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. Therefore, an entrepreneur invests if and only if rotation and performance evaluation are both sufficiently intense. 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); Knight (2014)). 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 expropriating an entrepreneur.[2] 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 to ensure local loyalty to the central government (Mann (2012); 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

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

[2] By contrast, a politician in a liberal democracy can make a more credible commitment to entrepreneurs because the politician's coercive power is limited by constitutional constraints (North and Weingast (1989); Acemoglu and Robinson (2012)).

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 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 reduces 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. This key complementarity further shapes the optimal rotation and performance evaluation, in addition to the incentive alignment effect in classic models of hidden actions (Holmström (1979); Bolton and Dewatripont (2004)). The complementarity is also robust to a variety of other extensions, such as relative performance evaluation (Lazear and Rosen (1981)) and the adaptability problem associated with firm entry and Schumpeterian "creative destruction" (Chassang (2010); Aghion et al. (2014)).

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 institutional features of the Chinese political system 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 depress investment in "immobile" capital from SOEs, whose exalted political and legal status guarantees 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)[3]. In relation to the production stage, Olson (1993) argues that property rights protect 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, our understanding of personnel institutions might be

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

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 more acute in an autocracy than a liberal democracy (North and Weingast (1989); Acemoglu and Robinson (2012)). By focusing on the holdup problem, my theory explains why high-powered incentives might be more destructive in autocracies than in liberal democracies. I also systematically explore how to limit the destructive side of performance evaluation.

My paper also contributes to the organizational economics literature on rotation and performance evaluation (Ortega (2001); Eriksson and Ortega (2006); Bar-Isaac (2012); Friebel and Raith (2013); Gibbons and Roberts (2013); Lazear and Oyer (2013); Jin and Waldman (2020); Bar-Isaac and Lévy (2022)). I make a novel contribution to the literature by addressing a unique challenge in organizational design for authoritarian government, whose intrinsic coercive power produces the aforementioned dual holdup problem, binding the feasible configuration of personnel institutions more strongly than generic organizations.[4]

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

[4]For example, managers of a private firm cannot *ex ante* confiscate firm-specific investment in human capital from the employees. But a private manager could still extract too much *ex post* surplus that is produced from the firm-specific investment in human capital (Hart (1995)). In most cases, it is either illegal or infeasible for a manager of a private firm to steal *ex ante* investment from others, unlike the confiscation by political officials. So a private firm faces one fewer holdup constraint than a coercive state.

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 connections in an autocracy, as by definition officials in an autocracy could 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. By doing so, my paper also contributes to the literature on developmental states (Knight (2014); Bardhan (2016)). Existing research has emphasized that a strong bureaucracy is capable of designing and implementing optimal economic policy, especially industrial policy (Evans (2012); Juhász and Steinwender (forthcoming); Lane (forthcoming)). My paper offers a complementing insight: a strong bureaucracy is also capable of disciplining its officials through personnel rules, thereby limiting their predation of private entrepreneurs.

The paper is organized as follows. Section 2 presents and discusses the model. Section 3 provides suggestive evidence for the main model. Section 4 concludes.

2 A model

2.1 The setup

There are four players, a principal, an entrepreneur, an incumbent official, and a "reserve" official from another jurisdiction. An official leads the local government of a jurisdiction. I first present the extensive form game in this section. In Section 2.2, I further comment on the key features of the setup.

The investment stage. Investment is modeled as a binary choice: the entrepreneur may invest $K > 0$ to start a firm, or the entrepreneur may refuse to invest. 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 resell it at ηK, with the parameter $\eta \in (0, 1]$.

The investigation stage. The incumbent official may order the local government to investigate the firm. To mobilize the local government, the incumbent official needs to pay a cost of $c > 0$.

After the investigation opportunity, with probability π 2 $[0, 1]$, 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.

The rotated incumbent official receives an exogenous payoff of U_O 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, the governing official knows the precise realized output y. Otherwise, the governing official still only knows $F( )$.

If the incumbent official confiscated the private investment, the entrepreneur cannot produce any output. The payoff to the principal is 0. The payoff to the entrepreneur is K. The incumbent official receives:

$$\eta K \quad c \quad \mathbf{1}_{\text{investig}}.$$

The indicator function $\mathbf{1}_{\text{investig}} = 1$ if the incumbent official investigated the firm, and $\mathbf{1}_{\text{investig}} = 0$ if the incumbent official did not investigate the firm. Whether he is replaced or not, the incumbent official receives ηK from reselling the capital, and $c \;\; \mathbf{1}_{\text{investig}}$ 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, 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. This rent w is obtained through an illegal process of corruption. If the entrepreneur accepts the proposal, the entrepreneur finishes the firm and produces the final output. The finished firm provides the following benefit to the governing official:

$$w + V(y, R). \tag{1}$$

The finished firm provides two payoffs to the governing official. First, the firm produces economic rents to the official at w. Second, the firm yields a performance-based reward at $V(y,R)$. I 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. Monotonicity in y means that the reward is indeed based on the economic performance. Meanwhile, 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. One can see that performance evaluation is "intense" if R is large, so that there is a sizable difference between receiving and not receiving the reward R.

With the proposal w accepted, the entrepreneur receives

$$y - w - K.$$

The principal as the autocrat receives a payoff of y. The principal cares about the economic output because a perceived competence in economic management is a crucial foundation of autocratic power (Guriev and Treisman (2020); Voigtländer and Voth (forthcoming); Egorov and Sonin (forthcoming)). I extensively discuss the objective of the principal in Section 2.2.

The payoff to the incumbent official is:

$$-c \cdot \mathbf{1}_{\mathsf{investig}} + [w + V(y,R)] \cdot (1 - \mathbf{1}_{\mathsf{rotn}}),$$

where the function $\mathbf{1}_{\mathsf{rotn}} = 1$ if rotation happened and $\mathbf{1}_{\mathsf{rotn}} = 0$ if rotation did not happen. The payoff to the reserve official is:

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

If the entrepreneur rejects the proposal, the output is not produced. The principal receives 0. The entrepreneur receives $-K$. The incumbent official receives $-c \cdot \mathbf{1}_{\mathsf{investig}}$, and the reserve official receives 0.

As a final note, the performance reward is implemented at the very end of the game, after the realized output becomes observable to all players.

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" applies to the performance-based reward. These dilemmas are solved by the joint implementation of rotation and the performance-based reward.

Why the performance contract is written over y, not over $y - w$. As an important feature of the model, the performance contract $V(y, R)$ is written over y, the output of the local economy, not $y - w$, the net surplus of the entrepreneur. Conceptually, the principal cannot write a contract over $y - w$ because the extracted rent w is unobservable to the principal. The official obtains the rent w through the illegal process of corruption. Because the process is illegal, it is usually hidden from the principal. The principal can only write a contract over the economic output y if he wants to induce a reduction in the hidden action of corruption w.

This setup is consistent with classic hidden action models (Holmström (1979); Bolton and Dewatripont (2004)). In these models, the principal wants to incentivize or discourage an action, but because that action is unobservable, the principal can only write a contract on an observable variable. In Holmström (1979), the hidden action is the effort from a worker, and the contractible variable is the output. In my model, the hidden action is rent extraction, and the contractible variable is the output of the firm.

The above discussion points out why, conceptually, I need to assume that the contract is written over y, not $y \quad w$. In addition, empirical literature shows that a higher economic output did improve the chance of promotion for local leaders in various contexts (Li and Zhou (2005); Markevich and Zhuravskaya (2011); Malesky and London (2014); Jia et al. (2015)). These empirical findings further support the assumption that the performance contract for appointed local leaders is usually written over the economic output y, as assumed by previous theoretical literature on performance evaluation of local leaders (e.g., Maskin et al. (2000)).

Why the principal's utility function is the economic output y. Why do I assume that the principal's utility function is the economic output y? A large economic output allows an autocrat to build up an image of economic competence among the population, substantially improving the chance for the autocrat to stay in power. The political economy literature on autocracies has shown that a perceived competence in economic management is a crucial foundation of autocratic power (Zhao (2009); Guriev and Treisman (2020); Guriev and Treisman (2022) ;Voigtländer and Voth (forthcoming); Egorov and Sonin (forthcoming)). A good economy therefore legitimizes autocratic power, and the continuation of power is the primary objective for any autocrat (Svolik (2012); Egorov and Sonin (forthcoming)). Thus, it is reasonable to assume that the principal as an autocrat wants to maximize the economic output y.

Note that under this interpretation, the principal cares about the economic output y for purely selfish reasons, not out of benevolence towards other players. Such a principal cares about the entrepreneur's payoff $y \quad w \quad K$ only indirectly, through its contribution to the aggregate output y that legitimizes the power of the principal. Such a self-interested principal is common in standard contract theory (Bolton and Dewatripont (2004)). This setup does not deny that we may be able to generate intriguing new predictions by assuming a principal with a benevolent motive, which is studied in behavioral contract theory (Kőszegi (2014)). I leave the integration of behavioral contract theory and the political economy of autocracies for future research.[5]

In addition, Appendix C allows the principal to directly tax the economic output y, therefore providing another reason for the principal to care about the economic output. Appendix C shows that all results are robust.

The persistence of knowledge within the local government. In my model, once the incumbent official launches an investigation of the firm through the local government, knowledge about the precise output of the firm is stored within the local government. How can the local government store knowledge? First, the local government keeps an extensive documentation of the local economy. Second, complementing the documentation, the local government employs permanent staff that master a lot of un-documented knowledge about the local economy.[6]

Because knowledge persists within the local government, there is an especially severe holdup problem against the entrepreneur. Even if the incumbent official who launched an investigation was rotated away, his successor can readily access the fruit of the investigation by reviewing the extensive documentation and interviewing the permanent staff members. So the successor will know and capture all output of the local firm. Under the persistence of knowledge, personnel institutions must prevent the incumbent official from investigating the local firm in the first place, which produces an especially robust solution to the holdup problem.[7]

In addition, knowledge about the local economy is the property of the local government, and knowledge controlled by the local government is accessible to the holder of a relevant office only by virtue of his office (pp.992-993, Weber (1978)). Therefore, the incumbent official does not control knowledge in the model as his private property.

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

[5]For a pioneering effort to incorporate benevolent motives for politicians in democracy and autocracy, see Gorodnichenko and Roland (2021).

[6]An extensive documentation and permanent staff are intrinsic features of modern bureaucracy: "The management of the modern office is 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 consequent persistence of knowledge within the bureaucracy is also well noted in recent empirical studies (Ahmed and Stasavage (2020)).

[7]Indeed, Online Appendix F shows that even when knowledge does not persist within the local government, the solution uncovered in this section still resolves the holdup problem against the entrepreneur.

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

where

$$\hat{w} \equiv \arg\max_{w}[1 - F(w)]w. \tag{3}$$

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. Rent extraction at $\hat{w}$ 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 2 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.

$$E[y + V(y, R)] - U(R) > c, \tag{4}$$

where

$$U(R) \equiv \max_{w} [1 - F(w)]\{w + E[V(y, R)|y \geq w]\}. \tag{5}$$

Assumption 2 formalizes the notion that an official with a long tenure will order the local government to accumulate too much local knowledge, creating a local government that is immensely powerful against the entrepreneur. The left hand side of Equation 4 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 4, $U(R)$, 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 finished 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 4). Equation 4 ensures that the incumbent official launches 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.

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

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

If the private capital is not confiscated, 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 finished 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 performance evaluation:

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

To ensure that w^* indeed maximizes the expected payoff, the second order condition is:

$$-2f(w^*) - f'(w^*)w^* - f'(w^*)V(w^*,R) - f(w^*)V_y(w^*,R) < 0,$$

where $V_y(w^*,R)$ is defined as the derivative of V with respect to the output y, evaluated at the point (w^*,R). We impose a sufficient condition to ensure the second order condition: $f'(z) > 0$ for all $z < \hat{w}$, where $\hat{w} = \arg\max_w [1 - F(w)]w$ (that is, $\hat{w}$ is the optimal rent extraction without any performance reward).

We can rearrange the first order condition as:

$$\frac{1 \quad F(w \ )}{f(w \ )} = w \ \ + V(w \ \ , R). \tag{6}$$

The distribution $F(\ )$ satisfies the monotone hazard rate property. So the inverse of hazard rate, $h(w) \quad \frac{1 \ F(w)}{f(w)}$, is monotonically decreasing in w. It is easy to show that[8]

$$\frac{dw}{dR} \quad 0. \tag{7}$$

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

$$S(R) \quad K, \tag{8}$$

where

$$S(R) \quad \Big\{1 \quad F[w \ (R)]\Big\}\Big\{E[yjy \quad w \ (R)] \quad w \ (R)\Big\}.$$

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 8 is the investment cost at the investment stage. Equation 8 characterizes a necessary condition to induce private investment.

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

All proofs are in Appendix A. In a reduced form manner, Lemma 1 encodes the notion that 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 can then obtain a high net surplus from his own investment.

In previous literature (e.g., Maskin et al. (2000); Li and Zhou (2005)), intense performance evaluation imposed on officials is sufficient to induce economic growth. In our model, intense

[8] Details are in the proof of Lemma 1, which is presented in Appendix A.

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:

$$y + V(y, R) - c \cdot (1 - \mathbf{1}_{\mathsf{rotn}}).$$

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

$$(1 - \pi)U(R) \geq -c + (1 - \pi)E[y + V(y, R)]. \tag{9}$$

The left hand side of Equation 9 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 6 from the private firm. The incumbent official will receive a payoff of $U(R)$ as in Equation 5, or

$$U(R) = [1 - F(w^*)]\Big\{w^* + E[V(y, R)|y \geq w^*]\Big\}. \tag{10}$$

The right hand side of Equation 9 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 9 yields the minimal rotation frequency:

$$\pi \geq 1 - \frac{c}{E[y + V(y,R)] - U(R)} \equiv \underline{\pi}(R) > 0. \tag{11}$$

Notice that the minimal rotation frequency $\underline{\pi}(R) > 0$ because $c < E[y + V(y,R)] - U(R)$, as I have assumed in Assumption 2 . The parameter c is the cost of investigation, and $E[y+V(y,R)] - U(R)$ is the benefit of investigation if the incumbent official always continues his tenure and becomes the governing official to bargain with the entrepreneur. If the cost of the investigation is so large that $c \geq E[y + V(y,R)] - U(R)$, even an incumbent official who will never be rotated does not investigate the firm. This is inconsistent with the basic intuition that an official who stays too long in a jurisdiction will actively accumulate too much "power" that can overwhelm other local actors.

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*

$$R \geq \hat{R} \text{ and } \pi \geq \underline{\pi}(R) > 0.$$

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 $\pi \quad \underline{\pi}(R)$. The incumbent official does not confiscate the capital if and only if

$$(1 \quad \pi)U(R) \quad \eta K + (1 \quad \pi) \quad 0. \tag{12}$$

The left-hand side is the payoff if the incumbent official does not confiscate the private investment. At the investigation stage, because $\pi \quad \underline{\pi}(R)$, 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 $1 \quad \pi$, the incumbent official stays in his jurisdiction and earns the payoff $U(R)$ as in Equation 10.

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 $1 \quad \pi$, 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 12 identifies an upper bound on rotation frequency:

$$\pi \quad 1 \quad \frac{\eta K}{U(R)} \quad \bar{\pi}(R). \tag{13}$$

To induce private investment, rotation must be less frequent than the threshold $\bar{\pi}(R)$. A higher likelihood of staying in his current 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:

$$(1 \quad \pi)E[y + V(y, R)] \quad \eta K. \tag{14}$$

Equation 14 is the same as Equation 12, 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

14 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. Proposition 1 is depicted in Figure 1, where the horizontal axis is the intensity of performance reward R and the vertical axis is the frequency of rotation π.[9] The solid orange curve is the minimal rotation frequency $\underline{\pi}(R)$ and the dashed blue curve is the maximal rotation frequency $\bar{\pi}(R)$. In addition, the dotted vertical line is the minimal performance reward $\hat{R}$ that makes the entrepreneur breaks even. The entrepreneur invests if and only if the performance reward is sufficiently intense ($R \geq \hat{R}$) and the rotation frequency is between the two curves ($\underline{\pi}(R) \leq \pi \leq \bar{\pi}(R)$). 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

[9]Figure 1 is parameterized as follows: the output follows a uniform distribution $y \sim U[0, 1]$; the performance reward $V(z, R) = z^{\alpha} \times R$, where $\alpha = 0.25$; the investigation cost is $c = 0.2$; the investment cost is $K = 0.18$; and the expropriation efficiency is $\eta = 1$. Under these parameters, the performance reward on the official that makes the entrepreneur to break even is $\hat{R} = 0.2515$, the dotted vertical line in Figure 1.

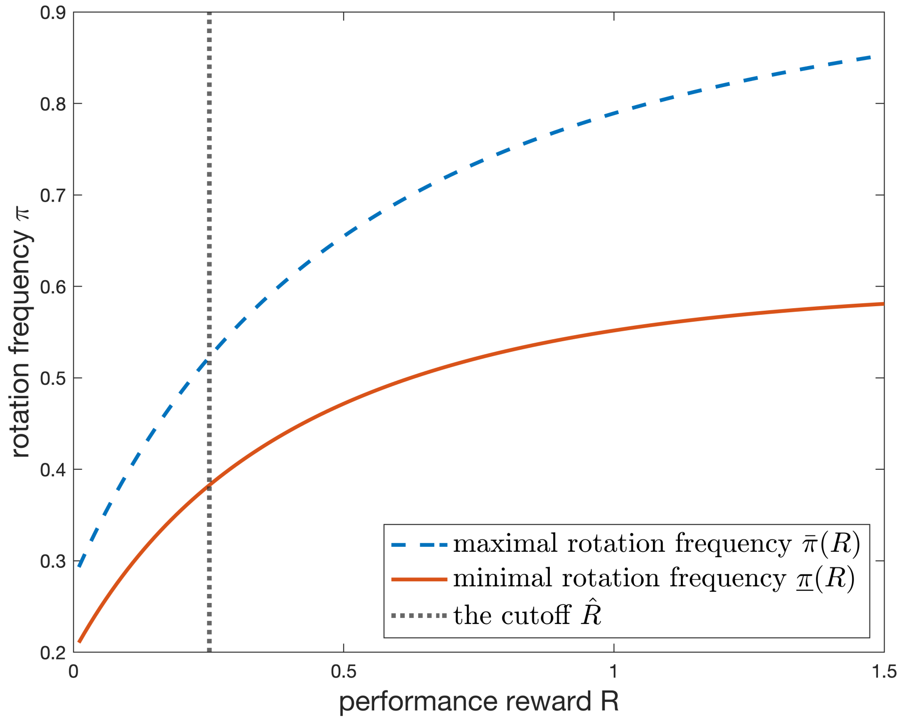

Figure 1: The complementarity between rotation and performance rewards

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 6, 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:

$$\underline{\pi}(R) = 1 - \frac{c}{E[y + V(y, R)] - U(R)}. \tag{15}$$

So we only need to show that

$$\Delta(R) \equiv E[y + V(y, R)] - U(R) \tag{16}$$

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:

$$U(R) = \max_{w} [1 - F(w)] \{ w + E[V(y, R) | y \geq w] \}. \tag{17}$$

By the envelope theorem,

$$\begin{aligned} U'(R) &= [1 - F(w)] E[V_R(y, R) | y \geq w] \\ &= \int_{w}^{y} V_R(z, R) f(z) dz. \end{aligned} \tag{18}$$

where w solves Equation 17. 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 18, we obtain the derivative $\Delta^{0}(R)$:

$$\Delta^{0}(R) = E[V_{R}(y, R)] \quad U^{0}(R)$$

$$= \int_{\underline{y}}^{y} V_{R}(z, R) f(z) dz \quad \int_{w}^{y} V_{R}(z, R) f(z) dz$$

$$= \int_{\underline{y}}^{w} V_{R}(z, R) f(z) dz > 0. \tag{19}$$

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 $\underline{\pi}(R) = 1 \quad c/\Delta(R)$ 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 of 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 actively 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:

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

We only need to show that $U^{0}(R) > 0$, which has been demonstrated before in Equation 18:

$$U^{0}(R) = [1 \quad F(w\ \ )] E[V_{R}(y, R) j y \quad w\ \ ] > 0.$$

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

Discussion: the infeasibility of collusion among rotating officials. The model implicitly assumes that it is infeasible for local officials from different jurisdictions to collude with each other. Consequently, under the bounds on R and π in Proposition 1, it is also impossible for officials to "cooperate," or to investigate their jurisdictions first and inherit knowledge from each other later.[10] Why is it reasonable to assume the absence of collusion?

Previous research shows that collusion among officials is feasible when they can coordinate their collusion through regular meetings (Myerson (2008)). Officials from the same jurisdiction indeed meet regularly in administrative meetings, making it possible for them to coordinate. To better discipline officials from the same jurisdiction, it might be important to investigate mechanisms that can prevent collusion (Laffont and Martimort (1997); Li (2022)). But in my model, officials are from different jurisdictions. Officials from different jurisdictions usually do not have an institutionalized means to meet and coordinate their actions. Even ***ad hoc*** meetings among them are very rare. Thus, it is reasonable for my model to assume away collusion among officials from different jurisdictions, as previous scholars did in many incentive models with multiple agents (e.g. Lazear and Rosen (1981); Green and Stokey (1983); Maskin et al. (2000)).

2.4 Comparison with the first-best outcome

It is also instructive to compare the equilibrium outcome with the first best. In the first best outcome, the entrepreneur should pay the investment cost K and always finish the firm regardless of the realized productivity y, an action that produces an expected output $E[y]$. This sequence of actions maximizes the joint payoff of the entrepreneur and the officials, as well as the payoff of a principal who uses a strong economy to legitimize his power.

To compare the first best and the equilibrium outcome, recall that Proposition 1 characterizes the necessary and sufficient condition for private investment:

$$R \quad \hat{R} \text{ and } \underline{\pi}(R) \quad R \quad \bar{\pi}(R). \tag{20}$$

Suppose that Condition 20 is not satisfied. So the entrepreneur does not invest, the expected output is zero, and the social welfare is at its lowest. This worst outcome applies, for example, when the performance reward is too weak to counterbalance the perverse effect of excessively

[10] Details are in Appendix A, on Pages 50-51. After the proof of Proposition 1, I show how to endogenize the payoff of a rotated official. Under this extended setup, we can investigate the feasibility of a "cooperative" equilibrium, which is ruled out by the bounds on π and R in Proposition 1.

frequent rotation ($\pi > \bar{\pi}(R)$), or when rotation is too infrequent to discourage the perverse effect of an excessively strong performance reward ($\pi < \underline{\pi}(R)$).

Suppose that Condition 20 is satisfied. The entrepreneur pays the investment cost K, so the investment level is at first best. But the entrepreneur only finishes the firm with probability $1 - F(w^*) < 1$, and the expected output is

$$[1 - F(w^*)] \cdot E[y | y \geq w^*] = \int_{w^*}^{\bar{y}} z f(z) dz.$$

The expected output is strictly smaller than $E[y] = \int_{\underline{y}}^{\bar{y}} z f(z) dz$ because the optimal extraction w^* is strictly larger than $\underline{y}$. Therefore, even when Condition 20 is satisfied, the expected output is smaller than the first-best level, an inefficiency that is caused by information asymmetry in the bargaining stage. An uninformed official cannot condition his extraction on the realized productivity of the firm y. Therefore, the equilibrium extraction proposal w^* will be rejected if the realized productivity y turns out to be smaller than w^*. This efficiency loss is qualitatively "small" because the firm produces nothing only when the realized productivity is sufficiently low ($y < w^*$).[11]

Note that the *ex post* inefficiency from asymmetric information is necessary to generate information rent for the entrepreneur. If the official also knows the productivity of the firm, the entrepreneur captures no surplus from his own investment. In my model, an *ex post* inefficiency in bargaining is indispensable to induce the *ex ante* efficiency in private investment. This *ex ante* efficiency is more first-order than the efficiency cost of *ex post* bargaining breakdown. The seemingly counterintuitive result reflects the key insight from the general theory of the second best (Lipsey and Lancaster (1956)): if an economy features an exogenous friction, the introduction of another friction may improve efficiency. In my model, because a holdup problem is intrinsic whenever an entrepreneur faces a powerful political actor, the introduction of frictional information asymmetry improves efficiency by granting information rent to the entrepreneur.

Summary. To summarize Section 2, 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 en-

[11]The efficiency loss also monotonically decreases as R increases, while still satisfying Condition 20. As $R \to \infty$, the efficiency loss becomes negligible because $\lim_{R \to \infty} w^*(R) = \underline{y}$, so we have

$$\lim_{R \to \infty} \int_{w^*}^{\bar{y}} z f(z) dz = \int_{\underline{y}}^{\bar{y}} z f(z) dz = E[y].$$

But unless $R = \infty$, the efficiency loss is always strictly positive.

trepreneurs by deterring the officials from *ex ante* capital confiscation. More importantly, 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. Rotation and performance evaluation jointly induce *ex ante* efficiency in investment by guaranteeing information rent, which is *ex post* inefficient, to the entrepreneur.

2.5 Extensions and robustness

2.5.1 Endogenous personnel institutions

The previous model treats rotation and performance rewards as given to highlight the complementarity between them.[12] In Online Appendix B, I endogenize the two personnel institutions by allowing the principal to choose them. Specifically, the principal pays a cost

$$H(y, R)$$

if he chooses a performance reward at R and the realized output is y. I assume that $H_R > 0$: the principal pays a higher cost to implement a performance reward that is more desirable to the official. The principal directly cares about the performance reward R through the cost function $H(y, R)$. Under this setup, the key complementarity between rotation and the performance reward is robust. The complementarity shapes implemented rotation and performance reward, along with the standard incentive alignment effect in classic models of hidden actions (Bolton and Dewatripont (2004)). Details are in Online Appendix B.

Further generalization of the principal's payoff function. In previous analysis, the principal cares about the economic output because it determines the performance legitimacy of the principal, without which the principal cannot maintain his political power. In Online Appendix C, we allow the principal to value the economic output for boosting his legitimacy and also for *scal revenue*. Online Appendix C shows that all results are robust, even for a principal who only cares about fiscal revenue.

[12]The treatment is reasonable because empirical literature shows that bureaucratic capacity is, to a large extent, determined historically (Dell et al. (2018); Xu (2019); Stasavage (2020)). Historical determination is especially salient in the case of performance rewards, which require long-term investment in infrastructure that collects, processes, and evaluates the performance record, as well as strong fiscal capacity to support a desirable performance reward (Ghosh (2020)). Nevertheless, a window of opportunity to reform the bureaucracy may occasionally arise (Xu (2018)), henceforth the interest in endogenizing personnel institutions.

2.5.2 Relative performance evaluation

In many contexts, a satisfactory performance record is rewarded by the promotion to a higher-ranked position. For such a performance tournament, there is usually a fixed number of higher-ranked positions as its trophies. The promotion probability of an official is largely determined by his performance record *relative to his peers* (Lazear and Rosen (1981)). I incorporate relative performance evaluation in Online Appendix D. Relative performance evaluation does introduce an additional effect, but the additional effect is dominated by the main effect of the workhorse model. The full setup and analysis are in Online Appendix D. Here I present a heuristic discussion on how I incorporate and analyze relative performance evaluation.

Incorporating relative performance evaluation. There is a unit mass of jurisdictions, indexed by $i \in [0,1]$. Each jurisdiction i is paired with an entrepreneur and an official. Each entrepreneur i may invest $K > 0$ to start a firm. The output from the firm of the jurisdiction i is $y_i \overset{\text{iid}}{\sim} F(\cdot)$. If the firm produces the output y_i, the governing official of the jurisdiction i receives a performance reward of

$$V(y_i, x, R)$$

at the end of the bargaining stage. The parameter R still proxies how attractive the performance reward is. The new variable is x, which is the (average) output of all jurisdictions. More precisely, denote x_j as the realized output of the jurisdiction j, and define the new variable x as:

$$x \equiv \int_0^1 x_j \, dj.$$

The same as the workhorse model, assume that $V_{y_i} > 0$ and $V_R > 0$. To capture relative performance evaluation, assume that

$$V_x < 0.$$

In other words, holding the output of the jurisdiction i constant at y_i, an increase in the average output of all jurisdictions worsens the performance record of the jurisdiction i. This setup formalizes relative performance evaluation in a highly general manner.

The two effects of R. Suppose that R increases. The direct effect is that the performance reward $V(y_i, x, R)$ becomes more attractive to the official i. This direct effect is conceptually the same as the effect of the performance reward in the workhorse model. A more attractive performance reward tempts the official to learn the precise output y_i, a temptation that must be discouraged by more frequent rotation.

But there is an indirect effect from a larger R. To obtain the more attractive performance reward, officials in all jurisdictions reduce their rent extraction. Reduced rent extraction increases the output of the whole economy x. Therefore, the official i's performance record relative to the whole economy x becomes less impressive, reducing the payoff that the official can obtain from the performance reward at $V(y_i, x, R)$. The indirect effect comes from the strategic response of other officials, an effect that does not exist in the main model because of the envelope theorem (Caputo (1996)).

The additional effect is dominated by the direct effect of the workhorse model. Nevertheless, I prove that relative to the direct effect, the indirect effect from the strategic response is small in any symmetric equilibrium that is stable against an arbitrarily small shock. The stability condition is a minimal restriction on the equilibrium. Without the stability condition, the equilibrium would be extremely fragile: an arbitrarily small deviation from the equilibrium leads to a permanent collapse of the equilibrium. In Online Appendix D, I show that this minimal demand on the stability of the equilibrium tightly bounds the scale of the strategic effect relative to the direct effect. Therefore, the message of the workhorse model stays the same: when the performance reward becomes more attractive, the minimal rotation frequency must increase to discourage the heightened temptation to investigate local firms, even if relative performance evaluation partially offsets the temptation. In a similar manner, we can show that the upper bound on the rotation frequency also increases with R. Therefore, Proposition 1 is robust to whether the performance evaluation is relative or not. The full analysis is presented in Online Appendix D.

3 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 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 this dual leadership in China. The Chinese dual leadership is an example of a popular strategy for autocrats to exert effective control over local provinces, the deliberate separation between political power and economic power in local governments (Weber (1978); Li (2022)).

Figure 2 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.[13] A 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)).[14] So a promotion opportunity is a special form (and the most common form) of 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.

3.1 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

[13] In addition, a rotation and promotion event occurs when a mayor is appointed to be the secretary of another city. I will explain in Section 3.1 and Section 3.2 why I don't focus on this personnel event.

[14] In my dataset, I show that a better GDP growth rate indeed predicts a higher chance of promotion for a mayor, but not rotation. Details are in the Online Appendices G.1 and G.2.

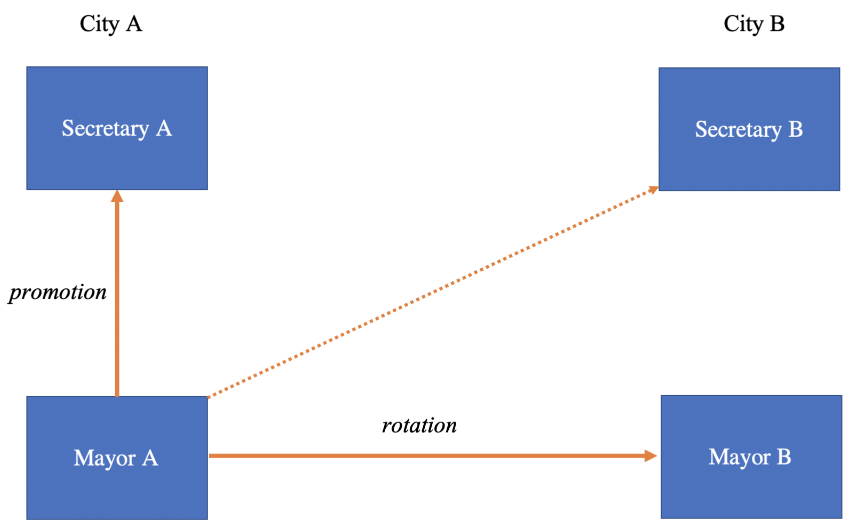

Figure 2: Rotation and promotion events for mayors

complementarity effect should not apply to state-owned enterprises (SOEs). SOEs do not need protection from better personnel institutions imposed on local officials because 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 3). A natural proxy for future rotation events is the anticipated retirement of mayors in *other* cities within the same province.[15] 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 vacancy within four years. When the mayor of City B is actually assigned to the honorary

[15] 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.

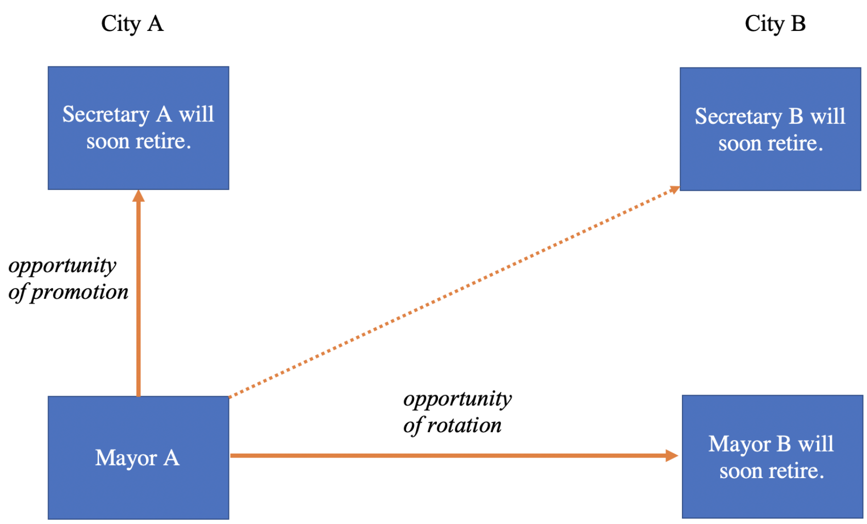

Figure 3: Opportunities of rotation and promotion

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. This cutoff strategy has proven effective in recent empirical studies of bureaucracy (Bertrand et al. (2020)).

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 of City A anticipates that the promotion opportunity will probably be available 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 the 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 3 illustrates the empirical variations I use to construct the proxies for anticipated personnel events.

The relevant model for the empirical proxies. It is important to note that the promotion proxy, whether a mayor's own secretary is more than 56 years old, isolates variations that are especially appropriate to test the workhorse model. Section 3.2 will show, the retirement of a secretary strongly predicts the turnover of his own mayor, but a secretary's retirement does not predict the turnover of mayors in other cities. Therefore, the future retirement of a secretary renders a desirable performance reward available to his own mayor in a largely non-tournament manner. This fits with how the workhorse model formalizes performance reward, which only depends on the output of an official's own jurisdiction. Because of this, the specific promotion proxy I use cannot lend empirical support to the model of relative performance evaluation in Section 2.5 and Online Appendix D. To be precise, the promotion proxy still informs the direct effect of relative performance evaluation, but it cannot inform the importance of the strategic reaction from other officials precisely because the promotion proxy only matters for one mayor.

3.2 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.[16] For firm characteristics, 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-in capital. I merge the ASIF data with the 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:

$$n_{jt} = \mu_j + PC_t + \text{retirement of other secretaries}_{jt} + \text{retirement of other mayors}_{jt} + s_{jt} + m_{jt} + \epsilon_{jt}. \tag{21}$$

The dummy variable n_{jt} is whether the mayor j's term in a city terminates in the year t. The

[16] 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. The management of such senior positions is entirely outside the jurisdiction of provincial organizational departments.

termination includes various personnel events, such as rotation to another mayor position, promotion to a secretary position, etc. 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 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.

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)	(6)	(7)	(8)
				capital composition				
own secretary old (S_{kt})	-0.00234		-0.00234	-0.00529	-0.00726	0.00760	-0.00727	-0.00596
	(0.00360)		(0.00362)	(0.00481)	(0.00602)	(0.00614)	(0.00623)	(0.00533)
fraction of other mayors old (M_{kt})		0.00225	0.00216	-0.0388	-0.00461	-0.0279	-0.0135	0.00705
		(0.0136)	(0.0139)	(0.0129)	(0.0163)	(0.0126)	(0.0172)	(0.0354)
fraction of other secretaries old (C_{kt})				0.00982	0.00707	-0.0677	0.00343	0.0320
				(0.0122)	(0.0141)	(0.0612)	(0.0157)	(0.0204)
other old mayors own secretary old ($M_{kt}\ \ S_{kt}$)				0.0705	0.0849	-0.224	0.108	-0.0608
				(0.0329)	(0.0384)	(0.0839)	(0.0401)	(0.0257)
Sample:								
Mayor age	all	all	all	all	young	old	young	young
Firm ownership	all	all	all	all	all	all	non-state	SOEs
N	283508	283508	283508	283508	223036	43267	204712	14153
adj. R^2	0.732	0.732	0.732	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. Firm characteristics include (the lag and logarithm of) output, the number of employees, inventory, and debt, as well as firm age, management fee, and the level of jurisdictional affiliation. Official characteristics include (for both the mayor and the party secretary) 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.

3.3 Anticipated retirement on the composition of capital

The main empirical specification is:

$$y_{ikt} = \alpha_0 + \mu_i + \lambda_t + \rho_1 S_{kt} + \rho_2 M_{kt} + \rho_3 M_{kt} \quad S_{kt} + \rho_4 C_{kt} + Z_{kt}\gamma_1 + X_{ikt}\gamma_2 + \varepsilon_{ikt}, \qquad (22)$$

where y_{ikt} is the ratio of fixed assets to total assets for a firm i in the city k and the 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_{kt} 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 $S_{kt} = 1$ if the secretary of the city k is older than 56 and 0 otherwise. The variable S_{kt} proxies the parameter R in theoretical the model, the extra payoff to a mayor who obtains the performance reward. The variable M_{kt} is the fraction of mayors in cities of the same province older than 56, excluding the city k. The variable M_{kt} proxies the parameter π in the theoretical model, the probability of rotation. The variable C_{kt} records the fraction of secretaries in other cities older than 56. We are mainly interested in the coefficient on $M_{kt} \quad S_{kt}$, the proxy for the complementary effect. The vector X_{ikt} is a list of firm characteristics, including (the lag and logarithm of) output, the number of employees, inventory, and debt, as well as firm age, management fee, and the level of jurisdictional affiliation. The vector Z_{kt} includes the characteristics of the officials who govern the city where the firm locates. I control (for both the mayor and the party secretary) 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.[17] For official characteristics, I also restrict my attention to mayors who are in the first and second years of their terms. As the average term is 3.8 years, mayors who are 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. For standard errors, they are two-way clustered at the city level and the firm level.

Table 2 lists the main empirical results. All columns include firm and year fixed effects (μ_i and λ_t), as well as all firm and official characteristics (C_{kt} and Z_{kt}). The first row is the proxy for anticipated promotion (S_{kt}), whether the city party secretary is more than 56

[17] I also include the dummy variable whether the mayor is older than 56, and its interaction with M_{kt} for Column (4). They are insignificant with very small point estimates. They are also dropped from Column (5) to Column (8) in Table 2 as the sample is restricted to either "young" or "old" mayors, to be defined later.

years old. The second row is the proxy for anticipated rotation (M_{kt}), the fraction of mayors in other cities who are more than 56 years old. The third row is the fraction of secretaries in other cities who are more than 56 years old (C_{kt}). 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 last row is the main explanatory variable, the interaction term between anticipated rotation and anticipated promotion ($M_{kt} \quad S_{kt}$).

From Column (1) to Column (4), we add proxies for future rotation and promotion successively. Column (1) includes only S_{kt}, the proxy for anticipated promotion. Column (2) includes only M_{kt}, the proxy for anticipated rotation. Column (3) includes both S_{kt} and M_{kt}, but not their interaction term $M_{kt} \quad S_{kt}$. Column (4) is the full specification, including S_{kt}, M_{kt}, C_{kt}, and the key interaction term $M_{kt} \quad S_{kt}$. We can see that no coefficient is statistically significant from Column (1) to Column (3). Therefore, the data does not support the theoretical postulation in the existing literature that promotion or rotation alone is enough to induce a mayor to encourage firm investment. Yet in Column (4), 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 (5) and Column (6) further split the full sample into "young" mayors and "old" mayors, with the cutoff at 53 years old.[18]Column (5) and Column (6) show that the complementarity effect in Column (4) 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 (5). In Column (6), 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 (5)). 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 (4) and Column (5), the fraction of secretaries in other cities more than 56 years old is not correlated with the composition of capital. The null result is reasonable because the fraction of retiring secretaries in other cities does not predict the turnover of a

[18]This cutoff allows me to implement two-way clustering standard errors at the city level and the firm level for Column (6). If I use cutoffs larger than 54, there would be too few cities to cluster for Column (6). The qualitative results are quite similar, however, if I employ different cutoffs.

mayor (Table 1). Furthermore, In Column (4) and Column (5), the coefficients on the proxy for rotation (M_{kt}) and the proxy for promotion (S_{kt}) remain either insignificant or negative (or both), further showing that the prospects of rotation and promotion must both present to incentivize mayors to promote private investment.

Column (7) and Column (8) 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 term is positive and significant for private firms in Column (7). The coefficient is negative for SOEs in Column (8). 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.

4 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.

I also extend the model to allow firm entry and exit (Online Appendix E). By doing so, I can study firm dynamics and Schumpeterian "creative destruction," a key source of growth in the long run (Aghion and Howitt (1992); Aghion et al. (2014)). To summarize the result here, the official acquires little information about existing firms under intense rotation and performance evaluation, 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. When implemented together, rotation and performance evaluation can resolve the acute trade-off between commitment and adaptability, a feature rarely satisfied by many other commitment devices to solve the holdup problem.

As mentioned, one such commitment device is the repeated interaction between an official and an entrepreneur. But such an official may develop strong entrenched interests (Levin (2003); Chassang (2010); Garicano and Rayo (2016)) so 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 (Olson (1982); Acemoglu et al. (2006); Acemoglu and Robinson (2012); Eichengreen et al. (2013)). Therefore, my theory also 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-centered development? Will such a strong bureaucracy block further market reforms that render 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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Appendix

A Proofs and further discussions for propositions

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

Proof. First, we want to show that

$$\lim_{R \to \infty} w^*(R) = 0. \tag{23}$$

To show Equation 23, we inspect the derivative of the official's payoff with respect to w as $R \to \infty$. The derivative is negative for all $w \in [\underline{y}, \bar{y}]$,

$$f(w)\left[\frac{1 - F(w)}{f(w)} - w - V(w, R)\right] < 0, \tag{24}$$

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 $dw^*/dR \leq 0$. Denote the inverse of the hazard rate as $h(w) = \frac{1-F(w)}{f(w)}$. For w^* that satisfies the first order condition 6, we can derive dw^*/dR:

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

So $dw^*/dR < 0$ because $V_R > 0$, $V_y > 0$, and $h' < 0$. Therefore, when the first order condition 6 is satisfied,

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

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

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

When the first order condition 6 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

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

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

the necessary and sufficient condition is

$$D(R) \equiv (c+\eta K)\Big\{1 - F[w^*(R)]\Big\}\Big\{w^*(R) + E[V(y,R)|y \geq w^*(R)]\Big\} - \eta K \cdot E[y+V(y,R)] > 0. \quad (25)$$

Assumption 3 is a sufficient condition for Equation 25. To see this, notice that a sufficient condition for Equation 25 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,

$$\eta K \quad \left\{\frac{E[y]}{[1 \quad F(\hat{w})]\hat{w}} \quad 1\right\} < c,$$

$$\text{or } (c+\eta K)\left\{1 \quad F(\hat{w})\right\}\hat{w} \quad \eta K \quad E[y] > 0.$$

Also, to ensure that $D^{0}(R) > 0$, or

$$D^{0}(R) = (c+\eta K)\left\{1 \quad F[w \ \ (R)]\right\}E[V_R(y,R) \boldsymbol{j} y \quad w \ \ (R)] \quad \eta K \quad E[V_R(y,R)] > 0,$$

$$\frac{c}{\eta K} \qquad \frac{F[w \ \ (R)]E[V_R(y,R) \boldsymbol{j} y \quad w \ \ (R)]}{\left\{1 \quad F[w \ \ (R)]\right\}E[V_R(y,R) \boldsymbol{j} y \quad w \ \ (R)]} = \frac{\int_{\underline{y}}^{w \ \ (R)} V_R(z,R)f(z)dz}{\int_{w \ \ (R)}^{y} V_R(z,R)f(z)dz}. \tag{26}$$

The term

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

is monotonically decreasing in R because $w \ \ (R)$ is monotonically decreasing in R. Therefore, a sufficient condition for Equation 26 is:

$$\frac{c}{\eta K} \qquad \frac{\int_{\underline{y}}^{w \ \ (0)} V_R(z,R)f(z)dz}{\int_{w \ \ (0)}^{y} V_R(z,R)f(z)dz} = \frac{\int_{\underline{y}}^{\hat{w}} V_R(z,R)f(z)dz}{\int_{\hat{w}}^{y} V_R(z,R)f(z)dz} = \frac{F(\hat{w})E[V_R(y,R) \boldsymbol{j} y \quad \hat{w}]}{\left\{1 \quad F(\hat{w})\right\}E[V_R(y,R) \boldsymbol{j} y \quad \hat{w}]},$$

which is guaranteed by Assumption 3.

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

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

Suppose that $R \quad \hat{R}$ and $\underline{\pi}(R) \quad \pi \quad \bar{\pi}(R)$. Because $\underline{\pi}(R) \quad \pi \quad \bar{\pi}(R)$, the incumbent official does not steal or investigate the private investment (Lemma 2 and Equation 13). If the entrepreneur invests, he obtains

$$S(R) = \left\{1 \quad F[w \ \ (R)]\right\}\left\{E[y \boldsymbol{j} y \quad w \ \ (R)] \quad w \ \ (R)\right\}.$$

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

Now suppose that it is not true that $R \quad \hat{R}$ and $\underline{\pi}(R) \quad \pi \quad \bar{\pi}(R)$. 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 $\quad K < 0$. 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 $\quad K < 0$. So the entrepreneur does not make the investment.

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

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

it is necessary and sufficient to show that

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

is monotonically increasing in R.

$$\Delta^0(R) = E[V_R(y,R)] \quad \frac{d}{dR}[1 \quad F(w\ )]\Big\{w\ + E[V(y,R)|y \quad w\ ]\Big\}$$

$$= E[V_R(y,R)] \quad [1 \quad F(w\ )]E[V_R(y,R)|y \quad w\ ]$$

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

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

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

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

it is necessary and sufficient to show that

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

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

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

□

Further discussion. I can endogenize the payoff of an incumbent official if he is rotated away from his jurisdiction. To do so, I slightly extend the workhorse model. Now we have two jurisdictions, labeled A and B. At the start of the game, each jurisdiction has an incumbent official and an entrepreneur. With probability π, rotation happens: the incumbent officials are rotated, so that the incumbent official A becomes the governing official of the jurisdiction B, and the incumbent official B becomes the governing official of the jurisdiction A. Everything else is the same as the workhorse model. In other words, incumbent officials are reserve officials for each other, the only substantive change from the workhorse model.

In this case, it is straightforward to see that all the central arguments of Proposition 1 are valid. Under the same bounds on R and π in Proposition 1, it is an equilibrium strategy for both entrepreneurs to invest because both incumbent officials refrain from stealing private capital or investigating local firms. Specifically, for the incumbent official A, his payoff on the equilibrium path is:

$$\pi U(R) + (1 - \pi)U(R) = U(R),$$

where $U(R) = \max_w [1 - F(w)]\{w + E[V(y,R)|y \geq R]\}$. His payoff from investigation is:

$$c + \pi U(R) + (1 - \pi)E[y + V(y,R)].$$

The payoff on the equilibrium path is higher than the single deviation of investigation:

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

$$\Leftrightarrow \pi \geq \underline{\pi}(R) = 1 - \frac{c}{\Delta(R)},$$

which is one of the necessary conditions for Proposition 1 that rotation frequency should be higher than the lower bound $\underline{\pi}(R)$.

Similarly, the payoff for the incumbent official from capital confiscation is:

$$\eta K + \pi U(R) + (1 - \pi) \cdot 0.$$

The payoff on the equilibrium path is higher than the single deviation of capital confiscation:

$$U(R) \geq \eta K + \pi U(R),$$

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

which is one of the necessary conditions for Proposition 1 that rotation frequency should be lower than the upper bound $\bar{\pi}(R)$. Arguments are symmetric for the incumbent official B.

A "cooperative" equilibrium? Under the lower bound $\underline{\pi}(R)$ of Proposition 1, it is also not an equilibrium for officials to "cooperate" on investigation. Intuitively, because officials cannot collude across different jurisdictions (Page 23), an official does not internalize the externality from investigation, an externality that benefits other officials. An official only considers his own benefits and costs from investigation.

More precisely, suppose that it is an equilibrium that, on the path where each entrepreneur invests, each incumbent official will refrain from capital confiscation, but each incumbent official will investigate his firm. Under this conjectured equilibrium, the payoff to the incumbent official A is:

$$\begin{aligned} & -c + \pi E[y + V(y,R)] + (1-\pi)E[y + V(y,R)] \\ = \; & -c + E[y + V(y,R)]. \end{aligned}$$

Under the conjectured equilibrium, each official pays his investigation cost c. Whether rotation happens or not, the official knows the precise output of the firm in his jurisdiction. The knowledge enables him to always extract surplus and obtain the performance reward, generating a payoff of $E[y + V(y,R)]$.

If the incumbent official A does not investigate, his payoff is:

$$\pi E[y + V(y,R)] + (1-\pi)U(R).$$

With probability π, the incumbent official A is rotated to jurisdiction B and knows the precise output of the firm B. His expected payoff is $E[y + V(y,R)]$. With probability $1-\pi$, the incumbent official A stays in the jurisdiction A. As an uninformed official, his expected payoff is $U(R) = \max_w [1-F(w)]\big\{w + E[V(y,R)|y \geq R]\big\}$.

The incumbent official A will single deviate and not investigate if:

$$\pi E[y + V(y,R)] + (1-\pi)U(R) > -c + E[y + V(y,R)],$$

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

The term $1 - \frac{c}{\Delta(R)}$ is the lower bound $\underline{\pi}(R)$ in Proposition 1. By slightly strengthening the weak inequality $\pi \geq \underline{\pi}(R)$ to the strict inequality $\pi > \underline{\pi}(R)$, a "cooperative" investigation fails simply because it is infeasible for the two incumbent officials to collude and coordinate on investigation. As I discussed before (Page 23), it is reasonable to assume that officials from different jurisdictions cannot collude because they don't have an institutionalized means to meet and coordinate their actions. Even *ad hoc* meetings between them are usually rare.

Online Appendices, Not for Printed Publication

B Endogenous personnel institutions

B.1 The setup

This section endogenizes rotation and the performance reward by adding a new stage before the extensive form in Section 2.1:

The organizational design stage.

1. The principal chooses R, the performance reward, which will cost the principal $H(y, R)$ at the end of the full game when the realized output is y. Assume that $H_R > 0$ and $H_{RR} \geq 0$.

2. After the principal has chosen R, the principal chooses π, the rotation frequency. For the principal, the cost of rotation is:

$$\begin{cases} C(1-\pi) & \text{if the state of the world is a ``crisis;''} \\ D(\pi) & \text{if the state of the world is ``normal.''} \end{cases} \tag{27}$$

   The cost function 27 is state contingent. Assume that the state is a crisis with probability $\nu \in [0, 1]$. In this state, the cost of rotation is $C(1-\pi)$, with $C'(\cdot) > 0$ and $C''(\cdot) \geq 0$. The cost of rotation is minimized at $\pi = 1$. With probability $1-\nu$, the state of the world is "normal." The cost of rotation is $D(\pi)$, with $D'(\cdot) > 0$ and $D''(\cdot) \geq 0$. The cost of rotation is minimized at $\pi = 0$. The principal chooses π after the state of the world is realized.

The cost function of rotation 27 incorporates a political trade-off in rotation, in addition to the more economic trade-off in the workhorse model.[19] A political crisis hits when local officials can threaten the autocratic principal with revolts. The principal in turn wants to rotate local officials as frequently as possible. At the organizational design stage, the principal expects that such a crisis arrives with probability ν, and the cost function $C(1-\pi)$ is minimized at $\pi = 1$. But when such a crisis is absent, the principal wants to keep local officials in their positions as long as possible to maximize political control over local territories. In the organizational design stage, the crisis does not arise with probability $1-\nu$, and the cost function $D(\pi)$ is minimized at $\pi = 0$.

[19] Specifically, Proposition 1 formalizes the more economic tradeoff in rotation: $\underline{\pi}(R) \leq \pi \leq \bar{\pi}(R)$ is a necessary condition to induce private investment.

The game then proceeds as in the workhorse model of Section 2.1. The payoffs to all players are the same as in the workhorse model, except for the principal. The principal's payoff at the end of the game is:

$$\begin{cases} L(y) \quad H(y,R) \quad C(1 \quad \pi) & \text{if the state of the world is a crisis;} \\ L(y) \quad H(y,R) \quad D(\pi) & \text{if the state of the world is normal.} \end{cases}$$

The function $L(\,) > 0$ is monotonically increasing, and it measures how much the principal values the legitimacy derived from economic performance in a more general manner than the workhorse model. In Appendix C, we also allow the principal to directly tax the output. Appendix C therefore incorporates a more generalized objective for the principal, including the case where the principal only cares about tax revenue ($L(\,) = 0$).

The term $H(y,R)$ is the direct cost that a principal pays to implement a performance reward. For example, $H(y,R)$ may include the financial cost of offering an attractive performance reward. The term $H(y,R)$ may also include non-financial costs that matter only to a political principal (e.g., an autocrat), but not to an economic principal (e.g., an owner of a business).[20]

We also restrict our attention to cases where the principal wants to induce a positive economic output in both crises and normal times. Formally, we impose the following condition.

$$\int_{w}^{y} [L(z) \quad H(z,R)] f(z) dz \quad \max f C(1 \quad \bar{\pi}(R)), D(\underline{\pi}(R)) g. \tag{28}$$

where w is defined in Equation 6, the same as in the workhorse model. The condition is satisfied when the principal assigns a sufficiently high value to the economic output. Otherwise, the principal wants to induce zero economic output in crises or in normal times, which are less interesting cases to consider.

B.2 Optimal rotation

The extended model is solved by applying backward induction. We first characterize the optimal rotation frequency under a given performance reward at R. Suppose that $R < \hat{R}$ where $\hat{R}$ is the performance reward that allows the entrepreneur to break even (as defined in Lemma 1). Whichever rotation frequency the principal chooses, the entrepreneur never invests. So the principal chooses $\pi = 1$ to minimize $D(\pi)$ in a crisis and $\pi = 0$ to minimize

[20] For example, an autocrat strongly dislikes the situation where his officials are much richer than the local population. See Jia et al. (forthcoming) on the danger of economic stratification for an autocrat, formalizing a central idea from Weber (1978).

$C(1 \quad \pi)$ in a normal time.

The next simple lemma characterizes optimal rotation when $R \quad \hat{R}$.

Lemma 3. *Given a performance reward $R \quad \hat{R}$, the principal chooses rotation at:*

$$\begin{cases} \bar{\pi}(R^0) & \textit{if the state of the world is in a \textbackslash crisis;"} \\ \underline{\pi}(R^0) & \textit{if the state of the world is \textbackslash normal."} \end{cases}$$

Proof. Suppose that the state of the world is in a crisis. Given an $R^0 \quad R$, the principal's optimization problem is:

$$\max \mathbf{1}_{\not 2[\_(R^0);\ (R^0)]} [\quad C(1 \quad \pi)] + \mathbf{1}_{2[\_(R^0);\ (R^0)]} \Big\{ \quad C(1 \quad \pi) + [1 \quad F(w \ (R^0))] \ E[L(y) \quad H(y, R^0) j y \quad w \ (R^0)] \Big\}.$$

If the principal chooses a rotation frequency $\pi \not 2 [\underline{\pi}(R^0), \bar{\pi}(R^0)]$, the entrepreneur does not invest, so the economic output is always 0. The principal only receives a cost $C(1 \quad \pi)$, which is minimized when the principal chooses $\pi = 1$. If the principal chooses a rotation frequency $\pi \ 2 \ [\underline{\pi}(R^0), \bar{\pi}(R^0)]$,the entrepreneur invests. The expected output minus the cost of performance reward $H(y, R)$ is:

$$[1 \quad F(w \ (R))] \quad E[L(y) \quad H(y, R) j y \quad w \ (R)] = \int_{w \ (R)}^{y} [L(z) \quad H(z, R)] f(z) dz.$$

The principal's payoff is maximized when he chooses $\pi = \bar{\pi}(R^0)$. Finally, we have:

$$C(1 \quad \bar{\pi}(R^0)) + \int_{w \ (R)}^{y} [L(z) \quad H(z, R)] f(z) dz \quad 0.$$

To conclude, in a crisis, for $R^0 \quad \hat{R}$, the principal chooses $\bar{\pi}(R^0)$. Suppose that the state of the world is normal. Given an R^0, the principal's optimization problem is:

$$\max \mathbf{1}_{\not 2[\_(R^0);\ (R^0)]} [\quad D(\pi)] + \mathbf{1}_{2[\_(R^0);\ (R^0)]} \Big\{ \quad D(\pi) + [1 \quad F(w \ (R^0))] \ E[L(y) \quad H(y, R^0) j y \quad w \ (R^0)] \Big\}.$$

If the principal chooses a rotation frequency $\pi \not 2 [\underline{\pi}(R^0), \bar{\pi}(R^0)]$, the entrepreneur does not invest, so the economic output is always 0. The principal only receives a cost $D(\pi)$, which is minimized when the principal chooses $\pi = 0$. If the principal chooses a rotation frequency $\pi \ 2 \ [\underline{\pi}(R^0), \bar{\pi}(R^0)]$,the entrepreneur invests. The principal's payoff is $\quad D(\pi) + \int_{w \ (R)}^{y} [L(z) \quad H(z, R)] f(z) dz$, which is maximized when the principal chooses $\pi = \underline{\pi}(R^0)$. Finally, we have:

$$D(\underline{\pi}(R)) + \int_{w \ (R)}^{y} [L(z) \quad H(z, R)] f(z) dz \quad 0.$$

To conclude, in normal times, for $R^0 \quad \hat{R}$, the principal chooses $\underline{\pi}(R^0)$. □

The principal still chooses rotation frequency to match the state of the world, but now he also wants to avoid the detrimental effects of rotation on the economy. In a political crisis, the principal wants to rotate officials as frequently as possible, while ensuring that the entrepreneur's investment remains intact. The principal chooses $\bar{\pi}(R^0)$, the highest rotation frequency under which the official does not steal private investment. In a normal time, the principal wants to minimize the rotation frequency, while still ensuring that the entrepreneur receives sufficient information rent to recoup the investment cost. The principal chooses $\underline{\pi}(R^0)$, the lowest rotation frequency under which the official does not launch a full investigation of the private firm.

Now I can characterize the optimal performance reward.

B.3 The trade-off in choosing the performance reward

Under the setup, the principal never chooses $R < \hat{R}$. At the start of the organizational design stage, the principal's optimization problem is:

$$\max_{R \quad \hat{R}} \quad \nu C(1 \quad \bar{\pi}(R)) \quad (1 \quad \nu) D(\underline{\pi}(R)) + \int_{w \ (R)}^{y} [L(z) \quad H(z,R)] f(z) dz.$$

Under a specific performance reward R, the principal in a crisis chooses $\bar{\pi}(R)$ at a cost of $C(1 \quad \bar{\pi}(R))$; the principal in a normal time chooses $\underline{\pi}(R)$ at a cost of $D(\underline{\pi}(R))$. The principal receives $\int_{w \ (R)}^{y} [L(z) \quad H(z,R)] f(z) dz$ from the economic output, where $H(z,R)$ is the direct cost of supporting the performance reward when the realized economic output is z.

Assuming that the optimal solution $R \ $ is interior, the first order condition is:

$$[L(w \ (R \ )) \quad H(w \ (R \ ), R \ )] f(w \ (R \ )) \frac{dw}{dR} \quad \int_{w \ (R \ )}^{y} H_R(z,R) f(z) dz$$

$$+\nu C(1 \quad \bar{\pi}(R \ )) \frac{d\bar{\pi}(R)}{dR} \quad (1 \quad \nu) D(\underline{\pi}(R \ )) \frac{d\underline{\pi}(R)}{dR} = 0 \tag{29}$$

The first order condition fully characterizes the trade-offs in choosing the performance reward. The first two terms of Equation 29 capture the standard trade-off in providing incentives for hidden actions. When the performance reward becomes more desirable, an uninformed official asks fewer economic rents from the private firm to obtain a better performance record. The expected output from the private firm increases. This effect is reflected by the term $[L(w \ (R \ )) \quad H(w \ (R), R \ )] f(w \ (R)) \frac{dw}{dR}$. A more desirable reward for the official is also more costly to implement for the principal, hence the term $\int_{w \ (R)}^{y} H_R(z,R) f(z) dz$.

The first two terms capture the standard benefits and costs in aligning the incentive of the official to the principal, the focus of the large literature on hidden actions.

But such an incentive-alignment effect presupposes an intact private capital and informational advantage for the entrepreneur, presuppositions that cannot be taken for granted in a political-economic setting. To sustain the two presuppositions, two extra terms emerge in the first order condition 29. These extra terms do not exist in the classical incentive theory of hidden action, and they further highlight the complementarity between rotation and performance rewards. A more desirable performance reward provides an additional benefit by supporting more frequent rotation in crises, deterring the official from capital confiscation. This mechanism produces a marginal benefit of $\nu C^{0}(1 \quad \bar{\pi}(R\ ))\frac{d\ (R)}{dR}$. A more desirable performance reward, however, also generates an additional cost. To support a more desirable performance reward, the rotation probability has to be more frequent to deter a full investigation of the private firm that would eliminate the information rents of the entrepreneur. This mechanism produces a marginal cost of $(1 \quad \nu)D^{0}(\underline{\pi}(R\ ))\frac{d\_(R)}{dR}$. The first order condition 29 further demonstrates how rotation and performance rewards support each other.

The complementarity can be further uncovered through a comparative static analysis. Suppose that the marginal benefit and cost in the first order condition 29 are "regular" in the sense that marginal benefit decreases as R increases, while the marginal cost increases as R increases.[21] We immediately obtain the following simple proposition.

Proposition 2. *Suppose that ν, the probability of a crisis, increases. The principal chooses a more desirable performance reward R, raises the rotation frequency in a crisis ($\bar{\pi}(R)$), and raises the rotation frequency in a normal time ($\underline{\pi}(R)$).*

Intuitively, if the principal is more concerned about threats from local officials, the principal values more his capability to rotate officials, while still keeping the private economy intact. To ensure that frequent rotation does not tempt the officials to steal private investment, the principal must offer a highly desirable performance reward. But if the state of the world turns out to be normal, such a desirable performance reward, without sufficiently frequent rotation, would tempt the official to eliminate information rents of the entrepreneur.

[21] The marginal benefit decreases with R if and only if

$$\frac{d}{dR}[w\ \ (R\ )f(w\ \ (R\ ))j\frac{dw}{dR}j + \nu C^{0}(1 \quad \bar{\pi}(R\ ))\frac{d\bar{\pi}(R)}{dR}] < 0.$$

The marginal cost increases with R if and only if

$$\frac{d}{dR}[H^{0}(R) + (1 \quad \nu)D^{0}(\underline{\pi}(R\ ))\frac{d\underline{\pi}(R)}{dR}] > 0.$$

Therefore, a more threatened autocrat bestows high-powered incentives and rotates local officials with a high frequency in *both* crises and normal times. By comparison, a more secure autocrat allows his officials to have longer tenure, while also reducing the promotion incentives for them. Rotation and performance rewards indeed move in the same direction, driven by the complementary support of the two personnel institutions.

C Further generalization of the principal's payoff

C.1 The setup

Suppose that for any economic output y, a fraction of $\tau \geq 0$ is taxed by the principal. Consistent with the large literature on fiscal capacity, we assume that τ is exogenous in our static model. In other words, the principal only has the capacity to collect a τ fraction of outputs from the private economy, and conditional on the upper bound τ on the tax rate, he wants to collect as much tax as possible (as in Besley and Persson (2009)). The setting is realistic in autocracies, whose fiscal capacity is usually much weaker than that of democracies (see Acemoglu and Robinson (2006), Besley and Persson (2011), Kleven (2014), and Besley (2020) on how democratic institutions may boost fiscal capacity).

The game proceeds in a similar manner as Appendix B on endogenous personnel institutions. There are only two differences. First, the official and the entrepreneur bargain over the surplus $(1 - \tau) \cdot y$ instead of y. Second, we look at a more generalized payoff to the principal:

$$\begin{cases} L(y) + (1 - \chi)\tau y - H(y,R) - C(1 - \pi) & \text{if the state of the world is a crisis;} \\ L(y) + (1 - \chi)\tau y - H(y,R) - D(\pi) & \text{if the state of the world is normal.} \end{cases}$$

The parameter $\chi \in [0, 1)$ is the efficiency loss in tax collection. When $L(\cdot) = 0$, the principal only cares about fiscal revenue collected from the private economy.

Condition 28 is also adjusted accordingly so that the principal wants to induce a positive economic output in both a crisis and a normal time:

$$\int_{W}^{y} \Big\{ L(z) + (1 - \chi)\tau z - H(z,R) \Big\} f(z) dz \geq \max\{C(1 - \bar{\pi}(R)), D(\underline{\pi}(R))\}. \tag{30}$$

Another assumption is necessary to ensure a minimal incentive for the entrepreneur to invest:

$$(1 - \tau)E[y] > K.$$

That is, if the entrepreneur can keep all after-tax output, he is willing to invest.

C.2 Solving the model

Rent extraction at the bargaining stage. The entrepreneur only accepts a proposal w if and only if $(1 - \tau)y \geq w$, or

$$y \geq \frac{w}{1 - \tau}.$$

So the problem of an uninformed official at the bargaining stage is:

$$\max_{w}[1 \quad F(\frac{w}{1 \quad \tau})]\Big\{w + E_y[V(y,R)jy \quad \frac{w}{1 \quad \tau}]\Big\}$$

$$= \max_{w}[1 \quad F(\frac{w}{1 \quad \tau})]w + \int_{\frac{w}{1 \quad \tau}}^{y} V(z,R)f(z)dz.$$

The first order condition is:

$$1 \quad F(\frac{w}{1 \quad \tau}) \quad f(\frac{w}{1 \quad \tau})\frac{w}{1 \quad \tau} \quad V(\frac{w}{1 \quad \tau}, R)f(\frac{w}{1 \quad \tau}) = 0,$$

$$\frac{1 \quad F(\frac{w}{1})}{f(\frac{w}{1})} = \frac{w}{1 \quad \tau} + V(\frac{w}{1 \quad \tau}, R).$$

Assuming the validity of the second-order condition, $\frac{w}{1}$ and w decreases with R. A necessary condition for the entrepreneur to invest is:

$$[1 \quad F(\frac{w \ (R)}{1 \quad \tau})]\Big\{E[(1 \quad \tau)yjy \quad \frac{w \ (R)}{1 \quad \tau}] \quad w \ (R)\Big\} \quad K. \tag{31}$$

The condition is satisfied for R sufficiently large, or $R \quad \hat{R}$, where $\hat{R}$ induces Equation 31 to be an equality:

$$[1 \quad F(\frac{w \ (\hat{R})}{1 \quad \tau})]\Big\{E[(1 \quad \tau)yjy \quad \frac{w \ (\hat{R})}{1 \quad \tau}] \quad w \ (\hat{R})\Big\} = K. \tag{32}$$

For an informed official, he asks to extract all after-tax surplus $(1 \quad \tau)y$ from the entrepreneur.

The lower bound on rotation. Now we analyze the investigation decision of the incumbent official. He does not investigate the firm if and only if:

$$(1 \quad \pi)E[(1 \quad \tau)y + V(y,R)] \quad c \quad (1 \quad \pi)U(R),$$

or

$$\pi \quad 1 \quad \frac{c}{\Delta(R)} \quad \underline{\pi}(R), \tag{33}$$

where

$$\Delta(R) = E[(1 \quad \tau)y + V(y,R)] \quad \Big\{[1 \quad F(\frac{w}{1 \quad \tau})]w \ + \int_{\frac{w}{1 \quad \tau}}^{y} V(z,R)f(z)dz\Big\}.$$

Therefore, Equation 33 is another necessary condition to induce private investment. It is also easy to show that $\underline{\pi}^{0}(R) > 0$ because

$$\Delta^{0}(R) = E[V_{R}(y, R)] \quad \int_{\frac{w}{1 \quad \tau}}^{y} V_{R}(z, R) f(z) dz$$

$$= \int_{\underline{y}}^{\frac{w}{1 \quad \tau}} V_{R}(z, R) f(z) dz > 0.$$

The upper bound on rotation. Finally, we analyze the confiscation decision of the incumbent official. He does not confiscate the investment if and only if

$$(1 \quad \pi) U(R) \quad \eta K,$$

$$\pi \quad 1 \quad \frac{\eta K}{U(R)} \quad \bar{\pi}(R). \tag{34}$$

The above inequality is the last necessary condition to induce private investment. It is also easy to show that $\bar{\pi}^{0}(R) > 0$ because

$$U^{0}(R) = \int_{\frac{w}{1 \quad \tau}}^{y} V_{R}(z, R) f(z) dz > 0.$$

In the same spirit of Assumption 3 in the workhorse model, I impose an upper limit on capital confiscation: η is small enough so that $\underline{\pi}(R) < \bar{\pi}(R)$ for all R. I gather all results into the following proposition, which is analogous to Proposition 1.

Proposition 3. *1. The necessary and su cient condition for the entrepreneur to invest is*

$$R \quad \hat{R} \text{ and } \underline{\pi}(R) \quad \pi \quad \bar{\pi}(R), \tag{35}$$

where $\hat{R}$ is de ned as in Equation 32, $\underline{\pi}(R)$ as in Equation 33, and $\bar{\pi}(R)$ as in Equation 34.

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

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

Proposition 3 shows that all the results in Section 2 still apply when the principal can tax the economy.

Optimal rotation and performance rewards. It is never optimal for the principal to choose $R < \hat{R}$. Given a performance reward $R' \geq \hat{R}$, the principal again matches the state of the world:

$$\begin{cases} \bar{\pi}(R') & \text{if the state of the world is in a “crisis;”} \\ \underline{\pi}(R') & \text{if the state of the world is “normal.”} \end{cases}$$

The principal chooses the performance reward R to maximize the following expected payoff:

$$\max_{R \geq \hat{R}} \; -\nu C(1-\bar{\pi}(R)) - (1-\nu)D(\underline{\pi}(R)) + \int_{w^*(R)}^{y} \Big\{ L(z) + (1-\chi)\tau z - H(z,R) \Big\} f(z)dz.$$

The first order condition is:

$$\Big\{[L(w^*(R)) + (1-\chi)\tau w^*(R) - H(w^*(R^*),R^*)\Big\} f(w^*(R^*)) \Big|\frac{dw^*}{dR}\Big| - \int_{w^*(R^*)}^{y} H_R(z,R)f(z)dz +$$

$$\nu C(1-\bar{\pi}(R^*))\frac{d\bar{\pi}(R)}{dR} - (1-\nu)D(\underline{\pi}(R^*))\frac{d\underline{\pi}(R)}{dR} = 0. \tag{36}$$

Notice that the last two terms, which further highlight the complementarity between rotation and performance rewards, are the same as in Equation 29 in Section B. Specifically, as Proposition 3 shows, $\frac{d\bar{\pi}(R)}{dR} > 0$ and $\frac{d\underline{\pi}(R)}{dR} > 0$. So the key finding of Appendix B is robust.

The first two terms capture the more traditional trade-off in providing incentives for hidden actions, only adjusting for taxation from the principal. The first two terms are again similar to the first two terms of Equation 29 in Appendix B. Adjusting for regularity condition, the comparative statics in Proposition 2 also apply.

To conclude, all results in Appendix B are robust to taxation from the principal, which provides another incentive for the principal to care about the economic output y.

D Relative performance rewards: a full model

D.1 The setup

There is a unit mass of jurisdictions indexed by $i \in [0,1]$. At the start of the game, each jurisdiction i is paired with an entrepreneur and an incumbent official. When there is no confusion, we also index the entrepreneur and the incumbent official by the index of their jurisdiction $i \in [0,1]$. The extensive form game is as follows.

The investment stage. Each entrepreneur $i \in [0,1]$ may invest $K > 0$ to start a firm in jurisdiction i. The output of the firm i is $y_i \overset{\text{iid}}{\sim} F(\cdot)$. The function $F(\cdot)$ satisfies the monotone hazard rate property: the hazard rate $\frac{f(y)}{1-F(y)}$ is strictly increasing in y.

The confiscation stage. If the entrepreneur i invests, the incumbent official of the jurisdiction i may confiscate the private investment and resell it at ηK, with the parameter $\eta \in (0,1]$.

The investigation stage. The incumbent official i may order the local government of the jurisdiction i to investigate the firm at a cost $c > 0$.

To model rotation in the simplest manner under a continuum of officials, assume that after the investigation stage, with probability $\pi \in (0,1]$, all officials are assigned to a new jurisdiction.

The bargaining stage. As in the workhorse model, the official in this stage is named as the "governing official." The incumbent official of any jurisdiction i is the same as the governing official of the jurisdiction i if and only if rotation did not happen.

If the incumbent official of the jurisdiction i launched an investigation, the governing official of the jurisdiction i knows the precise realized output y_i. Otherwise, the governing official still only knows $F(\cdot)$. If the incumbent official of the jurisdiction i confiscated the private investment K, the entrepreneur i cannot produce any output. The payoff to the entrepreneur is $-K$. From the confiscation, the incumbent official of the jurisdiction i receives

$$\eta K - c \cdot \mathbf{1}_{\text{investig}},$$

where $\mathbf{1}$ is an indicator function. The function $\mathbf{1}_{\text{investig}} = 1$ if and only if the incumbent official investigated the firm in his jurisdiction. If rotation happens, the governing official of the jurisdiction i receives

$$B \quad c \ \mathbf{1}_{\mathsf{investig}} + \eta K \ \ \mathbf{1}_{\mathsf{invest}} \ \ \mathbf{1}_{\mathsf{conf}}.$$

Abusing the notation slightly, $\mathbf{1}_{\mathsf{investig}} = 1$ if and only if the governing official investigated the firm in his previous jurisdiction. Furthermore, $\mathbf{1}_{\mathsf{invest}} = 1$ if and only if the entrepreneur of the previous jurisdiction invested, and $\mathbf{1}_{\mathsf{conf}} = 1$ if and only if the governing official confiscated the private investment in his previous jurisdiction.

If the incumbent official of the jurisdiction i did not confiscate the private investment K, the governing official of the jurisdiction i bargains with the entrepreneur over the final output y_i. The governing official makes a take-it-or-leave-it proposal to extract w_i from the firm's output. The output is produced if and only if the entrepreneur accepts the proposal w_i. The output provides the following benefit to the governing official of jurisdiction i:

$$w_i + V(y_i, x, R), \tag{37}$$

where $x = \int_{j \, 2[0;1]} y_j dj$ is the average output of the whole economy. Assume that

$$V_{y_i} > 0, V_x < 0, V_R > 0.$$

That is, the governing official receives a higher payoff from the relative performance reward if his own output is higher or if the average output of the whole economy is lower. The parameter R measures how attractive the performance reward is.

To simplify the notation, denote

$$V_y$$

as the derivative of the relative performance reward with respect to one's own output, ignoring the subscript i in y_i. We further denote:

$$V_y(y^0, x^0, R^0)$$

as the value of the derivative at a specific point (y^0, x^0, R^0). The notation is also similar for other derivatives.

The function $V(y_i, x, R)$ is very general in modeling relative performance evaluation, indeed perhaps a bit too general. For instance, there is little restriction on the interaction between y_i, one's own output, and x, the average output of the economy. To closely track the essential elements of relative performance evaluation, we impose more structures on the function $V(y, x, R)$ in relation to other fundamentals of the model.

Assumption 4.

$$V_{yR} \equiv \frac{\partial V}{\partial y \partial R} \geq 0, \textit{ and } V_R \textit{ is weakly concave in } y.$$

This assumption is straightforward if V is in a multiplicatively separable form:

$$V(y, x, R) = \Pi(y, x) \cdot J(R).$$

The separable form admits a natural interpretation: $\Pi(y, x) \in [0, 1]$ is the probability of promotion that depends on y, one's own output, and x, the average output of the whole economy; $J(R) \geq 0$ is the payoff to a governing official who receives a performance reward R. In this case,

$$V_{yR} = \Pi_y \cdot J_R \geq 0$$

because $\Pi_y > 0$ and $J_R > 0$[22]. Similarly, under the separable functional form, $\frac{\partial V}{\partial R}$ is weakly concave in y if and only if:

$$\Pi_{yy} \equiv \frac{\partial^2 \Pi}{\partial y^2} \leq 0. \tag{38}$$

Condition 38 simply states that the marginal effect of a higher output on the promotion probability is small when a jurisdiction already produces a large output.

To state the next two assumptions, we denote:

$$w_i^* = \arg\max_{w_i} [1 - F(w_i)] \Big\{ w_i + E_{y_i}[V(y_i, \int_{\bar{w}}^{\bar{y}} z f(z) dz, R) | y_i \geq w_i] \Big\}. \tag{39}$$

The variable w_i^* is the optimal extraction of an uninformed governing official i, given that all other officials $j \in [0, 1] \setminus \{i\}$ extract at $\bar{w}$. In this case, the average output of the economy is (Uhlig (1996)):

$$\bar{x} \equiv [1 - F(\bar{w})] E_y[y | y \geq \bar{w}] = \int_{\bar{w}}^{\bar{y}} z f(z) dz.$$

Furthermore, when $w_i^*(\bar{w}) = \bar{w}$, denote

$$w^* = \bar{w} = w_i^*(\bar{w}) \text{ for all } i \in [0, 1].$$

The variable w^* is the optimal extraction in a symmetric equilibrium. We can show the existence and uniqueness of w^*. To see this, the first order condition to 39 is:

$$1 - F(w_i^*) - f(w_i^*) w_i^* - f(w_i^*) \cdot V(w_i^*, \bar{x}, R) = 0.$$

[22] We know that $\Pi_y > 0$ because $V_y = \Pi_y J(R) > 0$, and $J_R > 0$ because $V_R = \Pi \cdot J_R > 0$.

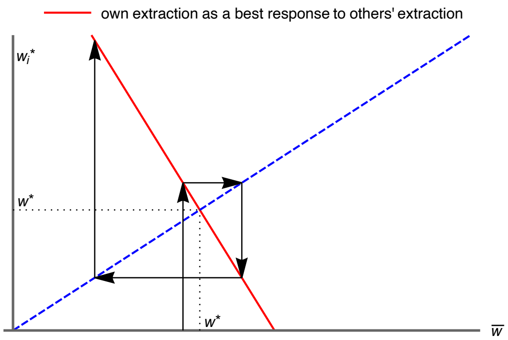

Figure 4: An unstable equilibrium

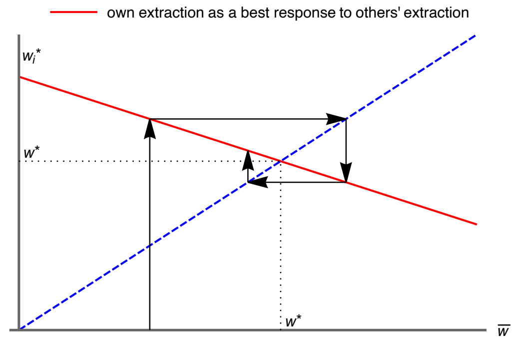

Figure 5: A stable equilibrium

The second order condition is

$$2f(w_i^*) - f'(w_i^*)w_i^* - f'(w_i^*)V(w_i^*,\bar{x},R) - f(w_i^*)V_y(w_i^*,\bar{x},R) < 0.$$

The second order condition is satisfied because $f'(z) > 0$ for all $z \le \hat{w}$, where $\hat{w} \equiv \arg\max_w [1 - F(w)]w$, an assumption that has already been asserted for the workhorse model in Section 2.

We can rewrite the first order condition as:

$$g(w_i^*) + w_i^* + V(w_i^*,\bar{x},R) = 0,$$

where $g(z) \equiv -\frac{1-F(z)}{f(z)}$ increases with z. Apply the implicit function theorem, we can show that $dw_i^*/d\bar{w} < 0$, or

$$\frac{dw_i^*}{d\bar{w}} = \frac{V_x(w_i^*,\bar{x},R) - \bar{w}f(\bar{w})}{g'(w_i^*) + 1 + V_y(w_i^*,\bar{x},R)} < 0, \tag{40}$$

since $V_x(w_i^*,\bar{x},R) < 0$, $g'(w_i^*) > 0$, and $V_y(w_i^*,\bar{x},R) > 0$. Also, $w_i^* > 0$ for $\bar{w} = 0$. This proves the existence and uniqueness of w^*, the optimal extraction in a symmetric equilibrium. We are ready to state the following assumption that is necessary for the local stability of the symmetric equilibrium:

Assumption 5. *$|V_x(w^*,x^*,R)|\, w^* f(w^*) < g'(w^*)+1+V_y(w^*,x^*,R)$, where $x^* \equiv \int_{w^*}^{y} z f(z)dz$.*

This assumption is necessary for the symmetric equilibrium to be robust to a small perturbation. The assumption is equivalent to:

$$\left|\frac{dw_i^*}{d\bar{w}}\right| < 1 \text{ at } w_i^* = \bar{w}.$$

Without this assumption, an arbitrarily small deviation from the symmetric equilibrium is followed by a permanent collapse of the equilibrium. Figure 4 shows a situation where

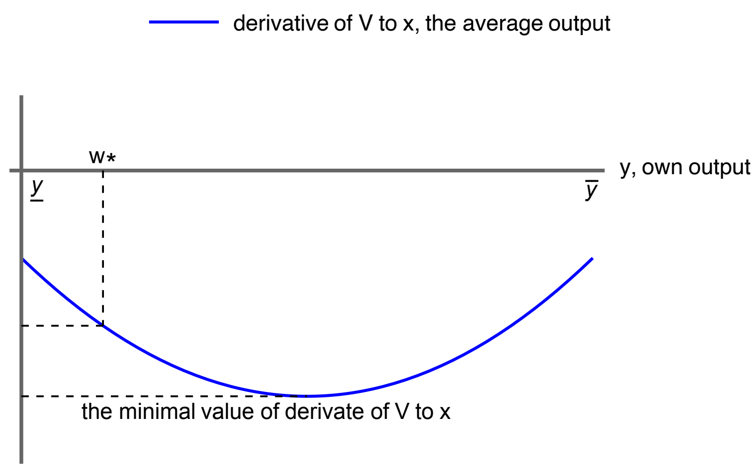

Figure 6: The function V_x over y

$|\frac{dw_i}{dw}| > 1$, so Assumption 5 is violated. The red solid line is the function $w_i(\bar{x})$, or the official i's best response to extraction of all other officials. The blue dashed line is the 45° line. The arrows show the dynamic of the adjustment from officials, following an exogenous shock that pushes the outcome away from the equilibrium w^*. Notice that the equilibrium permanently collapsed after an arbitrarily small shock. Figure 5 shows a situation where $|\frac{dw_i}{dw}| < 1$ for all $\bar{w}$, so Assumption 5 is satisfied. The equilibrium is restored after an exogenous deviation from w^*.

The last assumption reflects key characteristics of relative performance evaluation.

Assumption 6. *1.* $V_{xy} \equiv \frac{\partial V}{\partial x \partial y} < 0$ *for* $y \in [0, \hat{w}]$, *where* $\hat{w} = \arg\max[1 - F(w)]w$.

2. $\max_y |V_x(y, x^*, R)| < 2 \frac{\int_{w^*}^{\bar{y}} [f(z) - V_R(z; x^*; R)] dz}{\int_{w^*}^{\bar{y}} [f(z) - V_R(w^*; x^*; R)] dz} |V_x(w^*, x^*, R)|$.

This assumption is consistent with basic constraints on the configuration of relative performance evaluation. Intuitively, V_x should be a U-shape curve over a jurisdiction's own output y. When a jurisdiction's output y is very low (close to $\underline{y}$), the performance record of the official is already far below most other officials; even a large increase in the average output of the economy reduces his promotion probability by a small amount. So $|V_x|$ is small when y is close to $\underline{y}$, the minimal output level. When a jurisdiction's output is very high (close to $\bar{y}$, the maximal output level), the jurisdiction is ranked near the top of the distribution. Even when the average output of the economy increases a lot, the relative rank of the jurisdiction's output decreases only slightly, so $|V_x|$ is also small when y is close to $\bar{y}$. The term $|V_x|$ is large only when y is in the intermediate range, bounded away from $\underline{y}$ or $\bar{y}$. In the intermediate range, the yardstick competition is the most intense. Holding one's own output y fixed at an intermediate value, an increase in the average output x reduces one's rank by a larger amount than when one's own output y is close to extreme values.

Figure 6 shows the U-shape of V_x over one's own output y, capturing the notion that the yardstick competition is more intense in the middle range. Assumption 6 is consistent with the U-shape of V_x. First, V_x decreases over $[0, \hat{w}]$: as the yardstick competition becomes intense, a higher average output has a more adverse effect on one's own performance reward. Second, $\max_y jV_x(y, x\ \ , R)j$ is bounded. Indeed, with a continuous U-shape of V_x over y, the maximal $jV_x(y, x\ \ , R)j$, or the minimal $V_x(y, x\ \ , R)$, cannot go unbounded.

D.2 Solving the model

The objective is to identify the necessary and sufficient condition to sustain an equilibrium where all entrepreneurs invest, no officials confiscate private investment, and no officials launch an investigation. The equilibrium will also be symmetric in the sense that all uninformed officials propose the same amount of rents to be extracted from their entrepreneurs. For simplicity, I call this strategy profile "the symmetric equilibrium."

The bargaining stage when the official does not know the firm's output. Consider that all other governing officials choose to extract $\bar{w}$ from their entrepreneurs. The average output is (Uhlig (1996)):

$$\bar{x} \quad \int_{w}^{y} z f(z) dz.$$

In the jurisdiction i, the official uninformed about the precise output y_i solves the following problem:

$$U(R) \quad \max_{w_i} [1 \quad F(w_i)] \Big\{ w_i + E_{y_i}[V(y_i, \bar{x}, R) j y_i \quad w_i] \Big\}$$

$$= \max_{w_i} \left\{ [1 \quad F(w_i)] w_i + \int_{w_i}^{y} f(z) \quad V(z, \bar{x}, R) dz \right\}.$$

Denote the solution to the above problem as w_i. The first order condition is:

$$1 \quad F(w_i) \quad f(w_i) w_i \quad f(w_i) \quad V(w_i, \bar{x}, R) = 0,$$

or equivalently,

$$g(w_i) + w_i + V(w_i, \bar{x}, R) = 0$$

with $g(z) = \frac{1 \;\; F(z)}{f(z)}$ monotonically increasing in w. We have derived the best response function of w_i to $\bar{w}$ before (Equation 40):

$$\frac{dw_i}{d\bar{w}} = \frac{V_x(w_i, \bar{x}, R) \quad \bar{w} f(\bar{w})}{g^0(w_i) + 1 + V_y(w_i, \bar{x}, R)}.$$

In a symmetric equilibrium, $w_i = \bar{w} \quad w$. Also denote

$$x \;\; = \int_{w}^{y} z f(z) dz.$$

To ensure that the unique symmetric equilibrium is robust to small exogenous shocks, a necessary condition is:

$$j\frac{dw_i}{d\bar{w}} j_{w_i = w \;\; w} < 1,$$

which is guaranteed by Assumption 5. We can also sign $dw \; /dR$ in the symmetric equilibrium:

$$\frac{dw}{dR} = \frac{V_R(w \;, x \;, R)}{g^0(w \;) + 1 + V_y(w \;, x \;, R) \quad V_x(w \;, x \;, R) \;\; w \; f(w \;)} < 0$$

because $V_R > 0$, $V_y > 0$, and $V_x < 0$.

We have a similar necessary condition for all entrepreneurs to invest:

$$S(R) \quad [1 \quad F(w \;)]\Big\{E[y_i j y_i \quad w \;] \quad w \Big\} \quad K. \tag{41}$$

Lemma 4. *Denote the unique solution to $S(R) = K$ (Equation 41) as $\hat{R}$. A necessary condition for all entrepreneurs to invest in the symmetric equilibrium is $R \quad \hat{R} > 0$, or a su ciently strong performance reward.*

The bargaining stage when the official knows the precise output. Consider that from the symmetric equilibrium, the incumbent official of i has single deviated by launching an investigation of the private firm. At the bargaining stage, the governing official knows y_i, 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:

$$y_i + V(y_i, x \;, R) \quad c \;\; (1 \quad \mathbf{1}_{\text{rotn}}),$$

where $\mathbf{1}_{\mathsf{rotn}} = 1$ if and only if rotation happens.

The investigation stage. In a symmetric equilibrium, the incumbent official i does not launch an investigation of the private firm i if and only if:

$$\max_{w_i}[1 \quad F(w_i)]\Big\{w_i + E_{y_i}[V(y_i, x \ , R) | y_i \quad w_i]\Big\}$$

$$\pi \quad \max_{w_i}[1 \quad F(w_i)]\Big\{w_i + E_{y_i}[V(y_i, x \ , R) | y_i \quad w_i]\Big\}+$$

$$(1 \quad \pi) \quad E_{y_i}[y_i + V(y_i, x \ , R)] \quad c,$$

Equivalently,

$$\pi \quad 1 \quad \frac{c}{\Delta} \quad \underline{\pi}(R) \tag{42}$$

and

$$\Delta = E_{y_i}[y_i + V(y_i, x \ , R)] \quad \max_{w_i}[1 \quad F(w_i)]\Big\{w_i + E_{y_i}[V(y_i, x \ , R) | y_i \quad w_i]\Big\} > 0. \tag{43}$$

Lemma 5. *A necessary condition for all entrepreneurs to invest in the symmetric equilibrium is $R \quad \hat{R}$ and $\pi \quad \underline{\pi}(R)$, where $\underline{\pi}(R)$ is de ned as in Equation 42 and Equation 43. Entrepreneurs invest only if all o cials are intensely evaluated based on economic performance and the rotation frequency is su ciently high.*

The confiscation stage. In the symmetric equilibrium, the incumbent official i does not confiscate the private investment from the entrepreneur i if and only if

$$\max_{w_i}[1 \quad F(w_i)]\Big\{w_i + E_{y_i}[V(y_i, x \ , R) | y_i \quad w_i]\Big\}$$

$$\eta K + \pi \quad \max_{w_i}[1 \quad F(w_i)]\Big\{w_i + E_{y_i}[V(y_i, x \ , R) | y_i \quad w_i]\Big\},$$

$$\pi \quad 1 \quad \frac{\eta K}{\max_{w_i}[1 \quad F(w_i)]\Big\{w_i + E_{y_i}[V(y_i, x \ , R) | y_i \quad w_i]\Big\}} \quad \bar{\pi}(R). \tag{44}$$

In the same spirit of Assumption 3 in the workhorse model, we impose an upper limit on capital confiscation: η is small enough so that $\underline{\pi}(R) < \bar{\pi}(R)$ for all R. We can now prove the main proposition for relative performance reward, which is analogous to the central Proposition 1 for the main model.

Proposition 4. *Suppose that the performance evaluation is relative to peers.*

1. The necessary and su cient condition to support the symmetric equilibrium is

$$R \quad \hat{R} \text{ and } \underline{\pi}(R) \quad \pi \quad \bar{\pi}(R). \tag{45}$$

where $\hat{R}$ *is as de ned in Lemma 4,* $\underline{\pi}(R)$ *is as de ned by Equation 42, and* $\bar{\pi}(R)$ *is as de ned by Equation 44.*

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

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

Proof. First, given that all the conditions are satisfied, we check single deviations for every player. For an entrepreneur i, the payoff from investing is higher than not investing:

$$[1 \quad F(w \ )]\Big\{E[y_i j y_i \quad w \ ] \quad w \ \Big\} \quad K.$$

At the confiscation stage, the payoff from not stealing is higher than the single deviation of stealing:

$$\max_{w_i}[1 \quad F(w_i)]\Big\{w_i + E_{y_i}[V(y_i, x \ , R) j y_i \quad w_i]\Big\}$$

$$\eta K + \pi \quad \max_{w_i}[1 \quad F(w_i)]\Big\{w_i + E_{y_i}[V(y_i, x \ , R) j y_i \quad w_i]\Big\}.$$

At the investigation stage, the payoff from not investigating is higher than the single deviation of investigating:

$$\max_{w_i}[1 \quad F(w_i)]\Big\{w_i + E_{y_i}[V(y_i, x \ , R) j y_i \quad w_i]\Big\}$$

$$\pi \quad \max_{w_i}[1 \quad F(w_i)]\Big\{w_i + E_{y_i}[V(y_i, x \ , R) j y_i \quad w_i]\Big\} +$$

$$(1 \quad \pi) \quad E_{y_i}[y_i + V(y_i, x \ , R)] \quad c.$$

The claim is established.

Second, we show that $\partial\underline{\pi}/\partial R > 0$. We can see that $\text{sign}(\partial\underline{\pi}/\partial R) = \text{sign}(\partial\Delta/\partial R)$, where

$$\Delta = E_{y_i}[y_i + V(y_i, x \ , R)] \quad \max_{w_i}[1 \quad F(w_i)]\Big\{w_i + E_{y_i}[V(y_i, x \ , R) j y_i \quad w_i]\Big\}$$

$$= E_{y_i}[y_i] + \int_{\underline{y}}^{y} f(z) \quad V(z, x \ , R)dz \quad \max_{w_i}\Big\{[1 \quad F(w_i)]w_i + \int_{w_i}^{y} f(z) \quad V(z, x \ , R)dz\Big\}.$$

$$\frac{\partial \Delta}{\partial R} = \int_{\underline{y}}^{y} f(z) \quad V_R(z, x \;\; , R) dz \qquad \int_{\underline{y}}^{y} [f(z) \quad V_x(z, x \;\; , R) \quad w \;\; f(w \;\;) \frac{dw}{dR}] dz$$

$$\left\{ \int_{w}^{y} f(z) \quad V_R(z, x \;\; , R) dz \qquad \int_{w}^{y} [f(z) \quad V_x(z, x \;\; , R) \quad w \;\; f(w \;\;) \frac{dw}{dR}] dz \right\}$$

$$= \int_{\underline{y}}^{w} f(z) \quad V_R(z, x \;\; , R) dz \qquad \int_{\underline{y}}^{w} [f(z) \quad jV_x(z, x \;\; , R)j \quad w \;\; f(w \;\;)j \frac{dw}{dR} j] dz.$$

Denote

$$\Delta_1 = \int_{\underline{y}}^{w} f(z) \quad V_R(z, x \;\; , R) dz > 0$$

and

$$\Delta_2 = \int_{\underline{y}}^{w} [f(z) \quad jV_x(z, x \;\; , R)j \quad w \;\; f(w \;\;)j \frac{dw}{dR} j] dz > 0. \tag{46}$$

Notice that

$$j \frac{dw}{dR} j = \frac{V_R(w \;\; , x \;\; , R)}{g^0(w \;\;) + 1 + V_y(w \;\; , x \;\; , R) + jV_x(w \;\; , x \;\; , R)j \quad w \;\; f(w \;\;)}.$$

$$\Delta_2 = \int_{\underline{y}}^{w} [f(z) \quad jV_x(z, x \;\; , R)j \quad w \;\; f(w \;\;)j \frac{dw}{dR} j] dz$$

$$= \int_{\underline{y}}^{w} [f(z) \quad \frac{jV_x(z, x \;\; , R)j \quad w \;\; f(w \;\;) \quad V_R(w \;\; , x \;\; , R)}{g^0(w \;\;) + 1 + V_y(w \;\; , x \;\; , R) + jV_x(w \;\; , x \;\; , R)j \quad w \;\; f(w \;\;)}] dz$$

$$= \int_{\underline{y}}^{w} [f(z) \, V_R(w \;\; , x \;\; , R) \; \frac{jV_x(z, x \;\; , R)j}{jV_x(w \;\; , x \;\; , R)j} \; \frac{jV_x(w \;\; , x \;\; , R)j \quad w \;\; f(w \;\;)}{g^0(w \;\;) + 1 + V_y(w \;\; , x \;\; , R) + jV_x(w \;\; , x \;\; , R)j \quad w \;\; f(w \;\;)}] dz.$$

Because of Assumption 5,

$$jV_x(w \;\; , x \;\; , R)j \quad \bar{w} f(\bar{w}) < g^0(w \;\;) + 1 + V_y(w \;\; , x \;\; , R).$$

we have

$$\frac{jV_x(w \;\; , x \;\; , R)j \quad w \;\; f(w \;\;)}{g^0(w \;\;) + 1 + V_y(w \;\; , x \;\; , R) + jV_x(w \;\; , x \;\; , R)j \quad w \;\; f(w \;\;)} < \frac{1}{2}.$$

So we can bound Δ_2:

$$\Delta_2 < \frac{1}{2} \int_{\underline{y}}^{w} [f(z) \quad V_R(w \;\; , x \;\; , R) \quad \frac{jV_x(z, x \;\; , R)j}{jV_x(w \;\; , x \;\; , R)j} dz.$$

Notice also that for all z 2 $[\underline{y}, w \;\;]$, $jV_x(z, x \;\; , R)j \qquad jV_x(w \;\; , x \;\; , R)j$, or $V_x(z, x \;\; , R) \qquad V_x(w \;\; , x \;\; , R)$, because $V_{xy} < 0$. We can further bound Δ_2:

$$\Delta_2 < \frac{1}{2}\int_{\underline{y}}^{w} [f(z) \quad V_R(w \ , x \ , R)]dz$$

$$= \frac{1}{2}F(w \ ) \quad V_R(w \ , x \ , R).$$

Also,

$$\Delta_1 = \int_{\underline{y}}^{w} \ f(z) \quad V_R(z, x \ , R)dz$$

$$\int_{\underline{y}}^{w} \ \frac{F(w \ )}{w \qquad \underline{y}} \quad V_R(z, x \ , R)dz = \frac{F(w \ )}{w \qquad \underline{y}}\int_{\underline{y}}^{w} \ V_R(z, x \ , R)dz.$$

We obtain the inequality because $f^0(x) > 0$ for $x \quad w \ (0)$, and $V_R(z, x \ , R)$ increases with z ($\frac{@V}{@R@y} > 0$), and that $\int_{\underline{y}}^{w} \ f(z)dz = \int_{\underline{y}}^{w} \ \frac{F(w \ )}{w \quad \underline{y}}dz$.

Furthermore, because $V_R(y, x \ , R)$ is concave in y, we have:

$$\int_{\underline{y}}^{w} \ V_R(z, x \ , R)dz$$

$$\frac{1}{2}(w \qquad \underline{y})[V_R(w \ , x \ , R) + V_R(\underline{y}, x \ , R)].$$

Therefore,

$$\Delta_1 \quad \frac{F(w \ )}{w \qquad \underline{y}} \ \frac{1}{2}(w \qquad \underline{y})[V_R(w \ , x \ , R) + V_R(\underline{y}, x \ , R)]$$

$$\frac{1}{2}F(w \ )V_R(w \ , x \ , R).$$

We conclude that:

$$\frac{\partial \Delta}{\partial R} = \Delta_1 \quad \Delta_2 > 0.$$

Third, we show that $\partial\bar{\pi}/\partial R > 0$. Notice that $\text{sign}(\partial\bar{\pi}/\partial R) = \text{sign}(\partial U/\partial R)$, where:

$$U = \max_{w_i}[1 \quad F(w_i)]\Big\{w_i + E_{y_i}[V(y_i, x \ , R)\boldsymbol{j}y_i \quad w_i]\Big\}.$$

$$\frac{\partial U}{\partial R} = \int_{w}^{y} f(z) \quad V_R(z, x \ , R)dz \qquad \int_{w}^{y} [f(z) \quad \boldsymbol{j}V_x(z, x \ , R)\boldsymbol{j} \quad w \ f(w \ )\boldsymbol{j}\frac{dw}{dR}\boldsymbol{j}]dz$$

$$> \int_{w}^{y} f(z) \quad V_R(z, x \ , R)dz \qquad \frac{1}{2}\int_{w}^{y} [f(z) \quad V_R(w \ , x \ , R) \quad \frac{\boldsymbol{j}V_x(z, x \ , R)\boldsymbol{j}}{\boldsymbol{j}V_x(w \ , x \ , R)\boldsymbol{j}}dz$$

by the same argument before.

Also, notice that

$$\int_{w}^{y} f(z) \quad V_R(z, x \ , R)dz \quad \frac{1}{2}\int_{w}^{y} [f(z) \quad V_R(w \ , x \ , R) \quad \frac{|V_x(z, x \ , R)|}{|V_x(w \ , x \ , R)|} dz$$

$$\int_{w}^{y} f(z) \quad V_R(z, x \ , R)dz \quad \frac{1}{2}\int_{w}^{y} [f(z) \quad V_R(w \ , x \ , R) \quad \frac{\max_y |V_x(y, x \ , R)|}{|V_x(w \ , x \ , R)|} dz$$

$$= \int_{w}^{y} f(z) \quad V_R(z, x \ , R)dz \quad \frac{1}{2}\frac{\max_y |V_x(y, x \ , R)|}{|V_x(w \ , x \ , R)|}\int_{w}^{y} [f(z) \quad V_R(w \ , x \ , R)]dz > 0$$

by the assumption that:

$$\max_y |V_x(y, x \ , R)| < 2 \quad |V_x(w \ , x \ , R)| \quad \frac{\int_{w}^{y} f(z) \quad V_R(z, x \ , R)dz}{\int_{w}^{y} [f(z) \quad V_R(w \ , x \ , R)]dz}.$$

□

To understand the mechanism behind Proposition 4, here I sketch the proof for the key result that both bounds on rotation frequency increase with the performance reward. This is the central step in demonstrating the complementarity under relative performance evaluation. To determine the sign of $\underline{\pi}'(R)$, where $\underline{\pi}(R) = 1 \quad c/\Delta(R)$, we only need to determine the sign of $\Delta'(R)$. Recall that $\Delta(R)$ is the temptation to launch an investigation, and the expression for $\Delta(R)$ is:

$$\Delta(R) = E_{y_i}[y_i + V(y_i, x \ , R)] \quad U(R). \tag{47}$$

We can rewrite $U(R)$ in terms of an integral:

$$U(R) = [1 \quad F(w \ )]\Big\{w \ + E_{y_i}[V(y_i, x \ , R)|y_i \quad w \ ]\Big\}$$

$$= [1 \quad F(w \ )]w \ + \int_{w}^{y} V(z, x \ , R)f(z)dz.$$

We first derive $U'(R)$:

$$U'(R) = \int_{w}^{y} V_R(z, x \ , R)f(z)dz + \int_{w}^{y} V_x(z, x \ , R)f(z)dz \quad \frac{dx}{dR}.$$

Notice that we have applied the envelope theorem to one's own rent extraction. But importantly, we cannot apply the envelope theorem to x because the official does not choose the rent extraction for any other jurisdictions, even though all officials choose the same rent extraction in the symmetric equilibrium.

Now we complete the derivation of $\Delta^{0}(R)$:

$$\Delta^{0}(R) = E_{y_i}[V_R(y_i, x \ , R)] + E_{y_i}[V_x(y_i, x \ , R)] \ \frac{dx}{dR} \quad U^{0}(R).$$

$$= \int_{\underline{y}}^{w} V_R(z, x \ , R) f(z) dz + \int_{\underline{y}}^{w} V_x(z, x \ , R) f(z) dz \ \frac{dx}{dR}. \tag{48}$$

The expression 48 shows that there are two effects on $\Delta(R)$ when R increases. I discuss the two effects one by one as follows.

The direct effect. Denote the first term of Equation 48 as

$$\Delta_1 = \int_{\underline{y}}^{w} V_R(z, x \ , R) f(z) dz.$$

The first term appears in a similar manner in the workhorse model (Equation 19), capturing the same motive to investigate the firm in order to avoid bargaining breakdown. Bargaining will break down between the entrepreneur and an uniformed official if the realized output y_i turns out to be smaller than the proposed rent w . A bargaining breakdown eliminates any possibility for the official to capture the performance reward, which is more costly to an official if the performance reward becomes more attractive. In this case, officials are more tempted to investigate their firms in order to obtain a better performance record.

The strategic effect. But under relative performance evaluation, there is a new term that does not appear in the workhorse model. Denote this new term as Δ_2 [23]:

$$\Delta_2 \ = \frac{dx}{dR} \ \int_{\underline{y}}^{w} V_x(z, x \ , R) f(z) dz.$$

This term captures the effect from the strategic reaction of *other* officials to a more desirable performance reward. As discussed before, the reaction of other players cannot be ignored through the envelope theorem because one cannot choose the action of other players to maximize one's own payoff (Caputo (1996)). In our context, when performance reward becomes more desirable, all other officials ask fewer rents w because they still remain uninformed about their firms in the symmetric equilibrium. The reaction of other officials raises the average output of the whole economy. Therefore, the average output of the whole economy

[23] I use the notation Δ_2 because $\Delta_2 \ = \ \ \Delta_2$, where Δ_2 is defined by Equation 46 in the proof for Proposition 4.

$(x\ )$ increases when the performance reward R becomes more desirable:

$$\frac{dx}{dR} = \quad w\ f(w\ )\frac{dw}{dR} > 0.$$

Now consider an official who single deviates and investigates the firm i. Conditional on staying in the jurisdiction i, the investigation benefits the official because he avoids bargaining breakdown when the realized output y_i is smaller than $w\ $. But for any realized $y_i < w\ $, the official's performance record is worsened by a higher output of the whole economy $x\ $. This effect is captured by the second term of Δ_2:

$$\int_{\underline{y}}^{w} V_x(z, x\ , R) f(z) dz < 0.$$

To summarize, when the performance reward R becomes more desirable, the output of the whole economy $x\ $ increases, which worsens the performance record for any realized y_i, reducing the incentive to ensure bargaining success. Because of the strategic reaction of other officials that affect one's own performance record, I can conclude that:

$$\Delta_2\ < 0.$$

The direct effect dominates the strategic effect. I prove that relative to the direct effect, the effect from the strategic reaction is small in any symmetric equilibrium that is stable against an arbitrarily small shock. I show that the minimal demand on the stability of a symmetric equilibrium tightly bounds the scale of the strategic effect relative to the direct effect. Therefore, the message of the workhorse model stays the same: when the performance reward becomes more attractive, the minimal rotation frequency must increase to discourage the heightened temptation to investigate local firms, even if the relative performance evaluation partially offsets the temptation:

$$\Delta'(R) = \Delta_1 \quad |\Delta_2| > 0. \tag{49}$$

In a similar manner, we can also show that the upper bound on the rotation frequency also increases with R. Therefore, Proposition 1 is robust to whether the performance evaluation is relative or not.

D.3 Endogenous relative performance evaluation

We adopt an organizational design stage that is almost the same as in Online Appendix B. The key difference is the cost function H, which now needs to incorporate relative performance evaluation:

$$H(y_i, x, R).$$

The function $H(y_i, x, R)$ is the cost that the principal pays to implement a performance reward R to the governing official of the jurisdiction i. The variable y_i is the realized output of the jurisdiction i, and $x \equiv \int_0^1 x_j dj$ is the realized output of the whole economy. The new assumption to further reflect relative performance evaluation is

$$H_x(y_i, x, R) < 0.$$

The principal's payoff at the end of the game is:

$$\begin{cases} L(x) - \int_0^1 H(y_i, x, R)di - C(1-\pi) & \text{if the state of the world is a "crisis;"} \\ L(x) - \int_0^1 H(y_i, x, R)di - D(\pi) & \text{if the state of the world is "normal."} \end{cases}$$

We also assume that the principal wants to induce a positive economic output in both crises and in normal times. In other words, in a symmetric equilibrium where $w_i^* = w^*$ for all $i \in [0,1]$, and $x^* = \int_{w^*(R)}^{y} z f(z) dz$, we assume that:

$$\int_{w^*(R)}^{y} [L(z) - H(z, x^*, R)] f(z) dz \geq \max\{C(1-\bar{\pi}(R)), D(\underline{\pi}(R))\}. \tag{50}$$

The problem of choosing the optimal performance reward is similar to that in Online Appendix B:

$$\max_R \; -\nu C(1-\bar{\pi}(R)) - (1-\nu) D(\underline{\pi}(R)) + \int_{w^*(R)}^{y} [L(z) - H(z, x^*, R)] f(z) dz.$$

Assume that the solution is interior, the first order condition is:

$$[L(w^*(R)) - H(w^*(R), x^*, R)] f(z) \left|\frac{dw^*}{dR}\right| - \int_{w^*(R)}^{y} [H_R(z, x^*, R) - |H_x(z, x^*, R)| w^* f(w^*) \left|\frac{dw^*}{dR}\right|] f(z) dz$$

$$+\nu C(1-\bar{\pi}(R)) \frac{d\bar{\pi}(R)}{dR} - (1-\nu) D(\underline{\pi}(R)) \frac{d\underline{\pi}(R)}{dR} = 0. \tag{51}$$

Notice that the terms that highlight the complementarity are in the the second line of the first order condition 51. These terms shows that the rotation and performance rewards still complement each other since we have proved that $\frac{d\ (R)}{dR} > 0$ and $\frac{d\_(R)}{dR} > 0$ still holds under relative performance evaluation. The comparative statics in Proposition 2 still holds once the regularity conditions for marginal costs and benefits are adjusted.

The first line of the first order condition 51 reflects the traditional trade-off in incentive alignment for relative performance evaluation. The first term is the same as in the workhorse model. A more desirable performance reward induces local officials to reduce rent extraction, which increases the economic output that benefits the principal. A more desirable performance reward is more costly for the principal to implement, which is the term

$$\int_{w\ (R)}^{y} [H_R(z, x\ , R) \quad jH_x(z, x\ , R)j \ \ w\ f(w\ )j\frac{dw}{dR}j]f(z)dz.$$

But compared to the workhorse model, the cost is reduced by relative performance evaluation, an effect that is captured by the term $jH_x(z, x\ , R)j \ \ w\ f(w\ )j\frac{dw}{dR}j$ within the integral. Because a more desirable performance reward induces all local officials to reduce rent extraction, the average output of the whole economy increases, which means that the principal can reduce the overall cost of implementing the performance evaluation scheme. This is a well known advantage of relative performance evaluation. In the extreme case, the principal awards a fixed number of prizes no matter what happens. The cost of the principal to implement the performance evaluation always stays the same. In this case, the principal has much less incentive to manipulate performance records after his agents have exerted their efforts (in our case, after the officials have chosen rent extraction), which makes the performance evaluation scheme credible.

To conclude Appendix D, all results in the workhorse model are robust, as well as results about the optimal rotation and performance rewards.

E 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 bargaining. This appendix 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 evaluation, 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 governing official 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 governing official 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 choke "creative destruction" (Acemoglu et al. (2006)). Therefore, this appendix also offers an explanation for why informal institutions, which are usually based on relational enforcement, cannot fully substitute formal personnel institutions.

E.1 The setup

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 game is as follows.

The investment stage. The old entrepreneur may invest $\hat{K}$ to start the old firm. I assume that with probability $1 \quad q > 0$, $\hat{K} = K > 0$; 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 $\eta \in (0, 1]$.

The investigation stage. This stage is the same as in the investigation stage in Section 2. The incumbent official may order the local government to investigate the old firm. To mobilize the bureaucracy, the incumbent official must pay a cost of $c > 0$.

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

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

With probability $p > 0$, the new entrepreneur enters the jurisdiction, and he may invest in a new firm at a cost $K > 0$.[24] I treat the arrival of new firms as exogenous to focus on the key object of study for this appendix, i.e., how the governing official adapts to the arrival of new firms.

Restricted to this Online Appendix E, we denote x as the new firm's payoff. The variable x follows the cumulative distribution function $G(\cdot)$ with support $[\underline{y}, \bar{y}]$. The distribution $G(\cdot)$ first order stochastically dominates $F(\cdot)$.[25] So the new firm is "on average" better than the old firm, which generates a potential problem in adaptability: an official may be reluctant to support the new firm even when the new firm is more productive. To ensure the second order condition if the official decides to support the new firm, we also assume that $G'(x) > 0$ for $x \geq \hat{x}$, where $\hat{x} = \arg\max_w [1 - G(w)]w$.

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

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

The governing official decides whether to support the new firm or the old 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)).[26] 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 the 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

$$w + V\Big(y \;\; 1_{\mathsf{old}} + x \;\; (1 \quad 1_{\mathsf{old}}), R\Big).$$

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

$$(x \quad w)(1 \quad \mathbf{1}_{\mathsf{old}}) \quad K \;\; \mathbf{1}_{\mathsf{invest\_new}},$$

where $\mathbf{1}_{\mathsf{invest\_new}} = 1$ if the new entrepreneur invests, and $\mathbf{1}_{\mathsf{invest\_new}} = 0$ otherwise. The old entrepreneur receives:

$$(y \quad w)\mathbf{1}_{\mathsf{old}} \;\; (1 \quad \mathbf{1}_{\mathsf{conf}}) \quad \hat{K} \;\; \mathbf{1}_{\mathsf{invest}}.$$

where $\mathbf{1}_{\mathsf{conf}} = 1$ if the incumbent official has confiscated the investment of the old entrepreneur. The principal receives a payoff of $y \;\; \mathbf{1}_{\mathsf{old}} + x \;\; (1 \quad \mathbf{1}_{\mathsf{old}})$. The payoff to the incumbent official is:

$$c \;\; \mathbf{1}_{\mathsf{investig}} + \Big[w + V\Big(y \;\; \mathbf{1}_{\mathsf{old}} + x \;\; (1 \quad \mathbf{1}_{\mathsf{old}}), R\Big)\Big] \;\; (1 \quad \mathbf{1}_{\mathsf{rotn}}).$$

The payoff to the reserve official is

$$\Big[w + V\Big(y \;\; \mathbf{1}_{\mathsf{old}} + x \;\; (1 \quad \mathbf{1}_{\mathsf{old}}), R\Big)\Big] \;\; \mathbf{1}_{\mathsf{rotn}}.$$

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

If the supported entrepreneur rejects the proposal, the output is not produced. The principal receives 0. The new entrepreneur receives K $\mathbf{1}_{\mathsf{invest\_new}}$ and the old entrepreneur receives $\hat{K}$ $\mathbf{1}_{\mathsf{invest}}$. The incumbent official receives c $\mathbf{1}_{\mathsf{investig}}$, 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 7. *The function $V(z, R)$ is multiplicatively separable between z and R. So we can denote*

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

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

We can now solve the model by applying backward induction.

E.2 Solving the extended model

Equilibrium at the bargaining stage. If the governing official supported the old entrepreneur at the entry stage, and the old firm has been stolen, the governing official asks for no rent and receives no performance-based reward. The old entrepreneur receives $\hat{K}$. The new entrepreneur receives K $\mathbf{1}_{\mathsf{invest\_new}}$.

If the governing official supports the old entrepreneur at the entry stage, and the investment into the old firm has not been confiscated, 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 $\mathbf{1}_{\mathsf{invest\_new}}$.

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

$$w \ (R) = \arg\max_{w} \Big[1 \quad F(w)\Big]\Big\{w + E_f[J(R)V(y) j y \quad w]\Big\} \tag{52}$$

$$= \arg\max_{w} \left\{[1 \quad F(w)]w + J(R)\int_{w}^{y} V(z)f(z)dz\right\}.$$

The expectation $E_f[\ ]$ in Equation 52 is computed over the probability distribution $F(\ )$. The first order condition is:

$$1 \quad F(w \ ) \quad f(w \ )w \quad J(R)V(w \ )f(w \ ) = 0,$$

or

$$\frac{1 \quad F(w\ )}{f(w\ )} = w\ \ + J(R)V(w\ ). \tag{53}$$

We have shown that $w\ (R)$ monotonically decreases with R for the general functional form $V(y, R)$ (Equation 6 to Equation 7), 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

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

And denote the expected utility of the old entrepreneur as

$$S(R) \quad \hat{K} \quad \Big\{1 \quad F[w\ (R)]\Big\}\Big\{E_f[y \mathbf{j} y \quad w\ (R)] \quad w\ (R)\Big\} \quad \hat{K}.$$

The new entrepreneur receives K $\mathbf{1}_{\mathsf{invest\_new}}$.

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

$$\tilde{w}(R) = \arg\max_{w} \Big[1 \quad G(w)\Big]\Big\{w + E_g[J(R) \ \ V(x) \mathbf{j} x \quad w]\Big\},$$

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

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

$$\frac{1 \quad G(\tilde{w})}{g(\tilde{w})} = \tilde{w} + J(R)V(\tilde{w}).$$

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:

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

The expected utility of the new entrepreneur is:

$$\tilde{S}(R) \quad K \quad \Big\{1 \quad G[\tilde{w}(R)]\Big\}\Big\{E_g[x \mathbf{j} x \quad \tilde{w}(R)] \quad \tilde{w}(R)\Big\} \quad K.$$

The old entrepreneur receives $\hat{K}$ $\mathbf{1}_{\mathsf{invest}}$.

The entry stage. Suppose that the new entrepreneur arrives. If the incumbent official has stolen the investment into the old firm, the governing 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. Suppose that the new firm has arrived and the official knows the realized productivity of the intact old firm. The governing official supports the new firm if and only if:

$$y + J(R)V(y) \quad \tilde{U}(R). \tag{54}$$

The left hand side of Equation 55 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 55 is the payoff from supporting the new firm. Denote the cutoff productivity as $\hat{y}$,

$$\hat{y} + J(R)V(\hat{y}) = \tilde{U}(R). \tag{55}$$

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 old firm. The following result fully characterizes which firm the governing official will support.

Lemma 6. *1. Suppose that the governing o cial does not know y, the productivity of the old rm. The o cial supports the new rm with probability one.*

2. Suppose that the governing o cial knows y. The o cial supports the new rm with probability $F(\hat{y})$, where $\hat{y}$ is de ned by Equation 55. In addition, $F(\hat{y}) < 1$.

Proof. First, we show that a governing official uninformed about y always supports the new firm. By definition,

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

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

Notice that

$$\int_{w}^{y} V(z) \quad g(z)dz \qquad \int_{w}^{y} V(z) \quad f(z)dz$$

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 $G(y) \quad F(y)$ for all y and that for every weakly increasing utility function u, $\int u(x)dG \quad \int u(x)dF$.

Also, because for all y, $G(y) \quad F(y)$, we have $[1 \quad G(w \ )]w \quad [1 \quad F(w \ )]w$. So we conclude that

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

Second, we show that a governing official informed about y supports the new firm with a probability strictly less than one. A governing official informed about y supports the new firm if and only if:

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

or

$$y + J(R) \ \ V(y) \quad [1 \quad G(\widetilde{w})] \mathbf{f} \widetilde{w} + J(R) \ \ E_g[V(x) \mathbf{j} x \quad \widetilde{w}] \mathbf{g}.$$

We claim that there is a unique $\hat{y}$ **2** $(\underline{y}, \bar{y})$ with $\hat{y} + J(R) \ \ V(\hat{y}) = \tilde{U}$; furthermore, for $y > \hat{y}$, $y + J(R) \ \ V(y) > \tilde{U}$ and for $y < \hat{y}$, $y + J(R) \ \ V(y) < \tilde{U}$. To see this, notice that the left-hand side is a continuous function strictly increasing in y, while the right hand side is a constant when y, the productivity of the old firm changes.

First, note that for $y = \underline{y}$, we have $y + J(R) \ \ V(y) = \underline{y} < [1 \quad G(\widetilde{w})] \mathbf{f} \widetilde{w} + J(R) \ \ E_g[V(x) \mathbf{j} x$ $\widetilde{w}] \mathbf{g}$ because

$$[1 \quad G(\widetilde{w})] \mathbf{f} \widetilde{w} + J(R) \ \ E_g[V(x) \mathbf{j} x \quad \widetilde{w}] \mathbf{g} > [1 \quad G(\underline{y})] \mathbf{f} \underline{y} + J(R) \ \ E_g[V(x) \mathbf{j} x \quad \underline{y}] \mathbf{g}. \quad (56)$$

The strict inequality in Equation 56 is true because we assume that the second order condition is satisfied:

$$2g(\tilde{w}) \quad g^{0}(\tilde{w})\tilde{w} \quad g^{0}(\tilde{w})V(\tilde{w}, R) \quad g(\tilde{w})V_y(\tilde{w}, R) < 0,$$

which is true because $g^{0}(x) > 0$ for $x \quad \hat{w}^{0}$, where $\hat{w}^{0} = \arg\max_w [1 \quad G(w)]w$.

In addition,

$$[1 \quad G(\underline{y})] \mathbf{f} \underline{y} + J(R) \ \ E_g[V(x) \mathbf{j} x \quad \underline{y}] \mathbf{g} = \underline{y} + J(R) \ \ E_g[V(x)] > \underline{y}.$$

Second, note that for $y = \bar{y}$, we have $\bar{y} + J(R) \ \ V(\bar{y}) > [1 \quad G(\widetilde{w})] \mathbf{f} \widetilde{w} + J(R) \ \ E_g[V(x) \mathbf{j} x \quad \widetilde{w}] \mathbf{g}$ because $\bar{y} > [1 \quad G(\widetilde{w})]\tilde{w}$ and $J(R) \ \ V(\bar{y}) = J(R) \ \ \int_{\underline{y}}^{y} V(\bar{y})g(z)dz > J(R)\int_{w}^{y} V(z)g(z)dz =$ $[1 \quad G(\widetilde{w})] \ \ J(R) \ \ E_g[V(x) \mathbf{j} x \quad \widetilde{w}]$.

Applying the intermediate value theorem, we conclude that there is a unique $\hat{y}$ **2** $(\underline{y}, \bar{y})$ with $\hat{y} + J(R) \ \ V(\hat{y}) = \tilde{U}$. Furthermore, for $y > \hat{y}$, $y + J(R) \ \ V(y) > \tilde{U}$ and for $y < \hat{y}$, $y + J(R) \ \ V(y) < \tilde{U}$.

Because $\hat{y}$ is strictly smaller than $\underline{y}$, the probability that an informed official supports the new firm is:

$$F(\hat{y}) < 1.$$

□

An official informed of y holds entrenched interests in the old firm because he can always secure the output and, equally important, the performance rewards. If the informed official supports the new firm instead, he faces a real risk of bargaining breakdown, eliminating any economic rents and performance rewards. Therefore, the informed official will support the old firm as long as its realized productivity y is not too low.

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. 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.

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

$$c+(1-\pi)\left\{(1-p)\ E_f[y+J(R)-V(y)]+p\left\{F(\hat{y})\ \tilde{U}(R)+[1-F(\hat{y})]\ E_f[y+J(R)-V(y) | y \quad \hat{y}]\right\}\right\}$$

$$(1-\pi)\Big[(1-p)U(R)+p\tilde{U}(R)\Big], \tag{57}$$

The left hand side of Condition 57 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 $E_f[y+J(R)-V(y)]$. 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. Furthermore, 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 $E_f[y+J(R)-V(y) | y \quad \hat{y}]$.

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 6).

Condition 57 identifies the minimal rotation frequency in the "creative destruction" model to deter the incumbent official from launching an investigation.

Lemma 7. *A necessary condition for the old entrepreneur to always invest is:*

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

where the minimal rotation frequency $\underline{\pi}(R)$ *is*

$$\underline{\pi} = 1 - \frac{c}{(1-p)\Big\{E_f[y+J(R)-V(y)] - U(R)\Big\} + p\{1-F(\hat{y})\}\Big\{E_f[y+J(R)-V(y)|y \geq \hat{y}] - \tilde{U}(R)\Big\}}. \tag{58}$$

Lemma 7 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 $\underline{\pi}$ after I solve the model.

The confiscation stage. Suppose that $\pi \geq \underline{\pi}$, where $\underline{\pi}$ is defined by Equation 58. 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:

$$\begin{aligned} &\eta K + (1-\pi)[(1-p)\cdot 0 + p\cdot \tilde{U}(R)] \\ &\leq (1-\pi)[(1-p)\cdot U(R) + p\cdot \tilde{U}(R)]. \end{aligned} \tag{59}$$

Condition 59 identifies the upper bound on rotation frequency to discourage capital confiscation, as summarized in Lemma 8.

Lemma 8. *A necessary condition for the old entrepreneur to always invest in the investment stage is:*

$$\pi \leq \bar{\pi}(R) = 1 - \frac{\eta K}{(1-p)\cdot U(R)}. \tag{60}$$

Equation 60 is analogous to Equation 13 for the workhorse model. I also discuss the details of Equation 60 after I have solved the model.

Furthermore, in the same spirit of Assumption 3 in the workhorse model, we impose an upper limit on the "efficiency" of capital confiscation: η is small enough so that $\underline{\pi}(R) < \bar{\pi}(R)$ for all R.

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 in expectation to recoup their investment costs. This yields the following proposition.

Proposition 5. *1. Both entrepreneurs always invest if and only if the performance reward* R *is su ciently attractive for the o cial, and rotation frequency is between the two bounds* $\underline{\pi}(R)$ *and* $\bar{\pi}(R)$.

More precisely, the necessary and su cient condition for entrepreneurs to always invest is:

$$(1 \quad p)S(R) \quad K, \ \tilde{S}(R) \quad K, \text{ and } \underline{\pi}(R) \quad \pi \quad \bar{\pi}(R). \tag{61}$$

where $\underline{\pi}(R)$ *is de ned by Equation 58 and* $\bar{\pi}(R)$ *is de ned by Equation 60.*

2. Suppose it is relatively rare for a new rm to enter. Algebraically, suppose that $p/(1 \quad p) < (\int_{\underline{y}}^{w} V(z)f(z)dz)/(\int_{w}^{y} V(z)g(z)dz)$.

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

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

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

For Claim 2, to prove that

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

we only need to show that

$$\tilde{\Delta}(R) \quad (1 \quad p)\Big\{E_f[y+J(R)\,V(y)] \quad U(R)\Big\}+p\{1 \quad F[\hat{y}(R)]\}\Big\{E_f[y+J(R)\,V(y)jy \quad \hat{y}] \quad \tilde{U}(R)\Big\}$$

$$= (1 \quad p)\Big\{E_f[y+J(R)\ V(y)] \quad U(R)\Big\}+p\Big\{\int_{\hat{y}(R)}^{y}[z+J(R)\ V(z)]f(z)dz \quad f1 \quad F[\hat{y}(R)]g\tilde{U}(R)\Big\}$$

monotonically increases with R.

$$\tilde{\Delta}^0(R) = (1 \quad p)\Big\{J^0(R)\int_{\underline{y}}^{y} V(z)f(z)dz \quad J^0(R)\int_{w}^{y} V(z)f(z)dz\Big\}$$

$$+p\Bigg\{J^0(R)\int_{\hat{y}(R)}^{y} zf(z)dz \quad [\hat{y}+J(R)\,V(\hat{y})]f(\hat{y})\,\hat{y}^0(R)+f(\hat{y})\,\hat{y}^0(R)\,\tilde{U}(R) \quad [1 \quad F(\hat{y})]J^0(R)\int_{w}^{y} V(z)g(z)dz\Bigg\}$$

$$= (1 \quad p)J^0(R)\int_{\underline{y}}^{w} V(z)f(z)dz$$

$$+p\left\{ J^0(R) \int_{\hat{y}(R)}^{\bar{y}} zf(z)dz \quad f(\hat{y})\, \hat{y}^0(R)[\hat{y}+J(R)\; V(\hat{y}) \quad \tilde{U}(R)] \quad [1 \quad F(\hat{y})]J^0(R) \int_{w}^{\bar{y}} V(z)g(z)dz \right\}.$$

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

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

so we have:

$$\tilde{\Delta}^0(R) = (1 \quad p)J^0(R) \int_{\underline{y}}^{w} V(z)f(z)dz$$

$$+pJ^0(R)\left\{ \int_{\hat{y}(R)}^{\bar{y}} V(z)f(z)dz \quad [1 \quad F(\hat{y})] \int_{w}^{\bar{y}} V(z)g(z)dz \right\}. \tag{62}$$

We want to identify sufficient conditions for $\tilde{\Delta}^0(R)$ to be strictly positive:

$$\tilde{\Delta}^0(R) > 0. \tag{63}$$

Equation 63 is always true if $\int_{\hat{y}(R)}^{\bar{y}} V(z)f(z)dz \quad [1 \quad F(\hat{y})] \int_{w}^{\bar{y}} V(z)g(z)dz \quad 0$. Otherwise, Equation 63 is true if and only if

$$\frac{p}{1 \quad p} < \frac{\int_{\underline{y}}^{w} V(z)f(z)dz}{[1 \quad F(\hat{y})] \int_{w}^{\bar{y}} V(z)g(z)dz \quad \int_{\hat{y}(R)}^{\bar{y}} V(z)f(z)dz} \tag{64}$$

A sufficient condition for Equation 64 is:

$$\frac{p}{1 \quad p} < \frac{\int_{\underline{y}}^{w} V(z)f(z)dz}{\int_{w}^{\bar{y}} V(z)g(z)dz}. \tag{65}$$

Now we show that $\frac{d\ (R)}{dR} > 0$. It is sufficient to show that $U^0(R) > 0$. By the envelope theorem,

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

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

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

That is, the marginal temptation (divided by $J^0(R)$) to investigate if a new firm arrives has a lower bound at $\quad E_f[y]/J(R)$.

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

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

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

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

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

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

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

So a sufficient condition is

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

□

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 ($\bar{\pi}(R) \quad \underline{\pi}(R)$) 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 $(1 \quad p)S(R) \quad K$. In addition, the new entrepreneur must also expect a larger surplus than the cost of investment, or $\tilde{S}(R) \quad K$.

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 $\underline{\pi}(R)$ 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 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, which allows me to derive another sufficient condition for $\frac{d\_(R)}{dR} > 0$ as follows:

$$\int_{\hat{y}}^{y} V(z)f(z)dz \quad [1 \quad F(\hat{y})] \int_{w}^{y} V(z)g(z)dz \quad 0. \tag{66}$$

The left hand side of Equation 66 is the marginal temptation to launch an investigation with a stronger performance reward, conditional on the arrival of a new firm.[27] 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 66 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 ambiguity induced by the economic rent is qualitatively small, limited by a lower bound on Equation 66:

$$\int_{\hat{y}}^{y} V(z)f(z)dz \quad [1 \quad F(\hat{y})] \int_{w}^{y} V(z)g(z)dz \qquad \frac{E_f[y]}{J(R)}. \tag{67}$$

The lower bound $\quad E_f[y]/J(R)$ 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 67 is tight, it is reasonable to assume that $\int_{\hat{y}}^{y} V(z)f(z)dz \quad [1 \quad F(\hat{y})] \int_{w}^{y} V(z)g(z)dz \quad 0$, 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:

$$1 \quad \frac{\eta K}{(1 \quad p)U(R)}. \tag{68}$$

The equation reduces to the maximal rotation frequency with $p = 0$, the benchmark model without firm entry. With $\pi \quad \underline{\pi}$ as in Equation 60, the official will not launch an investigation of an intact old firm, earning an expected value of $(1 \quad p)U(R)$ 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

[27] Strictly speaking, the left hand side of Equation 66 is the marginal temptation divided by $J(R)$.

still induces the official to be especially averse to a bad performance record.

Rotation and performance rewards provide commitment and encourage adaptation. In the workhorse model, 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 provide *de facto* property rights.

F Knowledge destruction in bureaucracy

In this section, we investigate the workhorse model when the local government cannot store knowledge about firms. We can classify the outcomes as follows. The first three scenarios produce the same outcome as in Section 2, with only the fourth scenario possibly differing from Section 2. In the following classification, the variables $\hat{R}$, $\underline{\pi}(R)$, and $\bar{\pi}(R)$ are as defined in the workhorse model.

1. $R \quad \hat{R}$, $\underline{\pi}(R) \quad \pi \quad \bar{\pi}(R)$: the outcome is the same as in Section 2. The entrepreneur invests because the incumbent official neither steals the private capital nor investigates the local firm.

2. $R < \hat{R}$: The outcome is the same as in Section 2. The entrepreneur does not invest because the maximal net surplus he can expect is smaller than the investment cost.

3. $R \quad \hat{R}, \pi > \bar{\pi}(R)$: the outcome is the same as in Section 2. The entrepreneur does not invest because the incumbent official would steal the private capital.

4. $R \quad \hat{R}, \pi < \underline{\pi}(R)$ is the only situation where the outcome might be different from Section 2. The incumbent official does not confiscate private investment, but he will investigate the firm. If the entrepreneur invests, he expects a payoff of:

$$\pi S(R) = \pi\Big\{1 \quad F[w \ (R)]\Big\}\Big\{E[yjy \quad w \ (R)] \quad w \ (R)\Big\}.$$

   With probability $1 \quad \pi$, the incumbent official is not rotated. He extracts all surplus, leaving zero payoff to the entrepreneur. With probability π, the incumbent official is rotated away together with his knowledge about the local firm, and the new governing official does not know the precise output y. The new governing official asks to extract $w \ (R)$, leaving an expected surplus of $S(R)$ to the entrepreneur. If $\pi S(R) \quad K$, the cost of investment, the entrepreneur will invest. In other words, under the parametric space $R \quad \hat{R}$ and $\pi < \underline{\pi}(R)$, the entrepreneur will invest if and only if:

$$\pi \quad \frac{K}{S(R)}.$$

Therefore, the workhorse model focuses on the configuration of rotation and performance rewards ($R \quad \hat{R}$, $\underline{\pi}(R) \quad \pi \quad \bar{\pi}(R)$) because the configuration is a particularly robust solution to the holdup problem. The configuration always induces the entrepreneur to invest, regardless of whether the local government can transmit knowledge to a newly appointed official (as in Section 2) or not (as in this appendix). The configuration is therefore robust to the knowledge structure of the local government. By contrast, the other configuration ($R \quad \hat{R}, \pi < \underline{\pi}(R)$, and $\pi \quad \frac{K}{S(R)}$) can only induce private investment if the local government cannot transmit knowledge to a newly appointed official. But by the very definition of a well-functioning bureaucracy, a new governing official of the local government should be able to easily access its record of the local economy. The configuration $R \quad \hat{R}, \pi < \underline{\pi}(R)$, and $\pi \quad \frac{K}{S(R)}$ is therefore a fragile solution to the holdup problem.

G Further empirical tests

G.1 Does past GDP growth predict rotation?

Does a good economic record in the past predict a high probability of rotation for a mayor? Such a correlation would complicate the interpretation of the theoretical model. To test this correlation, I merge the personnel data from Chen (2016) with city-level GDP data from the year 2000 to the year 2012. I run the following regression:

$$\text{rotation}_i = \alpha + \beta \quad \text{GDP}_i + X_i \quad \gamma + \varepsilon_i. \tag{69}$$

The dummy variable "rotation$_i$" is one if and only if the mayor is rotated to a mayor position in another jurisdiction later. The key independent variable "GDP$_i$" is the average GDP growth rate throughout a mayor's tenure in the city where he served as a mayor for the first time. The vector X_i is a list of control variables for official i in the last year of his first tenure as a mayor, including age, gender, ethnicity, education, and work experiences. Work experiences further include 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.

Estimation of the coefficient on GDP$_i$ is in Table 3. Column (1) runs regression 69 without control variables. Column (2) adds X_i, the characteristics of mayors. Column (3) adds θ_k, fixed effects for the city that the official works for the first time as mayor, which may affect the probability of rotation after the official finishes his first mayorship. In other words, Column (3) runs the following regression:

$$\text{rotation}_{ik} = \alpha + \beta \quad \text{GDP}_{ik} + X_{ik} \quad \gamma + \theta_k + \varepsilon_{ik}. \tag{70}$$

In the first two columns, a higher GDP growth rate is negatively correlated with rotation to another mayorship later. In the third column, after controlling city fixed effects, the GDP growth rate does not predict rotation at all.

Table 4 did the same analysis as Table 3, only replacing GDP$_i$ as a "relative" GDP growth rate:

$$\text{rotation}_{ik} = \alpha + \beta \quad \text{relative GDP}_{ik} + X_{ik} \quad \gamma + \theta_k + \varepsilon_{ik}. \tag{71}$$

More precisely, I first compute the relative GDP growth rate for each city-year pair, defined as the GDP growth rate for each city minus the average GDP growth rate for all cities in the same province of that year (following Jia et al. (2015)). Then I take the average of this relative GDP growth rate for the city that an official i governs for the first time as a mayor,

Table 3: Economic performance and rotation

	(1)	(2)	(3)
		rotation	
GDP growth rate	-0.00855	-0.0107	0.000256
	(0.00340)	(0.00379)	(0.00376)
mayor characteristics	No	Yes	Yes
city fixed effects	No	No	Yes
N	1125	1062	1062
R^2	0.000	0.017	0.267

Robust standard errors are in parentheses. * p<0.1, ** p<0.05, *** p<0.01. The dependent variable is whether the mayor was rotated to another mayor position later after serving as a mayor for the first time in the dataset. "GDP growth rate" is the average GDP growth rate of the city during the tenure of a mayor when the official governed as a mayor for the first time. "Mayor characteristics" include the mayor's gender, ethnicity, age, and work experiences. Work experiences further include 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. "City fixed effect" controls for time-invariant features of the city that the official worked as a mayor for the first time.

which is then defined as "relative GDP_i." I look at "relative GDP_i" as an explanatory variable because a sizable literature argues that personnel incentives are, in many cases, yardstick competitions (Lazear and Rosen (1981); Maskin et al. (2000)).

Table 4 shows a very similar pattern when we measure the economic performance by the relative GDP growth rate. While Column (1) and Column (2) show that a higher growth rate in the relative GDP reduces the probability of rotation, Column (3) shows that the relative GDP growth rate does not predict rotation at all. Taken together, these results suggest the theoretical model formalizes rotation in a reasonable manner.

G.2 Does past GDP growth predict promotion?

A related question is, does past GDP growth actually predict promotion? It is instructive to empirically test this correlation since the theoretical model assumes that the performance reward $V(y, R)$ increases with the economic record y. To do so, I run the same regression as Equation 70, only replacing the dependent variable with "promotion_{ik}:"

$$\text{promotion}_{ik} = \alpha + \beta \quad \text{GDP}_{ik} + X_{ik} \quad \gamma + \theta_k + \varepsilon_{ik}, \tag{72}$$

where the dummy variable "promotion_{ik}" is one if and only if a mayor i was promoted to a secretary position later. The results are in Table 5. The same as in Table 3, Column (1) does not include any control variables, Column (2) include the mayor characteristics, and Column

Table 4: Relative economic performance and rotation

	(1)	(2)	(3)
		rotation	
relative GDP growth rate	-0.00847	-0.0117	-0.000984
	(0.00448)	(0.00504)	(0.00571)
mayor characteristics	No	Yes	Yes
city fixed effects	No	No	Yes
N	1125	1062	1062
R^2	0.000	0.017	0.267

Robust standard errors are in parentheses. * p<0.1, ** p<0.05, *** p<0.01. The dependent variable is whether the mayor was rotated to another mayor position later after serving as a mayor for the first time in the dataset. "Relative GDP growth rate" is defined in the text. "Mayor characteristics" include the mayor's gender, ethnicity, age, and work experience, containing 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. "City fixed effect" controls for time-invariant features of the city that the official worked as a mayor for the first time.

(3) further adds the city fixed effects θ_k. Table 5 shows that an excellent economic record strongly predicts a mayor's promotion to a secretary position later, even after including 305 city dummies. The pattern is similar when we replace "GDP_{ik}" with "relative GDP_{ik}" as defined for regression 71. I run the following regression:

$$\text{promotion}_{ik} = \alpha + \beta \quad \text{relative GDP}_{ik} + X_{ik} \quad \gamma + \theta_k + \varepsilon_{ik}. \tag{73}$$

The results are in Table 6. Again relative economic performance strongly predicts a mayor's promotion to a secretary position later. Table 5 and Table 6 confirm the central finding of a large empirical literature, the finding that a good economic record predicts promotion for a Chinese local leader (Li and Zhou (2005); Xu (2011); Jia et al. (2015)). Taken together, these results suggest that it is appropriate to assume that the key personnel reward of promotion is based on economic performance in my theoretical model, or $V_y(y, R) > 0$.

G.3 Does rotation predict promotion among Chinese mayors?

Existing literature has investigated a different "complementarity" between rotation and promotion. Rotation of managers helps them acquire a diverse set of skills from managing different departments, rendering these managers more eligible for future promotion. This "human capital" mechanism has proven very fruitful in understanding personnel dynamics in firms (Ortega (2001); Friebel and Raith (2013); Jin and Waldman (2020)).

It is instructive to investigate whether the human capital mechanism might also motivate

Table 5: Economic performance and promotion

	(1)	(2)	(3)
		promotion	
GDP growth rate	0.0732	0.0675	0.0830
	(0.0170)	(0.0169)	(0.0166)
mayor characteristics	No	Yes	Yes
city fixed effects	No	No	Yes
N	1125	1062	1062
R^2	0.006	0.065	0.274

Robust standard errors are in parentheses. * p<0.1, ** p<0.05, *** p<0.01. The dependent variable is whether the mayor was promoted to a secretary position. "GDP growth rate" is the average GDP growth rate of the city that the official governs as a mayor for the first time. "Mayor characteristics" include the mayor's gender, ethnicity, age, and work experiences. Work experiences further include 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. "City fixed effect" controls for time-invariant features of the city that the official worked as a mayor for the first time.

Table 6: Relative economic performance and promotion

	(1)	(2)	(3)
		promotion	
relative GDP growth rate	0.0587	0.0498	0.0645
	(0.0204)	(0.0194)	(0.0233)
mayor characteristics	No	Yes	Yes
city fixed effects	No	No	Yes
N	1125	1062	1062
R^2	0.003	0.063	0.271

Robust standard errors are in parentheses. * p<0.1, ** p<0.05, *** p<0.01. The dependent variable is whether the mayor was promoted to a secretary position. "Relative GDP growth rate" is defined in the text. "Mayor characteristics" include the mayor's gender, ethnicity, age, and work experiences. Work experiences further include 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. "City fixed effect" controls for time-invariant features of the city that the official worked as a mayor for the first time.

the rotation and promotion of Chinese mayors. To do so, I again utilize the personnel data on city-level officials from Chen (2016). I constructed a dataset of officials who served as a mayor for at least one city from the year 2000 to the year 2012. For such an official, I counted how many cities he served as a mayor and whether he was later promoted to be a city-level secretary. Then I run a simple regression:

$$\text{secretary}_i = \alpha + \beta \quad \text{mayorships}_i + X_i \quad \gamma + \varepsilon_i. \tag{74}$$

The dummy variable "secretary$_i$" is one if and only if the official i served as a secretary later after he finished all his mayorships. The variable "mayorship$_i$" is the number of cities that the official i used to govern as the mayor from the year 2000 to the year 2012. The vector X_i is a list of control variables for official i in the last year of his mayorship, including age, gender, ethnicity, education, and work experiences. Work experiences further include 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.[28]

To test the relevance of the "human capital" mechanism in the Chinese political economy, we focus our attention on β in Equation 74. If β is positive, an official who served as the mayor for multiple cities is more likely to be promoted to be a city party secretary. Therefore, a positive β would be supporting evidence for the "human capital" mechanism.

Estimation of β is listed in Table 7. Column (1) implements the regression 74 without any control variables, Column (2) includes all official characteristics. The point estimates for β are negative and insignificant. Table 7 indicates that the human capital mechanism might not be first order in the personnel management of Chinese mayors because empirically, mayors who governed more cities do not exhibit an advantage in promotion.

The result is not entirely surprising, because the Chinese political economy is structured as an M-Form organization whose local units are largely self-contained and similar to each other (Maskin et al. (2000); Qian et al. (2006)). Managers of M-Form organizations gain little human capital from working across these similar units, therefore not necessarily more eligible for future promotion. In addition, it is coercive power that defines politics (Weber (2004)). Compared with fostering governance skills of politicians, it might be a more important concern to constrain their coercive power that could be weaponized to expropriate the private sector (North and Weingast (1989)).

[28]One may want to further control for the city fixed effect that the mayor has governed in the past. The city fixed effect, however, is ill-defined for the mayors who have governed more than two cities. But we must include these mayors in the data to test the human capital mechanism.

Table 7: Rotation experience and later promotion

	(1) promote	(2) promote
the number of mayorship	-0.0392 (0.0537)	-0.0208 (0.0526)
mayor characteristics	No	Yes
N	1196	1128
R^2	0.000	0.074

Robust standard errors are in parentheses. * p<0.1, ** p<0.05, *** p<0.01. The dependent variable is whether the official was promoted to be a city secretary later. "The number of mayorships" is the number of different cities that an official served as their mayor. "Mayor characteristics" include the mayor's gender, ethnicity, age, and work experience. Work experiences further include 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.