have direct control over the allocation of managerial skills. Therefore, the social optimal allocation will be achieved only if the manager has an incentive to do so and it is not too costly for the central authority to provide incentives to the manager.

Managers care about their expected lifetime utility $\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t c_t$, where $c_t \geq 0$ is consumption and β is the inter-temporal discount factor.

Contractual frictions: The allocation of skills e_t and productivity z_t are private information and they are not observed by the central authority. As hinted earlier, this creates two moral hazard problems. First, the manager could divert part of the market output by claiming that the realization of productivity is low. The output diverted is $(z_H - z_L)k_t$. A fraction γ will be consumed by the manager while the remaining fraction will be lost. Second, the manager could allocate his/her skills to market activities to increase the probability that $z_t = z_H$. This raises the expected value of diversion $\gamma(z_H - z_L)\, k_t\, \varphi(z_H|e)$. For notational convenience we define $\alpha = \gamma(z_H - z_L)$. We can then write the value of diversion when the realization of productivity is high as αk_t.

Inspections are one of the instruments used to alleviate the second source of moral hazard. If a manager has deviated from the socially optimal allocation of skills, that is, $\eta_t = 1$, there is a probability η that an inspection reveals the deviation. We denote by d_{t+1} the outcome of the inspection: It takes the value of 1 if it reveals a deviation. Importantly, an inspection reveals the true value of e_t only if a deviation is observed. It does not reveal whether the manager did not deviate.[6]

If a deviation is not observed (i.e., $d_{t+1} = 0$), the manager will continue on the current managerial position. If caught deviating (i.e., $d_{t+1} = 1$), the manager is indicted and replaced by a newly hired manager. The reservation value for the indicted manager is q_R. We further assume that indictment also prevents the manager from diverting revenues (in this case γ becomes zero). The modeling of inspections captures the fact that the CCDI's ultimate goal is to align the SOEs' corporate policies with the CCP's social goals.[7]

[6]With this assumption, when a deviation is not observed, the principle cannot distinguish whether this is because the manger did not deviate or because the inspection failed to discover the deviation. In other words, an inspection could reveal $e_t = 1$ but not $e_t = 0$.

[7]We could assume that the reservation value for the indicted manager is lower than q_R

The final assumption is that there is an exogenous probability $1 - \rho$ that the manager quits. We will denote by λ_t the binary variable that takes the value of zero when the manager quits and 1 when the manager continues. Quitting arises after production. Exogenous quitting allows us to have a structure in which the manager will be paid at some point rather than postponing payments forever. As we will see, it is optimal to make payments to the manager only upon exogenous quitting.

Timing: At the end of the period t the SOE (interpreted as the aggregation of all controlled companies) invests in capital k_{t+1} and the manager chooses the allocation of skills e_{t+1}. At the beginning of the next period, after observing whether the manager continues (which happens with probability ρ), an inspection takes place. If the manager is caught deviating ($d_{t+1} = 1$), he/she will be replaced by a newly hired manager. If not ($d_{t+1} = 0$), the manager remains in the current position. Notice that quitting, which happens with probability $1 - \rho$, becomes known at the beginning of the period but the actual separation arises at the end of the period after production and diversion have taken place.

4.1 Recursive formulation of the long-term contract

Our goal is to characterize the optimal contract between the principle (central authority) and the agent (the manager). We formalize the contractual problem as the maximization of the principle's value subject to the constraint that the manager does not divert revenues, and subject to the participation constraint. The problem is made stationary by introducing promised utility as a state variable.

Denote the manager's promised utility *after* current consumption by q. For each q, the contract chooses the new capital, next period manager's consumption, and next period continuation utility. Next period consumption and continuation utility are conditional on three states: whether the manager

as a result of a more direct punishment. This would not change the key theoretical properties of the model, although the analytical characterization could become more complex. However, if we assume that the punishment is proportional to k (so that the reservation value with indictment takes the linear form $q_R - \mu k$), the characterization of the optimal contract is essentially analogous to the one provided here without direct punishment. Obviously, higher is the parameter μ, and higher is the enforceability of the social allocation. But besides this obvious insight, the structure of the optimal contract does not change.

will continue, $\lambda \in \{0,1\}$, whether diversion is observed, $d \in \{0,1\}$, and the shock inferred from the observation of market output, $z \in \{z_L, z_H\}$.

When the manager does not quit ($\lambda = 1$), the next period consumption and continuation utility are denoted, respectively, by $\bar{c}(d,z)$ and $\bar{q}(d,z)$. The variable d takes the value of zero if a deviation is not observed. Similarly, when the manager quits after production, next period consumption and continuation utility are denoted, respectively, by $\underline{c}(d,z)$ and $\underline{q}(d,z)$. The sequence of events and actions are illustrated in Figure 4.

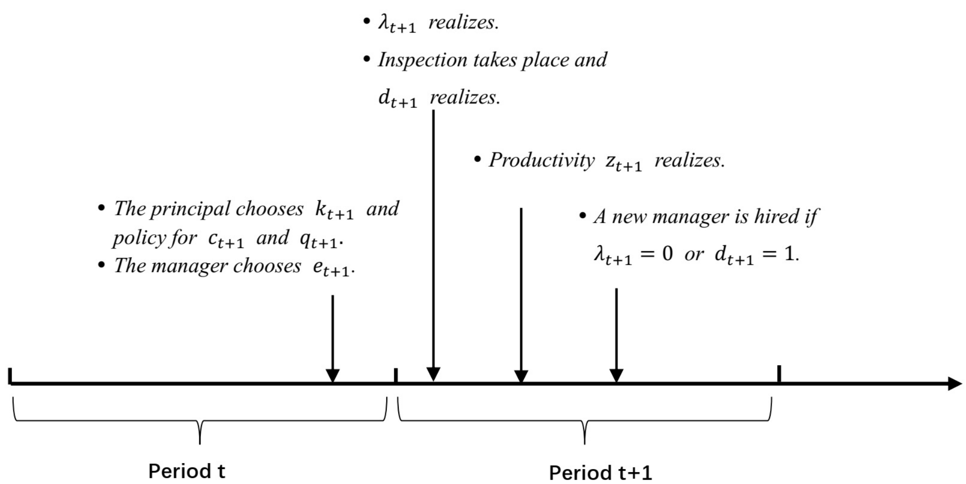

Figure 4: Timing.

The optimal contract when the manager does not quit is determined by the solution to the following problem:

$$\overline{V}(q) = \max_{\substack{k,\bar{c}(d,z),\bar{q}(d,z),\\ \underline{c}(d,z),\underline{q}(d,z)}} \Bigg\{ -k + \beta \sum_{d,z} \Bigg[F(k,z,e) + \rho \Bigg(-\bar{c}(d,z) + \overline{V}\Big(\bar{q}(d,z)\Big) + \\ (1-\rho)\Bigg(-\underline{c}(d,z) + \underline{V}\Big(\underline{q}(d,z)\Big)\Bigg)\Bigg]\Upsilon(d,z|e)\Bigg\} \quad (2)$$

subject to

$$q = \beta \sum_{d,z} \left[\rho \left(\bar{c}(d,z) + \bar{q}(d,z) \right) + (1-\rho)\left(\underline{c}(d,z) + \underline{q}(d,z) \right) \right] \Upsilon(d,z|e) \quad (3)$$

$$\bar{c}(0,z_H) + \bar{q}(0,z_H) \geq \bar{c}(0,z_L) + \bar{q}(0,z_L) + \alpha k \quad (4)$$

$$\underline{c}(0,z_H) + \underline{q}(0,z_H) \geq \underline{c}(0,z_L) + \underline{q}(0,z_L) + \alpha k \quad (5)$$

$$\bar{c}(d,z), \underline{c}(d,z) \geq 0; \qquad \bar{q}(d,z), \underline{q}(d,z) \geq q_R, \quad (6)$$

$$e = \arg\max_{e\in\{0,1\}} \ \beta \sum_{d,z} \left[\rho \left(\bar{c}(d,z) + \bar{q}(d,z) \right) + \\ (1-\rho)\left(\underline{c}(d,z) + \underline{q}(d,z) \right) \right] \Upsilon(d,z|e). \quad (7)$$

We denoted by $\Upsilon(d,z|e)$ the joint probability distribution of d and z conditional on the allocation of skills, which is equal to

$$\Upsilon(d,z|e) = \begin{cases} (1-e\eta)\,\varphi(z_L|e), & \text{for } d=0 \ \& \ z=z_L \\ (1-e\eta)\,\varphi(z_H|e), & \text{for } d=0 \ \& \ z=z_H \\ e\eta\,\varphi(z_L|e), & \text{for } d=1 \ \& \ z=z_L \\ e\eta\,\varphi(z_H|e), & \text{for } d=1 \ \& \ z=z_H \end{cases}$$

The optimization problem is solved at the end of the period and the function $\overline{V}(q)$ is the end-of-period value for the principle, conditional on continuing operation with the existing manager. The function $\underline{V}(q)$, instead, is the value when the manager is replaced by a new manager.

Equation (3) is the promised-keeping constraint, and equations (4)-(5) are the incentive-compatibility constraints. Incentive-compatibility makes sure that, when productivity is high, the manager will get an expected lifetime utility at least as large as the utility received if output were diverted. This constraint must be satisfied only when the inspection does not reveal a deviation, that is, when $d = 0$. This is because, once indicted, the manager is no longer able to divert output. Loosing the ability to divert output represents a cost for the manager that increases with η, that is, the probability of a successful inspection when the manager chooses $e = 1$ (deviation).

Constraints (6) impose limited liability. The assumption is that current consumption (payout) for the manager cannot be negative and the continuation value is at least as large as the reservation value q_R.

To maximize the incentive to enforce the recommended allocation of skills, the values received by the manager when caught deviating—the terms $\bar{c}(1, z) + \bar{q}(1, z)$ and $\underline{c}(1, z) + \underline{q}(1, z)$—should be set to the lowest possible values, that is,

$$\bar{c}(1, z) = \underline{c}(1, z) = 0$$
$$\bar{q}(1, z) = \underline{q}(1, z) = q_R.$$

Still, this may not be sufficient to implement the optimal allocation of skills because deviations are observed only with probability $\eta < 1$.

The last equation (7) defines the allocation of skills e chosen by the manager. Given the compensation structure, the manager chooses $e \in \{0, 1\}$ to maximize his/her value. The contractual problem (2) solves in every period a Stackelberg's game where the leader (central authority) chooses the structure of the contract (*i.e.*, k, $\bar{c}(d, z)$, $\bar{q}(d, z)$, $\underline{c}(d, z)$, $\underline{q}(d, z)$) and the follower (the manager) responds by choosing the allocation of skills. The leader anticipates the response of the follower, equation (7), which is taken into account in structuring the optimal contract.

4.2 Characterization of the optimal contract

To characterize the optimal contract, we proceed in two steps. In the first step (Subsection 4.2.1) we consider a simplified version of the contract where the principle does not attempt to implement the socially desirable allocation of skills. The problem solved in this step will be equivalent to Problem (2) but ignoring condition (7) and taking e as given. We will then characterize the optimal e chosen by the manager in this simplified environment. In the second step (Subsection 4.2.2) we return to the original problem and establish whether it is optimal for the principle to structure the contract in order to enforce $e = 0$.

4.2.1 Optimal contract when e is taken as given

The goal is to characterize the optimal contract for a given allocation of skills as if the structure of the contract does not affect the value of e chosen by the manager. The following proposition states the key result of this subsection.

Proposition 1 *If the optimal contract takes the allocation of skills as given, the manager will optimally choose* $e = 0$ *if and only if*

$$\varphi(z_H|0) > (1-\eta)\varphi(z_H|1).$$

Proof 1 *See Appendix B.1*

We have two cases. In the first case $\varphi(z_H|0) > (1-\eta)\varphi(z_H|1)$, and the optimal allocation of skills chosen by the manager is $e_t = 0$ for all t. In the second case $\varphi(z_H|0) < (1-\eta)\varphi(z_H|1)$, and the optimal allocation of skills chosen by the manager is $e_t = 1$ for all t. The intuition as follows.

In absence of a successful inspection, choosing $e = 1$ provides more value to the manager because the probability of high productivity is bigger than with $e = 0$, that is, $\varphi(z_H|1) > \varphi(z_H|0)$. However, by choosing $e = 1$, the manager faces the risk of being caught by an inspection, which arises with probability η. In this case the manager will lose the ability to divert output and his/her continuation value will fall to q_R. The first effect dominates if $\varphi(z_H|1)$ is big compared to $\varphi(z_H|0)$ and the probability of a successful inspection η is small. The second effect dominates if $\varphi(z_H|1)$ is not much bigger than $\varphi(z_H|0)$ and the probability of a successful inspection η is large. These two effects are captured by the condition $\varphi(z_H|0) > (1-\eta)\varphi(z_H|1)$. If the condition is not satisfied, it is not possible to enforce $e = 0$. In this case the manager will always choose $e = 1$, deviating from the socially desirable allocation.

We now derive analytical expressions for the value of the contract when the probability η takes two different values: $\bar{\eta}$ and $\underline{\eta}$. The first value satisfies $\varphi(z_H|0) > (1-\bar{\eta})\varphi(z_H|1)$ while the second satisfies $\varphi(z_H|0) < (1-\underline{\eta})\varphi(z_H|1)$. Thus, a manager with $\eta = \bar{\eta}$ always chooses $e = 0$ while a manager with $\eta = \underline{\eta}$ always chooses $e = 1$.

Case I: High probability of being caught ($\eta = \bar{\eta}$). Define $V(q|\bar{\eta})$ the value of the contract for the principle when $\eta = \bar{\eta}$. To define this function we use the properties derived earlier. In particular, when $\eta = \bar{\eta}$, the optimal allocation of skills chosen by the manager is $e = 0$ for all t and consumption is paid only when the manager quits, that is, $\bar{c}(0, z) = 0$ and $\underline{c}(0, z) = \alpha k$. The value of the contract for the principle can then be written as

$$
\begin{aligned}
V(q|\bar{\eta}) \quad = \quad & -k + \beta \Bigg\{ \mathbb{E}_z F(k, 0, z) + \rho \Big[V(q_R|\bar{\eta}) \Big(1 - \varphi(z_H|0) \Big) + V(q_R + \alpha k|\bar{\eta}) \varphi(z_H|0) \Big] \\
& \qquad\qquad + (1 - \rho) \Big[-\alpha k \varphi(z_H|0) + V(q_R|\bar{\eta}) \Big] \Bigg\} \qquad (8) \\
& \text{subject to} \\
& q = \beta \Big[q_R + \alpha k \varphi(z_H|0) \Big]
\end{aligned}
$$

The Bellman's equation takes into consideration that the manager keeps his/her position with probability ρ. In this case the manager's compensation is deferred to the future: if the realization of the shock is low, the continuation value for the manager is q_R; if the realization of the shock is high the continuation value is $q_R + \alpha k$. In the event of an exit, the manager receives a payment of αk (the value of diverting) but only if the realization of the shock is high. Otherwise the manager receives zero compensation and will be replaced by a new manager who will start with promised utility q_R. Thus, the continuation value for the principle is $V(q_R|\bar{\eta})$.

We now focus on the promise-keeping constraint to Problem (8). This constraint implies a linear relation between q and k that we can write as

$$
k = \frac{1}{\alpha \varphi(z_H|0)} \left(\frac{q}{\beta} - q_R \right). \qquad (9)
$$

This expression makes clear that k depends positively on the value of the contract for the manager, the variable q.

As established earlier, the next period promised utility is given by

$$
q' = \begin{cases} q_R + \alpha k & \text{if} \quad \lambda = 1 \ \& \ z = z_H, \\ q_R & \text{otherwise.} \end{cases} \qquad (10)
$$

Remember that when $\eta = \bar{\eta}$, the manager always chooses $e = 0$, indicating that $d = 0$ for all t. With probability ρ, the manager continues ($\lambda = 1$). In this case q' rises to $q_R + \alpha k$ if $z = z_H$, and drops to q_R if $z = z_L$. With probability $1 - \rho$, the manager quits ($\lambda = 0$) and a new manager starts with promised utility q_R. The value of quitting is still $q_R + \alpha k$ if $z = z_H$, and q_R if $z = z_L$. However, while a staying manager receives $q_R + \alpha k$ as promised utility, a quitting manager receives this value in part as payment, αk, in part as reservation value, q_R.

Combining (9) and (10) and taking expectations, the expected continuation value conditional on continuation is

$$\mathbb{E}(q'|\lambda = 1) = \frac{q}{\beta}. \tag{11}$$

Thus, conditional on continuation, the promised utility q grows, on average, at rate $1/\beta$. Unconditionally, however, the expected continuation value for the manager is

$$\mathbb{E}(q') = \rho \cdot \left(\frac{q}{\beta}\right) + (1 - \rho) \cdot q_R. \tag{12}$$

This takes into account that, if the manager quits—which happens with probability $1 - \rho$—the continuation value drops to q_R. Thus, q tends to grow faster on average if a manager stays longer in the position (i.e., higher value of ρ). As we will see, since investment depends positively on q, the contract value is then bigger when ρ is larger. The following lemma provides an analytical expression for the contract value.

Lemma 1 *The contract value for the principle is*

$$V(q|\bar{\eta}) = \frac{\beta A}{1 - \beta} + \bar{\chi}\, q, \tag{13}$$

with $\bar{\chi} = [s(0) + \mathbb{E}(z|e = 0) - 1/\beta]/[\alpha\varphi(z_H|0)(1 - \rho)] - 1$.

Proof 1 *See appendix B.2.*

Therefore, the contract value for the principle is linear in the utility of the manager q. The intercept, $\beta A/(1 - \beta)$, and the factor of proportionality, $\bar{\chi}$, are only functions of parameters. We impose the following parameter restrictions.

Assumption 2 *Parameter values are restricted to satisfy $\bar{\chi} < 0$.*

The assumption implies that the contract value for the principle, $V(q|\bar{\eta})$, decreases in the promised utility for the manager q. This property guarantees that the optimal contract has a bounded solution. To understand why, suppose that $\bar{\chi} > 0$. This implies that, increasing the value of the contract for the manager also increases the value for the principle: even if an increase in q raises the debt that the principle has toward the manager, a higher q relaxes the incentive-compatibility constraints and allows for more capital. Another way to say this is that the increase in capital raises the total surplus more than the increase in q. It is then optimal to choose q (and k) to be as large as possible and the optimal contract would not have a bounded solution. Assumption 2 insures that the increase in the surplus induced by a one unit increase in q is lower than 1. The intercept, which is positive, guarantees that the value for the principle is positive for low values of q.

Case II: Low probability of being caught ($\eta = \underline{\eta}$). When $\eta = \underline{\eta}$, the manager chooses $e_t = 1$ for all t. The value of the contract for the principle can be written as

$$\begin{aligned} V(q|\underline{\eta}) \quad = \quad & -k + \beta\Bigg\{\mathbb{E}_z F(k,1,z) + (1-\underline{\eta})\rho\Big[V(q_R|\underline{\eta})\Big(1-\varphi(z_H|1)\Big) + V(q_R + \alpha k|\underline{\eta})\varphi(z_H|1)\Big] \\ & + (1-\underline{\eta})(1-\rho)\Big[-\alpha k\varphi(z_H|1) + V(q_R|\underline{\eta})\Big] + \underline{\eta}V(q_R|\underline{\eta})\Bigg\} \qquad (14) \\ & \text{subject to} \\ & q = \beta\Big[q_R + (1-\underline{\eta})\alpha k\varphi(z_H|1)\Big] \end{aligned}$$

The Bellman's equation has a longer expression because now the manager could be caught deviating with probability $\underline{\eta}$. This is the last term in the objective (14). In this case the manager is replaced by a new manager who is hired with promising utility q_R (again, provided that the principle has the whole bargaining power).

The promise-keeping constraint in Problem (14) can be rewritten as

$$k = \frac{1}{(1-\underline{\eta})\alpha\varphi(z_H|1)}\left(\frac{q}{\beta} - q_R\right), \qquad (15)$$

which shows a positive relation between investment k and utility q.

Comparing this expression to equation (9) derived in case I, we can see that, for any given q, investment k is lower when $\eta = \underline{\eta}$ than when $\eta = \bar{\eta}$.

Let's turn now on the continuation utility q' which depends on the realization of λ, d and z, according to the following expression

$$q' = \begin{cases} q_R + \alpha k & \text{if} \quad \lambda = 1,\ d = 0, \text{ and } z = z_H, \\ \\ q_R & \text{otherwise.} \end{cases} \tag{16}$$

With probability ρ the manager continues. In this case, the next period promised utility rises to $q_R + \alpha k$ when $z = z_H$ and $d = 0$,that is, when the manager is not caught deviating. Otherwise, it drops to q_R. With probability $1-\rho$, the manager quits and a new manager takes over with initial promised utility q_R. Also, we can show that when $\eta = \underline{\eta}$, the expected promised utilities for the next period are given by (11) and (12). The next lemma provides an analytical expression for the contract value of the principle.

Lemma 2 *The contract value for the principle is*

$$V(q|\underline{\eta}) = \frac{\beta A}{1-\beta} + \underline{\chi}\, q, \tag{17}$$

with $\underline{\chi} = [s(1) + \mathbb{E}(z|e = 1) - 1/\beta]/[(1-\underline{\eta})\alpha\varphi(z_H|1)(1-\rho)] - 1.$

Proof 2 *See appendix B.2.*

For any q, $V(q|\underline{\eta})$ defined in (17) is smaller than $V(q|\bar{\eta})$ defined in (13). Thus, the value of the contract for the principle is higher when deviation can be detected with higher probability ($\eta = \bar{\eta}$). There are two reasons. First, when $\eta = \underline{\eta}$, the manager's skills are allocated less efficiently ($e = 1$), leading to a lower social return from investment. Second, when $\eta = \underline{\eta}$, investment tends to be lower given the value of q.

Notice that, Assumption 2 also ensures $\underline{\chi} < 0$, that is, the contract value $V(q|\underline{\eta})$ is decreasing in q. Since the contract value is decreasing in q, it is optimal for the principle to set the initial promised utility of a new manager to the lowest possible value, that is, the reservation q_R (provided that the principle has full bargaining power when signing a contract with a new manager). To ensure that the contract value for the principle is positive at q_R we make the following assumption:

Assumption 3 $A > -(1-\beta)\underline{\chi} q_R/\beta$.

This condition also guarantees that the contract value for the principle is positive at $q = q_R$ when $\eta = \bar{\eta}$.

4.2.2 Fully optimal contract

In the previous subsections we have shown that, when the principle does not structure the contract to enforce $e = 0$, the manager chooses $e = 1$ if $\varphi(z_H|0) < (1-\eta)\varphi(z_H|1)$. However, if the principle anticipates that the manager chooses $e = 1$, is it feasible to modify the contract to enforce $e = 0$? Furthermore, provided that it is feasible, would it be optimal for the principle to enforce $e = 0$? We show here that it is always possible to structure the contract to enforce $e = 0$. However, this is not necessarily optimal.

To show that the contract can always be structured to enforce $e = 0$, we start by looking at the incentive-compatibility constraints for the true revelation of z. Suppose that the principle does not attempt to enforce $e = 0$. The incentive-compatibility constraints when $d = 0$ are

$$\begin{aligned}
\bar{c}(0, z_L) + \bar{q}(0, z_L) &= q_R, \\
\bar{c}(0, z_H) + \bar{q}(0, z_H) &= q_R + \alpha k, \\
\underline{c}(0, z_L) + \underline{q}(0, z_L) &= q_R, \\
\underline{c}(0, z_H) + \underline{q}(0, z_H) &= q_R + \alpha k.
\end{aligned}$$

The first two conditions are for a continuing manager (for z_L and z_H) and the last two are for a quitting manager (for z_L and z_H).

Suppose that the principle increases all promised utilities by Δ, but only when inspections do not find a deviation, that is, when $d = 0$. The four conditions become

$$\begin{aligned}
\bar{c}(0, z_L) + \bar{q}(0, z_L) &= \Delta + q_R, \\
\bar{c}(0, z_H) + \bar{q}(0, z_H) &= \Delta + q_R + \alpha k, \\
\underline{c}(0, z_L) + \underline{q}(0, z_L) &= \Delta + q_R, \\
\underline{c}(0, z_H) + \underline{q}(0, z_H) &= \Delta + q_R + \alpha k.
\end{aligned}$$

With this modification the contract preserves incentive compatibility because the increase in values that the manager receives by reporting z_L, instead of the true productivity z_H, do not change. Let's see how the manager's value depends on the allocation of skills.

If the manager chooses $e = 0$, the expected utility is

$$Q_0 = \beta\Big[q_R + \Delta + \varphi(z_H|0)\alpha k\Big].$$

If instead the manager choose $e = 1$, the expected utility is

$$Q_1 = \beta\Big[q_R + (1-\eta)\Delta + (1-\eta)\varphi(z_H|1)\alpha k\Big].$$

Comparing the two values we can see that, as long as $\eta > 0$, the contract value Q_0 can always be made bigger than Q_1 by choosing a sufficiently large Δ. The intuition is that, raising the value of the contract by Δ only when a deviation is not observed ($d = 0$) reduces the manager's incentive to choose $e = 1$. This is because, by choosing $e = 1$, the manager faces a probability η of losing the extra value Δ (remember that Δ is received only if $d = 0$, which in this case happens with probability $1 - \eta$).

Even if it is always possible to enforce $e = 0$, it does not mean that this is optimal for the principle: increasing the manager's value implies a reduction in the value of the contract for the principle. Either because the manager needs to be promised more continuation utility or capital investment must be reduced. The next proposition establishes that enforcing $e = 0$ is optimal only if η is sufficiently high.

Proposition 2 *The optimal contract will enforce $e = 0$ if and only if the probability of successful inspection satisfies*

$$\eta > \left(\frac{\varphi(z_H|1) - \varphi(z_H|0)}{\varphi(z_H|1)}\right)\left(\frac{\beta[s(1) + \mathbb{E}(z|1)] - 1}{\beta[s(0) + \mathbb{E}(z|0)] - 1}\right).$$

Proof 2 *Appendix B.3.*

The probability η captures the ability of the principle to punish the manager for choosing $e = 1$. Higher is η and easier is to punish the manager with lower compensation in the eventuality that an inspection reveals diversion. The first term on the right-hand-side is the ratio of the difference in the probabilities that $z = z_H$ when the manager chooses $e = 1$ and $e = 0$, over the probability when $e = 1$. This captures the incentive of the manager to deviate from the socially desirable allocation of skills. When this value is low, the manager does not gain much from deviating. As a result, it becomes optimal for the principle to enforce $e = 0$ even for lower values of η.

The second term on the right-hand-side is the ratio of the marginal return on capital when $e = 1$ (numerator) and when $e = 0$ (denominator). By Assumption 1, this term is smaller than 1 and captures the social losses when the manager deviates by choosing $e = 1$. Smaller is this ratio and larger are the social losses. Thus, the principle finds optimal to enforce $e = 0$ even for lower values of η when this term is smaller.

5 Stochastic η and dynamics of investment

The ability to deviate from the socially desirable policy, while minimizing the probability of being caught by an inspection, is itself a skill. A skill that is likely to rise with experience within an organization. A newly appointed manager needs time to learn how to disguise corporate policies that deviate from the mandate in ways that are difficult to detect.

To formalize this idea, we assume that the probability that an inspection succeeds in revealing the true values of e and z is time-varying. A newly appointed manager starts with $\eta_t = \bar{\eta}$ but afterwards switches to $\underline{\eta} < \bar{\eta}$ with probability p. The transition probabilities are

$$P(\eta, \eta') = \begin{bmatrix} 1-p & p \\ \\ 0 & 1 \end{bmatrix}$$

Assumption 4 *The probabilities $\underline{\eta}$ and $\bar{\eta}$ satisfy*

$$\bar{\eta} > \frac{\varphi(z_H|1) - \varphi(z_H|0)}{\varphi(z_H|1)},$$

and

$$\underline{\eta} < \left(\frac{\varphi(z_H|1) - \varphi(z_H|0)}{\varphi(z_H|1)} \right) \left(\frac{\beta[s(1) + \mathbb{E}(z|1)] - 1}{\beta[s(0) + \mathbb{E}(z|0)] - 1} \right).$$

The first condition in Assumption 4 implies that, when the detection probability takes the high value $\bar{\eta}$, the manager finds optimal to choose $e = 0$.

In fact, the condition can be rewritten as $\varphi(z_H|0) > (1-\bar{\eta})\varphi(z_H|1)$ which, according to Proposition 1, implies that the manager always chooses $e = 0$. The second condition in Assumption 4 implies that, when the probability of successful inspection is $\underline{\eta}$, the principle does not find optimal to enforce $e = 0$. The manager, then, optimally chooses $e = 1$. Notice that the second equation implies $\varphi(z_H|0) > (1-\underline{\eta})\varphi(z_H|1)$. This is the condition in Proposition 1 under which the manager optimally chooses $e = 1$ when the contract does not attempt to enforce $e = 0$.

The value of η is public information. This implies that, once the value of η switches from $\bar{\eta}$ to $\underline{\eta}$, the principle has an incentive to replace the manager with a newly hired manager. However, we assume that replacement is only possible when a manager is caught deviating, that is, when an inspection reveals that $e = 1$. The replacement will be a new manager with $\eta = \bar{\eta}$.

The assumption that the manager can be replaced only if caught deviating is, admittedly, very stark. However, it captures the fact that in most SOEs the appointment and replacement of board members and senior executives are determined by government entities staffed by public servants who tend to lack flexibility (World Bank (2021)). A less stark assumption is that η is not observable by the principle. In this case the optimal contract will be structured using prior beliefs updated over time. However, if only the manager knows η, the principle and the manager would have different beliefs which would make the characterization of the optimal contract much more difficult and we would lose the analytical characterization we are able to do when η is public knowledge.

5.1 Contractual problem with stochastic η

Define $V(q,\eta)$ the value of the contract for the principle conditional on $\eta \in \{\bar{\eta}, \underline{\eta}\}$. We will use some of the properties established earlier. In particular, we will use the property that the manager chooses $e = 0$ when $\eta = \bar{\eta}$, while he/she chooses $e = 1$ when $\eta = \underline{\eta}$.

The value of the contract for the principle when the current value of η is

$\bar{\eta}$ (and, thus, $e = 0$) can be written as

$$V(q,\bar{\eta}) = -k + \beta\Big\{\mathbb{E}F(k,0,z') + \rho\sum_{\eta'}\Big[V(q_R,\eta')\Big(1-\varphi(z_H|0)\Big) + V(q_R+\alpha k,\eta')\times \varphi(z_H|0)\Big]P(\eta'|\bar{\eta}) + (1-\rho)\Big[-\alpha k\varphi(z_H|0) + V(q_R,\bar{\eta})\Big]\Big\} \quad (18)$$

subject to

$$q = \beta\Big[q_R + \alpha k\varphi(z_H|0)\Big]$$

This is the value for the principle at the end of the period when the firm employs a continuing manager of type $\bar{\eta}$ promised utility q. At this point all payments have been executed except for the cost of the investment k.

When the current value of η is $\underline{\eta}$ (and, thus, $e = 1$), instead, the value of the principle can be written as

$$V(q,\underline{\eta}) = -k + \beta\Big\{\mathbb{E}F(k,1,z') + (1-\underline{\eta})\rho\Big[V(q_R,\underline{\eta})\Big(1-\varphi(z_H|1)\Big) + V(q_R+\alpha k,\underline{\eta})\times \varphi(z_H|1)\Big] + (1-\underline{\eta})(1-\rho)\Big[-\alpha k\varphi(z_H|1) + V(q_R,\bar{\eta})\Big] + \underline{\eta}V(q_R,\bar{\eta})\Big\} \quad (19)$$

subject to

$$q = \beta\Big[q_R + (1-\underline{\eta})\alpha k\varphi(z_H|1)\Big].$$

In writing this problem we took into account that a manager caught deviating from the socially desirable policy will be replaced by a new manager. A new manager starts with $\eta = \bar{\eta}$ and with promised utility q_R. The value for the displayed manager is also the reservation value q_R.

5.2 Dynamic properties of SOEs

At the beginning of period t (with $t > 1$), there are two types of SOEs in the economy: those with $\bar{\eta}-$managers and those with $\underline{\eta}-$managers. The manager's type in period t is determined in the previous period $t-1$.

After the inspection, a fraction $\underline{\eta}$ of the $\underline{\eta}-$managers are indicted and are replaced by new managers at the end of period t. The remaining $\underline{\eta}-$managers and all $\bar{\eta}-$managers are non-indicted. A fraction p of continuing $\bar{\eta}-$managers become $\underline{\eta}-$managers at the end of period t. Continuing managers of $\underline{\eta}-$type maintain their type. The next step is to characterize the dynamic properties of investment.

Investment is positively related to promised utility. However, the relationship between k and q depends on manager's type. When η is stochastic, the promise-keeping constraint takes the form

$$q = \beta\Big[q_R + (1-\eta e)\alpha k \varphi(z_H|e)\Big].$$

This posits a linear relation between the value of the contract for the manager, q, and the invested capital k. By inverting the promise-keeping constraint we can express capital investment k as a linear function of the promise-utility q as

$$k(\eta) = c(\eta) + s(\eta)\cdot q,$$

where the constant and slope coefficients are, respectively,

$$\begin{aligned} c(\bar{\eta}) &= -\frac{q_R}{\alpha\varphi(z_H|\bar{\eta})}, \qquad s(\bar{\eta}) = \frac{1}{\alpha\beta\varphi(z_H|\bar{\eta})}, \\ c(\underline{\eta}) &= -\frac{q_R}{\alpha(1-\underline{\eta})\varphi(z_H|\underline{\eta})}, \qquad s(\underline{\eta}) = \frac{1}{\alpha\beta(1-\underline{\eta})\varphi(z_H|\underline{\eta})}. \end{aligned}$$

The derivation takes into account that the allocation of skills e depends on η (remember that a manager with $\eta = \bar{\eta}$ chooses $e = 0$ and a manager with $\eta = \underline{\eta}$ chooses $e = 1$). Thus, the coefficients depend on η.

We are now ready to state the main proposition.

Proposition 3 *Suppose that*

$$\frac{(1-\underline{\eta})\varphi(z_H|1)}{\varphi(z_2|0)} < 1 + \frac{\varphi(z_H|0)}{(1-\underline{\eta})\varphi(z_H|1)}.$$

In the period after inspection, SOEs with indicted managers experience

1. *lower average market return compared to non-indicted SOEs, and*

2. *lower average growth in investment compared to non-indicted SOEs.*

Proof 3 *See appendix B.4.*

These properties are consistent with the empirical findings showing that SOEs with indicted managers experience lower market performance (measured by corporate market indicators) and lower investment after the inspection. Although the detailed proof is somewhat involved, the intuition is straightforward.

Let's first consider the average market productivity of a SOE, which we also use interchangeably as market return. Average market productivity is

$$\mathbb{E}z = z_L \cdot \Big(1 - \varphi(z_H|e)\Big) + z_H \cdot \varphi(z_H|e).$$

Since $\varphi(z_H|1) > \varphi(z_H|0)$, SOEs with managers choosing $e = 1$ have higher average market productivity than SOEs where managers choose $e = 0$. An indicted manager has $\eta = \underline{\eta}$ and, therefore, chooses $e = 1$. This implies that the average productivity of the managed SOE is high. However, after indictment, the manager is replaced with a new manager who starts with $\eta = \bar{\eta}$. Since a new manager chooses, $e = 0$, market productivity drops.

To understand the drop in investment we have to consider that the new manager starts with a contract value of q_R. Before the replacement, however, contract values q are on average higher than q_R. Thus, a replacement causes on average a drop in the new contract value q'. Because capital is an increasing function of q', the drop in average q' causes a drop in average investment k'. The contract value of non-indicted managers, however, continues to increase on average.

The difficulty to establish this result analytically is that the relation between q' and k' changes depending on η'. Moreover, the contract value for managers does not grow in all SOEs with non-indicted managers. However, we are able to provide the analytical proof in the appendix. The proof shows that the average growth of capital is bigger for SOEs with non-indicted managers compared to SOEs with indicted managers. The average differential is what we capture in the empirical regression presented earlier in the paper.

6 Optimal monitoring, inspections and tunure

The presence of agency frictions limits the efficiency of social allocations. In this section we consider some policies that could improve allocations. The goal is to study some policies that could affect the initial value of the contract for the central authority.

Appendix B.5 shows that the value of the contract for the principle when a new manager is hired (with initial promised utility q_R) is given by

$$V(q_R, \bar{\eta}) = \omega \cdot V^F(q_R|\bar{\eta}) + (1-\omega) \cdot V^F(q_R|\underline{\eta}). \tag{20}$$

The functions $V^F(q_R|\bar{\eta})$ and $V^F(q_R|\underline{\eta})$ are the contract values when the probability η is fixed at $\bar{\eta}$ and $\underline{\eta}$, respectively. These functions were derived in Section 4.2.1 and the relative weight ω is only a function of parameters,

$$\omega = \frac{(1-\rho)\big[1-\beta\rho(1-\underline{\eta})\big]}{\big[1-\rho(1-p)\big]\big[1-\beta\rho(1-\underline{\eta}-p)\big]}. \tag{21}$$

Differentiating ω with respect to p and $\underline{\eta}$ we can verify that the weight is strictly decreasing in p—the probability that η switches—and strictly increasing in $\underline{\eta}$—the probability of successful inspections for experienced managers.

We consider three policies that could affect the initial value of the contract for the central authority, the function $V(q_R, \bar{\eta})$ defined in (20):

- **Ex-ante monitoring.** More frequent monitoring reduces the ability of the manager to disguise corporate policies. We formalize this with a reduction in the probability $p = P(\underline{\eta}|\bar{\eta})$.
- **Ex-post inspections.** More intensive or frequent inspections increase both $\bar{\eta}$ and $\underline{\eta}$, i.e., the probabilities of detection.
- **Tenure limits.** A tenure limit determines how long a manager can stay in the current position. In the model, this is governed by the probability of continuation ρ.

Although higher intensity of monitoring and/or inspections could improve the principle's value, there are also costs. The costs are not only in the resources that need to be deployed to perform these tasks but also in the form of a more hostile environment for the manager. Nobody likes to be constantly monitored and inspected. One way to formalize this is to assume that more intensive monitory and inspection increase the manager's dis-utility from managing SOEs.

Denote by $\psi(p, \underline{\eta})$ the flow dis-utility in managing a SOE. The function depends on p and $\underline{\eta}$ as they reflect, respectively, the intensity of monitoring and inspection. Since a newly hired manager must be promised the reservation utility q_R, higher is the dis-utility and higher is the compensation that the principle must provide to the manager. Thus, indirectly, $\psi(p, \underline{\eta})$ becomes a cost for the principle. We make the following assumptions about the cost.

Assumption 5 *The cost is incurred independently of whether the current state is $\eta = \underline{\eta}$ or $\eta = \bar{\eta}$, and the function $\phi(p, \underline{\eta})$ satisfies*

- $\psi(p, \underline{\eta}) = \psi_1(p) + \psi_2(\underline{\eta})$.
- $\psi_1' < 0$, $\psi_1'' > 0$, $\psi_1(0) = \infty$, $\psi_1(1) = 0$.
- $\psi_2' > 0$, $\psi_2'' > 0$, $\psi_2(\bar{\eta}) = \infty$, $\psi(0) = 0$.

The assumption that the manager always incurs the cost is justified by the fact that in practice SOEs are monitored and inspected independently of their current state η even if this is public information. The additive separability is for analytical convenience and the other assumptions guarantee that the optimal choices of p and $\underline{\eta}$ are interior.

For given values of p and $\underline{\eta}$, and thus $\psi(p, \underline{\eta})$, the optimal contract can be characterized following the same steps as in the environment without the dis-utility cost. All we have to do is to redefine the promised utilities.

Define the term κ as

$$\kappa = \frac{\beta \psi(p, \underline{\eta})}{1 - \beta}.$$

We then redefine the continuation utilities of the manager as

$$\begin{aligned} Q &= q + \kappa, \\ \overline{Q}(d, z) &= \bar{q}(d, z) + \kappa, \\ \underline{Q}(d, z) &= \underline{q}(d, z) + \kappa, \\ Q_R &= q_R + \kappa. \end{aligned}$$

Replacing q with Q as the state variable, the contract has the same structure as the contract with $\kappa = 0$ characterized earlier. Once we have characterized the optimal contract in terms of the state variable Q, we can derive the actual value for the manager $q = Q - \kappa$.

The transformation highlights an important property. For the principle, a higher value of $\psi(p, \underline{\eta})$ is equivalent to increasing the reservation value of the manager from q_R to $Q_R = q_R + \kappa$.

Increasing p and/or $\underline{\eta}$ has two effects. On the one hand, it increases the expected discounted value of compensations paid to managers. This is captured by the increase in the reservation value to $Q_R = q_R + \kappa$. Even if the lifetime utility for a newly hired manager remains q_R, to guarantee this utility the lifetime compensation must be increased to $Q_R = q_R + \kappa$. Higher values of p and $\underline{\eta}$ increase κ and, therefore, the effective cost for the principle. On the other hand, increasing p and/or $\underline{\eta}$, alleviates the agency frictions and makes the allocation of skills more efficient. Given the lifetime compensation Q_R promised to the manager, this increases the value of the contract for the principle. The optimal choice of p and/or $\underline{\eta}$ optimizes this trade-off.

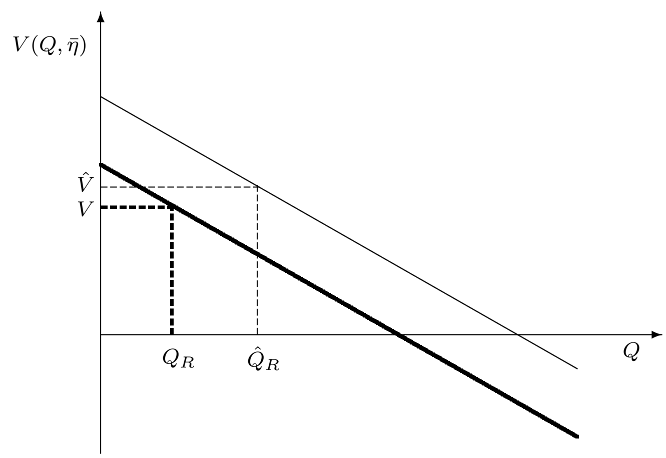

Figure 5: Contract value for the principle with a newly employed manager.

The two effects are illustrated in Figure 5. The figure plots the value of the contract for the principle as a function of the expected managerial payments $Q = q + \kappa$. As we have seen, the value for the principle is a linear function of Q with a negative slope (given the parameter restrictions). The fatter line is for a higher value of p and/or a lower value of $\underline{\eta}$. The thinner line is for a lower value of p and/or a higher value of $\underline{\eta}$. Reducing the probability of switching to a low detection state, p, or increasing the probability of detection, $\underline{\eta}$, increases the value of the contract for the principle. However, this also increases the compensation that the principle must provide to managers, raising the initial Q_R to $\hat{Q}_R$. In the example, the overall effect is positive as $\hat{V}$ is bigger than V. However, depending on parameters, it could also go the other way.

In the next subsections we explore in more detail each of the three policies listed above: optimal monitoring in Subsection 6.1, optimal inspections in Subsection 6.2, and optimal length of tenure in Subsection 6.3. Finally, in Subsection 6.4 we show how optimal monitoring and inspections change with certain economic conditions that may change over time.

6.1 Optimal level of monitoring

Monitoring makes more difficult for the manager to figure out (or learn) how to disguise policies in ways that are difficult for the central authority to verify. We formalize this by assuming that monitoring reduces p, that is, the probability with which η switches from $\bar{\eta}$ to $\underline{\eta}$. An example of actual monitoring is the party-building policy launched by the Chinese Communist Party (CCP) in 2015. This policy requires SOEs to formalize and elevate the role of the CCP in their corporate governance.

A lower value of the probability p reduces agency frictions and improves allocations, at least from the point of view of the central government. But, of course, monitoring is not without cost as we assumed above.

Taking the derivative of (20) with respect to p we obtain

$$\begin{aligned}\frac{\partial V(Q_R,\bar{\eta})}{\partial p} &= \underbrace{\frac{\partial \omega}{\partial p}\cdot\Big[V^F(Q_R|\bar{\eta})-V^F(Q_R|\underline{\eta})\Big]}_{Negative\ effect}+ \\ &\qquad\qquad \underbrace{\left[\omega\cdot\frac{V^F(Q_R|\bar{\eta})}{\partial Q_R}+(1-\omega)\cdot\frac{V^F(Q_R|\underline{\eta})}{\partial Q_R}\right]\cdot\frac{\partial Q_R}{\partial p}}_{Positive\ effect}\end{aligned}$$

Since $V^F(Q_R|\bar{\eta}) > V^F(Q_R|\underline{\eta})$, the initial value of the contract for the principle, $V(Q_R,\bar{\eta})$, is positively related to the weight ω. The weight, defined in equation (21), is negatively related to p. The first term, then, is negative, and captures the marginal benefit of lowering p with more intensive monitoring. The second term is positive because both $V^F(Q_R|\bar{\eta})$ and $V^F(Q_R|\underline{\eta})$ depend negatively on Q_R, which in turn depends negatively on p. This second term captures the marginal cost of monitoring. Thus, lowering p with monitoring improves the value of the contract for the principle, but at the cost of increasing Q_R.

Appendix B.6.1 derives the second order condition for an interior optimum and shows that, provided that $\psi_1''(p)$ is large enough, it is always satisfied. Thus, there is a unique solution to the optimal monitoring which is determined by the first order condition $\partial V(Q_R|\bar{\eta})/\partial p = 0$.

6.2 Optimal level of inspection

Inspections provide a mechanism that allows the principle to punish the manager when deviating from the recommended allocation of skills. As a result, more intensive or frequent inspections could improve allocations. We formalize this by assuming that more intensive inspections increase $\underline{\eta}$, that is, the probability of detecting the actual allocation of skills.

Taking the derivative of (20) with respect to $\underline{\eta}$ we obtain

$$\frac{\partial V(Q_R,\bar{\eta})}{\partial \underline{\eta}} = \underbrace{\frac{\partial \omega}{\partial \underline{\eta}} \cdot \left[V^F(Q_R|\bar{\eta}) - V^F(Q_R|\underline{\eta}) \right]}_{\textit{Positive effect}} + \underbrace{(1-\omega) \cdot \frac{\partial V^F(Q_R|\underline{\eta})}{\partial \underline{\eta}}}_{\textit{Positive effect}}$$
$$+ \underbrace{\left[\omega \cdot \frac{\partial V^F(Q_R|\bar{\eta})}{\partial Q_R} + (1-\omega) \cdot \frac{\partial V^F(Q_R|\underline{\eta})}{\partial Q_R} \right] \cdot \frac{\partial Q_R}{\partial \underline{\eta}}}_{\textit{Negative effect}}$$

Since $V^F(Q_R|\bar{\eta}) > V^F(Q_R|\underline{\eta})$, the initial value of the contract for the principle, $V(Q_R,\bar{\eta})$, is positively related to the weight ω, which increases in $\underline{\eta}$. Thus, the first term is positive. The second term is also positive. Although $V^F(Q_R|\bar{\eta})$ does not depend on $\underline{\eta}$ (see (13)), the function $V^F(Q_R|\underline{\eta})$ increases in $\underline{\eta}$ (see (17)). Together, the first two terms capture the marginal benefit of more intensive inspections.

The third term is negative since both $V^F(Q_R|\bar{\eta})$ and $V^F(Q_R|\underline{\eta})$ depend negatively on Q_R, while Q_R depends positively on $\underline{\eta}$. This term captures the marginal cost of inspection. Thus, increasing $\underline{\eta}$ with more intensive inspections improves the value of the contract for the principle, but at a cost of a higher Q_R.

Also for the case of inspections we derive the second order condition in Appendix B.6.2. We show that, if $\psi_2''(\underline{\eta})$ is large enough, the second derivative is always negative. The intensity of inspections, then, reaches the optimal value when the first order condition is satisfied, that is, $\partial V(Q_R|\bar{\eta})/\partial \underline{\eta} = 0$.

6.3 Optimal length of tenure

Limiting the length of managers' tenure is part of an ongoing reform of Chinese SOEs. The stated purpose is to alleviate agency problems. We ask whether this is a desirable policy in the context of our model.

As shown earlier, the initial contract value for the principle, $V(Q_R,\bar{\eta})$, is a weighted average of $V^F(Q_R|\bar{\eta})$ and $V^F(Q_R|\underline{\eta})$, the benchmark values when η remains constant at $\bar{\eta}$ and $\underline{\eta}$ respectively. If we take the derivative of $V(Q_R, \bar{\eta})$ with respect to ρ we obtain

$$\frac{\partial V(Q_R, \bar{\eta})}{\partial \rho} = \underbrace{\frac{\partial \omega}{\partial \rho} \cdot \left[V^F(Q_R|\bar{\eta}) - V^F(Q_R|\underline{\eta})\right]}_{\textit{Negative effect}} + \underbrace{\omega \cdot \frac{\partial V^F(Q_R|\bar{\eta})}{\partial \rho} + (1-\omega) \cdot \frac{\partial V^F(Q_R|\underline{\eta})}{\partial \rho}}_{\textit{Positive effect}}$$

This expression shows that a marginal increase in ρ has two opposite effects. Since $V^F(Q_R|\bar{\eta}) > V^F(Q_R|\underline{\eta})$, the contract value is positively related to the weight ω, which is decreasing in ρ.[8]

Thus, increasing the manager tenure reduces the contract value. The intuition is that a longer tenure (i.e., a higher ρ) increases the chances that the manager learns the 'skill' to disguise corporate policies, making the agency problem more severe.

The second effect derives from the impact that ρ has on $V^F(Q_R|\bar{\eta})$ and $V^F(Q_R|\underline{\eta})$. An increase in ρ has a positive impact on both of these two values. This is because when the length of job tenure increases, the promised-utility of the manager, q, grows for a longer period of time. Since investment k is positively related to q, the overall investment increases with a higher ρ.

The two contrasting effects—one negative and one positive—imply that reducing the tenure of a manager does not necessarily lead to greater social value. In fact, only when p (i.e., the probability with which η switches from $\bar{\eta}$ to $\underline{\eta}$) is large enough, the social value of SOE, $V(Q_R|\bar{\eta})$, may increase by reducing ρ. We provide a numerical example in Appendix C.4.

6.4 Changes in economic conditions

Arguably, the intensity of monitoring and inspection on central SOEs in China increased significantly since the early 2010s. How can we rationalize the increase in the context of our model? We consider three possibilities: (i) an increase in the reservation value for managers, q_R, (ii) a higher value of social activities, $s(e)$, and (iii) higher return from market activities, z.

[8] Expression (21) can be written as $\omega = \omega_1 \cdot \omega_2$ where $\omega_1 \equiv (1-\rho)/[1-\rho(1-p)]$ and $\omega_2 \equiv [1-\beta\rho(1-\underline{\eta})]/[1-\beta\rho(1-\underline{\eta}-p)]$. Note that $1/\omega_1 = 1+p\cdot\rho/(1-\rho)$, which is positive and increasing in ρ. Similarly, $1/\omega_2$ is also positive and increasing in ρ. This indicates that both ω_1 and ω_2 are positive and decreasing in ρ. It follows that ω is decreasing in ρ.

Higher reservation utility. The rise of private corporations increased the outside option of SOEs' managers. The competition for managers coming from private corporations forced SOEs to raise the compensation for their managerial teams. This is captured in the model by an increase in the reservation utility q_R. The higher value of q_R increases the optimal levels of monitoring and inspections.

Intuitively, the compensation for the manager is a fraction of the SOE's investment revenue. We have shown that a larger value of q_R allows for a higher initial investment k and, thus, a larger initial size of the firm. But when the firm is larger, the allocation of skills becomes more important (since skills are multiplicative to k). As a result, the marginal benefits of an efficient allocation of skills increases, making monitoring and inspections more desirable.

Higher social return. As environmental protection and poverty alleviation become more important nowadays, the social responsibility of SOEs increases. This could be formalized by an increase in the function $s(e)$, that is, the productivity of managerial skills in social activities. Thus, the optimal levels of monitoring and inspection rise with the rise in social return $s(e)$.

This result has also a simple intuition. With a higher return from social activities, the efficiency losses caused by the mis-allocation of skills increase. This increases the gains from improving the allocation of skills and justifies more intensive monitoring and inspections.

Higher market return. As the market economy becomes more prosperous in China, the market return of SOEs also rises. This is captured in the model by higher values of both z_H and z_L. In this case the impact on the optimal value of monitoring and inspection is ambiguous.

A higher market return increases not only total output but also the share of market output in total output. As the share of market output increases, the social cost of skill misallocation, captured by $V^F(Q_R|\bar{\eta}) - V^F(Q_R|\underline{\eta})$, decreases. This makes monitoring and inspections less desirable. At the same time, the higher market return also lowers the marginal cost of monitoring and inspections, $-\partial V^F(Q_R|\bar{\eta})/\partial Q_R$ and $-\partial V^F(Q_R|\underline{\eta})/\partial Q_R$. Therefore, we have two contrasting effects with ambiguous consequences for the optimal levels of monitoring and inspections.

The above properties are summarized in the following proposition.

Proposition 4 *Suppose that monitoring and inspections are at their optimal levels. Then,*

1. *The optimal p decreases when q_R or $s(e)$ rise. It can either increase or decrease when z_H and z_L rise.*

2. *The optimal $\underline{\eta}$ increases when q_R or $s(e)$ rise. It can either increase or decrease when z_H and z_L rise.*

Proof 4 *Appendix B.7.*

We conclude this section by discussing the implications for manager turnover. When the intensity of monitoring and inspections rises, what happens to managers' turnover? We show this with a numerical example.

We start with monitoring. Monitoring reduces the probability p with which η switches from $\bar{\eta}$ to $\underline{\eta}$: it will take a longer time for a new manager to learn how to disguise policies. The third panel of Figure 6 shows that, with more intensive monitoring (i.e., an increase in $1-p$), the expected length of time for a new manager to remain in the current position with $\eta = \bar{\eta}$ increases. Thus, the average duration moves closer to the duration limit $1/(1-\rho)$ (dashed line). The expected duration of the current position, independently of the value of η, increases as well (solid line).

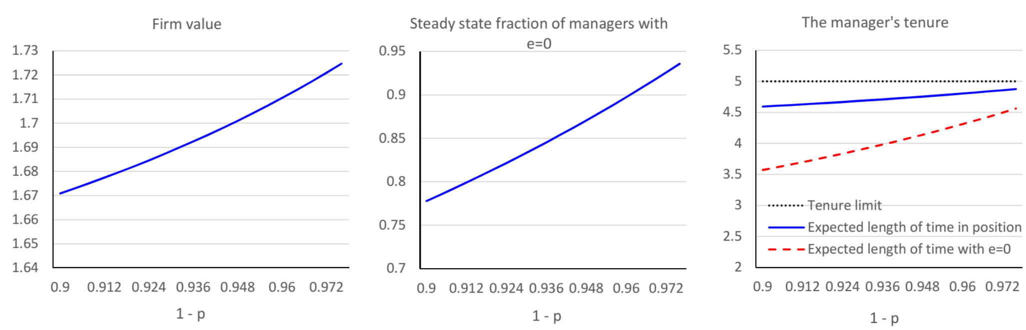

Figure 6: The effects of ex-ante monitoring.

Given the survival rate ρ, a lower p implies that it is more likely for a manager to quits before switching to $\eta = \underline{\eta}$. As a result, the steady state fraction of managers with $\eta = \bar{\eta}$ (and $e = 0$) in the market increases.

Let's consider now the sensitivity to inspections. More intensive inspections increase the probability $\underline{\eta}$ with which a deviation is detected. Thus, it takes less time for the principal to detect the actual allocation of skills. As shown in the third panel of Figure 7, more intensive inspections, i.e., higher $\underline{\eta}$, is associated with lower expected duration in the current job, while the expected duration with $\eta = \bar{\eta}$ remains unchanged. As a result, the average fraction of managers with $\eta = \bar{\eta}$ increases.

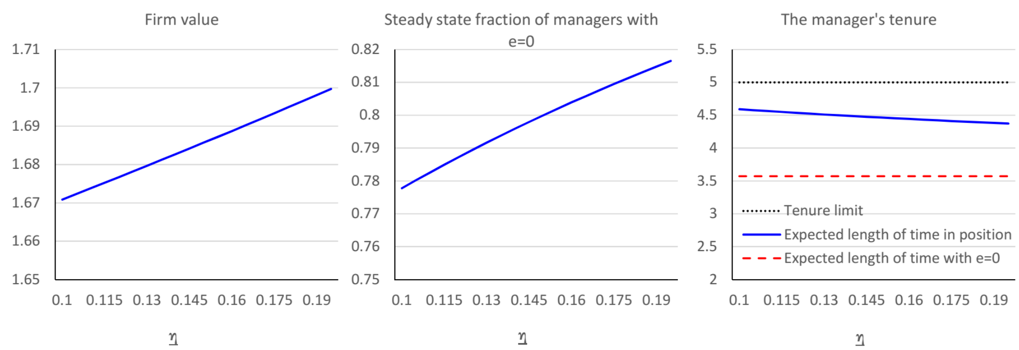

Figure 7: The effects of ex-post inspection.

The numerical example shows that ex-ante monitoring not only increases the contract value for the principal (first panel Figure 6), but it also increases the average duration of the job. The turnover rate is then lower. In contrast, ex-post inspection raises both the contract value (first panel of Figure 7) and the turnover rate of managers. Though we abstract from search frictions in this paper, finding a suitable replacement in a short period of time may not be easy. This suggests that ex-ante monitoring could be a better instrument compared to ex-post inspections if search frictions are severe.

7 Conclusion

Using Chinese firm-level data we find that companies controlled by indicted SOEs experience lower market performance and investment after the inspection, compared with companies controlled by non-indicted SOEs. The indictment of the controlling SOEs is followed by an increase in environmental and poverty alleviation expenditures by controlled companies, as well as their ESG rating.

To rationalize these empirical findings we constructed a principle-agent model with repeated moral hazard that captures some of the corporate control features of Chinese SOEs and, especially, their broader social objective. After showing that the model can generate the empirical corporate responses to inspections, we studied the impact of three changes on allocation efficiency: ex-ante monitoring, ex-post inspections, and length of managerial tenure.

Although more intensive monitoring and inspections mitigate the agency frictions, they also discourage managers from taking these positions, which translates in higher costs for SOEs. Thus, increasing monitoring and inspections is not always desirable. For the length of managerial tenure we also find that it generates two contrasting effects. On the one hand, longer tenure increases the average scale of firms, raising their social surplus. On the other, managers with longer tenure may find easier to mis-allocate skills, reducing the social surplus generated by the firm. Therefore, also for tenure, there could be an interior optimum. These considerations are helpful for understanding some of recent corporate control reforms for SOEs discussed in China.

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A Data and other empirical evidence

A.1 List of inspected firms

Table 4 lists the names of the inspected central SOEs. The order follows the inspection time. Names with stars refer to the SOEs whose top leaders were indicted and convicted for corruption after the inspections according to CCDI's official announcements.

Table 4: List of inspected central SOEs

Order	Name
1	China Grain Reserves Corporation
2	China Three Gorges Corporation
3	China Oil & Foodstuffs Corporation
4	China FAW Group Corporation (*)
5	China Huadian Corporation
6	Sinopec Group (*)
7	China Shenhua Group
8	China Unicom
9	Dongfeng Motor Corporation
10	China Southern Airlines (*)
11	China State Shipbuilding Corporation
12	China Shipping (Group) Corporation
13	State Grid Corporation of China
14	China Huaneng Group Corporation
15	China Ship Building Industry Corporation
16	China National Machinery Industry Corporation
17	Wuhan Iron and Steel Group (*)
18	China Ocean Shipping (Group) Corporation
19	China Electronics Corporation
20	China Electronics Technology Group
21	State Development & Investment Corporation
22	China State Construction Engineering Corporation
23	China Guodian Group Corporation
24	China General Technology (Group) Corporation
25	China Baowu Steel Group
26	China Telecom
27	China Mobile Communications Group
28	China National Petroleum Corporation (*)
29	State Nuclear Power Technology Corporation
30	China National Offshore Oil Corporation (*)
31	China Datang (Group) Corporation
32	State Power Investment Corporation Limited
33	China Nuclear Engineering & Construction Corporation
34	China National Nuclear Corporation
35	China Minerals Corporation
36	China Dongfang Electric Corporation (*)
37	China Southern Power Grid Corporation
38	SINOCHEM Group
39	China State Railway Group
40	China Post (Group) Corporation
41	China North Industries Group Corporation
42	Aluminum Corporation of China (*)
43	China South Industries Group Corporation
44	Ansteel Group Corporation
45	Commercial Aircraft Corporation of China
46	China Eastern Airlines Corporation
47	China National Aviation Holding Company
48	Aviation Industry Corporation of China
49	China National Travel Service (HK) Group Corporation (*)
50	China Aerospace Science and Industry Corporation
51	China Merchants Group Corporation
52	China Aerospace Science and Technology Corporation
53	China Resources (Holdings) Corporation (*)
54	Harbin Electric Corporation
55	China First Heavy Industries Corporation

B Mathematic derivations and proofs

B.1 Proof of Proposition 1

Suppose that a continuing manager does not deviate, that is, $e = 0$. Given the contractual policies, the expected value for the manager is

$$Q_0 = \beta \sum_z \left[\rho\Big(\bar{c}(0,z) + \bar{q}(0,z) \Big) + (1-\rho)\Big(\underline{c}(0,z) + q_R \Big) \right] \varphi(z|0), \tag{22}$$

If the manager deviates and chooses $e = 1$, the expected value is

$$\begin{aligned} Q_1 \quad = \quad & \beta \Bigg\{ (1-\eta) \sum_z \left[\rho\Big(\bar{c}(0,z) + \bar{q}(0,z) \Big) + \right. \\ & \left. (1-\rho)\Big(\underline{c}(0,z) + q_R \Big) \right] \varphi(z|1) + \eta q_R \Bigg\} \end{aligned} \tag{23}$$

Thus, Q_0 denotes the value for the manager when he/she chooses the socially optimal allocation of skills, and Q_1 the value when he/she deviates from the socially desirable allocation of skills. The manager will then choose $e = 0$ if $Q_0 > Q_1$ and viceversa.

We now take advantage of the linearity of the model to derive sharper characterizations of Q_0 and Q_1. Provided that the total surplus increases in k (this is a necessary condition for the firm to exist), it will be optimal to choose the highest input of capital that is compatible with the incentive of the manager to not divert market output. This implies that constraints (4)-(5) will be satisfied with equality. The intuition is that a larger spread between the values received by the manager under the two realizations of productivity allows a higher input of capital without violating incentive-compatibility. It is important to clarify that this is true here because we are assuming that the principle takes e as given. Later, however, we will see that this is not necessarily the case when we solve the original problem which takes into account the impact of the contract structure on the choice of e.

We can also show that the (simplified) optimal contract will set

$$\bar{c}(0,z_L) = \underline{c}(0,z_L) = 0 \quad \text{and} \quad \bar{q}(0,z_L) = q_R. \tag{24}$$

Thus, the incentive-compatibility constraint can be simplified to

$$\bar{c}(0,z_H) + \bar{q}(0,z_H) = q_R + \alpha k, \tag{25}$$

$$\underline{c}(0,z_H) = \alpha k. \tag{26}$$

This takes into account that, when the manager quits, the promised utility is the reservation value, i.e., $\underline{q}(0, z) = q_R$ for any $z \in \{z_L, z_H\}$.

The last constraint says that, upon quitting (which happens with probability $1 - \rho$), the payment received by the manager is exactly equal to the benefit of diverting output. In the case of continuation only the total value of the contract for the manager is determined. This can be delivered with higher current payments $\bar{c}(0, z_L)$ or, alternatively, with higher future payments $\bar{q}(0, z_L)$. As we will see, however, when the manager stays in the contract, it is always optimal for the principal to postpone the managers' consumption by setting $\bar{c}(0, z_H) = 0$ and $\bar{q}(0, z_H) = q_R + \alpha k$. This is because a higher $\bar{q}(0, z_H)$ allows more investment in the next period without violating the incentive compatibility constraint. What this means is that the manager receives zero payments until quitting.

We can now use conditions (24)-(26) to rewrite (22)-(23) as

$$Q_0 = \beta\Big[q_R + \varphi(z_H|0)\alpha k\Big], \tag{27}$$

$$Q_1 = \beta\Big[q_R + (1-\eta)\varphi(z_H|1)\alpha k\Big]. \tag{28}$$

To enforce $e = 0$, the value of the manager defined in (27) must be greater than the value defined in (28), that is, $Q_0 \geq Q_1$. Using the definition of these two values, the enforcement condition simplifies to

$$\varphi(z_H|0) > (1-\eta)\varphi(z_H|1), \tag{29}$$

which is the condition stated in Proposition 1.

Notice that the manager's continuation value does not enter the above condition. Therefore, if the optimal allocation of skills chosen by the manager is $e = 0$, it will also be optimal in the future. This follows from the linear structure of utility and technology. *Q.E.D.*

B.2 Derivation of $V(q|\bar{\eta})$ and $V(q|\underline{\eta})$

We start by deriving equation (13) (i.e., the expression for $V(q|\bar{\eta})$) using (8). For convenience, we define

$$U(q_t|\bar{\eta}) = V(q_t|\bar{\eta}) + q_t.$$

Thus, (8) can be re-written as

$$U(q_t|\bar{\eta}) = \beta(A + \hat{r}(0) \cdot k_t) + \beta \cdot \mathbb{E}_t\big[U(q_{t+1}|\bar{\eta})\big], \tag{30}$$

where

$$\hat{r}(0) \equiv s(0) + \mathbb{E}(z|e = 0) - 1/\beta,$$

and

$$q_{t+1} = \begin{cases} q_R + \alpha k_t & \textit{with probability } \rho \cdot \varphi(z_H|0), \\ q_R & \textit{with probability } 1 - \rho \cdot \varphi(z_H|0). \end{cases} \tag{31}$$

Recall that k_t depends on q_t,

$$k_t = \frac{1}{\alpha\varphi(z_H|0)}\Big(\frac{q_t}{\beta} - q_R\Big).$$

Thus, (31) indicates that the expected q in the next period is

$$\mathbb{E}_t(q_{t+1}) = \rho \cdot \left(\frac{q_t}{\beta}\right) + (1-\rho) \cdot q_R,$$

which implies

$$\mathbb{E}_t(q_{t+n}) = \Big(\frac{\rho}{\beta}\Big)^n q_t + \frac{\beta(1-\rho)}{\beta-\rho}\Big[1 - \Big(\frac{\rho}{\beta}\Big)^n\Big] q_R.$$

Note that by re-arranging (30), we have

$$U(q_t|\bar{\eta}) = \frac{\beta A}{1-\beta} + \hat{r}(0) \cdot \mathbb{E}_t \sum_{n=0}^{\infty} \beta^{n+1} k_{t+n}.$$

The expected life-time investment, $\hat{K}(q_t|\bar{\eta})$, is

$$\begin{aligned} \hat{K}(q_t|\bar{\eta}) &\equiv \mathbb{E}_t\left[\sum_{n=0}^{\infty} \beta^{n+1} k_{t+n}\right] \\ &= \frac{1}{\alpha\varphi(z_H|0)} \cdot \mathbb{E}_t\left[\sum_{n=0}^{\infty} \beta^n (q_{t+n} - \beta q_R)\right] = \frac{1}{\alpha\varphi(z_2|0)} \cdot \frac{q_t}{1-\rho}. \end{aligned}$$

Thus, we have

$$U(q_t|\bar{\eta}) = \frac{\beta A}{1-\beta} + \frac{\hat{r}(0)}{\alpha\varphi(z_2|0)} \cdot \frac{q_t}{1-\rho},$$

which indicates

$$V(q_t|\bar{\eta}) = \frac{\beta A}{1-\beta} + \Big[\frac{\hat{r}(0)}{\alpha(1-\rho)\varphi(z_2|0)} - 1\Big] q_t.$$

With a similar derivation, we can obtain (17) (i.e., the expression for $V(q_t|\underline{\eta})$).

B.3 Proof of Proposition 2

To enforce $e = 0$, we need to make sure that the value of the contract for the manager when $e = 0$ is greater than the value when $e = 1$. As shown in Section 4.2.2 this requires to raise continuation utilities when $d = 0$ (no observability of e and z) by a sufficiently high value of Δ. Without loss of generality we express this value $\Delta = \theta\alpha k$. Thus, choosing a sufficiently high value of Δ is equivalent to choosing a sufficiently high value of θ.

Using the expressions derived in Section 4.2.2, the contract values for the manager conditional on e can be written as

$$\begin{aligned} Q_0 &= \beta\Big[q_R + \hat{\varphi}(z_H|0)\alpha k\Big], \\ Q_1 &= \beta\Big[q_R + (1-\eta)\hat{\varphi}(z_H|1)\alpha k\Big], \end{aligned}$$

where $\hat{\varphi}(z_H|0) = \theta + \varphi(z_H|0)$ and $\hat{\varphi}(z_H|1) = \theta + \varphi(z_H|1)$. Thus, in order to enforce $e = 0$, we need to have that $Q_0 > Q_1$. Substituting the above expressions, this condition requires $\hat{\varphi}(z_H|0) > (1-\eta)\hat{\varphi}(z_H|1)$ or, equivalently, $\theta > [(1-\eta)\varphi(z_H|1) - \varphi(z_H|0)]/\eta$.

We now derive the value of the contract for the principle when

$$\theta = \frac{(1-\eta)\varphi(z_H|1) - \varphi(z_H|0)}{\eta}, \tag{32}$$

that is, the extra value Δ is the minimum required to enforce $e = 0$. By choosing this value of θ the manager always chooses $e = 0$. This allows us to use Lemma 1 to derive the value of the contract for the principle, that is,

$$\hat{V}(q|\eta) = \frac{\beta A}{1-\beta} + \hat{\chi}\, q, \tag{33}$$

where $\hat{\chi} = [s(0) + \mathbb{E}(z|e = 0) - 1/\beta]/[\alpha\hat{\varphi}(z_H|0)(1-\rho)] - 1$.

On the other hand, if the principle decides not to enforce $e = 0$ by choosing $\theta = 0$ and, under this contract the manager chooses $e = 1$, the value of the principle can be derived from Lemma 2. In this case it takes the form

$$V(q|\eta) = \frac{\beta A}{1-\beta} + \chi\, q, \tag{34}$$

where $\chi = [s(1) + \mathbb{E}(z|e = 1) - 1/\beta]/[(1-\eta)\alpha\varphi(z_H|1)(1-\rho)] - 1$.

The principle will find optimal to enforce $e = 0$ if $\hat{V}(q|\eta) > V(q|\eta)$. Using the definition of the two values provided in (33) and (33), this requires $\hat{\chi} > \chi$ or, equivalently

$$\frac{s(0) + \mathbb{E}(z|e=0) - 1/\beta}{\theta + \varphi(z_H|0)} > \frac{s(1) + \mathbb{E}(z|e=1) - 1/\beta}{(1-\eta)\varphi(z_H|1)}.$$

Substituting θ with its minimum value required to enforce $e = 0$ indicated in (32) and rearranging, we obtain the condition in Proposition 2. *Q.E.D.*

B.4 Proof of Proposition 3

The proof of the first part of the proposition is simple. Market production is zk. Therefore, z is the (gross) market return on capital. The average return is

$$\mathbb{E}z = z_1 \cdot \Big(1 - \varphi(z_2|e)\Big) + z_2 \cdot \varphi(z_2|e).$$

The assumption that $\varphi(z_2|1) > \varphi(z_2|0)$ implies that SOEs in which managers choose $e = 1$ have higher average market return than SOEs with managers choosing $e = 0$. A convicted manager chooses $e = 1$ while his replacement (at least in the first period after replacement) chooses $e = 0$. This determines a drop in the market return of the SOE. Among the SOEs where managers are not indicted, some will choose $e = 1$ (those with $\eta = \underline{\eta}$) and some will choose $e = 0$ (those with $\eta = \bar{\eta}$). So average productivity depends on the composition of these two types of SOEs. The Markov process assumed for η, implies that SOEs in which surviving managers are not indicted, will have a larger fraction of $\underline{\eta}$-managers in the next period. As a result, the average return of these SOEs increases in the next period.

We now prove the second property stated in the proposition, that is, the impact of indictment on investment. To prove the impact on investment we derive first the average growth of capital for SOEs with $\underline{\eta}$ managers who are indicted and $\underline{\eta}$ managers who are not indicted. We then derive the average growth of capital for SOEs with $\bar{\eta}$ managers. The goal is to prove that the growth of capital of indicted managers is smaller than the average of all other firms.

SOE with indicted $\underline{\eta}$-managers. Only managers with $\eta = \underline{\eta}$ are indicted and this happens with probability $\underline{\eta}$. An indicted manager is replaced by a new manager with $\eta = \bar{\eta}$ and with initial contract value q_R. The next period investment is then determined by the promise-keeping constraint $q' = \beta[q_R + \varphi(z_2|0)\alpha k']$ with $q' = q_R$, since the new manager starts with q_R. Inverting the promise-keeping constraint we obtain

$$k' = \frac{(1-\beta)q_R}{\alpha\beta\varphi(z_2|0)}.$$

Dividing both size by the initial capital k (chosen by the indicted manager now replaced by the new manager) we obtain the gross growth rate of capital,

$$\frac{k'}{k} = \frac{(1-\beta)q_R}{\alpha\beta\varphi(z_2|0)}\frac{1}{k}. \tag{35}$$

This is the growth of capital for a SOE with initial capital k in the period after the indicted manager has been replaced by a new manager. Our goal is to show that the growth of capital for this firm is lower than the average growth of capital for all other firms with the same initial capital k.

SOE with non-indicted $\underline{\eta}$-managers. Given the stock of capital invested in the previous period, the expected value of the contract for a manager, conditional on not being indicted, is

$$\mathbb{E}q' = q_R + \varphi(z_2|1)\alpha k. \tag{36}$$

Notice that the term $1-\underline{\eta}$ does not show in this expression because this is conditional on not being caught deviating.

Consider now the promise-keeping constraint in the new period after the realization of q', that is, $q' = \beta[q_R + (1-\underline{\eta})\varphi(z_2|1)\alpha k']$. Inverting this promise-keeping constraint we obtain the new capital as a function of the new realized value for the manager,

$$k' = \frac{q' - \beta q_R}{\alpha\beta(1-\underline{\eta})\varphi(z_2|1)}.$$

Taking expectations we obtain

$$\mathbb{E}k' = \frac{\mathbb{E}q' - \beta q_R}{\alpha\beta(1-\underline{\eta})\varphi(z_2|1)}.$$

We can now use (36) to eliminate $\mathbb{E}q'$ in the expression for the expected new investment. After re-arranging terms we arrive at the following expression

$$\frac{\mathbb{E}k'}{k} = \frac{1}{\beta(1-\underline{\eta})} + \left[\frac{(1-\beta)q_R}{\alpha\beta(1-\underline{\eta})\varphi(z_2|1)}\right]\left(\frac{1}{k}\right). \tag{37}$$

This is the expected gross growth rate of capital for SOEs managed by non-indicted $\underline{\eta}$-managers. This expression shows that the expected growth rate of capital is positive (that is, the gross growth rate is greater than 1) but declines in the size of the firm, that is, the initial stock of capital k.

Comparing indicted and non-indicted $\underline{\eta}$-managers. We can now compare the growth rate of capital for indicted and non-indicted managers who are both characterized by $\eta = \underline{\eta}$. We want to show that, if they have the same initial capital k, the growth rate of capital of SOEs with indicted manager—defined in equation (35)—is always smaller than the average growth of SOEs with non-indicted managers—defined in equation (37).

Let $\Delta(k)$ be the growth differential between SOEs where managers are not indicted and SOEs where managers are indicted (difference between (37) and (35)). This is equal to

$$\Delta(k) = \frac{1}{\beta(1-\underline{\eta})} + \left[\frac{(1-\beta)q_R}{\alpha\beta(1-\underline{\eta})\varphi(z_2|1)} - \frac{(1-\beta)q_R}{\alpha\beta\varphi(z_2|0)}\right]\left(\frac{1}{k}\right).$$

The growth differential depends on the initial stock of capital. Taking the first derivative we can show that $\Delta(k)$ increases in k. Therefore, if we can prove that $\Delta(k) > 0$ for the smallest admissible k, we have also proved that $\Delta(k) > 0$ for any k.

The smallest k is the capital determined by the promise-keeping constraint when the value of the contract for the manager is $q = q_R$ and $\eta = \underline{\eta}$, that is,

$$q_R = \beta\Big[q_R + (1-\underline{\eta})\varphi(z_2|1)\alpha k_{min}\Big].$$

Using this condition to eliminate k in the definition of $\Delta(k)$ and re-arranging, the condition for a positive growth differential associated with the lowest possible k, that is, $\Delta(k_{min}) > 0$, is

$$1 + \frac{1}{\beta(1-\underline{\eta})} > \frac{(1-\underline{\eta})\varphi(z_2|1)}{\varphi(z_2|0)}. \tag{38}$$

We can verify that this condition is satisfied if the (sufficient) condition imposed in Proposition 3 is satisfied.

SOE with $\bar{\eta}$-managers. So far we have compared SOEs with indicted $\underline{\eta}$-managers and non-indicted $\underline{\eta}$-managers. We now consider SOEs where managers have $\eta = \bar{\eta}$ initially. Again, the goal is to show that the average growth rate of capital for these SOEs is greater than for SOEs with indicted managers.

Given the stock of capital invested in the previous period, the expected next period value of the contract for a manager with $\eta = \bar{\eta}$ is

$$\mathbb{E}q' = q_R + \varphi(z_2|0)\alpha k. \tag{39}$$

Once q' is realized, the $\bar{\eta}$-manager could switch from $\bar{\eta}$ to $\underline{\eta}$ with probability p. The promise-keeping constraint in the new period will depend on the new η (either $\bar{\eta}$ or $\underline{\eta}$).

When the manager's type does not change, that is, $\eta' = \bar{\eta}$, the promise-keeping constraint in the new period is $q' = \beta[q_R + \varphi(z_2|0)\alpha k']$, which we can invert to obtain

$$k' = \frac{q' - \beta q_R}{\alpha\beta\varphi(z_2|0)}.$$

When the manager's type changes, that is, $\eta' = \underline{\eta}$, the promise-keeping constraint is $q' = \beta[q_R + (1-\underline{\eta})\varphi(z_2|1)\alpha k']$, which we can also invert to obtain

$$k' = \frac{q' - \beta q_R}{\alpha\beta(1-\underline{\eta})\varphi(z_2|1)}.$$

Using these expressions and considering that the switch happens with probability p, we can derive the expected next period capital

$$\mathbb{E}k' = \left[\frac{1-p}{\varphi(z_2|0)} + \frac{p}{(1-\underline{\eta})\varphi(z_2|1)}\right]\left(\frac{\mathbb{E}q' - \beta q_R}{\alpha\beta}\right).$$

We now use (39) to eliminate $\mathbb{E}q'$. Dividing the resulting expression by k we obtain

$$\frac{\mathbb{E}k'}{k} = \frac{1}{\beta}\left[1-p+p\frac{\varphi(z_2|0)}{(1-\underline{\eta})\varphi(z_2|1)}\right] + \frac{(1-\beta)q_R}{\alpha\beta\varphi(z_2|0)}\left[1-p+p\frac{\varphi(z_2|0)}{(1-\underline{\eta})\varphi(z_2|1)}\right]\left(\frac{1}{k}\right). \tag{40}$$

Comparing indicted and non-indicted $\bar{\eta}$-managers. We want to prove that (40) is always bigger than (35). As before, let's define $\Delta(k)$ the growth differential between (40) and (35). After substituting the corresponding expressions and collecting terms, the growth differential is

$$\Delta(k) = \frac{1}{\beta}\left[1-p+p\frac{\varphi(z_2|0)}{(1-\underline{\eta})\varphi(z_2|1)}\right] - \frac{p(1-\beta)q_R}{\alpha\beta\varphi(z_2|0)}\left[1-\frac{\varphi(z_2|0)}{(1-\underline{\eta})\varphi(z_2|1)}\right]\left(\frac{1}{k}\right)$$

We first notice that, since the term that multiplies $1/k$ is negative, $\Delta(k)$ is increasing in k. Therefore, to prove that $\Delta(k)$ is always positive, we only need to show that this is true for the lowest possible value of k. We derive this from the promise-keeping constraint $q = \beta[q_R + (1-\underline{\eta})\varphi(z_2|1)\alpha k]$, that is, the promise-keeping constraint for an $\underline{\eta}$-manager. The lowest value of k is obtained when the value of the contract for this manager is at the lowest bound, that is, $q = q_R$. Thus, setting $q = q_R$ allows us to derive

$$k_{min} = \frac{(1-\beta)q_R}{\alpha\beta(1-\underline{\eta})\varphi(z_2|1)}.$$

Substituting k_{min} in the growth differential we obtain

$$\Delta(k_{min}) = \frac{1}{\beta}\left[1 - p + p\frac{\varphi(z_2|0)}{(1-\underline{\eta})\varphi(z_2|1)}\right] - p\left[\frac{(1-\underline{\eta})\varphi(z_2|1)}{\varphi(z_2|0)} - 1\right].$$

A sufficient condition for $\Delta(k_{min}) > 0$ is

$$\frac{(1-\underline{\eta})\varphi(z_2|1)}{\varphi(z_2|0)} < \frac{1}{p} + \frac{\varphi(z_2|0)}{(1-\underline{\eta})\varphi(z_2|1)}. \tag{41}$$

This is obtained by eliminating $1/\beta$ on the right-hand-side of the expression that defines $\Delta(k_{min})$. Since $1/\beta > 1$, if the modified expression is positive, the original expression will also be positive. At this point we can verify that the (sufficient) condition imposed in Proposition 3 implies that condition (41) is satisfied. *Q.E.D.*

B.5 Derivation of contract value with stochastic η

We now derive equation (20) (i.e., the expression for $V(q_t|\bar{\eta})$) using (18) and (19). For convenience, we define

$$U(q_t, \bar{\eta}) = V(q_t, \bar{\eta}) + q_t \qquad \textit{and} \qquad U(q_t, \underline{\eta}) = V(q_t, \underline{\eta}) + q_t.$$

First, note that (19) can be re-written as

$$U(q_t, \underline{\eta}) = \beta(A + \hat{r}(1)\cdot k_t) + \beta\underbrace{[1-\rho(1-\underline{\eta})]\cdot U(q_R, \bar{\eta})}_{\textit{Replaced}} + \beta\underbrace{\rho(1-\underline{\eta})\cdot \mathbb{E}_t[U(q_{t+1}, \underline{\eta})]}_{\textit{Continue}}.$$

where

$$\hat{r}(1) = s(1) + \mathbb{E}(z|e=1) - 1/\beta,$$

and conditioned on continuation

$$q_{t+1} = \begin{cases} q_R + \alpha k_t & \textit{with probability } \varphi(z_H|1), \\ q_R & \textit{with probability } 1-\varphi(z_H|1). \end{cases}$$

Recall that k_t depends on q_t,

$$k_t = \frac{1}{\alpha(1-\underline{\eta})\varphi(z_H|1)}\left(\frac{q_t}{\beta} - q_R\right).$$

Thus, conditioned on continuation, the expected q in the next period is

$$\hat{q}_{t+1} \equiv \mathbb{E}(q_{t+1}|\lambda_t = 1, d_t = 0) = \frac{1}{1-\underline{\eta}} \cdot \frac{q_t}{\beta} - \frac{\underline{\eta}}{1-\underline{\eta}} \cdot q_R.$$

which implies

$$\hat{q}_{t+n} = \frac{1}{\beta^n(1-\underline{\eta})^n} \cdot q_t - \frac{\beta\underline{\eta}}{1-\beta(1-\underline{\eta})}\Big[\frac{1}{\beta^n(1-\underline{\eta})^n} - 1\Big]q_R.$$

By re-arranging the expression for $U(q_t, \underline{\eta})$, we have

$$U(q_t, \underline{\eta}) = \frac{\beta}{1-\beta\rho(1-\underline{\eta})} \cdot \Big\{A + [1-\rho(1-\underline{\eta})] \cdot U(q_R, \bar{\eta})\Big\} + \hat{r}(1) \cdot \mathbb{E}_t \sum_{n=0}^{\infty} \beta\big[\beta\rho(1-\underline{\eta})\big]^n k_{t+n}$$

The expected life-time investment, $\hat{K}(q_t, \underline{\eta})$, is

$$\begin{aligned}
\hat{K}(q_t, \underline{\eta}) &\equiv \mathbb{E}_t \sum_{n=0}^{\infty} \beta\big[\beta\rho(1-\underline{\eta})\big]^n k_{t+n} \\
&= \frac{1}{\alpha(1-\underline{\eta})\varphi(z_H|1)} \cdot \sum_{n=0}^{\infty} \big[\beta\rho(1-\underline{\eta})\big]^n (\hat{q}_{t+n} - \beta q_R) \\
&= \frac{1}{\alpha(1-\underline{\eta})\varphi(z_H|1)} \cdot \left\{\frac{q_t}{1-\rho} - \beta\Big[\frac{1-\rho(1-\underline{\eta})}{(1-\rho)[1-\beta\rho(1-\underline{\eta})]}\Big]q_R\right\}.
\end{aligned}$$

Thus, we have

$$\begin{aligned}
U(q_t, \underline{\eta}) =& \frac{\beta}{1-\beta\rho(1-\underline{\eta})} \cdot \Big\{A + [1-\rho(1-\underline{\eta})] \cdot U(q_R, \bar{\eta})\Big\} \\
&+ \frac{\hat{r}(1)}{\alpha(1-\underline{\eta})\varphi(z_H|1)} \cdot \left\{\frac{q_t}{1-\rho} - \beta\Big[\frac{1-\rho(1-\underline{\eta})}{(1-\rho)[1-\beta\rho(1-\underline{\eta})]}\Big]q_R\right\}. \quad (42)
\end{aligned}$$

Second, note that (18) can be re-written as

$$U(q_t, \bar{\eta}) = \beta(A + \hat{r}(0) \cdot k_t) + \beta \underbrace{(1-\rho) \cdot U(q_R, \bar{\eta})}_{Replaced} + \underbrace{\mathbb{E}_t\Big[\beta\rho p \cdot U(q_{t+1}, \underline{\eta}) + \beta\rho(1-p) \cdot U(q_{t+1}, \bar{\eta})\Big]}_{Continue}.$$

where

$$\hat{r}(0) = s(0) + \mathbb{E}(z|e=0) - 1/\beta,$$

and conditioned on continuation

$$q_{t+1} = \begin{cases} q_R + \alpha k_t & \textit{with probability } \varphi(z_H|0), \\ q_R & \textit{with probability } 1-\varphi(z_H|0). \end{cases}$$

Recall that k_t depends on q_t,

$$k_t = \frac{1}{\alpha\varphi(z_H|0)}\Big(\frac{q_t}{\beta} - q_R\Big).$$

Thus, conditioned on continuation, the expected q in the next period is

$$\mathbb{E}_t(q_{t+1}|\lambda_t = 1) = \frac{q_t}{\beta},$$

which implies

$$\hat{q}_{t+n} = \frac{q_t}{\beta^n}.$$

By re-arranging the above expression for $U(q_t, \bar{\eta})$, we have

$$\begin{aligned} U(q_t, \bar{\eta}) =& \frac{\beta}{1-\beta\rho(1-p)} \cdot \Big\{A + (1-\rho)U(q_R, \bar{\eta})\Big\} + \hat{r}(0) \cdot \mathbb{E}_t \sum_{n=0}^{\infty} \beta[\beta\rho(1-p)]^n k_{t+n} \\ &+ \beta\rho p \cdot \mathbb{E}_t \sum_{n=0}^{\infty} [\beta\rho(1-p)]^n U(q_{t+1+n}, \underline{\eta}). \end{aligned}$$

Thus, by using (42), we have

$$\begin{aligned} \mathbb{E}_t \sum_{n=0}^{\infty} [\beta\rho(1-p)]^n U(q_{t+1+n}, \underline{\eta}) =& \frac{1}{1-\beta\rho(1-p)} \cdot \Bigg\{ \frac{\beta}{1-\beta\rho(1-\underline{\eta})} \cdot \Big\{A + [1-\rho(1-\underline{\eta})] \cdot U(q_R, \bar{\eta})\Big\} \\ &- \frac{\hat{r}(1)}{\alpha(1-\underline{\eta})\varphi(z_H|1)} \cdot \beta\Big[\frac{1-\rho(1-\underline{\eta})}{(1-\rho)[1-\beta\rho(1-\underline{\eta})]}\Big] q_R \Bigg\} \\ &+ \frac{\hat{r}(1)}{\alpha(1-\underline{\eta})(1-\rho)\varphi(z_H|1)} \cdot \frac{q_t/\beta}{1-\rho(1-p)}, \end{aligned}$$

and the expected life-time investment with $\eta = \bar{\eta}$ is

$$\begin{aligned} \hat{K}(q_t, \bar{\eta}) &\equiv \mathbb{E}_t \sum_{n=0}^{\infty} \beta[\beta\rho(1-p)]^n k_{t+n} \\ &= \frac{1}{\alpha\varphi(z_H|0)} \cdot \mathbb{E}_t \sum_{n=0}^{\infty} [\beta\rho(1-p)]^n (q_t - \beta q_R) \\ &= \frac{1}{\alpha\varphi(z_H|0)} \cdot \Big[\frac{q_t}{1-\rho(1-p)} - \frac{\beta q_R}{1-\beta\rho(1-p)}\Big]. \end{aligned}$$

For convenience, we define

$$x_p \equiv \frac{\beta}{1-\beta\rho(1-p)}, \quad x_e \equiv \frac{\beta}{1-\beta\rho(1-\underline{\eta})}, \quad c_p \equiv 1-\rho(1-p) \quad \textit{and} \quad c_e \equiv 1-\rho(1-\underline{\eta}),$$

$$\hat{R}_H \equiv \frac{\hat{r}(0)}{\alpha(1-\rho)\varphi(z_H|0)} \qquad \textit{and} \qquad \hat{R}_L \equiv \frac{\hat{r}(1)}{\alpha(1-\underline{\eta})(1-\rho)\varphi(z_H|1)}.$$

Thus, we have

$$\begin{aligned} U(q_t,\bar{\eta}) =& x_p[A+(1-\rho)\cdot U(q_R,\bar{\eta})] + \rho p x_p x_e[A + c_e \cdot U(q_R,\bar{\eta})] \\ &+ \hat{R}_H \cdot \Big[\Big(\frac{1-\rho}{c_p}\Big)\cdot q_t - (1-\rho)x_p \cdot q_R\Big] + \hat{R}_L \cdot \Big[\Big(1-\frac{1-\rho}{c_p}\Big)\cdot q_t - \rho p c_e x_p x_e \cdot q_R\Big]. \end{aligned}$$

By setting $q_t = q_R$ and rearranging the above equation we have

$$\begin{aligned} U(q_R,\bar{\eta})\cdot&[1-(1-\rho)x_p - \rho p c_e x_p x_e] = A\cdot(x_p + \rho p x_p x_e) \\ &+ \hat{R}_H \cdot \Big[\Big(\frac{1-\rho}{c_p}\Big) - (1-\rho)x_p\Big] q_R + \hat{R}_L \cdot \Big[\Big(1-\frac{1-\rho}{c_p}\Big) - \rho p c_e x_p x_e\Big] q_R. \end{aligned}$$

Note that $\beta[1-(1-\rho)x_p - \rho p c_e x_p x_e] = (1-\beta)(x_p + \rho p x_p x_e)$.[9] Thus, the above equation implies

$$U(q_R,\bar{\eta}) = \frac{\beta A}{1-\beta} + \omega \cdot \hat{R}_H \cdot q_R + (1-\omega)\cdot \hat{R}_L \cdot q_R,$$

where

$$\omega \equiv \frac{(1-\rho)/c_p - (1-\rho)x_p}{1-(1-\rho)x_p - \rho p c_e x_p x_e}.$$

B.6 First and second order conditions for p and $\underline{\eta}$

The function $V(Q_R|\bar{\eta})$ given by (20) can be re-written as

$$V(Q_R|\bar{\eta}) = \frac{\beta A}{1-\beta} - \Big[1 - \omega\bar{R} - (1-\omega)\frac{\underline{R}}{1-\underline{\eta}}\Big] Q_R,$$

where

$$\bar{R} = \frac{s(0) + \mathbb{E}(z|e=0) - 1/\beta}{\alpha(1-\rho)\varphi(z_H|e=0)} \qquad \text{and} \qquad \underline{R} = \frac{s(1) + \mathbb{E}(z|e=1) - 1/\beta}{\alpha(1-\rho)\varphi(z_H|e=1)}.$$

We can verify that $\frac{\underline{R}}{1-\underline{\eta}} < \bar{R} < 1$.

[9] Note that $\beta[1-(1-\rho)x_p - \rho p c_e x_p x_e] = \beta(1-c_p x_p) + \rho p \cdot \beta(1-c_e x_e)$, where $\beta(1-c_p x_p) = (1-\beta)x_p$ and $\beta(1-c_e x_e) = (1-\beta)x_e$.

B.6.1 Optimal conditions for monitoring, p.

Taking the derivative of $V(Q_R|\bar{\eta})$ with respect to p, we obtain

$$\frac{\partial V(Q_R|\bar{\eta})}{\partial p} = \frac{\partial \omega}{\partial p} \cdot \Big(\bar{R} - \frac{\underline{R}}{1-\underline{\eta}}\Big) Q_R - \Big[1 - \omega \bar{R} - (1-\omega)\frac{\underline{R}}{1-\underline{\eta}}\Big] \cdot \frac{\partial Q_R}{\partial p}.$$

The second derivative is

$$\begin{aligned}\frac{\partial^2 V(Q_R|\bar{\eta})}{\partial p^2} &= \frac{\partial^2 \omega}{\partial p^2} \cdot \Big(\bar{R} - \frac{\underline{R}}{1-\underline{\eta}}\Big) Q_R + 2 \cdot \frac{\partial \omega}{\partial p} \cdot \frac{\partial Q_R}{\partial p} \cdot \Big(\bar{R} - \frac{\underline{R}}{1-\underline{\eta}}\Big) - \\ &\qquad \Big[1 - \omega \bar{R} - (1-\omega)\frac{\underline{R}}{1-\underline{\eta}}\Big] \cdot \frac{\partial^2 Q_R}{\partial p^2}.\end{aligned}$$

Note that $1 - \omega\bar{R} - (1-\omega)\underline{R}/(1-\underline{\eta}) > 0$ and $\partial^2 Q_R/\partial p^2 = \psi_1''(p) > 0$. Thus, $\partial^2 V(Q_R|\bar{\eta})/\partial p^2 < 0$ when $\psi_1''(p)$ is large enough.

B.6.2 Optimal conditions for inspection, $\underline{\eta}$.

Taking the derivative of $V(Q_R|\bar{\eta})$ with respect to $\underline{\eta}$, we obtain

$$\frac{\partial V(Q_R|\bar{\eta})}{\partial \underline{\eta}} = \Big[\frac{\partial \omega}{\partial \underline{\eta}} \cdot \Big(\bar{R} - \frac{\underline{R}}{1-\underline{\eta}}\Big) + (1-\omega)\frac{\underline{R}}{(1-\underline{\eta})^2}\Big] Q_R - \Big[1 - \omega \bar{R} - (1-\omega)\frac{\underline{R}}{1-\underline{\eta}}\Big] \cdot \frac{\partial Q_R}{\partial \underline{\eta}}.$$

The second derivative is

$$\begin{aligned}\frac{\partial^2 V(Q_R|\bar{\eta})}{\partial \underline{\eta}^2} &= \Big[\frac{\partial^2 \omega}{\partial \underline{\eta}^2} \cdot \Big(\bar{R} - \frac{\underline{R}}{1-\underline{\eta}}\Big) - 2 \cdot \frac{\partial \omega}{\partial \underline{\eta}} \cdot \frac{\underline{R}}{(1-\underline{\eta})^2} + 2 \cdot (1-\omega)\frac{\underline{R}}{(1-\underline{\eta})^3}\Big] Q_R + \\ &\qquad 2\Big[\frac{\partial \omega}{\partial \underline{\eta}} \cdot \Big(\bar{R} - \frac{\underline{R}}{1-\underline{\eta}}\Big) + (1-\omega) \cdot \frac{\underline{R}}{(1-\underline{\eta})^2}\Big] \cdot \frac{\partial Q_R}{\partial \underline{\eta}} - \\ &\qquad \Big[1 - \omega \bar{R} - (1-\omega)\frac{\underline{R}}{1-\underline{\eta}}\Big] \cdot \frac{\partial^2 Q_R}{\partial \underline{\eta}^2}.\end{aligned}$$

Note that $1 - \omega\bar{R} - (1-\omega)\underline{R}/(1-\underline{\eta}) > 0$ and $\partial^2 Q_R/\partial \underline{\eta}^2 = \psi_2''(\underline{\eta}) > 0$. Thus, $\partial^2 V(Q_R|\bar{\eta})/\partial \underline{\eta}^2 < 0$ when $\psi_2''(\underline{\eta})$ is large enough.

B.7 Proof of Proposition 4

Assume that the initial intensity of monitoring and inspection are optimal, that is, p and $\underline{\eta}$ satisfy $\partial V(Q_R|\bar{\eta})/\partial p = 0$ and $\partial V(Q_R|\bar{\eta})/\partial \underline{\eta} = 0$, with $\partial^2 V(Q_R|\bar{\eta})/\partial p^2 < 0$ and $\partial^2 V(Q_R|\bar{\eta})/\partial \underline{\eta}^2 < 0$ (see Appendix B.6.1 and B.6.2).

Changes in optimal p. Suppose an increase in q_R raises $Q_R = q_R + \kappa(p, \underline{\eta})$. As a consequence of that, $\partial V(Q_R|\bar{\eta})/\partial p$ becomes negative (since $\partial\omega/\partial p < 0$). Because $\partial V(Q_R|\bar{\eta})/\partial p < 0$ after the rise in q_R, to reach the optimal condition p has to decrease. Thus, all else being equal, the optimal level of monitoring rises with reservation utility q_R.

Suppose $s(0)$ and $s(1)$ rise, let's say, by 1%. This raises both $\bar{R}$ and $\underline{R}$ and also widens the spread between $\bar{R}$ and $\underline{R}/(1-\underline{\eta})$.[10] As a result of this change, $\partial V(Q_R|\bar{\eta})/\partial p$ drops below zero (since $\partial\omega/\partial p$ and $\partial Q_R/\partial p$ are negative). Then, for the first-order condition to return to zero after the rise in $s(e)$, p has to decrease. Thus, all else being equal, the optimal level of monitoring rises with the rise in social return $s(e)$.

Suppose both z_H and z_L rise by 1%. This generates an increase in $\bar{R}$ and $\underline{R}$. However, it may reduce the spread between $\bar{R}$ and $\underline{R}/(1-\underline{\eta})$. Thus, it is unclear whether this generates shifts in $\partial V(Q_R|\bar{\eta})/\partial p$ in one direction or the other. We conclude then that an increase in market returns z_H and z_L may have ambiguous effects on the optimal level of monitoring.

Changes in optimal $\underline{\eta}$. Similarly, $\partial V(Q_R|\bar{\eta})/\partial\underline{\eta}$ becomes positive after a rise in reservation utility q_R or an increase in social return $s(e)$. Then, for the first-order condition to return to zero after the rises in q_R or $s(e)$, $\underline{\eta}$ has to increase. Thus, all else being equal, the optimal level of inspection rises with increases in q_R and $s(e)$. Also, since the rise in z_H and z_L may generate shifts in $\partial V(Q_R|\bar{\eta})/\partial\underline{\eta}$ in one direction or the other. We conclude then that an increase in market returns may have ambiguous effects on the optimal level of inspection.

C Numerical examples

C.1 Duration of position

The expected length of tenure is

$$T_L = \mathbb{E}_0 \sum_{t=0}^{\infty} \rho^t = \frac{1}{1-\rho}.$$

The expected duration of position with $\eta = \bar{\eta}$ is

$$T_E = \mathbb{E}_0 \sum_{t=0}^{\infty} [\rho \cdot (1-p)]^t = \frac{1}{1-\rho(1-p)}. \tag{43}$$

[10] Recall that $s(0) > s(1)$ and $\varphi(z_H|e=0) < (1-\underline{\eta})\varphi(z_H|e=1)$.

The expected duration after η switches to $\underline{\eta}$ is

$$T_D = \mathbb{E}_0 \sum_{t=0}^{\infty} [\rho \cdot (1-\underline{\eta})]^t = \frac{1}{1-\rho(1-\underline{\eta})}.$$

Thus, the expected duration of position is

$$T_A = 1 + \rho[(1-p) \cdot T_A + p \cdot T_L],$$

which implies

$$T_A = \frac{1-\rho(1-\underline{\eta}-p)}{\left[1-\rho(1-p)\right]\left[1-\rho(1-\underline{\eta})\right]}.$$

C.2 Distribution of managers

Note that for the type of the manager in position, the transition probabilities are

$$\tilde{P}(\eta, \eta') = \begin{bmatrix} 1-\rho p & \rho p \\ 1-\rho(1-\underline{\eta}) & \rho(1-\underline{\eta}) \end{bmatrix}$$

If $\eta = \bar{\eta}$ for the manager in position in the current period, then for the manager in position in the next period, $\eta' = \bar{\eta}$ with probability $1-\rho p$ and $\eta' = \underline{\eta}$ with probability ρp. Also if $\eta = \underline{\eta}$ in the current period, then in the next period, $\eta' = \bar{\eta}$ with probability $1-\rho(1-\underline{\eta})$ and $\eta' = \underline{\eta}$ with probability $\rho(1-\underline{\eta})$.

Let (π_H^*, π_L^*) denote the steady state fractions of managers with $\eta = \bar{\eta}$ and $\eta = \underline{\eta}$. Thus,

$$\pi_H^* = 1 - \frac{\rho p}{1-\rho(1-\underline{\eta}-p)} \quad \textit{and} \quad \pi_L^* = \frac{\rho p}{1-\rho(1-\underline{\eta}-p)}.$$

C.3 Parameter values

C.4 The effects of raising tenure limit, ρ

Table 5: Parameter values

Parameter	Description	Value
ρ	Probability of continuation	0.8
p	Probability with which η switches to $\underline{\eta}$	0.1
$\underline{\eta}$	Probability that deviation of an experienced manager is detected	0.1
A	Constant in the production function	2
$s(0)$	Social return when $e = 0$	1.05
$s(1)$	Social return when $e = 1$	0.45
z_H	Market return when productivity is high	0.7
z_L	Market return when productivity is low	0
$\varphi(z_H\|0)$	Probability that productivity is high when $e = 0$	0.1
$\varphi(z_H\|1)$	Probability that productivity is high when $e = 1$	1
α	Share of value that can be diverted	0.5
β	Discount factor	0.9

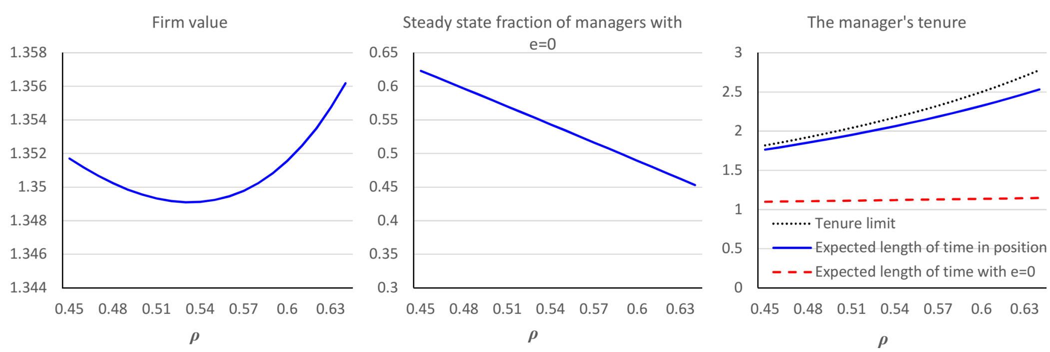

Figure 8: The effects of raising tenure limit ρ when $p = 0.8$.

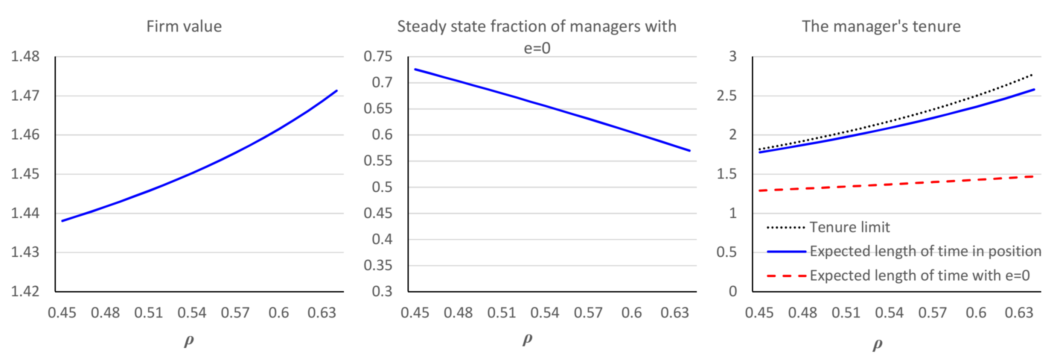

Figure 9: The effects of raising tenure limit ρ when $p = 0.5$.