Rotation, Performance Rewards, and Property Rights

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Abstract

Economic growth needs a strong and well-functioning government. But a government too strong can dominate private firms, leading to a holdup problem that is especially severe in autocracies. This paper studies how to constrain local officials in autocracies through personnel rules, with a special focus on rotation and performance-based evaluation. Through a game theoretic model, I show that rotation or performance evaluation alone makes the holdup problem even worse. But it is exactly their combination that covers each other's weakness and solves the holdup problem together. Frequently rotated and carefully evaluated, officials also develop few entrenched interests in existing firms. This helps avoid crony capitalism and encourages Schumpeterian "creative destruction," solving another key problem with government-assisted development. Thus, rotation and performance evaluation resolve the tradeoff between commitment and flexibility, a feature rarely satisfied by other commitment devices. Firm-level panel data from China are consistent with the key predictions of the model.

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1 Introduction

Why do entrepreneurs invest actively in many autocracies? This is an important question because private investment plays a decisive role in the economic take-off under many autocratic rules[1] (Young (1995); Acemoglu and Robinson (2006); Xu (2011)). Classical economic theories, however, predict the opposite (Persson and Tabellini (2002); Acemoglu (2003)): an entrepreneur should be reluctant to invest in an autocracy because officials cannot credibly commit to not expropriate an entrepreneur. Put differently, an autocracy suffers from a severe holdup problem. To solve this problem, what are the constraints on officials to limit excessive extraction?

There are two common solutions in the literature. First, in repeated games, reputation concerns can constrain the extraction of an official (Olson (1993); Mailath and Samuelson (2006)). But under repeated interactions, an official inevitably develops entrenched interests in existing firms, blocking the entrance of new firms and the associated "creative destruction." Since creative destruction is a key source of long-run economic growth, reputation-based solutions can cause prolonged economic stagnation (Schumpeter (2013); Aghion et al. (2014)). In any case, reputation is largely irrelevant for local officials under frequent rotation or strict term limits, personnel rules that many institutionalized autocracies enforce (Magaloni and Kricheli (2010)).

Second, if the central government evaluates and promotes a local official based on economic growth (Maskin et al. (2000); Xu (2011)), the official would encourage private investment by extracting less from entrepreneurs. But since performance evaluation is also a form of incentive contracts, performance evaluation presupposes commitment power instead of providing one. Also, in this paper, I will show that performance evaluation makes the holdup problem even worse. The research question becomes even more intriguing: many autocracies frequently rotate their local officials and regularly evaluate local officials based on economic performance (Finer (1997b); Weber (1978)); how can these autocracies possibly solve the holdup problem against entrepreneurs?

In this paper, I show that rotation or performance evaluation alone indeed makes the holdup problem even worse; but it is exactly their combination that forms a credible constraint on officials to solve the holdup problem. In other words, rotation and performance evaluation can restrain the unintended consequences of each other, helping to unleash their desirable incentive effects. To illustrate the idea, I build a game theoretic model with three stages. In the first stage, the entrepreneur makes an investment to install a firm, with the

[1] In most cases, industrial takeoffs actually took place when the political regimes were not yet democratized (pp.1609-1610, Finer (1997b)).

size of its future surplus as the entrepreneur's private information. In the second stage, I introduce two forms of the holdup problem: a local official can steal the invested capital before production even begins; the official can also learn the precise size of the firm's future surplus, an action that eliminates the entrepreneur's information rent and allows the official to extract all surplus. In the third stage, the official and the entrepreneur bargain over the surplus. Then the official is evaluated and rewarded by a central government based on the size of the total surplus produced by the firm.

The model produces three key insights. First, performance evaluation makes the holdup problem even worse. Under intense evaluation pressure, the official really wants to know his jurisdiction well to design the most informed economic policy. In our specific setup, under intense evaluation, the official wants to know the precise size of the firm's surplus because the knowledge induces efficient bargaining between the official and the entrepreneur. By contrast, if the official learns nothing about the firm, the bargaining process will be frictional and inefficient, resulting in a bad performance record. But at the same time, if the official knows more, he would also extract too much surplus when he bargains with the entrepreneur. Anticipating the excessive extraction, the entrepreneur refuses to invest in the first place.

Second, rotation alone also exacerbates the holdup problem. This is the standard "roving bandits" story articulated by Olson (1993): frequent rotation can reduce the time horizon of the official so that the official finds it optimal to steal the private investment instead of waiting for the investment to produce the final surplus.

Third, as the main result of the paper, rotation and performance evaluation cover each other's weakness and jointly solve the holdup problem. On the one hand, rotation helps performance evaluation. Recall that performance evaluation is problematic because it encourages the official to learn too much about the firm, a move that would eliminate the entrepreneur's information rent. But with frequent rotation, the official does not want to know much about the local firm, because his detailed information about the local firm becomes completely useless if he is rotated to another jurisdiction. So even if performance evaluation is intense, the official will never learn about the firm as long as rotation is sufficiently frequent. On the other hand, performance evaluation also helps rotation. Rotation is problematic because an impatient official may steal private investment. But under intense performance evaluation, the official needs to think twice before stealing private investment, an action that would really hurt his chance of getting a good performance record. So even if rotation is frequent, the official will never steal private investment as long as performance evaluation is sufficiently intense. Therefore, rotation and performance evaluation are highly interdependent. Frequent rotation discourages information acquisition tempted by performance evaluation; intense performance evaluation makes it costly for the official to steal

private investment, which allows frequent rotation. Consequently, the official will not steal the private investment and will yield most of the final surplus to the entrepreneur, who makes the investment in the first place.

For the other key result of the paper, I extend the model to allow the entrance of new firms. The extension enables me to study firm dynamics and Schumpeterian "creative destruction," a key source of sustainable growth (Aghion and Howitt (1992); Aghion et al. (2014)). Under intense rotation and performance evaluation, the official acquires little information about existing firms, so the official has no entrenched interests in existing firms as compared with new firms. The absence of entrenched interests encourages firm entry and exit, fostering "creative destruction" and sustaining long-term growth. By contrast, a repeatedly appointed official may develop such strong entrenched interests that he blocks the entrance of new firms, a fundamental problem behind the "middle-income trap" of many economies that rely on crony capitalism to initiate industrial takeoff (Acemoglu et al. (2006); Acemoglu and Robinson (2012)). Here lies the other key result: when implemented together, rotation and performance evaluation can resolve the acute trade-off between commitment and flexibility, a feature rarely satisfied by many other commitment devices studied in the literature.

I provide suggestive evidence for the main prediction of the model, the complementarity between rotation and performance evaluation on officials in inducing private investment. The complementarity should only apply to private capital that is largely "immobile," henceforth helpless when the extraction is imminent. The complementarity should not apply to "mobile" assets that can be easily moved away against extraction threats. To study these predictions, I utilize unique features of Chinese political institutions to measure anticipated events of rotation or promotion for mayors. A private firm shifts more investment in "immobile" capital if the firm is located in a city whose mayor faces a high probability of both rotation and promotion. A private firm does not do so if the mayor only faces a high probability of rotation or a high probability of promotion. The complementarity effect actually turns negative for state-owned enterprises (SOEs). The negative complementarity effect for SOEs can be attributed to higher demand for investment goods from private firms, which drives up the prices for investment goods. Higher prices depresses investment from SOEs, whose exalted political and legal status guarantee that their assets cannot be expropriated by local mayors regardless of personnel institutions.

The paper is related to a few other strands of literature. The paper integrates the two views on property rights separately advocated by Olson (1993) and Grossman and Hart (1986)[2]. In relation to the production stage, Olson (1993) argues that property rights protect

[2]The second view is further developed in, for example, Hart and Moore (1990) and Hart (1995).

against *ex ante* extraction, or capital confiscation, while Grossman and Hart (1986) argues that property rights protect against *ex post* extraction of the final surplus. I show how both forms of property rights against political extraction can be substituted by personnel institutions over officials. More importantly, I show that we can generate fresh insights from the integration of the two views, an integration that produces the interdependence between rotation and performance evaluation. Indeed, it is necessary to integrate the two views; with only one view on property rights, the understanding of personnel institutions would be incomplete and misleading.

In the political economy literature on rotation, we have an apparent paradox: there are two views on rotation that are diametrically different. On the one hand, following the seminal work in Olson (1993), many papers demonstrate that frequent rotation reduces the time horizon of officials so that they steal a lot from the private sector, impoverishing the entrepreneurs (Rose-Ackerman and Palifka (2016)). On the other hand, frequent rotation forces the officials to rely on the superior information of local elites for effective governance so that local elites become immensely rich and powerful (Chang (1955); Finer (1997a); Shi et al. (2021)). My paper resolves the paradox. Rotation can be constructive or destructive, depending on whether it is complemented by performance evaluation. Actually, political rotation and performance evaluation help each other, interacting in a symbiotic way. The two institutions are destructive as stand-alone arrangements, but their interactions restore their desirable incentive effects.

My paper is also related to the literature on why high-powered incentives may misfire and create unintended consequences (Gibbons (1987); Gibbons (1998); Holmstrom and Milgrom (1991); Holmström (1999); Gibbons and Roberts (2013)). To my knowledge, my paper is the first attempt to understand how intense performance evaluation may exacerbate the holdup problem. By doing so, the analysis uncovers strong nonlinearity of the effect of performance evaluation. The holdup problem is especially acute in an autocracy. By focusing on the holdup problem, my theory explains why high-powered incentives can be especially destructive in autocracies than in liberal democracies. I also systematically explore how to limit the destructive side of performance evaluation.

It is straightforward to generalize the insights of my paper to generic organizations, relabeling the officials as managers, the entrepreneurs as junior employees, and jurisdictions as business units. Thus, my paper also speaks to the organizational economics literature on rotation and performance evaluation (Bar-Isaac (2012); Gibbons and Roberts (2013); Lazear and Oyer (2013);Bar-Isaac and Lévy (2022)). When studying rotation and performance evaluation together, most existing studies take a human capital approach (Ortega (2001); Eriksson and Ortega (2006)). They show that rotation of managers helps the managers

accumulate a diverse set of skills that improves their eligibility for promotion, generating a complementarity between rotation and promotion (Friebel and Raith (2013); Jin and Waldman (2020)). These pioneering studies feature powerful insights; but the main mechanism implicitly assumes U-Form organizations as its object of study (Chandler Jr (1969); Maskin et al. (2000); Qian et al. (2006)). In a U-Form organization, each unit specializes in one functionality, so rotation across different units does help the manager learn different skills. Yet different units in an M-Form organization are broadly similar to each other, weakening the key mechanism popular in the existing literature. The relatively low explanatory power for M-Form casts a problem, since M-Form becomes "the dominant form for large, complex firms around the world" (Roberts and Saloner (2012)), as well as more successful political economies (Qian et al. (2006)). The mechanism I study applies to both M-Form and U-Form organizations, as the mechanism does not rely on heterogeneity across different units. The wider applicability becomes even more important as "large U.S. firms are moving away from the pure U-form and M-form" (Roberts and Saloner (2012)). My model's wider applicability is an important contribution to the organizational economics literature.

My paper is also related to the literature on political connections of private business. Many papers demonstrate that political connection can increase business value, especially in an autocracy or a weak democracy (Khwaja and Mian (2005); Ferguson and Voth (2008); Do et al. (2017); Bai et al. (2020); Li et al. (2022)). However, it is puzzling that private business can reap such a large benefit from political connection in an autocracy, as by definition officials in an autocracy command formidable coercive power that should enable them to capture the bulk of the surplus (North and Weingast (1989)). My paper offers a simple mechanism that empowers entrepreneurs against officials in autocracies, but only when the bureaucracy is disciplined in a specific manner.

The paper is organized as follows. Section 2 presents and discusses the main model. Section 3 extends the main model to study "creative destruction." Section 4 provides suggestive evidence for the main model. Section 5 concludes.

2 A workhorse model

2.1 The setup

There are four players, a principal, an entrepreneur, an incumbent official, and a "reserve" official from another jurisdiction. The extensive form game is as follows.

The investment stage The entrepreneur may invest $K > 0$ to start a firm. The output from the firm is y, following the distribution function $F(\cdot)$ with full support in $[\underline{y}, \bar{y}]$. As a standard assumption in the contract theory (Bolton and Dewatripont (2004)), the hazard rate for the random variable y, $\frac{f(z)}{1-F(z)}$, is monotonically increasing in z.

After the investment cost K has been sunk, the entrepreneur learns the precise realization of the output y.

The confiscation stage If the entrepreneur invests, the incumbent official may confiscate the private investment and resells it at ηK, with the parameter $\eta \in (0, 1]$. Denote $\xi \in \{0, 1\}$ as the confiscation decision, and $\xi = 1$ if the incumbent official confiscates the private investment.

The investigation stage The incumbent official may order the bureaucracy to investigate the firm. To mobilize the bureaucracy, the incumbent official needs to pay a cost of $c > 0$. Denote the investigation decision as $\delta \in \{0, 1\}$, where $\delta = 1$ if the incumbent official launches the investigation.

After the investigation opportunity, with probability $\pi \in [0, 1]$, the incumbent official is rotated; the rotated incumbent official is replaced with the reserve official, the latter serving as the governing official for the next stage. Otherwise, an un-rotated incumbent official will serve as the governing official. The parameter π is the first key parameter, proxying the intensity of rotation.

Denote $\rho \in \{0, 1\}$, and $\rho = 1$ if the incumbent official is rotated. The rotated incumbent official receives an exogenous payoff of $U_O \geq 0$ from ruling another jurisdiction. It is straightforward to endogenize the payoff U_O, and all results would remain the same. To further simplify algebra, normalize U_O to 0, which is without loss of generality.

The bargaining stage If the incumbent official launched the investigation ($\delta = 1$), the governing official knows the precise realized output y. Otherwise, the governing official still only knows $F(\cdot)$.

If the incumbent official confiscated the private investment ($\xi = 1$), the entrepreneur cannot produce any output. The payoff to the principal is 0. The payoff to the entrepreneur is $-K$. The incumbent official receives:

$$\eta K - c \cdot \mathbf{1}_{\delta=1}.$$

Whether he is replaced or not, the incumbent official receives ηK from reselling the capital, and $-c \cdot \mathbf{1}_{\delta=1}$ from the investigation. No output can be produced by a firm whose investment

was confiscated. Therefore, the incumbent official cannot extract any output from the firm; neither could the incumbent official receive any performance-based reward. Similarly, the reserve official receives 0.

If the incumbent official did not steal the private investment ($\xi = 0$), the current governing official can bargain with the entrepreneur over the final output y. The governing official makes a take-it-or-leave-it proposal to extract w from the firm's output. If the entrepreneur accepts the proposal, the output is produced. The finished firm provides the following benefit to the governing official:

$$w + V(y, R).$$

The finished firm provides two payoffs to the governing official. First, the firm produces economic rents to the official at w. Second, the firm yield a performance-based reward at $V(y, R)$. For the workhorse model, we impose minimal assumptions on the performance reward. First, the performance-based reward $V(y, R)$ is a strictly monotonic function of both the output y and the parameter R. The key parameter R proxies the intensity of the performance reward or performance evaluation, two terms that I use interchangeably. Second, the performance reward function satisfies that $\lim_{R\to\infty} V(y, R) = \infty$. Third, for any y and R, $V(y, 0) = 0$ and $V(0, R) = 0$.

For a concrete example of the performance reward, suppose that $V(y, R) = y \cdot R$. The linear functional form admits a simple interpretation when the output y is normalized between 0 and 1. The official is awarded a reward $R > 0$ with probability y, so the reward is indeed based on performance.

With the proposal w accepted, the entrepreneur receives

$$y - w - K.$$

The principal receives a payoff of y as he cares about economic growth *per se*. Such a dominant concern over economic performance is a defining characteristic of ideal-type "welfarist autocrats" (Weber (1978)).

Furthermore, the payoff to the incumbent official is:

$$-c \cdot \mathbf{1}_{\delta=1} + [w + V(y, R)] \cdot \mathbf{1}_{\rho=0},$$

and the payoff to the reserve official is:

$$[w + V(y, R)] \cdot \mathbf{1}_{\rho=1}.$$

If the entrepreneur rejects the proposal, the output is not produced. The principal

receives 0. The entrepreneur receives $-K$. The incumbent official receives $-c \cdot \mathbf{1}_{\delta=1}$, and the reserve official receives 0.

2.2 Comments on the setup

Confiscation and investigation as two forms of the holdup problem As discussed in the introduction (Section 1), the model introduces two forms of the holdup problem. The official may confiscate private capital (Olson (1993); Persson and Tabellini (2002)), an action that would discourage private investment. Private entrepreneurs invest actively only under institutions that protect the private capital against political confiscation (Olson (1993); Clague et al. (1996); Acemoglu and Robinson (2006); Diermeier et al. (2017)). Many such institutions extend the time horizon of the official, presumably because a forward-looking official benefits more from an intact capital that only produces the final product in the distant future.

But even if the capital is fully protected, the official may extract too much from its final output. In this case, the entrepreneur still refuses to invest because the net surplus cannot recoup the investment cost. The official can extract an especially large output if the official has boosted his own bargaining power against the entrepreneur. In my model, the official can invest in such power by investigating the private firm, therefore eliminating the information advantage of the entrepreneur. It is essential to secure a strong bargaining position for the entrepreneur from the perspective of the incomplete contract approach to property rights (Grossman and Hart (1986), Hart and Moore (1990), Hart (2017)). Institutions that secure Hartian property rights for the entrepreneur should deter the official from boosting his own bargaining power.

To the best of my knowledge, the literature has not analyzed the confiscation of capital and extraction of the output in the same model. The following analysis will show that it is fruitful to incorporate both problems. Such an analysis uncovers a deep tension in property-rights institutions: institutions that secure one form of property rights may undermine another form. For example, Olsonian property rights can be secured by a long tenure of an official, a tenure that prevents the official from stealing the capital immediately. At the same time, the long tenure may destruct Hartian property rights by empowering the official against the entrepreneur. We will see that a similar dilemma of "double bind" that applies to the performance-based reward. These dilemmas are solved by the joint implementation of rotation and the performance-based reward.

The bureaucracy that stores knowledge about private economy Once the local bureaucracy investigates the private firm, the knowledge about the precise output of the

firm is stored within the bureaucracy. Therefore, the official at the bargaining stage knows the precise output of the firm even if he is newly appointed. The setup resonates with the fundamental "knowledge superiority" of an ideal-type bureaucracy (Weber (1978); Stasavage (2020)). Above all, the knowledge superiority is caused by "the management of the modern office ... based upon written documents (the 'files'), which are preserved in their original or draft form, and upon a staff of subaltern officials and scribes of all sorts" (pp.957, Weber (1978)). The knowledge superiority of bureaucracy is also well noted in recent empirical studies (Ahmed and Stasavage (2020)). Also, knowledge produced by the bureaucracy is not the private property of the incumbent official because a bureaucracy separates its staff from its "material resources of administration," analogous to the separation between workers and capital in capitalist enterprises (pp.37-38, Weber (2004)). In a bureaucracy, knowledge can be accessed by the current holder of relevant offices only by the virtue of their offices. The knowledge is inaccessible to anyone who does not work for the bureaucracy, including ex office-holders (pp.992-993, Weber (1978)). My assumption on the persistence of knowledge within the bureaucracy is consistent with these defining characteristics of ideal-type bureaucracies.

The bargaining process The bargaining process is the simplest setup to capture the key notion that players can always achieve an agreement when they bargain under complete information, while players often fail to achieve an agreement when they bargain under asymmetric information. As a consequence, complete information bargaining is efficient, but asymmetric information bargaining can be inefficient (Muthoo (1999)). This contrast in efficiency is the main driver for the key result that the incumbent official is tempted to investigate the private firm to eliminate information asymmetry in the bargaining process. The temptation is especially strong when the official is intensely evaluated by the economic performance of his jurisdiction, an evaluation procedure that renders the official especially averse to a bargaining breakdown. An intense evaluation procedure, therefore, induces the official to launch a full investigation of the private firm, which achieves *ex post* efficiency. But the *ex post* efficiency is accompanied by the maximal *ex ante* inefficiency. The entrepreneur reaps too little surplus from his own investment from the *ex post* bargaining with a knowledgeable official, so the entrepreneur refuses to invest in the first place.

We now impose a few assumptions to help maintain realistic outcomes.

Assumption 1.

$$1.\ k < E[y].$$

$$2.\ k > [1 - F(\hat{w})]\Big\{E[y|y \geq \hat{w}] - \hat{w}\Big\}, \tag{1}$$

where

$$\hat{w} \equiv \arg\max_{w}[1 - F(w)]w.$$

The assumption that $k < E[y]$ is minimal: the necessary investment for the private firm must cost less than the expected output from the firm. The assumption ensures that a benevolent social planner always invests in the firm at the investment stage. Therefore, if the entrepreneur refuses to make the *ex ante* investment, the outcome is *ex ante* inefficient.

The second part of Assumption 1 is also natural. The variable $\hat{w}$ maximizes the expected payoff to an uninformed official who only cares about rent extraction. Presumably, such an official would extract too much surplus from the output of the private firm, an extraction that discourages *ex ante* investment. Indeed, the right hand side of Equation 1 is the expected payoff to an entrepreneur if he invests under an official who only cares about rent extraction. The official would ask to extract $\hat{w}$. The entrepreneur would accept such an extraction if and only if $y \geq \hat{w}$, which would happen with a probability of $1 - F(\hat{w})$. In this case, the conditional expectation of output is $E[y|y \geq \hat{w}]$, so the expected surplus to the entrepreneur is the probability of firm completion, $[1 - F(\hat{w})]$, times the net surplus $\Big\{E[y|y \geq \hat{w}] - \hat{w}\Big\}$. Per Assumption 1, the expected net surplus is smaller than the *ex ante* investment cost when the official only cares about rent extraction. The assumption embodies a recurrent theme in the literature on performance evaluation of officials (Weber (1978); Lieberthal (2004); Jia et al. (2015); Bai et al. (2020)). To put it simply, Assumption 1 says that without evaluation pressure, an uninformed official would still be too predatory over the private firm.

Assumption 2.

$$E[y + V(y, R)] - U(R) > c, \tag{2}$$

where

$$U(R) \equiv \max_{w}[1 - F(w)]\big\{w + E[V(y, R)|y \geq w]\big\}. \tag{3}$$

Assumption 2 formalizes the notion that an official with a long tenure will order the bureaucracy to accumulate too much local knowledge, creating a local government that is immensely powerful against the entrepreneur. The left hand side of Equation 2 is the value of local knowledge for the governing official. The term $E[y + V(y, R)]$ is the expected payoff to the official if he knows the precise output of the private firm. The knowledgeable official can precisely calibrate rent extraction based on the realized output, enabling full extraction of the output with an expected value at $E[y]$. The precise calibration also eliminates bargaining breakdown, securing an expected performance-based reward of $E[V(y, R)]$ for the entrepreneur.

The second term on the left hand side of Equation 2, $U(R)$, is the expected payoff to an official who does not know the output of the private firm. By choosing a rent extraction at w, the uninformed official receives a benefit from the completed firm with probability $1 - F(w)$. The benefit has two components, the economic rent w and the expected performance reward $E[V(y, R)|y \geq w]$.

The value of knowledge is the extra payoff to an informed official, or $E[y+V(y, R)]-U(R)$. To ensure that the equilibrium is non-trivial, the value of knowledge $E[y + V(y, R)] - U(R)$ should be larger than the cost of knowledge c (Equation 2). Equation 2 ensures that the incumbent official will launch an investigation of the entrepreneur's firm if the incumbent official will continue his tenure into the bargaining stage with probability one. Therefore, under a zero probability of being rotated, the incumbent official will invest too much in (informational) power, overwhelming the entrepreneur later.

Assumption 3.

$$\eta < \frac{c}{K} \frac{1}{\max\{\frac{E[y]}{[1-F(\hat{w})]\hat{w}} - 1,\ \frac{F(\hat{w})E[V_R(y,R)|y \leq \hat{w}]}{[(1-F(\hat{w})]E[V_R(y,R)|y \geq \hat{w}]}\}}.$$

where $\hat{w} = \arg\max_w [1 - F(w)]w$.

Assumption 3 imposes an upper limit on the "efficiency" of capital confiscation. Without this assumption, it might be impossible to induce investment from the entrepreneur under any personnel institutions. The parameter η can be micro-founded as how immobile the private firm is. Capital confiscation is efficient (η is large), for example, when the entrepreneur finds it difficult to relocate his firm. When the official is on the verge of confiscating the private investment, the private entrepreneur may move away from the jurisdiction with probability $1 - \eta$, which denies capital confiscation and any future output to the jurisdiction. Such capital mobility might be improved by economic reforms of factor markets, supporting a large enough $1 - \eta$ for personnel institutions to discipline officials. Therefore, Assumption 3 limits our attention to at least a partially capitalist economy. The assumption is consistent with fundamental insights that a (partially) capitalist economy is a crucial material foundation for a rational bureaucracy (pp. 963-969, Weber (1978)).

We are now ready to solve the game by applying backward induction.

2.3 Solving the model

The bargaining stage when the official does not know the firm's productivity Suppose that the incumbent official has stolen the private capital ($\xi = 1$). The entrepreneur

cannot produce any output. The official extracts 0 from the entrepreneur, and the game ends.

If the private capital is not confiscated ($\xi = 0$), the official can bargain with the entrepreneur over the final surplus y. An official uninformed about the precise output y solves the following problem:

$$w^*(R) = \arg\max_w [1 - F(w)]\Big\{w + E[V(y,R)|y \geq w]\Big\}$$

$$= \arg\max_w \left\{[1 - F(w)w + \int_w^{\bar{y}} V(z,R)f(z)dz\right\}.$$

The official proposes to extract w to maximize his expected payoff, the probability of firm completion $1 - F(w)$ times the payoff from a completed firm, including the extracted rent w and the performance rewards $E[V(y,R)|y \geq w]$. The first order condition characterizes the optimal extraction w^* as a function of R, the intensity of the performance reward:

$$1 - F(w^*) - f(w^*)w^* - V(w^*,R)f(w^*) = 0,$$

$$\frac{1 - F(w^*)}{f(w^*)} = w^* + V(w^*,R). \tag{4}$$

The distribution $F(\cdot)$ satisfies the monotone hazard rate property. So the inverse of hazard rate, $h(w) \equiv \frac{1-F(w)}{f(w)}$, is monotonically decreasing in w. It is easy to show that[3]

$$\frac{dw^*}{dR} \geq 0. \tag{5}$$

Therefore, the optimal rent extraction $w^*(R)$ is a monotonically decreasing function of R, the intensity of the performance reward. So the model yields the first necessary condition for the entrepreneur to invest:

$$S(R) \geq K, \tag{6}$$

where

$$S(R) \equiv \Big\{1 - F[w^*(R)]\Big\}\Big\{E[y|y \geq w^*(R)] - w^*(R)\Big\}.$$

The function $S(R)$ is the expected net surplus captured by the entrepreneur, assuming that the official did not confiscate or investigate the private investment. The right hand side of Equation 6 is the investment cost at the investment stage. Equation 6 characterizes a necessary condition to induce private investment.

[3]Details are in the proof of Lemma 1.

Lemma 1. *Denote the unique solution to $S(R) = K$ as $\hat{R}$. A necessary condition for the entrepreneur to invest is $R \geq \hat{R} > 0$, or a sufficiently strong performance reward.*

All proofs are in the appendix. In a reduced form manner, Lemma 1 encodes the notion that an intense performance evaluation imposes on officials (i.e. promotion incentives) are conducive to economic growth (Rauch and Evans (2000); Maskin et al. (2000); Xu (2011); Jia et al. (2015)). With the private investment intact and its precise output unknown, the official faces a trade-off between larger rent extraction and a higher risk of bargaining breakdown. A bargaining breakdown imposes an especially large cost on the official when he is intensely evaluated based on local economic performance. Therefore, under a high pressure of performance evaluation, the official cares much more about successful bargaining than the economic rent extracted from the private firm. To maintain a higher probability of reaching a bargaining agreement, the official has to extract a smaller economic rent from the private firm. The entrepreneur therefore expects a high expected net surplus from his own investment.

In previous literature (e.g., Maskin et al. (2000); Li and Zhou (2005)), an intense performance evaluation imposed on officials is sufficient to induce economic growth. In our model, an intense evaluation is only a necessary condition. Intense evaluation can only discipline the official when the official did not confiscate or investigate the private investment. What if the official has launched an investigation?

The bargaining stage when the official knows the precise productivity Suppose that the incumbent official did not steal the private investment, but the incumbent official has launched an investigation of the private firm. At the bargaining stage, the governing official knows y, the realized productivity of the private firm. The official proposes to extract all the surplus. The entrepreneur accepts the extraction proposal because the payoff from acceptance, $-K$, is the same as rejection. The entrepreneur receives no benefits from his own costly investment.

The governing official's payoff is:

$$y + V(y, R) - c \cdot \mathbf{1}_{\rho=0}.$$

The official extracts all the output, y, and also secures the performance reward $V(y, R)$ under any realization of y.

I have completely characterized the equilibrium for all subgames at the bargaining stage. I now characterize the equilibrium strategy at the investigation stage.

The investigation stage Suppose that the incumbent official has stolen the private investment before the investigation stage. The incumbent official does not launch the investigation because he knows that the entrepreneur cannot produce any output.

Suppose that the incumbent official has kept the private investment intact. The incumbent official does not launch an investigation of the private firm if and only if

$$(1-\pi)U(R) \geq -c + (1-\pi)E[y + V(y,R)]. \tag{7}$$

The left hand side of Equation 7 is the expected payoff to the incumbent official if he does not launch the investigation. With probability π, the reserve official replaces the incumbent official, the latter receiving a normalized payoff of 0. With probability $1-\pi$, the incumbent official bargains with the entrepreneur, asking to extract w^* as in Equation 4 from the private firm. The incumbent official will receive a payoff of $U(R)$ as in Equation 3, or

$$U(R) = [1 - F(w^*)]\Big\{w^* + E[V(y,R)|y \geq w^*]\Big\}. \tag{8}$$

The right hand side of Equation 7 is the expected payoff to the incumbent official if he launches the investigation. By paying the cost c, with probability $1-\pi$ the incumbent official exploits his full knowledge of the private firm, extracting all surplus and securing the performance-based reward. Equation 7 yields the minimal rotation frequency:

$$\pi \geq 1 - \frac{c}{E[y + V(y)] - U(R)} \equiv \underline{\pi}(R).$$

Under a sufficiently high frequency of rotation, the incumbent official receives a smaller benefit from investigating the local firm. I obtain the second necessary condition for the entrepreneur to invest.

Lemma 2. *A necessary condition for the entrepreneur to invest is*

$$R \geq \hat{R} \text{ and } \pi \geq \underline{\pi}(R).$$

The entrepreneur invests only if the official is intensely evaluated based on economic performance and the rotation frequency is sufficiently high.

The lemma is intuitive. If the private investment remains intact, sufficiently frequent rotation discourages the incumbent official from the investigation because the incumbent official is unlikely to reap benefits from the investigation. Therefore, rotation preserves the information rents for the entrepreneur. The information rents can recoup the investment cost only if the official is evaluated intensely based on local economic performance, an evaluation

procedure that induces low rent extraction from an uninformed official. The lemma formalizes a straightforward complementarity between rotation and the performance reward. Rotation and the performance reward have to be both intense enough to induce private investment.

Much more interesting than the straightforward complementarity is the sign of $\underline{\pi}(R)$, or how minimal rotation frequency changes when performance evaluation becomes more intense. The sign of $\underline{\pi}(R)$ codifies one side of a much deeper complementarity between rotation and the performance reward, which will be discussed after we have fully solved the model.

The confiscation stage Suppose that the private entrepreneur has invested $K > 0$. Further suppose that $\pi \geq \underline{\pi}(R)$. The incumbent official does not confiscate the capital if and only if

$$(1-\pi)U(R) \geq \eta K + (1-\pi) \cdot 0. \tag{9}$$

The left-hand side is the payoff if the incumbent official does not confiscate the private investment. At the investigation stage, because $\pi \geq \underline{\pi}(R)$, the incumbent official will not launch an investigation of the private firm. With probability π, the incumbent official is rotated, earning a normalized payoff of 0. With probability $1-\pi$, the incumbent official stays in his jurisdiction and earns the payoff $U(R)$ as in Equation 8.

The right-hand side is the payoff if the incumbent official confiscates the private investment. The incumbent official obtains ηK from the confiscation. With probability π, the incumbent official is rotated, receiving the normalized payoff of 0. With probability $1-\pi$, the incumbent official stays in his jurisdiction. Because the private investment has been expropriated, the entrepreneur cannot produce any output. The incumbent official receives zero rent, as well as zero rewards based on economic performance.

Equation 9 identifies an upper bound on rotation frequency:

$$\pi \leq 1 - \frac{\eta K}{U(R)} \equiv \bar{\pi}(R). \tag{10}$$

To induce private investment, rotation must be less frequent than the threshold $\bar{\pi}(R)$. A higher likelihood to stay in his jurisdiction discourages the incumbent official from confiscating the private investment. Through capital confiscation, the incumbent official receives an immediate gain from reselling the capital. But with a sufficiently low rotation frequency, it is likely that the incumbent official will bear the consequences. Expropriated of his investment, the entrepreneur cannot produce any output, which denies any economic rent or any performance-based reward to the official. I will discuss later how the maximal rotation frequency changes when the performance-based reward changes, which codifies the other side

of the deep complementarity between rotation and the performance-based reward.

To complete my analysis, suppose instead that $\pi < \underline{\pi}(R)$. The incumbent official does not confiscate the capital if and only if:

$$(1-\pi)(1+R)E[y+V(y,R)] \geq \eta K. \tag{11}$$

Equation 11 is the same as Equation 9, only replacing $U(R)$ with $E[y+V(y,R)]$ because the incumbent official will launch an investigation of the private firm under $\pi < \underline{\pi}(R)$. Equation 11 identifies another upper bound on rotation frequency:

$$\pi \leq 1 - \frac{\eta K}{E[y+V(y,R)]} \equiv \hat{\pi}(R).$$

This second upper bound on rotation frequency $\hat{\pi}(R)$ is larger than $\bar{\pi}(R)$ because $E[y + V(y,R)]$ is larger than $U(R)$. Therefore, the minimal upper bound on rotation frequency is $\bar{\pi}(R)$. Intuitively, capital confiscation would be more consequential for an informed official because he would have lost a larger economic rent and a larger performance reward.

We are now ready to state the main proposition.

Proposition 1. *1.The necessary and sufficient condition for the entrepreneur to invest is*

$$R \geq \hat{R} \text{ and } \underline{\pi}(R) \leq \pi \leq \bar{\pi}(R).$$

2. $\underline{\pi}'(R) > 0$*: the minimal rotation frequency increases with stronger performance evaluation.*

3. $\bar{\pi}'(R) > 0$*: the maximal rotation frequency increases with stronger performance evaluation.*

The proposition completely characterizes the personnel institutions that solve both forms of the holdup problem against the private entrepreneur, henceforth inducing private investment. Figure 1 depicts the proposition, where the shaded area includes all personnel institutions that induce private investment, while non-shaded areas are personnel institutions that cannot induce private investment. With a sufficiently intense performance evaluation and adequately frequent rotation, the entrepreneur invests because the official will neither steal the private investment nor extract too much surplus, securing sufficiently high information rent to recoup the cost of investment for the entrepreneur.

The proposition also highlights the complementarity between rotation and the performance reward through the two derivatives $\underline{\pi}'(R) > 0$ and $\bar{\pi}'(R) > 0$. These derivatives

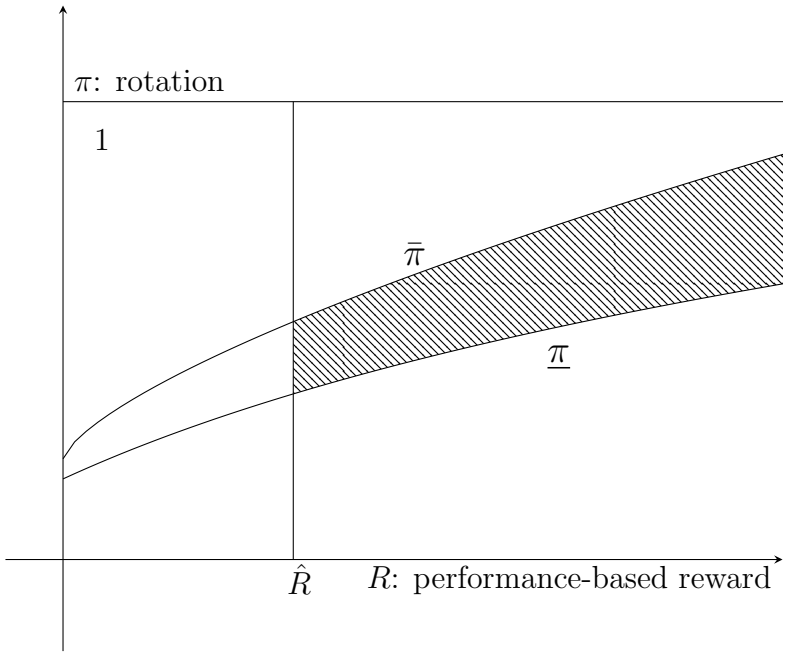

Figure 1: Rotation and the performance reward

warrant detailed discussion because they encode the deep complementarity between rotation and the performance reward.

The minimal rotation frequency $\underline{\pi}(R)$ increases with a stronger performance reward. This is a major novel insight. A stronger performance reward intensifies the temptation for the incumbent official to investigate the private firm, a temptation that must be discouraged by a higher probability of rotation. By eliminating the negative effect of performance evaluation that would have eroded the bargaining power of the entrepreneur, frequent rotation unleashes the desirable effect of performance evaluation, the effect that induces the uninformed official to extract less from the entrepreneur.

Why does performance evaluation intensify the temptation of investigation? A fully informed official at the bargaining stage precisely calibrates rent extraction based on the realized productivity, ensuring that the entrepreneur will accept the extraction proposal for any realized productivity. The entrepreneur will always produce the final output, so the official always captures a performance-based reward under any circumstances. In other words, there is no risk of bargaining breakdown after the official has launched the investigation. But there is a substantive risk of bargaining breakdown between an uninformed official and the entrepreneur. The uninformed official asks to extract w^*, as defined by Equation 4, regardless of the realized productivity. If the realized productivity turns out to be larger than w^*, everything is good: the entrepreneur accepts the extraction and produces the final output,

which confers a good performance record on the uninformed official. But if the realized productivity is smaller than w^*, the entrepreneur rejects the extraction and walks away from his own investment. The uninformed official receives no economic rent and, far more importantly, the worst performance-based evaluation. If performance-based evaluation matters a lot, the incumbent official is strongly tempted to eliminate any possibility of bargaining breakdown so he can capture the performance-based reward that is all-important.

The heightened temptation to investigate the private firm can be discouraged by frequent rotation, which reduces the stake of bargaining breakdown for the incumbent official. Therefore, frequent rotation limits the side effects of performance evaluation by discouraging the investigation of the private firm, an investigation that would otherwise be tempted by strong performance evaluation. Having eliminated the investigation temptation that is heightened by performance evaluation, frequent rotation unleashes the desirable effect of performance evaluation that induces the uninformed official to extract less from the entrepreneur.

To gain a better understanding of the result, it is instructive to investigate the algebra behind the result. The minimal rotation frequency is:

$$\underline{\pi}(R) = 1 - \frac{c}{E[y + V(y, R)] - U(R)}.$$

So we only need to show that

$$\Delta(R) \equiv E[y + V(y, R)] - U(R)$$

increases with R, where $\Delta(R)$ is the difference between the expected payoff to an informed official and the expected payoff to an uninformed official at the bargaining stage. In other words, $\Delta(R)$ is the temptation to launch an investigation. Recall that:

$$U(R) = \max_w [1 - F(w)]\big\{w + E[V(y, R)|y \geq w]\big\}. \tag{12}$$

By Envelope Theorem,

$$\begin{aligned} U'(R) &= [1 - F(w^*)]E[V_R(y, R)|y \geq w^*] \\ &= \int_{w^*}^{\bar{y}} V_R(z, R) f(z) dz. \end{aligned} \tag{13}$$

where w^* solves Equation 12. Notice that as performance evaluation becomes more important, the uninformed official still only captures the performance reward when the realized output falls into the the interval $[w^*, \bar{y}]$, entailing a substantial risk of bargaining breakdown.

With Equation 13, we obtain the derivative $\Delta'(R)$:

$$\Delta'(R) = E[V_R(y,R)] - U'(R)$$

$$= \int_{\underline{y}}^{\bar{y}} V_R(z,R)f(z)dz - \int_{w^*}^{\bar{y}} V_R(y,R)f(z)dz$$

$$= \int_{\underline{y}}^{w^*} V_R(z,R)f(z)dz > 0.$$

The derivative captures the (marginal) temptation to launch an investigation. When performance evaluation becomes more important, the temptation of investigation increases because the incumbent official finds it more urgent to avoid bargaining breakdown, which will happen when the realized output y falls into the interval $[\underline{y}, w^*]$. Therefore, the minimal rotation frequency $\underline{\pi}(R) = 1 - c/\Delta(R)$ increases to counterbalance the heightened temptation.

The maximal rotation frequency $\bar{\pi}(R)$ increases with a stronger performance reward. Though frequent rotation can fix the problem with a strong performance reward, rotation too frequent would be equally destructive. If the incumbent official would be rotated with probability one, the incumbent official would confiscate the private investment because the incumbent official himself would not bear any consequences from capital confiscation. Therefore, the rotation frequency must be lower than an upper bound at $\bar{\pi}(R)$. The upper bound $\bar{\pi}(R)$ also increases with R. Intuitively, more intense performance evaluation induces a more grave consequence from capital confiscation, keeping the private investment intact even under more frequent rotation. If the incumbent official confiscates the private investment, the official would obtain the worst performance record, an outcome that will be avoided by an incumbent official who cares a lot about performance evaluation.

To see the mechanism more clearly, note the expression for the maximal rotation frequency:

$$\bar{\pi}(R) = 1 - \frac{\eta K}{U(R)}.$$

We only need to show that $U'(R) > 0$, which has been demonstrated before in Equation 13:

$$U'(R) = [1 - F(w^*)]E[V_R(y,R)|y \geq w^*] > 0.$$

A strong performance reward deters capital confiscation by conferring a huge benefit on the official whose jurisdiction has an intact private capital, allowing the rotation to be frequent without triggering capital confiscation.

Summary To summarize, rotation of officials secures Hartian property rights by boosting the *ex post* bargaining position of the entrepreneurs against frequently rotated officials. At the same time, performance evaluation secures Olsonian property rights for entrepreneurs by deterring the officials from *ex ante* capital confiscation. More important, it is precisely the two personnel institutions for property rights that constrain the destructive side effects of each other. Rotation constrains the destructive effect of performance evaluation in encouraging the official to accumulate informational power. At the same time, the performance-based reward limits the destructive effect of rotation in inducing the "roving bandit"(Olson (1993)) to confiscate private capital.

3 Personnel institutions and creative destruction

In the workhorse model, rotation and the performance reward unleash the desirable effects of each other in providing property rights throughout investment and distribution. This section shows that the joint implementation of rotation and the performance reward also encourages "creative destruction" by facilitating firm entry and exit, a key source of long-run growth (Schumpeter (2013); Aghion et al. (2014)). Though algebraically cumbersome, the result is conceptually straightforward. Under intense rotation and performance reward, the incumbent official does not launch an investigation of existing firms, an action that preserves information rents for the existing entrepreneurs. Equally important, without detailed knowledge of existing firms, the local government holds no entrenched interests in existing firms as compared with any new firms. It would be equally challenging to bargain with existing firms versus new firms. The local government refuses to block the entry of new firms that are more productive than existing firms, fostering Schumpeterian "creative destruction."

The joint implementation of rotation and performance evaluation therefore can resolve the trade-off between commitment and adaptability, in sharp contrast to most commitment devices that are based on repeated interactions. As discussed in the introduction, these commitment devices rely on relational enforcement, which usually induces rigidity (Levin (2003); Chassang (2010); Garicano and Rayo (2016)) and may chock "creative destruction" (Acemoglu et al. (2006)). Therefore, this section also offers an explanation for why informal institutions, which are usually based on relational enforcement, cannot fully substitute formal personnel institutions.

3.1 The setup

We discuss these intuitions in a more precise manner through a model extended from the workhorse model. As said, the algebra is necessarily much more tedious to capture the trade-off in supporting versus blocking the entry of new firms, while still fully incorporating the two forms of the holdup problem in the workhorse model.

There are five players. Four players are the same as in Section 2, including a principal, an "old" entrepreneur, an incumbent official, and a reserve official from another jurisdiction. The model admits another player, a "new" entrepreneur, who may arrive after the incumbent official has launched an investigation of the firm of the old entrepreneur. The new entrepreneur has a new firm, whose productivity is "on average" better than the productivity of the "old" firm by the old entrepreneur. The extensive form is as follows.

The investment stage The old entrepreneur may invest $\hat{K}$ to start the old firm. Denote the decision as $\sigma \in \{0, 1\}$, where $\sigma = 1$ if the old entrepreneur invests.

We assume that with probability $1 - q > 0$, $\hat{K} = K > 0$; with probability $q > 0$, the investment cost is $\hat{K} = 0$. A positive probability of zero investment cost is the simplest setup to incorporate entrenched interests in existing firms. If the old entrepreneur always needs to pay a strictly positive cost of investment (as in Section 2), the old entrepreneur always refuses to invest if he anticipates the official's investigation of his firm, an action that denies the possibility that the official could form entrenched interests over an existing firm.

The same as in the workhorse model of Section 2, the output from the old firm y follows the distribution function $F(\cdot)$ with support $[\underline{y}, \bar{y}]$. The random variable satisfies the monotone hazard rate property.

After the investment cost $\hat{K}$ has been sunk, the old entrepreneur learns the precise realization of y.

The confiscation stage This stage is the same as in the confiscation stage in Section 2. If the old entrepreneur invests, the incumbent official may confiscate the private investment and resell it at $\eta\hat{K}$, with the parameter $\eta \in (0, 1]$. Denote $\xi \in \{0, 1\}$ as the confiscation decision, and $\xi = 1$ if the incumbent official confiscates the private investment.

The investigation stage This stage is the same as in the investigation stage in Section 2. The incumbent official may order the bureaucracy to investigate the old firm. To mobilize the bureaucracy, the incumbent official must pay a cost of $c > 0$. Denote the investigation decision as $\delta \in \{0, 1\}$, where $\delta = 1$ if the incumbent official launches the investigation.

After the investigation opportunity, with probability $\pi \in [0,1]$, the incumbent official is replaced with the reserve official to serve as the governing official for the next stage.

Denote $\rho \in \{0,1\}$, and $\rho = 1$ if the incumbent official is replaced. The incumbent official receives an exogenous payoff of $U_O = 0$, a normalization that is without loss of generality.

The entry stage If the incumbent official launched the investigation ($\delta = 1$), the governing official knows the precise realized output y. Otherwise, the governing official still only knows $F(\cdot)$.

With probability $p > 0$, a new entrepreneur enters the jurisdiction, and he may invest in a new firm at a cost $K > 0$.[4] Denote his investment decision as $\varsigma \in \{0,1\}$, where $\varsigma = 1$ if the new entrepreneur invests. The new firm's payoff, denoted as x, follows the cumulative distribution function $G(\cdot)$ with support $[\underline{y}, \bar{y}]$. The distribution $G(\cdot)$ first order stochastically dominates $F(\cdot)$.[5]

The governing official decides whether to support the new firm or the old firm. Denote the decision as $\theta \in \{0,1\}$ where $\theta = 1$ if the governing official supports the new firm. A firm can only produce the surplus with support from the governing official, consistent with a sizable literature that demonstrates the importance of political support for industrialization (Evans (2012); Bai et al. (2020); Juhász et al. (2022); Lane (forthcoming);).[6] I also implicitly assume a limited span of attention for the local official because he can only support one firm. The assumption is consistent with the literature on political support of private firms (Bai et al. (2020)) and the literature on the limited span of control because of institutional or cognitive constraints (Qian (1994); Sims (2003)). I further assume that an official supports the new firm if he is indifferent between the new firm and the old firm.

The bargaining stage The governing official makes a take-it-or-leave-it proposal to extract w from the output of the supported firm. If the supported entrepreneur accepts the proposal, the output is produced. The finished firm provides a payoff to the governing official at

$$w + V(y \cdot 1_{\theta=0} + x \cdot 1_{\theta=1}, R).$$

There are again two components in the payoff of the governing official, the economic rent w and the performance reward $V(y \cdot 1_{\theta=0} + x \cdot 1_{\theta=1}, R)$. The performance reward depends on, among others, which firm the governing official supports. For other players, the new

[4]The result does not change if I assume that the new firm also costs the random variable $\hat{K}$.

[5]That is, for all $z \in [\underline{y}, \bar{y}]$, $G(z) \leq F(z)$ and for some $z \in [\underline{y}, \bar{y}]$, $G(z) < F(z)$.

[6]The necessity of political support for the entrepreneur's firm is also implicit in Section 2.

entrepreneur receives

$$(x-w)\mathbf{1}_{\theta=1} - K \cdot \mathbf{1}_{\varsigma=1},$$

and the old entrepreneur receives:

$$(y-w)\mathbf{1}_{\theta=0} \cdot \mathbf{1}_{\xi=0} - \hat{K} \cdot \mathbf{1}_{\sigma=1}.$$

The principal receives a payoff of $y \cdot 1_{\theta=0} + x \cdot 1_{\theta=1}$. The payoff to the incumbent official is:

$$-c \cdot \mathbf{1}_{\delta=1} + [w + V(y \cdot 1_{\theta=0} + x \cdot 1_{\theta=1}, R)] \cdot \mathbf{1}_{\rho=0}.$$

The payoff to the reserve official is

$$[w + V(y \cdot 1_{\theta=0} + x \cdot 1_{\theta=1}, R)] \cdot \mathbf{1}_{\rho=1}.$$

If the supported entrepreneur rejects the proposal, the output is not produced. The principal receives 0. The new entrepreneur receives $-K \cdot \mathbf{1}_{\varsigma=1}$ and the old entrepreneur receives $-\hat{K} \cdot \mathbf{1}_{\sigma=1}$. The incumbent official receives $-c \cdot \mathbf{1}_{\delta=1}$, and the reserve official receives 0.

To obtain sharper predictions from the extended model, I impose additional structure on the performance reward function $V(z, R)$.

Assumption 4. *1. The function $V(z, R)$ is multiplicatively separable between y and R. So we can denote*

$$V(z, R) = J(R) \cdot \hat{V}(z),$$

with $J'(R) > 0$ and $\hat{V}'(z) > 0$. Abusing the notation slightly, denote $\tilde{V}(z) = V(z)$.

2. $V(z)$ is convex in z:

$$V''(z) \geq 0.$$

We can now solve the model by applying backward induction.

3.2 Solving the extended model

Equilibrium at the bargaining stage If the governing official supported the old entrepreneur at the entry stage ($\theta = 0$), and the old firm has been stolen ($\xi = 1$), the governing official asks for no rent and receives no performance-based reward. The old entrepreneur receives $-\hat{K}$. The new entrepreneur receives $-K \cdot \mathbf{1}_{\varsigma=1}$.

If the governing official supports the old entrepreneur at the entry stage ($\theta = 0$), and the investment into the old firm has not been confiscated ($\xi = 0$), an informed official asks to

extract all the realized output at y. The official receives

$$y + J(R)V(y).$$

The old entrepreneur receives $-\hat{K}$. The new entrepreneur receives $-K \cdot \mathbf{1}_{\varsigma=1}$.

If the governing official supports the old entrepreneur at the entry stage ($\theta = 0$), and the old firm has not been stolen ($\xi = 0$), an uninformed official asks $w^*(R)$ that solves:

$$w^*(R) = \arg\max_w \Big[1 - F(w)\Big]\Big\{w + E_f[J(R)V(y)|y \geq w]\Big\} \tag{14}$$

$$= \arg\max_w \left\{[1 - F(w)]w + J(R)\int_w^{\bar{y}} V(z)f(z)dz\right\}.$$

The expectation $E_f[\cdot]$ in Equation 14 is computed over the probability distribution $F(\cdot)$. The first order condition is:

$$1 - F(w^*) - f(w^*)w^* - J(R)V(w^*)f(w^*) = 0,$$

or

$$\frac{1 - F(w^*)}{f(w^*)} = w^* + J(R)V(w^*). \tag{15}$$

We have shown that $w^*(R)$ monotonically decreases with R for the general functional form $V(y, R)$(Equation 4 to Equation 5), so the same conclusion applies when the performance reward is multiplicatively separable. Further denote the indirect utility function of the governing official by supporting the old firm as

$$U(R) = [1 - F(w^*)]w^* + J(R)\int_{w^*}^{\bar{y}} V(z)f(z)dz.$$

And denote the expected utility of the old entrepreneur as

$$S(R) - \hat{K} \equiv \Big\{1 - F[w^*(R)]\Big\}\Big\{E_f[y|y \geq w^*(R)] - w^*(R)\Big\} - \hat{K}.$$

The new entrepreneur receives $-K \cdot \mathbf{1}_{\varsigma=1}$.

If the official supports the new entrepreneur at the entry stage ($\theta = 1$), the official asks $\tilde{w}(R)$ that solves:

$$\tilde{w}(R) = \arg\max_w \Big[1 - G(w)\Big]\Big\{w + E_g[J(R) \cdot V(x)|x \geq w]\Big\},$$

$$= \arg\max_{w} \left\{ [1 - G(w)]w + J(R) \cdot \int_{w}^{\bar{y}} V(z)g(z)dz \right\}.$$

The expectation $E_g[\cdot]$ is computed over the probability distribution $G(\cdot)$. The first order condition is:

$$\frac{1 - F(\tilde{w})}{f(\tilde{w})} = \tilde{w} + J(R)V(\tilde{w}).$$

Applying the same argument for $w^*(R)$, the optimal rent extraction $\tilde{w}(R)$ monotonically decreases with R. Denote the indirect utility function of the official as:

$$\tilde{U}(R) = [1 - G(\tilde{w})]\tilde{w} + J(R) \cdot \int_{\tilde{w}}^{\bar{y}} V(z)g(z)dz.$$

The expected utility of the new entrepreneur is:

$$\tilde{S}(R) - K \equiv \Big\{1 - G[\tilde{w}(R)]\Big\}\Big\{E_g[x|x \geq \tilde{w}(R)] - \tilde{w}(R)\Big\} - K.$$

The old entrepreneur receives $-\hat{K} \cdot \mathbf{1}_{\sigma=1}$.

The entry stage Suppose that the new entrepreneur arrives. If the incumbent official has stolen the investment into the old firm($\xi = 1$), the official supports the new firm, acquiring an expected payoff of $\tilde{U}(R)$.

Now we look at the case where the old firm has not been stolen ($\xi = 1$). Suppose that the new firm has arrived and the official knows the realized productivity of the intact old firm. The official supports the new firm if and only if:

$$y + J(R)V(y) \leq \tilde{U}(R). \tag{16}$$

The left hand side of Equation 16 is the payoff from supporting the old firm, with the governing official knowing that the productivity of the old firm is precisely at y. The right hand side of Equation 16 is the payoff from supporting the new firm. Denote the cutoff productivity as $\hat{y}$, which is an implicit function of R:

$$\hat{y}(R) + J(R)V\Big(\hat{y}(R)\Big) = \tilde{U}(R).$$

Is the informed official more likely to support the new firm when the performance-based reward becomes stronger? The following lemma gives an affirmative answer.

Lemma 3. *For an official who is informed about the old firm, the performance-based reward encourages adaptation.*

Specifically, the informed official endorses the new firm with probability $F[\hat{y}(R)]$, *and* $dF[\hat{y}(R)]/dR > 0$. *But for any* $R \in [0, \infty]$, $F(\hat{y}(R)) < 1$.

Therefore, the performance-based reward can reduce entrenched interests, as $F[\hat{y}(R)]$, the probability that the new firm is supported, increases with R. But no matter how strong the performance reward is, the governing official still supports the old firm with a strictly positive probability.

What about a governing official who does not know the productivity of the old firm? He has zero entrenched interests in the old firm. So he will always support the new firm, which is "on average" better than the new firm.

Lemma 4. *For an official who does not know the realized productivity of the intact old firm, he supports the new firm* ($\theta = 1$).

For an uninformed official, both the new firm and the old firm entail a substantial risk of bargaining breakdown. It is equally challenging for him to bargain with the old entrepreneur versus the new entrepreneur. Given that the new firm is "on average" more productive, the uninformed official will support the new firm that can offer more rents *and* more performance-based reward on expectation.

Notice that the optimal degree of adaptation is to support the new firm with probability $F[E_g(x)]$, while an uninformed official always supports the new firm. An uninformed official fully avoids entrenched interests, but at a real cost. An uninformed official may abandon an old firm that turns out to be valuable because he does not know the value of the old firm. This generates excessive adaptation that is undesirable from the perspective of the principal. But, of course, this is a "necessary evil"; otherwise, an informed and unchecked official would just extract all surplus, eliminating all incentives for the old entrepreneur to invest.

The investigation stage The incumbent official launches an investigation if and only if:

$$-c+(1-\pi)\Bigg\{(1-p)\cdot E_f[y+J(R)\cdot V(y)]+p\cdot\Big\{F(\hat{y})\cdot\tilde{U}(R)+[1-F(\hat{y})]\cdot E_f[y+J(R)\cdot V(y)|y\geq\hat{y}]\Big\}\Bigg\}$$

$$\geq (1-\pi)\Big[(1-p)U(R)+p\tilde{U}(R)\Big], \tag{17}$$

The left hand side of Condition 17 is the payoff to an incumbent official who launches an investigation by paying the cost c. With probability $1-\pi$, the incumbent official retains his position. In this case, with probability $1-p$, the new entrepreneur does not arrive. Without an alternative option, the official always supports the old firm, which confers an

expected payoff of $E_f[y + J(R) \cdot V(y)]$. The official ensures the full extraction of the surplus from the old firm, as well as the associated performance reward. With probability p, the new entrepreneur arrives. The optimal strategy of the official is characterized by Lemma 3: with probability $F(\hat{y})$, the official endorses the new firm, which confers an expected payoff of $\tilde{U}(R)$; with probability $1 - F(\hat{y})$, the official still endorses the old firm, which confers an expected payoff of $E_f[y + J(R) \cdot V(y)|y \geq \hat{y}]$.

If the incumbent official does not launch an investigation and he stays in his jurisdiction, with probability $1 - p$ he endorses the old firm, which confers an expected payoff of $U(R)$; with probability p, the official endorses the new firm that arrives, which confers an expected payoff of $\tilde{U}(R)$ (Lemma 4).

Condition 17 identifies the minimal rotation frequency in the "creative destruction" model to deter the incumbent official from launching an investigation.

Lemma 5. *A necessary condition for the old entrepreneur to always invest is:*

$$(1-p)S(R) \geq K \text{ and } \pi \geq \underline{\tau}(\pi, p)$$

where the minimal rotation frequency $\underline{\tau}(\pi, p)$ *is*

$$\underline{\tau} = 1 - \frac{c}{(1-p)\Big\{E_f[y + J(R) \cdot V(y)] - U(R)\Big\} + p\big\{1 - F(\hat{y})\big\}\Big\{E_f[y + J(R) \cdot V(y)|y \geq \hat{y}] - \tilde{U}(R)\Big\}}. \tag{18}$$

Lemma 5 is analogous to Lemma 2. Sufficiently frequent rotation discourages the investigation from the incumbent official, preserving information rents for the old entrepreneur. I will implement a detailed analysis of the lower bound $\underline{\tau}$ after I solve the model.

The confiscation stage Suppose that $\pi \geq \underline{\tau}$, so the incumbent official will not launch an investigation of the old firm. If $\hat{K} = K > 0$, the incumbent official does not confiscate the old firm if and only if:

$$\eta K + (1-\pi)[(1-p) \cdot 0 + p \cdot \tilde{U}(R)] \leq$$
$$(1-\pi)[(1-p) \cdot U(R) + p \cdot \tilde{U}(R)]. \tag{19}$$

Condition 19 identifies the lower bound on rotation frequency to discourage capital confiscation, as summarized in Lemma 6.

Lemma 6. *A necessary condition for the old entrepreneur to always invest in the investment*

stage is:

$$\bar{\tau}(R) = 1 - \frac{\eta K}{(1-p) \cdot U(R)}. \tag{20}$$

Equation 20 is analogous to Equation 10 for the workhorse model. I also discuss the details of Equation 10 after we have solved the model.

The investment stage In addition to personnel institutions that discourage confiscation or investigation of the old firm, both entrepreneurs must expect a sufficiently large surplus on expectation to recoup their investment costs. This yields the following proposition.

Proposition 2. *1. Suppose that η is small enough so that $\bar{\tau}(R) \geq \underline{\tau}(R)$ for all $R \geq 0$. The necessary and sufficient condition for both entrepreneurs to always invest is:*

$$\underline{\tau}(R) \leq \pi \leq \bar{\tau}(R),\ (1-p)S(R) \geq K,\ \textit{and}\ \tilde{S}(R) \geq K.$$

2.Suppose that $p/(1-p) < (\int_{\underline{y}}^{w^*} V(z)f(z)dz)/(\int_{\tilde{w}}^{\bar{y}} V(z)g(z)dz)$. Alternatively, suppose that $\int_{\hat{y}}^{\bar{y}} V(z)f(z)dz - [1-F(\hat{y})]\int_{\tilde{w}}^{\bar{y}} V(z)g(z)dz \geq 0$, where $\hat{y}$ is defined as the y that solves $y + J(R) \cdot V(y) = \tilde{U}(R)$.

Then $\frac{d\underline{\tau}(R)}{dR} > 0$: the minimal rotation frequency increases with more intense performance evaluation.

3. $\frac{d\bar{\tau}(R)}{dR} > 0$: the maximal rotation frequency increases with more intense performance evaluation.

The proposition first characterizes the necessary and sufficient condition for the two entrepreneurs to always invest in their firms. The rotation frequency should be between the two bounds ($\bar{\tau}(R) \geq \underline{\tau}(R)$) to discourage both confiscation and investigation of the old firm. In this case, the governing official supports the old firm if and only if the new firm did not arrive. Even under a well-behaving incumbent official, the old entrepreneur must also expect a larger surplus than the highest cost of investment, or $(1-p)S(R) \geq K$. In addition, the new entrepreneur must also expect a larger surplus than the cost of investment, or $\tilde{S}(R) \geq K$.

The proposition further characterizes conditions for the complementarity between rotation and the performance reward in the extended model.

Rotation supports the performance reward The minimal rotation frequency still increases with a stronger performance reward when it is relatively rare for a new firm to arrive (p is small). It is reasonable to assume the rarity of such a new firm because the new firm

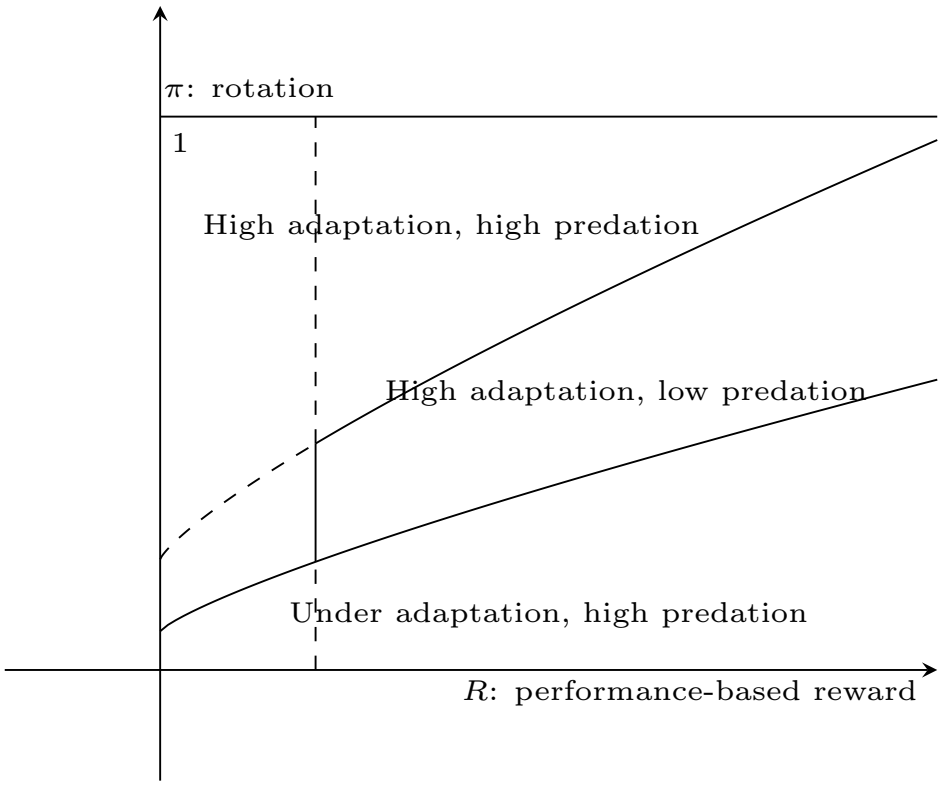

Figure 2: Adaptation and predation under different personnel institutions

produces an output that first order stochastically dominates the old firm, indicating a breakthrough innovation. When the new firm does not arrive too frequently, the temptation effect of the performance reward in the workhorse model dominates any ambiguity that may arise from firm entry.

This ambiguity from firm entry can be further bounded. To see this, note that the alternative condition for $d\underline{\tau}/dR > 0$ is that:

$$\int_{\hat{y}}^{\bar{y}} V(z)f(z)dz - [1 - F(\hat{y})] \int_{\tilde{w}}^{\bar{y}} V(z)g(z)dz \geq 0. \tag{21}$$

The left hand side of Equation 21 is the marginal temptation to launch an investigation with a stronger performance reward, conditional on the arrival of a new firm.[7] The marginal temptation has two terms. A higher R increases the performance reward from supporting an old firm whose (high) productivity is known to the official, as well as the performance reward from supporting a new firm whose productivity is unknown to the official. Equation 21 would always be true if the official only cares about the performance reward. But the sign is ambiguous because the official also cares about the economic rent. Nevertheless, the

[7]Strictly speaking, the left hand side of Equation 21 is the marginal temptation divided by $J(R)$.

ambiguity induced by the economic rent is qualitatively small, limited by a lower bound on Equation 21:

$$\int_{\hat{y}}^{\bar{y}} V(z)f(z)dz - [1 - F(\hat{y})] \int_{\tilde{w}}^{\bar{y}} V(z)g(z)dz \geq -\frac{E_f[y]}{J(R)}. \tag{22}$$

The lower bound $-E_f[y]/J(R)$ is intuitive. The numerator $E_f[y]$ is the maximal extra rent that the informed official can extract from the old firm in comparison with the rent from the new firm. This motive of rent extraction should be adjusted by the intensity of the performance reward $J(R)$ in the denominator. Since the lower bound 22 is tight, it is reasonable to assume that $\int_{\hat{y}}^{\bar{y}} V(z)f(z)dz - [1 - F(\hat{y})] \int_{\tilde{w}}^{\bar{y}} V(z)g(z)dz \geq 0$, especially when the performance reward is not too weak.

The performance reward supports rotation The maximal rotation frequency still increases under more intense performance evaluation, with no extra conditions. The maximal rotation frequency is:

$$1 - \frac{\eta K}{(1-p)U(R)}. \tag{23}$$

The equation reduces to the maximal rotation frequency with $p = 0$, the benchmark model without firm entry. With $\pi \geq \underline{\tau}$ as in Equation 20, the official will not launch an investigation of an intact old firm, earning an expected value of $(1 - p)U(R)$ from the old firm. At the confiscation stage, the temptation to confiscate capital can be discouraged by a strong performance reward even when a new firm may arrive, since a strong performance reward still induces the official to be especially averse to a bad performance record.

Rotation and performance rewards provide commitment and encourage adaptation The results are summarized in Figure 2, which shows that the complementarity between rotation and the performance-based reward persists under "creative destruction." Intense rotation and performance reward again help each other to discourage the dual temptation to investigate or confiscate the old firm, preserving sufficient information rent for the old entrepreneur. In the extended model, an investigation discourages private investment with probability $1 - q$. But in addition to this holdup cost that has been highlighted in the workhorse model, the investigation of the old firm will induce the official to foster strong entrenched interests with probability q. Everything else equal, a strong performance reward would have tempted an investigation of the old firm, potentially forming entrenched interests that block the entry of new firms. Yet even under a strong performance reward, the incumbent official does not launch the investigation if the incumbent official is rotated with a high probability. So the governing official later cannot hold entrenched interests in the old firm, therefore always refusing to block the entry of a new firm. In a word, rotation can

reduce the temptation in fostering entrenched interests in existing firms, a temptation that is exacerbated by a strong performance reward. At the same time, the problem of rotation to tempt capital confiscation is fixed by none other than the strong performance reward itself.

To summarize, the extended model formalizes the notion that rotation and the performance-based reward provide both Olsonian and Hartian property rights and facilitate "creative destruction," a feature rarely satisfied by many other commitment devices that provides *de facto* property rights.

4 Preliminary evidence

I provide suggestive empirical evidence on how anticipated personnel events on local officials affect firms' investment decisions in China. Before discussing these empirical results in detail, I introduce the institutional background. Local governments have four tiers in China. There are thirty-one province-level units. Each province is subdivided into approximately ten to fifteen cities or prefectures. A city usually has jurisdiction over several counties. The two key officials in a city are the party secretary and the mayor. The party secretary is the chief official in the city. The mayor is formally subordinate to the secretary because the mayor always holds the concurrent position of a deputy party secretary. However, there is a distinctive division of labor between the party secretary and the mayor (Shirk (1993)). The party secretary wields political power unmatched by any other official in the city. He secures such power through direct control of the organizational department and the propaganda department, among other powerful departments in the city party committee. The organizational department of a city appoints county-level officials under the authority of the city. The propaganda department directs government-owned media and controls the censorship of commercial media. But everyday management of the city government is the direct responsibility of the mayor. Most economic departments, such as revenue, construction, or commerce, are under the direct leadership of the mayor. By contrast, the city party committee, directly controlled by the party secretary, does not include major economic departments. This arrangement is different from local authorities in the Soviet Union, where the party secretary also wields direct economic power through economic departments in the party committee (Hough (2013)). The empirical strategy relies on variations from the dual leadership in China.

Figure 3 illustrates the definition of rotation and promotion that I use for the empirical analysis. Rotation is defined as a lateral transfer of a mayor to the mayorship of another city. A promotion event occurs when a mayor is appointed as the secretary of his own city.[8] A

[8]In addition, a rotation and promotion event occurs when a mayor is appointed to be the secretary of

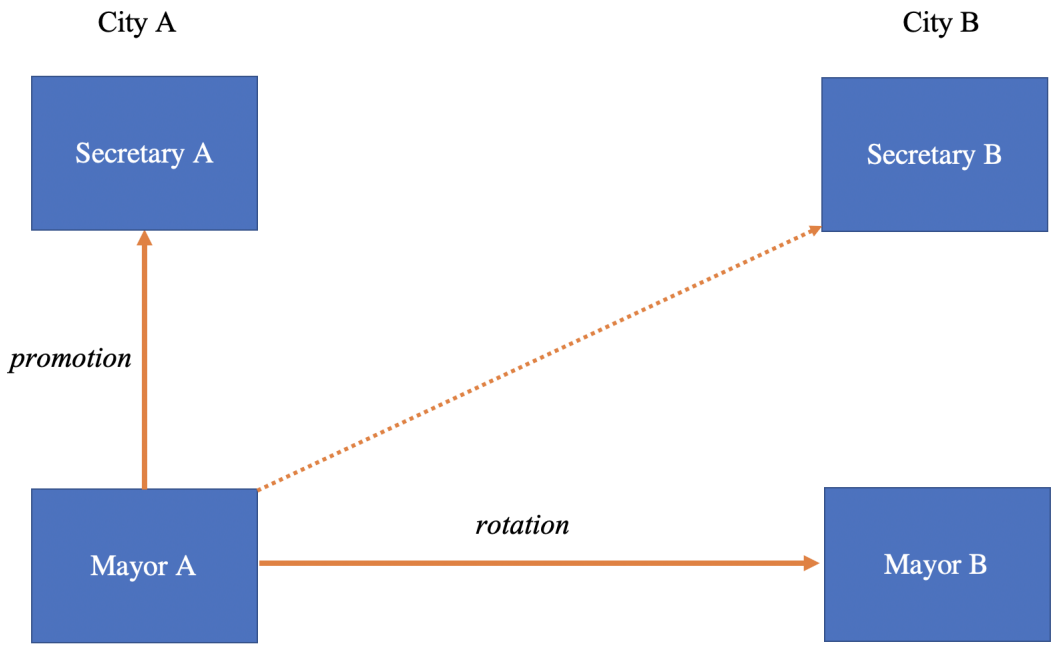

Figure 3: Rotation and promotion events for mayors

large literature documents that promotion in China is strongly correlated with economic performance, among many other factors (Maskin et al. (2000); Li and Zhou (2005); Xu (2011); Jia et al. (2015)). So a promotion opportunity is a special form (and the most common form) of a stronger performance-based evaluation in China. In addition, the personnel management of city-level officials is devised and implemented by the provincial organizational department, including the appointment of both the party secretary and the mayor of a city. Hence, a transfer of a city-level official to a different province is rare, which has important implications for empirical analysis.

4.1 Testable implications from the theory

As the main testable implication, my theory predicts that a private firm invests more in assets that are more vulnerable to expropriation when the prospect of rotation and promotion are both strong for the mayor of the city where the firm locates. This complementarity effect should mostly apply to assets that are difficult to move away against expropriation threats, rather than liquid assets or intangible assets. The complementarity effect should also be robust after accounting for the separate effects of rotation and promotion. In addition, the complementarity effect should not apply to state-owned enterprises (SOEs). SOEs do not need the protection from better personnel institutions imposed on local officials because

another city. I will explain in Section 4.1 and Section 4.2 why I don't focus on this personnel event.

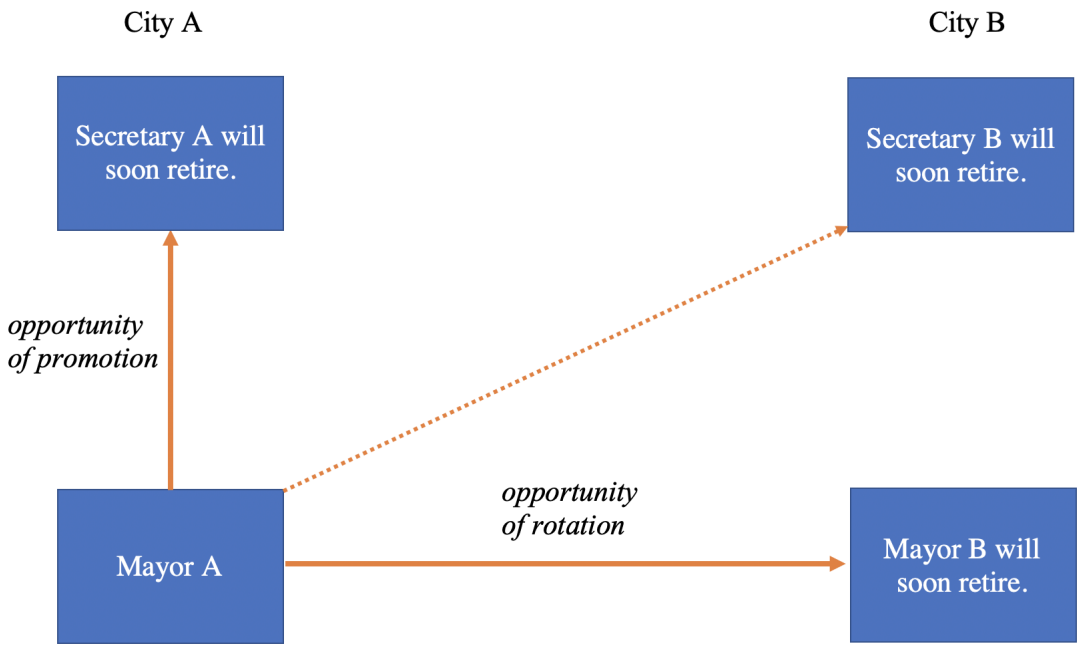

Figure 4: Opportunities of rotation and promotion

SOEs have already enjoyed substantial bargaining power against local officials from the exalted legal and political status of SOEs.

The ideal experiment is to randomly assign mayors into four groups. The first group serves as the control group; the second group receives only promotion prospect; the third group receives only rotation prospect; the fourth group receives both. Since such random assignment is rare, I attempt to utilize variations in anticipated rotation and promotion that are largely out of the control of mayors. Nevertheless, the analysis presented in this section is a thoroughly suggestive exercise, mainly to show the empirical relevance of my theory in previous sections. Rigorous causal evidence is for future work.

Specifically, I explore the "jackknife" or "leave-one-out" variation (see Figure 4). A natural proxy for future rotation events is the anticipated retirement of mayors in *other* cities within the same province.[9] City-level officials in China face a mandatory retirement age at 60. Before formal retirement at age 60, these officials could be transferred to an honorary position in the local legislature or the political consultative conference, institutions that are largely powerless. These transfers serve as transitions to full retirement (Wang (2016); Xi et al. (2018)). Such an event could happen any time after the city-level official has turned 56. Thus, if the mayor of City B turns 56, all officials in the province expect a job

[9]I restrict my attention to within-provincial retirements because, as mentioned, personnel management at the city level is controlled by the provincial organizational department. So inter-provincial transfers of city-level officials are extremely rare.

vacancy within four years. When the mayor of City B is actually assigned to the honorary position or even fully retires, the mayor of City A is among the likely candidates to fill up the mayorship in City B of the same province. Hence, I proxy anticipated rotation by the fraction of mayors in *other* cities of the same province who are more than 56 years old.

For a promotion event, I look at whether the secretary in a city (e.g., City A) is more than 56 years old. In this case, the mayor in city A anticipates a high likelihood of promotion, because the mayor of City A is the most likely candidate for the secretary position in City A.

The interaction between the above proxies for rotation and promotion can reasonably measure the complementarity effect. In addition, it seems that the personnel institution generates another proxy for the complementarity effect: the anticipated retirement of secretaries in *other* cities of the same province might improve the prospect of both rotation and promotion for a mayor. But we will see that in the data, the anticipated retirement of secretaries in other cities does not predict a turnover of a mayor's term. So I focus on the interaction term between rotation and promotion as the key proxy for the complementarity effect. Figure 4 illustrates the empirical variations I use to construct the proxies for anticipated personnel events.

4.2 Relevance of retirement in other cities on a mayor's own tenure

I obtain personnel data on officials from Chen (2016). For each city-year observation, the dataset identifies the governing secretary and mayor along with their age, gender, ethnicity, education, and work experiences. The dataset covers all cities in the 27 provinces and autonomous regions between the year 2000 and the year 2012.[10] For firm covariates, I obtain them from the Annual Survey of Industrial Firms (ASIF) from the year 2000 to the year 2007 (see Brandt et al. (2012), Brandt et al. (2014), and He et al. (2020) for more details about ASIF). The survey contains all firms that have annual sales above 5 million RMB (equivalent to around 700,000 USD). For each firm-year observation, the survey tracks the location, sales, the inventory, the number of employees, total assets, fixed assets (physical capital), the accumulated depreciation, liquid assets (such as cash and account receivables), intangible assets (such as intellectual property), liability, the industry code, and the ownership by paid-

[10]In other words, the dataset only excludes the four cities of provincial status, i.e., Beijing, Shanghai, Tianjin, and Chongqing. It is reasonable to exclude these cities, as their mayors and party secretaries are exceptionally important politicians with provincial ranks. These party secretaries further secure a seat in the elite council of Politburo. Therefore, the management of such senior positions is entirely outside the jurisdiction of provincial organizational departments. In addition, the availability of these positions is irrelevant to the mayor and the party secretary of a generic city, officials that only enjoy city ranks. Even the strongest candidate with a city rank can only be promoted to a position with a *deputy* provincial rank.

in capital. I merge the ASIF data with personnel data of mayors and party secretaries so that each firm-year observation is identified with officials ruling the city where the firm locates.

Before testing the main theoretical predictions, I document the relevance of retirement in other cities for mayor turnover in a city. The regression is:

$$n_{jt} = \mu_j + PC_t + \text{retirement of other secretaries}_{jt} + \text{retirement of other mayors}_{jt} + s_{jt} + m_{jt} + \epsilon_{jt}. \tag{24}$$

The dummy variable n_{jt} is whether the mayor j's term terminates in the year t. The variable μ_j is mayor fixed effects. The variable PC_t is the important and well-documented effect of "party congresses:" the turnover rate becomes much higher as a party congress approaches (Xi et al. (2018)). The retirement of other secretaries/mayors records the fraction of secretaries/mayors who are 59 years old in the province in the year t. These officials will retire within the year t. In the process, their retirement generates vacancies for the provincial organizational department to fill up. We will see that with a different cutoff (i.e. retiring in two or three years), results are very similar.

The dummy variable s_{jt} denotes whether the secretary co-ruling with the mayor j is older than 56, and the dummy variable m_{jt} is whether mayor j himself is older than 56. Robustness checks with different age cutoffs are also implemented, showing similar results. All standard errors are clustered at the mayor level.

Table 1 shows that a mayor's own turnover is positively correlated with the retirement of other mayors. In the first three columns, the retirement of other mayors is the fraction of mayors who will retire within one year. In the fourth/fifth column, the retirement of other mayors is the fraction of mayors who will retire within two/three years. For each column, the retirement of other secretaries is computed with the same cutoff as the retirement of other mayors. When mayors in other cities retire, their retirement strongly predicts the termination of a mayor's own term. But notice that when secretaries in other cities retire, their retirement does not predict the termination of a mayor's own term. This absence of correlation shows that a mayor is unlikely to be promoted to serve as the party secretary of *another* city.

Other coefficients are also reasonable. If the mayor or the secretary is old, turnover is more likely. An old mayor faces a high "risk" of a transfer to an honorary position in the local legislature or the political consultative conference, while an old secretary increases the likelihood of promotion for the mayor in the same city. For the party congress effects, the omitted years are "party congress in 5 years." As the constitution of the Chinese Communist Party requires a meeting of the party congress every 5 years, the omitted category represents the year immediately following a party congress. This year comes with the lowest turnover

probability. We can see that two or one years before a party congress, along with the year when a party congress assembles, feature a pronounced higher likelihood of turnover. This finding confirms previous studies of the party congress effects on personnel turnovers (e.g., Xi et al. (2018)).

To summarize, all columns show a consistent pattern: the retirement of mayors in other cities robustly predicts the turnover of a mayor, but not the retirement of secretaries in other cities.

4.3 Anticipated retirement on the composition of capital

The main empirical specification is:

$$y_{it} = \alpha_0 + \mu_i + \lambda_t + X_{it}\rho_0 + \rho_1 s_{it} + \rho_2 R_{it} + \beta s_{it} * R_{it} + \gamma C_{it} + \varepsilon_{it}, \tag{25}$$

where y_{it} is the ratio of fixed assets to total assets for a firm i in year t, after accounting for depreciation. In the Chinese Accounting Standards, fixed assets are defined as physical capital with long-term returns. The variable μ_i is firm fixed effects, λ_t is year fixed effects, and s_i is a proxy for the performance-based reward. As discussed before, studies on Chinese political economy show that an age cutoff works well to proxy for promotion opportunities (Wang (2016); Xi et al. (2018)). A secretary older than 56, who will retire in the next four years, presents a promotion opportunity for the mayor. Hence, I denote $s_{it} = 1$ if the secretary is older than 56 and 0 otherwise. The variable R_{it} is the fraction of mayors in other cities of the same province older than 56. The variable C_{it} records the fraction of secretaries in other cities older than 56. We are mainly interested in the coefficient on $s_{it} * R_{it}$, the proxy for the complementary effect. The variable X_{it} is a vector of control variables in all specifications of Table 2. The vector X_{it} includes rich covariates measuring the characteristics of the firm, as well as the mayor and the party secretary of the city where the firm locates. For firm characteristics, I control (lag and logarithm of) output, the number of employees, value added, profit, management fee, inventory, firm age, and debt. For official characteristics, I control (for both the mayor and the party secretary) age, gender, ethnicity, education, and work experience, including whether the official used to work in the Communist Youth League and whether the official used to work as a personal assistant or the director of the office for a senior official.[11] I also restrict my attention to mayors who are in first and second years of their terms. As the average term is 3.8 years, mayors who are

[11] Whenever possible, I also include the dummy variable whether the mayor is older than 56, and its interaction with R_{it}. They are insignificant with very small point estimates. They are also dropped from most specifications as the sample is usually restricted to either "young" or "old" mayors, to be defined later.

Table 1: relevance of retirement in other cities on own turnover

	(1)	(2)	(3)	(4)	(5)
			Mayor turnover		
retirement of other mayors	1.059***	1.495***	1.185**	0.976**	1.554***
	(0.303)	(0.479)	(0.481)	(0.380)	(0.314)
retirement of other secretaries	-0.139	0.0674	0.208	0.00225	-0.112
	(0.139)	(0.194)	(0.197)	(0.146)	(0.131)
secretary age ≥ 56	0.0903***	0.300***	0.252***	0.250***	0.241***
	(0.0170)	(0.0307)	(0.0332)	(0.0332)	(0.0331)
mayor age ≥ 56	0.205***	0.447***	0.431***	0.433***	0.428***
	(0.0328)	(0.0500)	(0.0494)	(0.0494)	(0.0493)
party congress in:					
this year			0.189***	0.192***	0.197***
			(0.0324)	(0.0326)	(0.0319)
2 year			0.157***	0.157***	0.148***
			(0.0317)	(0.0321)	(0.0309)
3 year			0.152***	0.158***	0.155***
			(0.0273)	(0.0268)	(0.0274)
4 year			0.0140	0.0163	0.0225
			(0.0222)	(0.0216)	(0.0215)
Mayor FE	No	Yes	Yes	Yes	Yes
Retirement of other officials in	one year	one year	one year	two years	three years
N	2884	2884	2884	2884	2884
R^2	0.027	0.098	0.127	0.127	0.139
adj. R^2	0.025	0.097	0.125	0.125	0.136

Standard errors are in parentheses and are clustered at the mayor level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The dependent variable is whether the mayor's term is terminated in year t.

Table 2: Anticipated job vacancy on capital composition

	(1)	(2)	(3)	(4)	(5)
			Capital composition		
own secretary old $*$ other old mayors ($s_{it} * R_{it}$)	0.0705**	0.0849**	-0.224**	0.108***	-0.0608**
	(0.0329)	(0.0384)	(0.0839)	(0.0401)	(0.0257)
fraction of other secretaries old (C_{it})	0.00982	0.00707	-0.0677	0.00343	0.0320
	(0.0122)	(0.0141)	(0.0612)	(0.0157)	(0.0204)
fraction of other mayors old (R_{it})	-0.0388***	-0.00461	-0.0279**	-0.0135	0.00705
	(0.0129)	(0.0163)	(0.0126)	(0.0172)	(0.0354)
own secretary old (s_{it})	-0.00529	-0.00726	0.00760	-0.00727	-0.00596
	(0.00481)	(0.00602)	(0.00614)	(0.00623)	(0.00533)
Sample:					
Mayor age	all	young	old	young	young
Firm ownership	all	all	all	non-state	SOEs
N	283508	223036	43267	204712	14153
adj. R^2	0.732	0.736	0.779	0.727	0.788

Standard errors are in parentheses and are two-way clustered at the city level and the firm level. * p<0.1, ** p<0.05, *** p<0.01. The dependent variable is the ratio of fixed assets to total assets. All specifications control firm fixed effects, year fixed effects, the firm's characteristics, and the officials' characteristics. For firm characteristics, I control (lag and logarithm of) output, the number of employees, value added, profit, the management fee, the inventory, the firm age, and debt. For official characteristics, I control (for both the mayor and the party secretary) age, gender, ethnicity, education, and work experiences, including whether the official used to work in the Communist Youth League and whether the official used to work as a personal assistant or the director of the office for a senior official.

more than three years in their terms face very little incentive to promote private investment, investment that can only generate a payoff in the future.

Table 2 lists the main empirical results. The first row is the main explanatory variable, the interaction term between anticipated rotation and anticipated promotion. The second row is the fraction of secretaries in other cities who are more than 56 years old. The previous Table 1 has shown that the fraction of retiring secretaries in other cities has little predictive power for the turnover of a mayor. Therefore, we expect a null correlation for the coefficients in the second row. The third row is the proxy for anticipated rotation, the fraction of mayors in other cities who are more than 56 years old. The fourth row is the proxy for anticipated promotion, whether the city party secretary is more than 56 years old. Column (1) is restricted to the full sample. Columns (2) and (3) split the sample into "young" mayors and "old" mayors, with the cutoff at 53 years old.[12]

In Column (1), the interaction between the rotation proxy and the promotion proxy is statistically and economically significant, supporting the main prediction of my theory on the complementarity effect of rotation and promotion on private investment. Column (2) and Column (3) show that the complementarity effect in Column (1) is entirely driven by "young" mayors who are less than 53 years old. For mayors who are less than 53 years old, the coefficient for the interaction term remains statistically and economically significant in Column (2). In Column (3), which restricts to mayors who are more than 53 years old, the interaction term is negative. To understand the negative coefficient, a larger interaction term is correlated with a better incentive to promote private investment in cities with "young" mayors (as in Column 2). The stronger private investment in other cities with young mayors presumably increases the price of investment goods in factor markets, depressing private investment in cities with old mayors who face a much weaker incentive to promote investment from anticipated personnel events.

For Column (1) and Column (2), the fraction of secretaries in other cities more than 56 years old is not correlated with the composition of private capital. The null result is reasonable because the fraction of retiring secretaries in other cities does not predict the turnover of a mayor (Table 1). Also, the coefficients on the proxy for rotation (R_{it}) and the proxy for promotion (s_{it}) are either insignificant or negative, showing that the prospects of rotation and promotion must both present to incentivize mayors to promote private investment.

Column (4) and Column (5) further split the sample of young mayors to test heterogeneous effects on private firms versus SOEs. We can see that the coefficient on the interaction

[12]This cutoff allows me to implement two-way clustering standard errors at the city level and the firm level for Column (3). If I use cutoffs larger than 54, there would be too few cities to cluster for Column (3). The qualitative results are quite similar, however, if I employ different cutoffs.

term is positive and significant for private firms in Column (4). The coefficient is negative for SOEs in Column (5). The preferred explanation is similar to the previous negative coefficient for firms in cities ruled by old mayors. Because SOEs already enjoy a large bargaining power against local governments, better personnel incentives for mayors matter little for SOEs. But because better personnel incentives for mayors promote stronger investment from private firms, SOEs are now operating under a more competitive factor market for physical assets, which presumably reduces the investment of SOEs in physical assets.

5 Conclusion

The paper studies how strong bureaucratic capacity can support a private economy. Bureaucratic capacity is the focus of the seminal contributions to the study of state capacity (Weber (1978); Mann (2012)), as well as more recent studies (Snowberg and Ting (2019)). Building on previous works on bureaucracies, the key new insight of the paper is that frequent rotation and intense performance evaluation cover each other's weakness, working together to empower the entrepreneurs.

Another new insight is about the acute tradeoff between commitment and flexibility. Rotation and performance evaluation can resolve the tradeoff and achieve strong commitment and flexibility simultaneously, a feature rarely satisfied by other commitment devices. This insight generates another empirical prediction: countries with more disciplined bureaucracies are more likely to escape "the middle-income trap." Economies may get stuck in such a middle-income trap when they rely too much on long-term interactions to solve the commitment problem between officials and private entrepreneurs, fostering strong entrenched interests with existing firms and blocking the entry of new firms (Olson (1982); Acemoglu et al. (2006); Acemoglu and Robinson (2012); Eichengreen et al. (2013)). Different from solutions based on repeated interactions, a bureaucracy that is disciplined through the combination of rotation and performance evaluation is ready to support any new firms and technologies because its officials are more insulated from entrenched interests. Therefore, my theory offers an explanation for the divergence between "East Asian Miracles" with their strong bureaucracies, and the stagnated industrialization of many economies in Latin America and Southeast Asia where bureaucracies are much weaker and less disciplined (Rauch and Evans (2000); Evans (2012)).

There are many other research questions related to this paper. Even if carefully designed, what are the costs of such bureaucracy-assisted development? Will such a strong bureaucracy block further market reforms that renders bureaucracy-based solutions less important? Moreover, what are the social and historical origins of the bureaucratic disciplines

that I investigate in this paper? These are potentially fruitful areas for further exploration.

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A Proofs for Propositions

Lemma 1. *Denote the unique solution to $S(R) = K$ as $\hat{R}$. A necessary condition for the entrepreneur to invest is $R \geq \hat{R} > 0$, or a sufficiently strong performance reward.*

Proof. First, we want to show that

$$\lim_{R\to\infty} w^*(R) = 0. \tag{26}$$

To show Equation 26, we inspect the derivative of the official's payoff with respect to w as $R \to \infty$. The derivate is negative for all $w \in [\underline{y}, \bar{y}]$,

$$f(w)[\frac{1-F(w)}{f(w)} - w - V(w,R)] < 0, \tag{27}$$

because $\lim_{R\to\infty} V(w,R) = \infty$ and $f(w) > 0$.

Second, we want to show that $S(R=\infty) > K$ and $S(R=0) < K$. The two inequalities are implied by Assumption 1:

$$K < E[y] \text{ and } K > [1-F(\hat{w})]\Big\{E[y|y \geq \hat{w}] - \hat{w}\Big\},$$

where $\hat{w} = w^*(R=0)$. Notice that $E[y] = S(R=\infty)$ because $w^*(R=\infty) = 0$. Also, $[1-F(\hat{w})]\Big\{E[y|y \geq \hat{w}] - \hat{w}\Big\} = S(R=0)$ by construction.

Third, we want to show that $dw^*/dR \geq 0$. Denote the inverse of the hazard rate as $h(w) = \frac{1-F(w)}{f(w)}$. For w^* that satisfies the first order condition 4, we can derive dw^*/dR:

$$\frac{dw^*}{dR} = \frac{V_R}{1 + V_w - h'}.$$

So $dw^*/dR > 0$ because $V_R > 0$, $V_w > 0$, and $h' < 0$. Therefore, when the first order condition 4 is satisfied,

$$S'(R) = \frac{d}{dR}\{\int_{w^*}^{\bar{y}} z f(z)dz - w^* \int_{w^*}^{\bar{y}} f(z)dz\}$$

$$= -w^* f(w^*)\frac{dw^*}{dR} - \int_{w^*}^{\bar{y}} f(z)dz\frac{dw^*}{dR} + w^* f(w^*)\frac{dw^*}{dR}$$

$$= -\int_{w^*}^{\bar{y}} f(z)dz\frac{dw^*}{dR} > 0.$$

When the the first order condition 4 is not satisfied (for example, as $R \to \infty$), $S'(R) = 0$.

Gathering all arguments above, there exists a unique $\hat{R}$, such that for $R > \hat{R}$, $S(R) > K$ and for $R < \hat{R}$, $S(R) < K$. □

Proposition 1. *1.The necessary and sufficient condition for the entrepreneur to invest is*

$$R \geq \hat{R} \text{ and } \underline{\pi}(R) \leq \pi \leq \bar{\pi}(R).$$

2. $\underline{\pi}'(R) > 0$*: the minimal rotation frequency increases with stronger performance evaluation.*

3. $\bar{\pi}'(R) > 0$*: the maximal rotation frequency increases with stronger performance evaluation.*

Proof. 1. I will first show that the result for any $R \geq 0$, $\underline{\pi}(R) < \bar{\pi}(R)$ follows from Assumption 3.To show that $\underline{\pi}(R) < \bar{\pi}(R)$, or

$$1 - \frac{c}{E[y + V(y,R)] - \Big\{1 - F[w^*(R)]\Big\}\Big\{w^*(R) + E[V(y,R)|y \geq w^*(R)]\Big\}}$$

$$\leq 1 - \frac{\eta K}{\Big\{1 - F[w^*(R)]\Big\}\Big\{w^*(R) + E[V(y,R)|y \geq w^*(R)]\Big\}},$$

the necessary and sufficient condition is

$$D(R) \equiv (c+\eta K)\Big\{1-F[w^*(R)]\Big\}\Big\{w^*(R)+E[V(y,R)|y \geq w^*(R)]\Big\} - \eta K \cdot E[y+V(y,R)] > 0. \quad (28)$$

Assumption 3 is a sufficient condition for Equation 28. To see this, notice that a sufficient condition for Equation 28 is that $D(R=0) > 0$ and $D'(R) > 0$. First, $D(R=0) > 0$ because of Assumption 3:

$$D(R=0) = (c+\eta K)\Big\{1 - F[w^*(0)]\Big\}w^*(0) - \eta K \cdot E[y]$$

$$= (c+\eta K)\Big\{1 - F(\hat{w})\Big\}\hat{w} - \eta K \cdot E[y].$$

Assumption 3 says:

$$\eta < \frac{c}{K}\frac{1}{\max\{\frac{E[y]}{[1-F(\hat{w})]\hat{w}} - 1,\ \frac{F(\hat{w})E[V_R(y,R)|y \leq \hat{w}]}{[(1-F(\hat{w})]E[V_R(y,R)|y \geq \hat{w}]}\}}$$

$$\Leftrightarrow \eta K \cdot \max\{\frac{E[y]}{[1-F(\hat{w})]\hat{w}} - 1,\ \frac{F(\hat{w})E[V_R(y,R)|y \leq \hat{w}]}{[(1-F(\hat{w})]E[V_R(y,R)|y \geq \hat{w}]}\} < c.$$

Therefore,

$$\eta K \cdot \Big\{ \frac{E[y]}{[1-F(\hat{w})]\hat{w}} - 1 \Big\} < c,$$

$$\text{or } (c+\eta K)\Big\{1-F(\hat{w})\Big\}\hat{w} - \eta K \cdot E[y] > 0.$$

Also, to ensure that $D'(R) > 0$, or

$$D'(R) = (c+\eta K)\Big\{1-F[w^*(R)]\Big\}E[V_R(y,R)|y \geq w^*(R)] - \eta K \cdot E[V_R(y,R)] > 0,$$

$$\frac{c}{\eta K} \geq \frac{F[w^*(R)]E[V_R(y,R)|y \leq w^*(R)]}{\Big\{1-F[w^*(R)]\Big\}E[V_R(y,R)|y \geq w^*(R)]} = \frac{\int_{\underline{y}}^{w^*(R)} V_R(z,R)f(z)dz}{\int_{w^*(R)}^{\bar{y}} V_R(z,R)f(z)dz}. \tag{29}$$

The term

$$\frac{\int_{\underline{y}}^{w^*(R)} V_R(z,R)f(z)dz}{\int_{w^*(R)}^{\bar{y}} V_R(z,R)f(z)dz}$$

is monotonically decreasing in R because $w^*(R)$ is monotonically increasing in R. Therefore, a sufficient condition for Equation 29 is:

$$\frac{c}{\eta K} \geq \frac{\int_{\underline{y}}^{w^*(0)} V_R(z,R)f(z)dz}{\int_{w^*(0)}^{\bar{y}} V_R(z,R)f(z)dz} = \frac{\int_{\underline{y}}^{\hat{w}} V_R(z,R)f(z)dz}{\int_{\hat{w}}^{\bar{y}} V_R(z,R)f(z)dz} = \frac{F(\hat{w})E[V_R(y,R)|y \leq \hat{w}]}{\Big\{1-F(\hat{w})\Big\}E[V_R(y,R)|y \geq \hat{w}]},$$

which is guaranteed by Assumption 3.

2. I now show that the necessary and sufficient condition for the entrepreneur to invest is

$$R \geq \hat{R} \text{ and } \underline{\pi}(R) \leq \pi \leq \bar{\pi}(R).$$

Suppose that $R \geq \hat{R}$ and $\underline{\pi}(R) \leq \pi \leq \bar{\pi}(R)$. Because $\underline{\pi}(R) \leq \pi \leq \bar{\pi}(R)$, the incumbent official does not steal or investigate the private investment (Lemma 2 and Equation 10). If the entrepreneur invests, he obtains

$$S(R) = \Big\{1-F[w^*(R)]\Big\}\Big\{E[y|y \geq w^*(R)] - w^*(R)\Big\}.$$

The expected net surplus $S(R) \geq K$ if and only if $R \geq \hat{R}$. Therefore the entrepreneur makes the investment K.

Now suppose that it is not true that $R \geq \hat{R}$ and $\underline{\pi}(R) \leq \pi \leq \bar{\pi}(R)$. First, suppose that $R < \hat{R}$. Then the maximal possible payoff to the entrepreneur from the investment is:

$$-K + S(R) < 0.$$

So the entrepreneur does not make the investment.

Second, suppose that $\pi < \underline{\pi}(R)$. If the entrepreneur makes the investment, the incumbent official would not confiscate the investment but would investigate it. The payoff to the entrepreneur is $-K < 0$. So the entrepreneur does not make the investment.

Third, suppose that $\pi > \bar{\pi}(R)$. If the entrepreneur makes the investment, the incumbent official would confiscate the investment. The payoff to the entrepreneur is $-K < 0$. So the entrepreneur does not make the investment.

3. To show that $\underline{\pi}'(R) > 0$, notice that because

$$\underline{\pi}(R) = 1 - \frac{c}{E[y + V(y, R)] - U(R)},$$

it is necessary and sufficient to show that

$$\Delta(R) \equiv E[y + V(y, R)] - U(R)$$

is monotonically increasing in R.

$$\begin{aligned}
\Delta'(R) &= E[V_R(y, R)] - \frac{d}{dR}[1 - F(w^*)]\Big\{w^* + E[V(y, R)|y \geq w^*]\Big\} \\
&= E[V_R(y, R)] - [1 - F(w^*)]E[V_R(y, R)|y \geq w^*] \\
&= \int_{\underline{y}}^{\bar{y}} V_R(z, R)f(z)dz - \int_{w^*}^{\bar{y}} V_R(z, R)f(z)dz \\
&= \int_{\underline{y}}^{w^*} V_R(z, R)f(z)dz > 0.
\end{aligned}$$

4. To show that $\bar{\pi}'(R) > 0$, notice that because

$$\bar{\pi}(R) = 1 - \frac{\eta K}{U(R)},$$

it is necessary and sufficient to show that

$$U(R) = [1 - F(w^*)]\Big\{w^* + E[V(y, R)|y \geq w^*]\Big\}$$

is monotonically increasing in R. We indeed have $U'(R) > 0$:

$$U'(R) = [1 - F(w^*)]E[V_R(y, R)|y \geq w^*] > 0.$$

□

Lemma 3. *For an official who is informed about the old firm, the performance-based reward encourages adaptation.*

Specifically, the informed official endorses the new firm with probability $F[\hat{y}(R)]$, *and* $dF[\hat{y}(R)]/dR > 0$. *But for any* $R \in [0, \infty]$, $F(\hat{y}(R)) < 1$.

Proof. An informed official supports the old project with a realized productivity y, if and only if

$$y + J(R) \cdot V(y) \geq \tilde{U}(R),$$

or

$$y + J(R) \cdot V(y) \geq \max_{w} \left\{ [1 - G(w)]w + J(R) \cdot \int_{w}^{\bar{y}} V(z)g(z)dz \right\}.$$

Notice that, first, the left hand side is monotonically increasing in y. Second, the left hand side is larger than the right hand side if the realized productivity y is sufficiently large. Third, the left hand side is 0 if the productivity $y = 0$, being smaller than the right hand side. Therefore, there exists a unique $\hat{y}$, such that

$$\hat{y} + J(R) \cdot V(\hat{y}) = \max_{w} \left\{ [1 - G(w)]w + J(R) \cdot \int_{w}^{\bar{y}} V(z)g(z)dz \right\}.$$

To take the derivative of $\hat{y}$ with respect to R,

$$d\hat{y} + J'(R) \cdot V(\hat{y})dR + J(R) \cdot V'(\hat{y})d\hat{y} = J'(R) \cdot \int_{\tilde{w}}^{\bar{y}} V(z)g(z)dz \cdot dR,$$

$$[1 + J(R) \cdot V'(\hat{y})]d\hat{y} = J'(R) \cdot [\int_{\tilde{w}}^{\bar{y}} V(z)g(z)dz - V(\hat{y})] \cdot dR,$$

$$\frac{d\hat{y}}{dR} = J'(R) \cdot \frac{\int_{\tilde{w}}^{\bar{y}} V(z)g(z)dz - V(\hat{y})}{1 + J(R) \cdot V'(\hat{y})}.$$

We only need to determine the sign of $\int_{\tilde{w}}^{\bar{y}} V(z)g(z)dz - V(\hat{y})$. By contradiction, suppose that

$$\int_{\tilde{w}}^{\bar{y}} V(z)g(z)dz - V(\hat{y}) \leq 0.$$

By construct,

$$\hat{y} + J(R) \cdot V(\hat{y}) = [1 - G(\tilde{w})]\tilde{w} + J(R) \cdot \int_{w}^{\bar{y}} V(z)g(z)dz.$$

So we have

$$\hat{y} - [1 - G(\tilde{w})]\tilde{w} = J(R) \cdot [\int_{\tilde{w}}^{\bar{y}} V(z)g(z)dz - V(\hat{y})] \leq 0. \tag{30}$$

Also, notice that

$$\int_{\tilde{w}}^{\bar{y}} V(z)g(z)dz = [1 - G(\tilde{w})]E_g[V(x)|x \geq \tilde{w}].$$

By conditional Jensen's inequality,

$$[1 - G(\tilde{w})]E_g[V(x)|x \geq \tilde{w}] \geq [1 - G(\tilde{w})]V\Big(E_g[x|x \geq \hat{w}]\Big).$$

Together with that $\int_{\tilde{w}}^{\bar{y}} V(z)g(z)dz - V(\hat{y}) \leq 0$, or $V(\hat{y}) \geq \int_{\tilde{w}}^{\bar{y}} V(z)g(z)dz$, we have:

$$V(\hat{y}) \geq [1 - G(\tilde{w})]V\Big(E_g[x|x \geq \hat{w}]\Big).$$

Also, note that

$$E_g[x|x \geq \hat{w}] > \hat{w}.$$

The term $E_g[x|x \geq \hat{w}]$ is strictly larger than $\hat{w}$ because $\hat{w} < \bar{y}$ and $f(x) > 0$ for all $x \in [\underline{y}, \bar{y}]$.

So we have

$$V(\hat{y}) > [1 - G(\tilde{w})]V(\tilde{w}).$$

Furthermore, following the definition of convexity,

$$[1 - G(\tilde{w})]V(\tilde{w}) \geq V\Big([1 - G(\tilde{w})]\tilde{w}\Big).$$

Therefore,

$$V(\hat{y}) > V\Big([1 - G(\tilde{w})]\tilde{w}\Big),$$

Because $V'(\cdot) > 0$, we have

$$\hat{y} > [1 - G(\tilde{w})]\tilde{w}.$$

a contradiction to Equation 30 where $\hat{y} \leq [1 - G(\tilde{w})]\tilde{w}$. Therefore, we conclude that:

$$\int_{\tilde{w}}^{\bar{y}} V(z)g(z)dz - V(\hat{y}) > 0,$$

and

$$\frac{d\hat{y}}{dR} = J'(R) \cdot \frac{\int_{\tilde{w}}^{\bar{y}} V(z)g(z)dz - V(\hat{y})}{1 + J(R) \cdot V'(\hat{y})} > 0.$$

To see that for all R, $F(\hat{y}(R)) < 1$, note that in the limit as $R \to \infty$, rents extracted from private projects are completely dwarfed by performance rewards. The official extracts

no rents from the new project ($\lim_{R\to\infty}\tilde{w}(R)=0$), and supports the old project if and only if

$$J(R)\cdot V(y)\geq J(R)\cdot E[V(x)],$$

or simply

$$V(y)\geq E[V(x)].$$

Notice that that $E[V(x)]=\int_{\underline{y}}^{\bar{y}}V(z)g(z)dz<\int_{\underline{y}}^{\bar{y}}V(\bar{y})g(z)dz=V(\bar{y})$. Therefore, as $R\to\infty$, the governing official supports the old project with a strictly positive probability, which is also the infimum of the probability that the old project is supported under any $R\in[0,\infty)$. So for any R, the governing official supports the old project with strictly positive probability.

□

Lemma 4. *For an official who does not know the realized productivity of the intact old firm, he supports the new firm ($\theta=1$).*

Proof. By definition,

$$\tilde{U}\equiv\max_{w}[1-G(w)]\{w+J(R)\cdot E_g[V(x)|x\geq w]\}=[1-G(\widetilde{w})]\{\widetilde{w}+J(R)\cdot E_g[V(x)|x\geq\widetilde{w}]\}\geq$$

$$[1-G(w^*)]\{w^*+J(R)\cdot E_g[V(x)|x\geq w^*]\}=[1-G(w^*)]w^*+J(R)\int_{w^*}^{\bar{y}}V(z)\cdot g(z)dz$$

Notice that

$$\int_{w^*}^{\bar{y}}V(z)\cdot g(z)dz\geq\int_{w^*}^{\bar{y}}V(z)\cdot f(z)dz$$

because of first order stochastic dominance. This conclusion results from an equivalent definition of first order stochastic dominance. Specifically, for G to first order stochastically dominates F, a necessary condition is that $G(y)\leq F(y)$ for all y and that for every weakly increasing utility function u, $\int u(x)dG\geq\int u(x)dF$.

Also, because for all y, $G(y)\leq F(y)$, we have $[1-G(w^*)]w^*\geq[1-F(w^*)]w^*$. So we conclude that

$$\tilde{U}\geq[1-G(w^*)]w^*+J(R)\int_{w^*}^{\bar{y}}V(z)g(z)dz\geq[1-F(w^*)]w^*+J(R)\int_{w^*}^{\bar{y}}V(z)f(z)dz=U.$$

□

Proposition 2. *1. Suppose that η is small enough so that $\bar{\tau}(R)\geq\underline{\tau}(R)$ for all $R\geq 0$. The necessary and sufficient condition for both entrepreneurs to always invest is:*

$$\underline{\tau}(R)\leq\pi\leq\bar{\tau}(R),\ (1-p)S(R)\geq K,\ \text{and}\ \tilde{S}(R)\geq K.$$

2.Suppose that $p/(1-p) < (\int_{\underline{y}}^{w^*} V(z)f(z)dz)/(\int_{\tilde{w}}^{\bar{y}} V(z)g(z)dz)$. *Alternatively, suppose that* $\int_{\hat{y}}^{\bar{y}} V(z)f(z)dz - [1-F(\hat{y})]\int_{\tilde{w}}^{\bar{y}} V(z)g(z)dz \geq 0$, *where* $\hat{y}$ *is defined as the* y *that solves* $y + J(R)\cdot V(y) = \tilde{U}(R)$.

Then $\frac{d\underline{\tau}(R)}{dR} > 0$: *the minimal rotation frequency increases with more intense performance evaluation.*

3. $\frac{d\bar{\tau}(R)}{dR} > 0$: *the maximal rotation frequency increases with more intense performance evaluation.*

Proof. Claim 1 is straightforward to verify. Notice that $(1-p)S(R) \geq K$ also guarantees that $\tilde{S}(R) \geq K$.

For Claim 2, to prove that

$$\frac{d\underline{\tau}(R)}{dR} > 0,$$

we only need to show that

$$\tilde{\Delta}(R) \equiv (1-p)\Big\{E_f[y+J(R)\cdot V(y)]-U(R)\Big\}+p\big\{1-F[\hat{y}(R)]\big\}\Big\{E_f[y+J(R)\cdot V(y)|y\geq\hat{y}]-\tilde{U}(R)\Big\}$$

$$= (1-p)\Big\{(1+R)E_f[y+J(R)\cdot V(y)]-U(R)\Big\}+p\Big\{\int_{\hat{y}(R)}^{\bar{y}}[z+J(R)\cdot V(z)]f(z)dz-\{1-F[\hat{y}(R)]\}\tilde{U}(R)\Big\}$$

monotonically increases with R.

$$\tilde{\Delta}'(R) = (1-p)\Big\{J'(R)\cdot\int_{\underline{y}}^{\bar{y}} V(z)f(z)dz - J'(R)\cdot\int_{w^*}^{\bar{y}} V(z)f(z)dz\Big\}$$

$$+p\Bigg\{J'(R)\cdot\int_{\hat{y}(R)}^{\bar{y}} zf(z)dz-[\hat{y}+J(R)\cdot V(\hat{y})]f(\hat{y})\cdot\hat{y}'(R)+f(\hat{y})\cdot\hat{y}'(R)\cdot\tilde{U}(R)-[1-F(\hat{y})]J'(R)\cdot\int_{\tilde{w}}^{\bar{y}} V(z)g(z)dz\Bigg\}$$

$$= (1-p)J'(R)\int_{\underline{y}}^{w^*} V(z)f(z)dz$$

$$+p\Bigg\{J'(R)\cdot\int_{\hat{y}(R)}^{\bar{y}} zf(z)dz-f(\hat{y})\cdot\hat{y}'(R)[\hat{y}+J(R)\cdot V(\hat{y})-\tilde{U}(R)]-[1-F(\hat{y})]J'(R)\cdot\int_{\tilde{w}}^{\bar{y}} V(z)g(z)dz\Bigg\}.$$

Recall that $\hat{y}$ is the cutoff such that

$$\hat{y} + J(R)\cdot V(\hat{y}) = \tilde{U}(R),$$

We want to identify sufficient conditions for $\tilde{\Delta}'(R)$ to be strictly positive:

$$\tilde{\Delta}'(R) = (1-p)J'(R)\int_{\underline{y}}^{w^*} V(z)f(z)dz$$

$$+pJ'(R)\left\{\int_{\hat{y}(R)}^{\bar{y}} V(z)f(z)dz - [1-F(\hat{y})]\int_{\tilde{w}}^{\bar{y}} V(z)g(z)dz\right\} > 0. \tag{31}$$

Equation 31 is always true if $\int_{\hat{y}(R)}^{\bar{y}} V(z)f(z)dz - [1-F(\hat{y})]\int_{\tilde{w}}^{\bar{y}} V(z)g(z)dz \geq 0$. Otherwise, Equation 31 is true if and only if

$$\frac{p}{1-p} < \frac{\int_{\underline{y}}^{w^*} V(z)f(z)dz}{[1-F(\hat{y})]\int_{\tilde{w}}^{\bar{y}} V(z)g(z)dz - \int_{\hat{y}(R)}^{\bar{y}} V(z)f(z)dz}.$$

Now we show that $\frac{d\bar{\tau}(R)}{dR} > 0$. It is sufficient to show that $U'(R) > 0$. By Envelope Theorem,

$$U'(R) = J'(R)\int_{w^*}^{\bar{y}} V(z)f(z)dz > 0.$$

This completes the proof. Finally, we show the auxiliary result that

$$\int_{\hat{y}(R)}^{\bar{y}} V(z)f(z)dz - [1-F(\hat{y})]\int_{\tilde{w}}^{\bar{y}} V(z)g(z)dz \geq -\frac{E_f[y]}{J(R)}.$$

That is, the marginal temptation (divided by $J'(R)$) to investigate if a new firm arrives has a lower bound at $-E_f[y]/J(R)$.

Notice that for any $y \geq \hat{y}(R)$, by construction,

$$y + V(y)J(R) \geq [1-G(\tilde{w})]\tilde{w} + J(R)\int_{\tilde{w}}^{\bar{y}} V(z)g(z)dz.$$

Multiply both sides by $f(y)$, the probability density at y:

$$V(y)J(R)f(y) \geq [1-G(\tilde{w})]\tilde{w}f(y) - yf(y) + J(R)\int_{\tilde{w}}^{\bar{y}} V(z)g(z)dz \cdot f(y).$$

The inequality is valid for any $y \geq \hat{y}(R)$. We can integrate both sides from $\hat{y}(R)$ to $\bar{y}$:

$$\int_{\hat{y}(R)}^{\bar{y}} V(v)J(R)f(v)dv \geq [1-F(\hat{y})][1-G(\tilde{w})]\tilde{w} - \int_{\hat{y}}^{\bar{y}} vf(v)dv + [1-F(\hat{y})]J(R)\int_{\tilde{w}}^{\bar{y}} V(z)g(z)dz,$$

$$J(R)\left[\int_{\hat{y}(R)}^{\bar{y}} V(v)f(v)dv - [1-F(\hat{y})]\int_{\tilde{w}}^{\bar{y}} V(z)g(z)dz\right] \geq [1-F(\hat{y})][1-G(\tilde{w})]\tilde{w} - \int_{\hat{y}}^{\bar{y}} vf(v)dv.$$

So a sufficient condition is

$$\left[\int_{\hat{y}(R)}^{\bar{y}} V(v) f(v) dv - [1 - F(\hat{y})] \int_{\tilde{w}}^{\bar{y}} V(z) g(z) dz \right] \geq -\frac{E_f[y]}{J(R)}.$$

□