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Abstract

We examine the power of incentives in bureaucracies by studying contracts offered by a bureaucrat to her agent. The bureaucrat operates under a fixed budget, optimally chosen by a funding authority, and she can engage in policy drift, which we define as inversely related to her intrinsic motivation. Interaction between a fixed budget and policy drift results in low-powered incentives. We discuss how the bureaucrat may benefit from stricter accountability as it leads to larger budgets. Low-powered incentives remain even in an alternative centralized setting, where the funding authority contracts directly with the agent using the bureaucrat to monitor output.

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Keywords: bureaucracy, fixed budgets, power of incentives.

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1. Introduction

> "*In the days leading up to September 30, the federal government is Cinderella, courted by legions of individuals and organizations eager to get grants and contracts from the unexpended funds still at the disposal of each agency. At midnight on September 30, the government's coach turns into a pumpkin. That is the moment – the end of the fiscal year—at which every agency, with few exceptions, must return all unexpended funds to the Treasury Department.*" (Wilson (1989))

It is a characteristic of many government bureaucracies to operate under a mostly fixed budget that has to be returned if unspent by the end of the fiscal year. Such an arrangement is not limited to government bureaucracies. It is also widely observed in public and non-profit organizations including many state universities.

Although bureaucrats are supposed to return this unspent budget to the funding authority, it is well-known that they instead go on a "spending spree." For instance, the end of the fiscal year often witnesses the purchase of new equipment and travel to exotic places for conferences. In the U.S., July marks the start of the last quarter of the fiscal year and this period is known among federal contractors as "Christmas in July."[1] In 2005, an audit by the U.S. Department of Defense Inspector General denounced the approval of hundreds of millions of dollars on questionable "last-minute" projects.[2] It revealed that 74 out of 75 selected purchases scheduled at the end of fiscal year 2004 "were either hastily planned or improperly funded." Noting that bureaucrats can also appropriate unspent budgets, it also found that the Department of Defense "parked" $2 billion that were unspent at the end of 2004 in a special account intended for information technology purchases, apparently to keep it out of sight of Congress and so it could be spent later. "They know the money is lost to them if they don't use it," says Eugene Waszily, an assistant inspector general at the General Services Administration.[3]

This example shows that bureaucrats performing under fixed budgets can appropriate unspent budget at the end of the fiscal year. This hidden, unspent budget allows the bureaucrat to pursue goals different from those of the funding authority, and this behavior is known as "policy

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[1] Wall Street Journal editorial, "Christmas in July," July 19, 2006.
[2] Department of Defense, Office of the Inspector General (2005), http://www.dodig.osd.mil/Audit/ reports/FY05/05-096.pdf.
[3] Wall Street Journal editorial, *ibid*.

drift." In this article, we study how these distinctive features of the bureaucratic environment affect contracts *offered by* bureaucrats to their own agents.

We highlight the role of policy drift and fixed budgets in a model of bureaucracy with three layers: a funding authority ("it"), a bureaucrat ("she"), and an agent ("he"). As we argue below, the funding authority has no informational capability, ability or time to run the many agencies it funds. In the language of Aghion and Tirole (1997), the funding agency has formal authority but it relinquishes real authority to a bureaucrat who runs the agency. More specifically, we assume that the funding authority, unlike the bureaucrat, cannot observe output, and therefore gives a fixed budget to the bureaucrat who will then contract with the agent (e.g., a procurement firm) to produce the output. The agent has private information about the production costs and is offered an incentive contract by the bureaucrat.

The first key element of our model is the concept of policy drift. Policy drift is distinct from standard shirking. Bureaucrats offer contracts to their agents that generate unspent budget, which can be hidden from the funding authority and becomes discretionary. The discretionary budget, also known as "slack" (Antle and Eppen (1985)), is sometimes seen as the "bureaucratic equivalent of personal income" (Moe (1997)) and allows bureaucrats to pursue their own goals distinct from those of the funding authority. A bureaucrat's preference for policy drift is also noted by Migué and Bélanger (1975), which is the most well-known variation of Niskanen (1971).[4]

Along with policy drift, the second key element of our model is that the funding authority delegates the contracting authority to the bureaucrat by giving her a fixed budget. There is a large literature in political science that argues why funding authorities may have little control over a bureaucratic agency other than being able to fix its budget.[5] Brehm and Gates (1997) note that civil servants enjoy considerable protection from political influence, and they cite several commentators who have advocated for such protection. Besides Weber's (1947) well-known fear of "dilettantism" by politicians, Wilson (1887) also argues that a bureaucracy should remain "outside the sphere of politics" to shield bureaucrats from the narrow interests of politicians.

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[4] Another example of policy drift is public employees moonlighting in the private sector (Biglaiser and Ma (2007)).

[5] In the political science literature, various authors have challenged Niskanen's (1971) argument that the bureaucrat determines and maximizes the budget. Aberbach et al. (1981) state that agency chiefs may argue for increments in their budgets but have little control over their budgets, and Moe (1997) cites authors who question the budget-maximizing assumption.

Even if one questions whether bureaucrats should be shielded from the influence of politicians, as a practical matter, political bodies have little knowledge in delivering public service. Although Congress may want to provide an education-friendly budget by increasing the allocation to education, it has to leave the details of implementation to the Department of Education run primarily by career bureaucrats. Congress may well state general goals but, as Wilson (1989) explains, bureaucracies are best defined by "tasks." Promoting the "long-range security interests of the United States" may be the stated goal of the State Department, but it is bureaucrats who must develop guidelines and implement actions to achieve such a goal. Congress has limited ability to condition the budget on specific performance measures.

In the economics literature, Tirole (1994) also recognizes the difficulty of measuring the performance of agencies characterized by such general goals and by the absence of yardstick competition.[6] In our model, this lack of measurement capacity (inability to observe the output) will lead the funding authority to provide fixed budgets to the bureaucrat. Tirole also highlights the lack of commitment abilities of political authorities. Not only are the goals of political authorities fairly diverse but they change over time "in a non-contractible manner." This lack of time consistency also prevents political authorities from committing to budgets that are contingent on performance.[7]

Whether by design (to prevent undue political influence) or by necessity (due to lack of measurement capacity or commitment ability), the budget can be seen as depending very little on the agencies' actual performance.[8] This view of bureaucracy begs a question: how to provide incentives to bureaucrats? The literature has indicated that bureaucracies rely on the bureaucrat's self-motivation and professionalism to resolve incentive problems.[9] Bureaucrats are

[6] To quote Tirole: "…even an econometrician may have a hard time measuring the regulator's contribution to the net consumer surplus. And who will put reliable numbers on the US Department of States performance in 'promoting the long range security and well-being of the United States,' and on the US Department of Labor's success in 'fostering, promoting, and developing the welfare and the wage earners of the US'?" (p. 4).
[7] Budgets unrelated to performance, i.e., fixed budgets, are akin to low-powered incentives for bureaucrats. In addition to lack of time-consistency, other reasons for low-powered incentives for bureaucrats are career concerns (Dewatripont et al. (1999) and Alesina and Tabellini (2007)), multitasking (Holmstrom and Milgrom (1991)), and multiple principals (Martimort (1996, 2007) and Dixit (2002)). For empirical evidence of low-powered incentives for bureaucrats, see Borcherding and Besocke (2003).
[8] Moreover, as noted by Johnson and Libecap (1989), at the individual level, a bureaucrat is difficult to fire and a bureaucrat's salary is not tied to the agency's budget.
[9] In addition to professionalism, Dewatripont et al. (1999) and Alesina and Tabellini (2007) suggest that bureaucrats are motivated by career concerns.

professionals: they are trained in "professions which emphasize not only technical competence but also conscientious devotion to duty" (Rose-Ackerman (1986)). They receive most of their incentives from outside the bureaucracy, mainly from organized groups of fellow practitioners and the self-satisfaction of doing their duty well.[10] Besley and Ghatak (2005) and Prendergast (2007) point out that agents in public office are often intrinsically motivated to deliver goods or services they are engaged to produce (see also Benabou and Tirole (2003) on intrinsic motivation). They argue that bureaucracies are organized around a mission and bureaucrats work harder when they buy into the mission of the organization.[11]

In this article, we will call the bureaucrats "motivated" when they are intrinsically motivated to produce the goods or services of the bureaucracy. For example, a bureaucrat in charge of the EPA would be called motivated if she is an environmentalist at heart. Therefore, our bureaucrat has twin objectives of output and policy drift, but a more motivated bureaucrat is more interested in output and less tempted by policy drift.

We offer a new explanation for low-powered incentive schemes in bureaucracies in a model of delegated bureaucracies with fixed budgets and policy drift. Although previous studies have largely focused on why contracts *for* bureaucrats are low powered (e.g., when given fixed budgets), they are silent about contracts offered *by* bureaucrats.[12] We offer a reason why such contracts may be low powered. Because contracts in public-sector hierarchies are determined by bureaucrats, our study offers complementary results about the power of incentive schemes in bureaucracies.

We show that the interaction of fixed budgets and the bureaucrat's preference for policy drift leads to low-powered incentives. A key insight is that a less motivated bureaucrat wants to generate unspent budget to engage in policy drift and therefore would like to offer high-powered incentive schemes. Anticipating this behavior, the funding authority limits the budget given to the

[10] Brehm and Gates (1997), discussing the role of professional standard norms and self-selection, write in the preface to their book, "the police officer, the social worker, the NASA engineer, the health inspector chose their jobs not for the possibility of maximizing leisure, or even for the material rewards of the job, but for the intrinsic character of the job itself.", and elsewhere, "Our book offers one answer: bureaucratic accountability depends most of all on the preferences of individual bureaucrats. Fortunately for us, those preferences are overwhelmingly consistent with the jobs the American democracy sets for them to do."

[11] Wilson (1989) defines a mission as a culture "that is widely shared and warmly endorsed by operators and managers" (p.95).

[12] We discuss two exceptions below, Banerjee (1997) and Prendergast (2003).

less motivated bureaucrat. In response, the bureaucrat decreases the unspent budget and the power of incentives in order to balance her twin objectives of output and policy drift. A more motivated bureaucrat also offers relatively low-powered incentive schemes since she values unspent budgets less.[13] Thus, bureaucracies will have low-powered incentives regardless of how mission-oriented the unit is.

A priori, it is not clear whether the funding authority prefers a more motivated bureaucrat. Indeed, the preferences of a more motivated bureaucrat are not necessarily better aligned with those of the funding authority as she cares less about the cost of production. We find that the funding authority does prefer a more motivated bureaucrat and allocates relatively larger budgets to her. Even though a less motivated bureaucrat offers stronger incentive schemes, she generates lower expected output and a larger unspent budget.

This result is complementary to Besley and Ghatak (2005), who argue that matching motivated agents to mission-oriented tasks acts as a substitute for high-powered incentives and leads to more efficient outcomes. Together, the two articles suggest that well-matched bureaucracies may be characterized by large budgets and low-powered incentive schemes, both for contracts offered *to* the bureaucrat and *by* the bureaucrat, whereas the expected output may remain high.

We also discuss stricter accountability standards imposed by the funding authority on the bureaucrat. We show how the bureaucrat may benefit from stricter accountability as it leads to larger budgets. Finally, we contrast our model of bureaucracy to a centralized setting where the funding authority contracts directly with the agent. The bureaucrat is used to monitor the output, but the agent and bureaucrat may collude.[14] As the funding authority cannot observe the output, a notion of "fixed budgets" appears endogenously to prevent collusion between the bureaucrat and the agent under centralization. We also find that the agent is offered low-powered incentive schemes even under centralization. Furthermore, we clarify when delegation is costly and discuss how it can be justified.

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[13] Note that she is also given a limited budget since she tends to produce 'too much.' Therefore, regardless of the degree of motivation, the funding authority limits the budget given to the bureaucrat.

[14] In Section 5, we study collusion under asymmetric information between the bureaucrat and the agent. See Laffont and Martimort (1998), Faure-Grimaud et al. (2003), Mookherjee and Tsumagari (2004), and Celik (2009). See also Mookherjee (2012) for a survey.

Although we focus on government bureaucracies, our model can also apply to large private corporations. The fiscal rule of a fixed budget that has to be returned if unspent is also common in the private sector where large firms are organized similarly. Jack Welch, a former CEO of General Electric, once described this process with his often quoted statement: "The budget is the bane of corporate America" (Fortune Magazine 1995). Private firms tend to be more flexible with budgets as they do not have to follow strict administrative rules of public bureaucracies. Still, it is common for private companies to operate with fixed budgets for their various departments and the rule that unspent budgets are lost at the end of the fiscal year. With various means and ways, the departments end up spending the unspent budgets as the fiscal year moves toward its end.

Several articles in the economics and political science literatures have studied the power of incentives in bureaucracies. However, as mentioned above, most of them focus on the incentive scheme offered to a bureaucrat in a standard two-level hierarchy with a principal and an agent. Exceptions are Banerjee (1997) and Prendergast (2003). Both of them consider a situation where the bureaucrat, on the behalf of the government, designs resource allocation schemes for consumers who have private information about their types and show how these schemes are distorted or result in inefficiency. These articles are similar to ours in that they consider a three-level hierarchy in bureaucracies and analyze the distortion on incentive schemes offered by the bureaucrat to her clients who have private information. An important difference is that, although the principal in their models controls the bureaucrat by monitoring, the principal in our model has no access to monitoring and can only control the bureaucrat by choosing the size of her budget. We consider the possibility of monitoring in Section 5. Thomas (2002), Gautier and Mitra (2006), and Levin (2003) highlight the role of a binding budget constraint resulting in pooling of types. Given a limited budget, we also show that the bureaucrat may offer a pooling contract, which is the extreme case of low-powered incentives.

Our article is also related to Hiriart and Martimort (2012) who argue that delegation may be optimal in a hierarchy of congress-regulator-firm. The regulator offers an incentive contract to the firm in order to limit some potential damage (e.g., pollution) by the firm. The regulator has private information about the potential damage, so delegation – letting the regulator choose the optimal contract – allows the regulator to tailor the contract to the potential damage. However, the regulator puts more weight on the firm's payoff than congress, so congress limits the regulator's ability to design the contract (its discretion) by imposing rules (limits on transfers) on the optimal contract. Similarly, we find that the principal can curb the bureaucrat's discretion by limiting her budget. Both articles provide examples of how agency problems may propagate within a hierarchy.

The rest of the article is organized as follows. We present a model of bureaucracy with a funding authority, a bureaucrat, and an agent in Section 2. After characterizing the contract a bureaucrat will offer an agent in Section 3, we study the funding authority's problem in Section 4 to show that there will be low-powered incentives in a bureaucracy. We consider extensions in Section 5 and conclude in Section 6.

2. The model

We consider a three level hierarchy with hidden information: a funding authority, a bureaucrat, and an agent, where the agent has private information about production cost. The funding authority could be the legislature. It is interested in the production of some output but does not have the time or the ability to manage the agent who runs the production process. In particular, we assume the funding authority cannot observe the output and therefore delegates the task of contracting with the agent to the bureaucrat.[15]

The agent is the productive unit in the hierarchy. He produces an output, denoted by $X \geq 0$, at cost $C(X) = \frac{c}{2}X^2$, where $c > 0$; so efficiency implies that $X = \frac{1}{c}$. The constant c is private information of the agent and represents his type. It can take two values: c_L with probability q_L and c_H with probability q_H (with $\Delta c \equiv c_H - c_L > 0$ and $q_L + q_H = 1$). The bureaucrat offers a contract to the agent specifying the output (X_L or X_H) and a contingent transfer (t_L or t_H).

The agent is a standard procurement firm, which has private information about his production cost and must be given an incentive scheme to limit his information rent. The procurement problem has received much attention in economics (see, e.g., Laffont and Tirole (1993)). Our contribution is to analyze a procurement contract offered by a motivated bureaucrat operating under a fixed budget, and to show how and why this contract is different from the one offered by a private principal. The agent could also be seen as a street-level bureaucrat who is not

[15] Alternatively, it can use the bureaucrat as a monitor of output and directly contract with the agent. In Section 5, we discuss this centralized contracting and compare it with our model of delegated bureaucracy.

a professional and requires a formal incentive scheme (See Lipsky (1980)). Street-level bureaucrats may have conflicting preferences with the upper management (our bureaucrat).[16]

Because the funding authority cannot observe the output, it gives the bureaucrat a fixed budget, denoted by B, to maximize expected net benefit, $q_L X_L + q_H X_H - B$.

As argued in the introduction, the bureaucrat is motivated to deliver the goods or services of the bureaucracy ($q_L X_L + q_H X_H$), but she also values unspent budgets ($B - q_L t_L - q_H t_H$) to engage in policy drift. We capture this idea by introducing a parameter $k \in [0,1]$ to represent the bureaucrat's relative preference for policy drift, i.e., her intrinsic motivation.[17] Thus, we have the following objective function for the bureaucrat:

$$U = q_L X_L + q_H X_H + k[B - q_L t_L - q_H t_H]. \tag{1}$$

If $k = 0$, the bureaucrat only cares about the output – she is "extremely motivated" like an environmentalist running the EPA or a school teacher running the department of education. If $k = 1$, the bureaucrat cares about policy drift as much as the output. Accordingly, a higher k indicates that the bureaucrat is less motivated and has a stronger preference for policy drift. Note that the preferences of a more motivated bureaucrat are not necessarily better aligned with those of the funding authority as she cares less about the cost of production.

The timing of the game is as follows: the funding authority presents the bureaucrat with a fixed budget B. Next, the bureaucrat offers an incentive contract to the agent specifying the output (X_L and X_H) expected from each type of agent as well as the corresponding transfers (t_L and t_H).

[16] For example, Heckman et al. (1996) present a detailed empirical study of the Job Training Partnership Act (JTPA). They find that case workers (street-level bureaucrats) in JTPA training centers were motivated to help the less employable participants even though it decreased the performance measure of the training center and the middle manager (bureaucrat). As Dixit (2002) notes, perhaps the bureaucrat "should have devised an incentive scheme to induce truthful revelation of information by the case workers." In the political science literature, Brehm and Gates (1997) also point out the informational advantage of the agent: "One can easily imagine similar task idiosyncrasies in public bureaucracies: regulators who understand the ways in which polluting, firms disguise their transmissions of toxins, police officers who have a sense of when community tensions are peaking, or social workers who are personally familiar with the work records of their clients" (p. 16).

[17] In Section 5, we relax the assumption that $k \leq 1$ and show that our main result about low-powered incentives generalizes. By assuming $k \leq 1$ in the main text, we are restricting attention to the case where the bureaucratic mission matters more than policy drift to a bureaucrat. Implicitly, we are assuming that the funding authority has other instruments, such as monitoring and administrative controls, to limit policy drift (see McCubbins et al. (1987) for example). Alternatively, as emphasized in Brehm and Gates (1997) and Besley and Ghatak (2005), there is likely to be matching of preferences between a bureaucrat and the unit's mission such that the mission remains more important than any alternatives. When such matching is not possible, they argue that the mission should not be fulfilled by a public bureaucracy.

We assume that the agent learns his type before signing this contract and therefore we have a model of adverse selection. Finally, production takes place and the appropriate contingent transfer is given to the agent.

We assume that the funding authority does not observe the details of the contract offered by a bureaucrat. If it could, it would also know the amount of any unspent budget and easily prevent misdirected spending by the bureaucrat.[18] We also assume that the funding authority does not benefit from however the unspent budget is used. This does not necessarily mean the money is 'stolen.' It may be used to produce output that the bureaucrat values, e.g., research in a teaching college that the Dean does not value.

Using the Revelation Principle, we impose the following incentive constraints on the bureaucrat's maximization problem:

$$t_i - \frac{c_i}{2}X_i^2 \geq t_j - \frac{c_i}{2}X_j^2 \quad \text{for } i, j = L, H, \qquad (IC_i)$$

along with the participation constraints,

$$t_i - \frac{c_i}{2}X_i^2 \geq 0 \quad \text{for } i = L, H, \qquad (IR_i)$$

and the budget constraints,

$$t_i \leq B \quad \text{for } i = L, B. \qquad (BG_i)$$

(IC_i) and (IR_i) are standard constraints in a model of adverse selection, and (BG_i) is the budget constraint limiting the transfers to the agent by the budget B available to the bureaucrat.

We use the *standard second-best contract* as our benchmark, but we label it *the private procurement contract* as it characterizes the optimal contract for a principal who can observe output and can therefore contract directly with an agent. As noted above, a key difference between our model of bureaucracy and private procurement is the principal's (funding authority) inability to observe output. Thus, our analysis can also be thought of as characterizing optimal contracts

[18] In Section 5, we allow the funding authority to monitor the bureaucrat such that it can control how the budget is spent by the bureaucrat.

under the two different monitoring technologies. The private procurement contract, (PP), is given by the menu: [19]

$$X_H^{PP} = \frac{q_H}{q_H c_H + q_L \Delta c}, t_H^{PP} = \frac{c_H}{2}(X_H^{PP})^2;\ X_L^{PP} = \frac{1}{c_L}, t_L^{PP} = \frac{c_L}{2}(X_L^{PP})^2 + \frac{\Delta c}{2}(X_H^{PP})^2 \qquad (PP)$$

The low-cost (efficient) type produces at the efficient level and obtains a rent whereas the high-cost (inefficient) type has his output distorted below the efficient level and receives no rent. This is a separating contract that sorts agents based on their types. The low-cost type produces more than what the high-cost type does, $X_L^{PP} > X_H^{PP}$, which implies that $t_L^{PP} > t_H^{PP}$.

We define the ratio of outputs, $\frac{X_L}{X_H}$, as the *power of incentives*. If $X_L = X_H$, there are no incentives: the agent produces the same output and receives the same transfer regardless of the state. As stronger incentives must induce a higher effort/output when the cost is low, the ratio $\frac{X_L}{X_H}$ is a simple but informative measure of the power of incentives in a procurement contract with adverse selection. Next, we will study how the power of incentives varies with B and k in bureaucracies.

3. The bureaucrat's problem

We begin our main analysis with the bureaucrat's problem taking as given the budget B from the funding authority. The bureaucrat maximizes (1), such that (IC_i), (IR_i), and (BG_i), for $i = L, H$, are satisfied.

Note that this problem is different from the private procurement benchmark in two ways: the objective function (1) includes two new parameters, k and B, and there are two new budget constraints (BG_i). As explained below, the bureaucrat will offer the private procurement contract only if neither budget constraints are binding and $k = 1$. Thus, there are two sources of departures from the private procurement contract, those implied by a binding budget, and those implied by $k < 1$. A binding budget may prevent the bureaucrat from having enough resources to implement the private procurement contract even if $k = 1$. If $k < 1$, the bureaucrat will not implement the

[19] It can be characterized by maximizing $q_L X_L + q_H X_H - q_L t_L - q_H t_H$ such that (IC_i) and (IR_i), for $i = L, H$, are satisfied. See, for example, Laffont and Tirole (1993).

private procurement contract even with an unlimited budget as the marginal cost of transfers is smaller. The focus of this article is to study how the interaction of a binding budget and a bureaucrat's intrinsic motivation shapes the optimal contract offered by the bureaucrat.

The first analytic departure from the private procurement benchmark is that the typically ignored (IC_H) becomes relevant. In the private procurement case, the low-cost agent produces the efficient level of output and receives an information rent, whereas the (IC_H) can be ignored as the high-cost agent does not want to claim that his cost is low. However, with a budget constraint, the private procurement t_L may exceed the budget. Then, it may be optimal to distort X_L below the efficient level. If (IC_H) is ignored, X_L could fall below X_H, which would violate (IC_H). As (IC_L) is binding in equilibrium, to make the exposition simpler, we can replace (IC_H) with the following monotonicity condition:

$$X_L \geq X_H. \qquad (M)$$

We can verify ex post that (IC_H) is satisfied by our optimal contract.[20] If the constraint (M) is binding, the optimal contract is *pooling*, and otherwise, it is *separating*.

As usual, we can ignore (IR_L) as it is implied by (IR_H) and (IC_L), and given $X_L \geq X_H$, the constraint (IC_L) implies that $t_L \geq t_H$. Therefore, (BG_H) will be satisfied if (BG_L) holds. Based on these arguments, we can present the bureaucrat's problem using only the relevant constraints:

$$\max_{X_L, X_H, t_L, t_H} (1)\text{, subject to } (IR_H), (IC_L), (BG_L), \text{and } (M) \qquad (BP)$$

Note that (IR_H) and (IC_L) are binding because otherwise the bureaucrat could reduce the transfers and gain. Substituting t_L and t_H using the binding (IR_H) and (IC_L), we can rewrite the budget constraint as:

$$B - \left(\frac{c_L}{2}X_L^2 + \frac{\Delta c}{2}X_H^2\right) \geq 0, \qquad (BG_L)'$$

and write the Lagrangian as:

$$L = q_L X_L + q_H X_H + k\left[B - q_L\left(\frac{c_L}{2}X_L^2 + \frac{\Delta c}{2}X_H^2\right) - q_H\frac{c_H}{2}X_H^2\right] + \lambda\left[B - \left(\frac{c_L}{2}X_L^2 + \frac{\Delta c}{2}X_H^2\right)\right] + \mu(X_L - X_H),$$

[20] It is easy to check that binding (IC_L) and (M) imply that (IC_H) holds.

where $\lambda \geq 0$, $\mu \geq 0$ are the Lagrange multipliers for $(BG_L)'$ and (M), respectively.

Equilibrium contracts

The equilibrium contracts depend on whether the two constraints, $(BG_L)'$ and (M), are binding or not.

Proposition 1: *If* $B \geq \bar{B}(k) \equiv \frac{c_L}{2}\left[\frac{1}{kc_L}\right]^2 + \frac{\Delta c}{2}\left[\frac{q_H}{k(q_H c_H + q_L \Delta c)}\right]^2$*, the budget constraint is not binding, and it is optimal for the bureaucrat to offer a separating contract. If* $B < \bar{B}(k)$*, the budget constraint is binding, and either a pooling or a separating contract can be optimal.*

Proof: In Appendix A.

For large values of B (i.e., $B \geq \bar{B}(k)$), the bureaucrat's problem is standard as the budget constraint is not binding, and the optimal contract is given by:

$$X_H^N = \frac{q_H}{k(q_H c_H + q_L \Delta c)}, t_H^N = \frac{c_H}{2}(X_H^N)^2;\ X_L^N = \frac{1}{kc_L}, t_L^N = \frac{c_L}{2}(X_L^N)^2 + \frac{\Delta c}{2}(X_H^N)^2 \quad (2)$$

where the superscript N refers to "Non-binding budget."

This contract is very similar to the private procurement contract (PP) and is identical if k = 1. For k < 1, the outputs are larger than those under the private procurement. Intuitively, with an unrestricted budget, the bureaucrat increases the output until the marginal value of output equals the marginal cost (including information rents) evaluated at rate k. So the separating equilibrium occurs because the agents' marginal costs are different and overproduction occurs because the bureaucrat evaluates the marginal cost at a lower rate than the private principal. The cut-off level of budget $\bar{B}(k)$ gives the bureaucrat just enough money to implement X_L^N by paying t_L^N.

For small values of B (i.e., $B < \bar{B}(k)$), the budget constraint is binding. We consider this case for the rest of this section. We will show later in Section 4 that the funding authority will pick a budget such that the bureaucrat's budget constraint is binding in equilibrium. The main impact of a binding budget is an additional (implicit) cost of increasing either of the outputs. As $B = \frac{c_L}{2}X_L^2 + \frac{\Delta c}{2}X_H^2$, an increase in one output must be accompanied by a reduction in the other. This additional cost plays a critical role in the occurrence of pooling. Indeed, depending on parameter values, either pooling or separation can be optimal. As shown in Appendix A, the optimal separating contract is given by:

$$X_H^S = \frac{q_H}{k(q_H c_H + q_L \Delta c) + \lambda \Delta c}, t_H^S = \frac{c_H (X_H^S)^2}{2}; X_L^S = \frac{q_L}{k q_L c_L + \lambda c_L}, t_L^S = B, \qquad (3)$$

where λ is obtained from the binding budget constraint $(BG_L)'$. The optimal pooling contract is:

$$X^P = \sqrt{\frac{2B}{c_H}}, t^P = B. \qquad (4)$$

Using (3), it is easy to check that pooling occurs if:

$$\lambda(q_H c_L - q_L \Delta c) \geq k q_L \Delta c, \qquad (P)$$

as $X_L \leq X_H$ when this condition holds. Thus, pooling can only occur if the budget is binding ($\lambda >$ 0), and therefore the additional implicit cost of increasing output comes into play. However, whether pooling will actually occur is determined by the bureaucrat's balancing of her twin objectives of output and unspent budget.

By considering the special case of $k = 0$, we can abstract from the effect of the bureaucrat's preference for policy drift and characterize a necessary condition for pooling:

$$q_H c_L - q_L \Delta c \geq 0. \qquad (NP)$$

Thus separation is optimal if (*NP*) *does not* hold. In contrast, if (*NP*) holds, either separation or pooling can be optimal depending on values of k and λ.

Different preference for policy drift *k*

We now turn our attention to the effects of k and B on the power of incentive schemes and the expected output, given that the budget is binding. We start with looking at the impact of changing the bureaucrat's preference for policy drift, her motivation.

Proposition 2: *In a pooling contract, the output and power of incentives are independent of k, the motivation of the bureaucrat. In a separating contract, the more motivated the bureaucrat (smaller k), the larger the expected output and the lower the power of incentives.*

Proof: In Appendix A.

For pooling contracts, it is easily seen from (4) that the output is independent of k: pooling contracts ignore incentives as they require a constant output, X^P, irrespective of the actual cost of production.

For separating contracts, it is intuitive, and proved in Appendix A, that an increase in k makes the budget constraint less tight (λ falls as the bureaucrat is now less interested in output). However, the impact of k on the outputs is not immediate from (3). A key insight is that the bureaucrat has a larger unspent budget under a stronger incentive scheme. Given a fixed B, the bureaucrat can increase the unspent budget only by reducing X_H. Therefore, she lowers X_H if her preference for policy drift, k, increases. The reduction of X_H implies that the rent given to the low-cost agent decreases, which allows the bureaucrat to increase X_L and pursue her parallel objective of obtaining high output. In other words, for given binding budgets, bureaucracies will tend to have lower-powered incentives if bureaucrats are more motivated (small k).

Our model suggests a new argument why bureaucracies may find lower-powered incentives optimal: the lower value of an unspent budget for a more motivated bureaucrat under the constraint of fixed budgets.

The expected output falls with k because, with a given budget, the bureaucrat sacrifices expected output in favor of a larger unspent budget. Technically, given convex cost, more dissimilar output levels (making X_L/X_H larger) would violate the fixed budget unless the expected output is reduced. Then, the expected output, $E[X^S]$, decreases with k as X_L/X_H increases with k. Therefore, bureaucracies with more motivated bureaucrats produce higher output.

Different levels of budget *B*

We now examine the new features implied by a change in the budget B. Clearly, this is only relevant when the budget is binding.

Proposition 3: *In a pooling contract, the output increases with the budget, but the power of incentives remains constant. In a separating contract, the larger the budget, the larger the expected output and the higher the power of incentives.*

Proof: In Appendix A.

The more interesting case is the separating contract as the pooling case immediately follows from (4). To analyze the effect of changing *B* on separating contracts, we rely on (3). As a decrease in *B* tightens the budget constraint $(BG_L)'$ and increases its shadow value, λ, both outputs decrease with the budget. The power of incentives falls as the budget decreases. With a binding budget, there is an additional implicit cost of increasing output as noted earlier. A decrease in *B* implies that the bureaucrat has to decrease the expected output. As she values both output and unspent budget, she distributes the negative impact of a decreased budget by reducing her unspent budget, which results in a decrease in the power of incentives. Technically, a decrease in *B* implies a decrease in t_L, which has a direct impact on X_L but only an indirect impact on X_H via the rent. Accordingly, the bureaucrat decreases X_L more than X_H.

Our model suggests a new argument why bureaucracies may find lower-powered incentives optimal: bureaucrats are under-funded.

When is pooling likely?

Having established how output and the power of incentive schemes are affected by the two key parameters, k and B, we can now state when pooling is likely.

Proposition 4: *Given that (NP) holds, there exist* $k_T(B) > 0$ *and* $B_T(k) > 0$ *such that pooling occurs if* $k \leq k_T(B)$ *or* $B \leq B_T(k)$. *Furthermore,* $\frac{\partial k_T(B)}{\partial B} < 0$ *and* $\frac{\partial B_T(k)}{\partial k} < 0$.

Proof: In Appendix A.

From Propositions 2 and 3, the power of incentives falls as *B* and *k* decrease. A smaller budget or a stronger preference for output, both imply a tighter budget constraint (λ increases), which makes it more likely that the pooling condition (*P*) will be satisfied, provided the necessary condition (*NP*) holds.

To clarify the key ideas behind Proposition 4, we use an example to illustrate how the output changes with *k* for a given *B*: $c_L = 0.1$; $c_H = 0.15$; $q_L = q_H = 0.5$; $B = 3.33$ (see Figure 1). Consider first the extreme case where $k = 0$. A pooling contract is optimal as the bureaucrat places no value on the unspent budget. As *k* increases, the bureaucrat moves from offering a pooling to a separating contract, which happens at the critical value k_T. For higher values of *k*, the bureaucrat decreases the expected output as she puts more value on the unspent budget.

The critical value k_T depends on the budget. As B increases, the potential gain from the unspent budget (kq_H (B–t_H)) increases as well because t_H increases but by less than the increase in B. Thus, the bureaucrat begins to offer a separating contract for a smaller k when budgets are larger, and the value of the unspent budget outweighs the loss in expected output.

Figure 1 about here

Using the same example as above, we show in Figure 2 how the outputs change with B for a given k (= 0.5). For small budgets, the bureaucrat offers a pooling contract. The unspent budgets obtained by offering a separating contract are not worth the loss in expected output. This is because convex costs make it less costly to increase output for small budgets. As the budget increases, the bureaucrat will eventually offer a separating contract to enjoy the unspent budgets and the power of incentives will increase.

Figure 2 about here

B_T is the critical budget level dividing the pooling and separating regions. As the pooling condition depends on k, the critical B_T also depends on k. With a higher k, the bureaucrat benefits more from the unspent budget. Because only separating contracts generate the unspent budget, the bureaucrat begins to offer a separating contract earlier (smaller B) for higher values of k.

To summarize, for large values of k, the bureaucrat cares more about the unspent budget, which can be enjoyed only if she offers a separating contract. In contrast, for small values of k, the bureaucrat cares more about output levels and offers a pooling contract whose output is greater than the output of a separating contract for a given budget (assuming (*NP*) holds). Similarly, given a large B, the bureaucrat can afford to create a large unspent budget, which is only possible under separation. For a small B, the bureaucrat focuses only on expected output by offering a pooling contract which does not leave any unspent budget.

4. The funding authority's problem

In Section 3, we characterized the optimal contract a bureaucrat would offer an agent given a fixed budget from the funding authority. In this section, we will discuss the role of *B* and *k* in the funding authority's problem anticipating the optimal contract offered by the bureaucrat.

The role of the budget *B*

In this subsection, we allow the funding authority to choose the size of the budget given a *k*. We show that this choice will induce the bureaucrat to offer lower-powered contracts relative to a private procurement contract.

Proposition 5: *The funding authority offers a budget $B(k) < \bar{B}(k)$ which implies that the bureaucrat's budget constraint is binding. Given a binding budget, the bureaucrat offers a lower-powered incentive scheme than in the private procurement case.*

Proof: In Appendix A.

With the ability to offer only a fixed budget to a bureaucrat, the funding authority sees the incentive contract differently than it would if it could contract directly with the agent. As a result, it will offer the bureaucrat a restrictive budget. To see this, consider the separating contract in the extreme case of $k = 1$, where the bureaucrat and the funding authority have identical relative values of money. [21] If the budget is not binding, the bureaucrat would implement the private procurement outputs, but the funding authority would not be pleased because the bureaucrat would appropriate the unspent budget. Because it must give a fixed budget, the funding authority is not able to save money when the cost is high (and the output is small), which it would be able to do in a private procurement contract. The funding authority's marginal cost of the contract offered to the agent (through a fixed budget) is larger than the bureaucrat's marginal cost (through a contingent transfer). This implies that the bureaucrat would produce more than what the funding authority wants if she had access to an unlimited budget. Therefore, the funding authority wants to give a smaller budget to the bureaucrat than the amount necessary to implement the private procurement outputs even when $k = 1$. For the bureaucrat, then, the budget constraint is binding.

[21] In a pooling contract, the power of incentives is trivially smaller than under private procurement because there is no pooling under private procurement.

For $k < 1$, if the budget was not binding, the bureaucrat would even overproduce more relative to the case where $k = 1$ because she has a stronger preference for output (as shown in Section 3). It implies that the funding authority would again give her a small budget to insure that the constraint is binding. Therefore, the budget constraint is always binding in the bureaucrat's problem (i.e., $B(k) < \bar{B}(k)$).

With a limited budget, the bureaucrat has to decrease outputs. To balance her twin objectives of output and unspent budget, she decreases the unspent budget, resulting in lower-powered incentives as argued in Proposition 3. Technically, from Propositions 2 and 3, the power of incentive schemes increases with both *k* and *B*, and we also know that the private procurement benchmark corresponds to the case where *k* = 1 and *B* is unrestricted. Thus, the fact that the budget is always limited for any *k* implies that the power of incentives is lower in a bureaucracy than in the private procurement benchmark.

It is worth noting that a contract with strong incentives is not necessarily attractive to the funding authority when it must offer a fixed budget. With a fixed budget, stronger incentives are associated with large unspent budgets, which are costly for the funding authority.

The role of the bureaucrat's preference for policy drift *k*

Although we have shown that the budget is binding regardless of *k* in Proposition 5, we have not discussed how the optimal budget varies with *k*. In this subsection, we first show that the optimal budget declines with *k*, i.e., less motivated bureaucrats receive smaller budgets. This result raises an interesting tradeoff regarding the power of incentives when the budget is endogenous: although less motivated bureaucrats tend to offer higher-powered incentives (see Proposition 2), they also receive smaller budgets implying lower-powered incentives (see Proposition 3). We later show which effect dominates and conclude this subsection by discussing the optimal value of *k* for the funding authority.

To understand how the optimal budget varies with *k*, we must solve the funding authority's problem for different values of *k*. This problem is complex because it requires the funding authority to anticipate the bureaucrat's optimization problem that itself results in different types of equilibria. That is, the funding authority's problem is a nested problem. Although we do not provide a formal proof, we present a numerical example with various parameter values and find that the optimal budget is weakly decreasing in k (see Appendix B).[22]

The intuition is as follows. Recall that the funding authority allocates the fixed budget to maximize its expected net benefit, $q_L X_L + q_H X_H - B$. It anticipates that for higher values of k the bureaucrat offers a stronger incentive scheme. However, the bureaucrat does so to engage in policy drift (by increasing the amount of unspent budget), which comes at the cost of a lower expected output. Therefore, for higher values of k, the funding authority curtails the bureaucrat's ability to engage in policy drift by lowering the budget.

We show in Appendix B that the power of incentives rises with k even when the budget is endogenous.[23] This is not a priori obvious as the budget size counteracts the bureaucrat's preference for offering strong incentive schemes to her agent. We find that in response to an increase in k, the funding authority lowers the budget, but it is too costly to completely counteract the bureaucrat's preference. Similarly, more motivated bureaucrats still offer lower-powered incentive schemes despite the higher budgets offered by the funding authority. This leads us to ask which type of bureaucrat would the funding authority prefer if it had a choice.

Proposition 6. *The funding authority's payoff is non-increasing in k, i.e., it prefers a more motivated bureaucrat.*

Proof: In Appendix A.

This is not trivial as the preferences of a more motivated bureaucrat are not necessarily better aligned with those of the funding authority as she puts too small a weight on the cost of production. The funding authority prefers a more motivated bureaucrat because she offers a lower-powered incentive scheme to her agent, which leads to a smaller unspent budget and larger expected output. Of course, the above intuition is relevant only when the bureaucrat offers a separating contract. The funding authority has no preference over k if the bureaucrat were to offer a pooling contract as the output would be independent of k and there would be no unspent budget.

Our result is complementary to Besley and Ghatak (2005). They argue that matching motivated agents to mission-oriented tasks acts as a substitute for high-powered incentives and

[22] For instance, if $\left(\partial^2 X_H / \partial k \partial B\right) \leq 0$, then we can formally show that the optimal budget is weakly decreasing in k.

[23] But, as shown in Proposition 5, the power of incentives is always less than in the private procurement contract.

leads to more efficient outcomes. Thus a motivated bureaucrat would receive a low-powered incentive scheme but will nevertheless be productive. Examining contracts offered by a bureaucrat under a fixed budget, we also find that the funding authority prefers a more motivated bureaucrat despite the fact that the bureaucrat will offer lower-powered schemes to her agents. The funding authority will offer the more motivated bureaucrat a larger budget and obtain a higher expected output. Combining the messages of the two articles, we may conclude that efficient bureaucracies may be characterized by large budgets and low-powered incentives schemes, both for contracts offered *to* the bureaucrat and *by* the bureaucrat, whereas the expected output may remain high.

5. Extensions

Bureaucrat's accountability: tighter control by the funding authority

Up to now, we have assumed that the funding authority has little control over the bureaucrat as it cannot observe the output or the unspent budget. Suppose now that the funding authority can create accountability by exerting some control over how the budget is spent and increase its effective utilization. Tighter control by the funding authority makes it difficult for the bureaucrat to divert funds from the production of the agency's main mission. Not surprisingly, we first show that tighter control allows the funding authority to be better off because it can offer larger budgets and increase expected output. Less obviously, the bureaucrat may also benefit from tighter control. The reason is that the bureaucrat benefits from the larger budget allocated by the funding authority. Even though the tighter control limits the bureaucrat's ability to benefit from the unspent budget, she receives a larger budget. The overall effect is in general uncertain, but we present cases where the bureaucrat benefits from tighter control by the funding authority.

We model the funding authority's control in a simple way by assuming that it reduces the value of the unspent budget.[24] If the funding authority exerts control with intensity $p \geq 0$, the bureaucrat's relative value of money is given by a decreasing function of p: $\hat{k}(p,k) \in [0,k]$, where $\hat{k}(0,k) = k$. We assume that control is costly and that the funding authority can commit to the control intensity. The bureaucrat's objective function is now:

$$U = q_L X_L + q_H X_H + \hat{k}(p,k)[B - q_L t_L - q_H t_H].$$

[24] See Pagano and Roell (1998) or Khalil et al. (2007) for similar models of monitoring.

If the funding authority does not exert any control (p = 0), our previous model applies. Given B and p, the bureaucrat solves her own problem with the same (*IC*) and (*IR*) constraints as before and determines the optimal outputs and transfers for the agent, $X_i(B, \hat{k}), t_i(B, \hat{k})$.

The impact of control is to lower the value of the unspent budget; the '*effective k*' is now $\hat{k}$, which leads to more resources being spent on producing output given any budget. Thus, we find that if the funding authority can control budget expenditures, it will offer the bureaucrat a larger budget. The bureaucrat will respond by producing a higher (expected) output and lowering the power of incentives.

With greater accountability, i.e., tighter control, the bureaucrat benefits less from the unspent budget or policy drift but also receives a larger budget. The overall effect on her utility is ambiguous. In Appendix C, we show that a bureaucrat can actually be better off if the hidden information problem with the agent is not too large, i.e., if the difference in the cost types, $\Delta c = c_H - c_L$, is small. Intuitively, when Δc is small, the funding authority is less concerned about the bureaucrat pursuing policy drift as the unspent budget is very small. This is because the two types of agents are not very different and receive similar contracts. In other words, the bureaucrat may actually like increased accountability because the funding authority is now willing to allocate larger budgets.

Delegation and centralization

In the main model, we assumed that the funding authority delegates to the bureaucrat the authority to contract with the agent. An alternative contractual arrangement, called centralization, would be for the funding authority to contract with the agent directly and use the bureaucrat to monitor the output. If the bureaucrat was free and honest, centralization would allow the funding authority to reach the second best. An interesting question is whether centralization is still a better contractual arrangement if the bureaucrat can collude with the agent and misreport information. This is the focus of an insightful literature, pioneered by Laffont and Martimort (1998), Faure-Grimaud et al. (2003), Mookherjee and Tsumagari (2004), Celik (2009) and surveyed recently in Mookherjee (2012).

As is well known from this literature, by an argument akin to the Revelation Principle, delegation can be at best equivalent to centralization even under the threat of collusion. Our model, however, is different from this literature in that the funding authority does not observe output and its contracts are based on the bureaucrat's report of the output. This creates new issues relative to the standard models in the literature.

In our model of centralization, we retain the same information structure, preferences, and bargaining power as under delegation. The timing is as follows: 1) The funding authority offers a grand contract to the bureaucrat and the agent based on the bureaucrat's report of the agent's output and the agent's report of his realized cost. Because the funding authority cannot observe output, she can only make the transfers contingent on the bureaucrat's report about the output, not the output itself. 2) Once the grand contract is accepted by both, the bureaucrat offers a side contract to the agent that specifies the output to be produced, the side transfers, and the reports to be made to the funding authority. The side contract is assumed to be enforceable so the bureaucrat and agent can commit to future side transfers and to their reports to the funding authority when they participate in the grand contract.[25] 3) After accepting (or rejecting) the side contract, the agent reports his cost to the funding authority and produces output. 4) The bureaucrat reports the output to the funding authority.[26] 5) The transfers and side transfers take place.

In the side contract, the bureaucrat's problem is analogous to a standard second-best contract as the bureaucrat observes the output but not the agent's cost. However, if the agent rejects the side contract, he plays the grand contract non-cooperatively, and his reservation utility in the side contract is determined by the grand contract. The funding authority can anticipate the optimal side contract and therefore influence it when designing the grand contract.

Because the funding authority does not observe output, it has to rely on the bureaucrat in order to induce production by the agent as under delegation. In addition, to prevent collusion between the bureaucrat and agent, the sum of grand-contract transfers to the agent and bureaucrat must be independent of the bureaucrat's output report.[27] This appears as a fixed expenditure in the funding authority's objective function. A notion of fixed budgets reappears but endogenously.

[25] See Tirole (1986, 1992), and Kofman and Lawarree (1993). Martimort (1999) provides a dynamic foundation for self-enforceable side contracts.
[26] We assume that when the bureaucrat is indifferent, she reports the truth about the output.
[27] It is because the coalition always offers the reports that maximize the sum of transfers from the principal. In equilibrium, this translates into constraint (NM^G) in Appendix C.

These two features (relying on the bureaucrat to induce production and fixed budget) are also the same key characteristics of our delegation model and therefore it is not clear how centralization is able to improve upon delegation in our model. However, in the grand contract, the funding authority can determine how the 'fixed budget' is allocated between the agent and the bureaucrat because it directly pays the transfer to the agent. We explain below that this allows the funding authority to improve upon the delegation outcome by creating countervailing incentives in the side contract.

Under delegation, due to her preference for policy drift, the bureaucrat increases the unspent budget at the cost of a lower expected output. She distorts X_H downwards to create more unspent budget. Under centralization, as the funding authority can directly control the transfer to the agent, it can counteract this effect. The funding authority can increase the transfer to the high-cost agent in the grand contract to induce a higher X_H, which would increase the low-cost agent's rent. Since this rent is his outside option in the side contract, the bureaucrat will not be able to reverse the increase in X_H because the low-cost agent will refuse the side contract otherwise. This can create a well-known countervailing incentive in the side contract, and increase the efficiency of centralization over delegation by mitigating the adverse impact of the bureaucrat's preference for policy drift.

We can now show that the creation of countervailing incentives also results in lower-powered incentives under the centralization compared to delegation. This is again because the funding authority counteracts the distortion in outputs due to the bureaucrat's preference for policy drift and makes the two output levels closer together to increase the expected output under centralization. Then, using Proposition 5, we conclude that our key insight about lower-powered incentives in a bureaucracy holds even under centralization.

Proposition 7: *Under centralization, the agent is given lower-powered incentives than in the private procurement case.*

Proof: In Appendix C.

In addition to the power of incentives, the above discussion clarifies the reason why delegation cannot replicate the outcome of centralization. Under delegation, with the ability to determine only the size of budgets, the funding authority lacks enough instruments to control the output distortion due to the bureaucrat's preference for policy drift. However, if the bureaucrat's preference for policy drift does not distort the output choice under delegation, delegation is equivalent to centralization: *Delegation is equivalent to centralization when $k = 0$, or when there is pooling under delegation. Otherwise, delegation is strictly dominated.* [28]

To the extent that policy drift can be controlled[29] and pooling characterizes bureaucratic contracts, our delegation model can be justified. However, in other cases, we must rely on arguments outside our model. Besides the reasons discussed in the introduction to motivate delegation, there is also a literature that directly justifies delegation over centralization. The trade-off between control and the use of better information is the focus in the articles by Dessein (2002) and Hiriart and Martimort (2012). Beaudry and Poitevin (1995) model how delegation can address the principal's lack of commitment ability. Melumad et al. (1992, 1997) argue that centralization is less effective in the presence of communication costs and contractual complexity. Laffont and Martimort (1998) also emphasize communication costs and the role of bargaining power in the hierarchy. In general, when the funding authority cannot control the allocation of the transfers to the agent, centralization will no longer dominate delegation.

Non-linear value function of unspent budget

In the base model, we assumed a linear value function for the unspent budget, $k(B-t)$, but we now consider a more general formulation. The bureaucrat's preference for policy drift is given by the non-linear function $V(B-t)$, where $lim_{t\to B}V'(B-t) = \infty, V'(\cdot) > 0 > V''(\cdot)$. There are two key benefits of this formulation. First, the bureaucrat's marginal value of the unspent budget becomes very large as the unspent budget becomes small. [30] Second, as a result of these large marginal values, we will see that the budget is not binding, which allows us to characterize the power of incentives without the impact of a binding budget. We find that our main result still holds: due to the bureaucrat's preference for policy drift, the power of incentives offered by the bureaucrat remains lower than that in the private procurement contract.

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[28] See Appendix C for details.

[29] See for instance the previous subsection on tighter control by the funding authority.

[30] In our main model, the result on the power of incentive holds for the case of $k > 1$ as well. The key idea of examining the large marginal value of unspent budget is to explore the implication of relaxing the binding budget, which we now do in a more general manner in this subsection. But, if we were to continue with our base model with k, note that the optimal quantities offered by the bureaucrat, given by (3), are still valid for $k > 1$. A little algebraic manipulation shows that the power of incentives given by the outputs in (3) is lower than that under private procurement if $\lambda > 0$. As the ratio X_L/X_H is identical to that under private procurement when $\lambda = 0$, this completes the proof.

The bureaucrat's objective function is now given by:

$$U = q_L X_L + q_H X_H + q_L V(B - t_L) + q_H V(B - t_H).$$

The marginal value of the unspent budget is the opportunity cost of producing more output, and this cost becomes very high as the unspent budget becomes small. Thus, the bureaucrat will always want to keep some unspent budget even when the cost of production is low (c_L), indicating that the budget will not be binding ($\lambda = 0$). Recall from our discussion in Section 3 that $\lambda > 0$ is necessary for pooling to occur.

Because the incentive and participation constraints for the agent remain unchanged, we will still have $t_L = \frac{c_L}{2} X_L^2 + \frac{\Delta c}{2} X_H^2$ and $t_H = \frac{c_H}{2} X_H^2$, with $t_L > t_H$ in equilibrium. Maximizing the bureaucrat's objective function above, subject to (IR_H), (IC_L), (BG_L), and (M), the optimal separating equilibrium outputs are given by

$$X_L = \frac{1}{V'(B - t_L) c_L}, X_H = \frac{q_H}{V'(B - t_H) q_H c_H + V'(B - t_L) q_L \Delta c},$$

which would be identical to the private procurement benchmarks X_L^{PP} and X_H^{PP} if $V'(\cdot) \equiv 1$. The power of incentives is given by

$$\frac{X_L}{X_H} = \frac{1}{c_L}\left[\frac{V'(B - t_H)}{V'(B - t_L)} c_H + \frac{q_L}{q_H} \Delta c\right],$$

which is strictly less than the power of incentives under private procurement, $\frac{1}{c_L}\left(c_H + \frac{q_L}{q_H} \Delta c\right)$, as $\frac{V'(B - t_H)}{V'(B - t_L)} < 1$.

The bureaucrat's preference for policy drift represents the opportunity cost of increasing output and this cost is higher for X_L as $t_L > t_H$. This leads to low powered incentives as reducing t_L leads to a greater reduction in X_L for the same reasons as in Section 3. [31] Therefore, we are able to generalize our result that the power of incentive is lower than in the private procurement contract due to the bureaucrat's preference for policy drift.

[31] As already noted in Section 3, reducing X_L is more effective in lowering t_L as it directly lowers cost of production, whereas reducing X_H lowers t_L indirectly by lowering the rent.

6. Conclusion

Bureaucrats who operate under the budget rule “use it or lose it” are expected to return any unspent budget at the end of a fiscal year. Instead, they tend to view unspent budgets as discretionary and go on spending sprees towards the end of the fiscal year even though much of the expenses are not in the interest of the funding authority. This phenomenon is known as policy drift. Sometimes, bureaucrats even “park” the unspent budget in “no year” accounts. Staffers from the Homeland Security and Government Affairs Subcommittee on Federal Financial Management, Government Information, and International Security estimated such amount to be $376 billion in 2006.[32]

In this article, we investigated how fixed budgets and the bureaucrats’ preference for policy drift affect the optimal incentive contract offered by bureaucrats. Policy drift and fixed budgets, which can be interpreted as low-powered incentive schemes offered to bureaucrats, translate into low-powered incentive schemes offered by bureaucrats to agents. Thus, bureaucracies exhibit low-powered incentives throughout the hierarchy.

We showed that contracts in bureaucracies may offer flat incentives for small budgets. Even though it ultimately lowers the power of incentives, funding authorities find it optimal to limit the budget given to bureaucrats. These results are consistent with the casual observation that contracts in bureaucracies are characterized by a lack of incentives, compared to contracts in private sectors.

If tighter control by funding authorities can reduce policy drift, bureaucrats will be given larger budgets, but the power of incentives will be lower. We showed how the bureaucrat may benefit from stricter accountability as it leads to larger budgets. In an alternative centralized setting, we showed that the power of incentives given to agents is still lower than the private procurement case.

Finally, we showed that funding authorities prefer more motivated bureaucrats, which can explain matching motivated bureaucrats to mission-oriented tasks. Our contribution is to point out that two key features of bureaucracies, fixed budgets and bureaucrats’ taste for policy drift, may explain why contracts in bureaucracies exhibit lower-powered incentives.

[32] http://coburn.senate.gov/ffm/index.cfm?FuseAction=LatestNews.NewsStories&ContentRecord_id= 1f90396c-802a-23ad-4386-174142756310

Appendix A

■ Proof of Proposition 1

From the Lagrangian in Section 3, the first-order conditions with respect to the outputs are:

$$\frac{\partial L}{\partial X_L} = q_L - (kq_Lc_L + \lambda c_L)X_L + \mu = 0, \tag{A1a}$$

$$\frac{\partial L}{\partial X_H} = q_H - (kq_Hc_H + kq_L\Delta c + \lambda\Delta c)X_H - \mu = 0. \tag{A1b}$$

In what follows, we prove that (i) If $B \geq \bar{B}(k) \equiv \frac{c_L}{2}\left[\frac{1}{kc_L}\right]^2 + \frac{\Delta c}{2}\left[\frac{q_H}{k(q_Hc_H+q_L\Delta c)}\right]^2$, (a) $\lambda = 0$ and (b) $X_L > X_H$; (ii) If $B < \bar{B}(k)$, $\lambda > 0$; (iii) Given $\lambda > 0$, (a) $X_L > X_H$ if $\lambda(q_Hc_L - q_L\Delta c) < kq_L\Delta c$, and (b) $X_L = X_H$ if $\lambda(q_Hc_L - q_L\Delta c) \geq kq_L\Delta c$.

(i) (a) Suppose to the contrary that $\lambda > 0$ but $B \geq \bar{B}(k)$. If $\mu = 0$, from (A1a) and (A1b), $X_L = \frac{q_L}{kq_Lc_L+\lambda c_L} < \frac{1}{kc_L}$ and $X_H = \frac{q_H}{kq_Hc_H+kq_L\Delta c+\lambda\Delta c} < \frac{q_H}{kq_Hc_H+kq_L\Delta c}$. If $\mu > 0$, $X_L = X_H = \frac{q_H-\mu}{kq_Hc_H+kq_L\Delta c+\lambda\Delta c} < \frac{q_H}{kq_Hc_H+kq_L\Delta c} < \frac{1}{kc_L}$ from (A1b). Thus, in both cases, $\frac{c_L}{2}X_L^2 + \frac{\Delta c}{2}X_H^2 < \bar{B}(k) \leq B$, which implies $\lambda = 0$, and we have a contradiction. (b) $X_L > X_H$ if $\lambda = 0$. This follows immediately from (A1a) and (A1b).

(ii) Suppose to the contrary that $\lambda = 0$. Then $\mu = 0$ because $X_L > X_H$ from (i) above. From (A1a) and (A1b), $X_L = \frac{1}{kc_L}$ and $X_H = \frac{q_H}{k(q_Hc_H+q_L\Delta c)}$. Thus $\frac{c_L}{2}X_L^2 + \frac{\Delta c}{2}X_H^2 = \bar{B}(k) > B$, which is a contradiction as it violates the (BG_L) constraint.

(iii) (a) Suppose to the contrary that $X_L = X_H$ but $\lambda(q_Hc_L - q_L\Delta c) < kq_L\Delta c$. Given that $\lambda > 0$, from (A1a) and (A1b), $X_L = \frac{q_L+\mu}{kq_Lc_L+\lambda c_L} > X_H = \frac{q_H-\mu}{kq_Hc_H+kq_L\Delta c+\lambda\Delta c}$, which is a contradiction. (b) Suppose to the contrary that $X_L > X_H$ but $\lambda(q_Hc_L - q_L\Delta c) \geq kq_L\Delta c$. Then $\mu = 0$. Given that $\lambda > 0$, from (A1a) and (A1b), $X_L = \frac{q_L}{kq_Lc_L+\lambda c_L} \leq X_H = \frac{q_H}{kq_Hc_H+kq_L\Delta c+\lambda\Delta c}$, which is a contradiction.

Q.E.D.

■ Proof of Proposition 2

For a pooling contract, it immediately follows from (4) that the output and the power of incentives are independent of k.

For a separating contract, we first give the following claim.

Claim 1: *For a given* $B < \bar{B}(k)$, $\frac{\partial \lambda}{\partial k} < 0$ *in a separating contract*.

Proof: With $\mu = 0$ for separating outputs, taking derivatives of (A1a), (A1b) and the binding $(BG_L)'$ with respect to *k* gives:

$$-\alpha_0 - \alpha_1 \frac{\partial \lambda}{\partial k} - \alpha_2 \frac{\partial X_L^S}{\partial k} = 0, \quad \text{(A2a)}$$

$$-\beta_0 - \beta_1 \frac{\partial \lambda}{\partial k} - \beta_2 \frac{\partial X_H^S}{\partial k} = 0, \quad \text{(A2b)}$$

$$-\gamma_1 \frac{\partial X_L^S}{\partial k} - \gamma_2 \frac{\partial X_H^S}{\partial k} = 0, \quad \text{(A2c)}$$

where $\alpha_0 = q_L c_L X_L^S$, $\alpha_1 = c_L X_L^S$, $\alpha_2 = kq_L c_L + \lambda c_L$, $\beta_0 = (q_H c_H + q_L \Delta c) X_H^S$, $\beta_1 = \Delta c X_H^S$, $\beta_2 = k(q_H c_H + q_L \Delta c) + \lambda \Delta c$, $\gamma_1 = c_L X_L^S$, $\gamma_2 = \Delta c X_H^S$, and all of these coefficients are positive. From these, $\frac{\partial \lambda}{\partial k} = -\frac{\alpha_0 \beta_2 \gamma_1 + \alpha_2 \beta_0 \gamma_2}{\alpha_0 \beta_2 \gamma_1 + \alpha_2 \beta_1 \gamma_2} < 0$. *Q.E.D.*

With $\mu = 0$, from (A1a) and (A1b),

$$\frac{X_L^S}{X_H^S} = \frac{q_L(kq_H c_H + kq_L \Delta c + \lambda \Delta c)}{q_H(kq_L c_L + \lambda c_L)}, \quad \text{(A2d)}$$

and

$$\frac{\partial}{\partial k}\left(\frac{X_L^S}{X_H^S}\right) = \frac{q_L c_L c_H}{(kq_L c_L + \lambda c_L)^2}\left(\lambda - k\frac{\partial \lambda}{\partial k}\right) > 0 \quad \text{(A2e)}$$

because $\frac{\partial \lambda}{\partial k} < 0$ from Claim 1. Let us define $g \equiv \frac{X_L^S}{X_H^S}$. Then the binding $(BG_L)'$ becomes $B - \frac{c_L g^2 + \Delta c}{2}(X_H^S)^2 = 0$. From this, $\frac{\partial X_H^S}{\partial k} = -2c_L g\sqrt{\frac{2B}{c_L g^2 + \Delta c}}\frac{\partial g}{\partial k} < 0$ because $\frac{\partial g}{\partial k} > 0$ from (A2e). Then, (A2c) implies that $\frac{\partial X_L^S}{\partial k} > 0$.

Finally, to prove that $\frac{\partial E[X^S]}{\partial k} < 0$, denote the optimal outputs by $X_i{}'$ for $k = k'$, with $X_L{}' > X_H{}'$. Let k increase by a small amount to k''. An increase in k implies that X_L increases to $X_L{}''$ and X_H decreases to $X_H{}''$. The bureaucrat's objective function is $E[X^S] + kq_H[B - \frac{c_H}{2}(X_H^S)^2]$.

Thus the second term increases with k, and we claim that the first term $E[X^S]$ must fall. Suppose not. Then the outputs X_i'' yield a higher payoff than X_i' to the bureaucrat with k', which is a contradiction. This is because the outputs X_i'' are feasible under k' (because both X_i' and X_i'' satisfy the budget constraint with the same budget), but not chosen. *Q.E.D.*

■ **Proof of Proposition 3**

For a pooling contract, it immediately follows from (4) that the output increases with B and that the power of incentives is independent of B.

For a separating contract, we first give the following claim.

Claim 2: *For* $B < \bar{B}(k)$, $\frac{\partial \lambda}{\partial B} < 0$ *in a separating contract*.

Proof: With $\mu = 0$, taking derivatives of (A1a), (A1b) and the binding $(BG_L)'$ with respect to B gives:

$$-\alpha_1 \frac{\partial \lambda}{\partial B} - \alpha_2 \frac{\partial X_L^S}{\partial B} = 0, \tag{A3a}$$

$$-\beta_1 \frac{\partial \lambda}{\partial B} - \beta_2 \frac{\partial X_H^S}{\partial B} = 0, \tag{A3b}$$

$$1 - \gamma_1 \frac{\partial X_L^S}{\partial B} - \gamma_2 \frac{\partial X_H^S}{\partial B} = 0, \tag{A3c}$$

where all coefficients α, β, and γ are positive and defined in the proof of Claim 1. From these, $\frac{\partial \lambda}{\partial B} = -\frac{\alpha_2 \beta_2}{\alpha_1 \beta_2 \gamma_1 + \alpha_2 \beta_1 \gamma_2} < 0$. *Q.E.D.*

With $\frac{\partial \lambda}{\partial B} < 0$, $\frac{\partial X_L^S}{\partial B} > 0$ from (A3a) and $\frac{\partial X_H^S}{\partial B} > 0$ from (A3b). Thus $\frac{\partial E[X^S]}{\partial B} > 0$.

Finally, from (A2d),

$$\frac{\partial}{\partial B}\left(\frac{X_L^S}{X_H^S}\right) = -\frac{1}{[q_H(kq_Lc_L + \lambda c_L)]^2} k q_L q_H^2 c_L c_H \frac{\partial \lambda}{\partial B} > 0 \tag{A3d}$$

because $\frac{\partial \lambda}{\partial B} < 0$ from Claim 2. *Q.E.D.*

■ **Proof of Proposition 4**

We first consider $k_T(B)$. For a given $B < \bar{B}(k)$, if (NP) holds, we have $k_T(B) > 0$, which is defined from (P) by:

$$\lambda(B, k_T(B))(q_H c_L - q_L \Delta c) \equiv k_T(B) q_L \Delta c. \tag{A4a}$$

Because $\frac{\partial \lambda}{\partial k} < 0$ from Claim 1, $k_T(B)$ is unique, and (P) is satisfied for $k \leq k_T(B)$.

From (A4a),

$$\frac{\partial k_T}{\partial B} = -\left[\frac{\partial \lambda}{\partial k}(q_H c_L - q_L \Delta c) - q_L \Delta c\right]^{-1} \frac{\partial \lambda}{\partial B} < 0$$

because $\frac{\partial \lambda}{\partial k} < 0$ from Claim 1, $\frac{\partial \lambda}{\partial B} < 0$ from Claim 2, and $q_H c_L - q_L \Delta c > 0$ from (NP).

Next, we consider $B_T(k)$. As B goes to zero, the binding $(BG_L)'$ implies that both outputs must go to zero, which is only true if λ becomes unbounded (see (3)). Then, given that (NP) holds, (P) must be satisfied as a strict inequality because all other variables are bounded. Thus, if (NP) holds, we have $B_T(k) > 0$, which is defined from (P) by:

$$\lambda(B_T(k), k)(q_H c_L - q_L \Delta c) \equiv k q_L \Delta c. \tag{A4b}$$

Because $\frac{\partial \lambda}{\partial B} < 0$ (from Claim 2) and $\lambda = 0$ when $B \geq \bar{B}(k)$, $B_T(k)$ is unique and (P) is satisfied for $B \leq B_T(k)$.

From (A4b),

$$\frac{\partial B_T}{\partial k} = \left(\frac{\partial \lambda}{\partial B}\right)^{-1} \left[q_L \Delta c - \frac{\partial \lambda}{\partial k}(q_H c_L - q_L \Delta c)\right] < 0$$

because $\frac{\partial \lambda}{\partial k} < 0$ from Claim 1, $\frac{\partial \lambda}{\partial B} < 0$ from Claim 2, and $q_H c_L - q_L \Delta c > 0$ from (NP). *Q.E.D.*

■ **Proof of Proposition 5**

First, we prove that the budget is binding, i.e., the funding authority chooses the budget such that $B(k) < \bar{B}(k)$.

Consider the bureaucrat's problem where the budget is not binding: $Max\,(1)$, $s.t.\,(IR_H)$ and (IC_L). Using the binding (IR_H) and (IC_L), the outputs can be expressed as $X_H = X_H(t_H)$ and $X_L = X_L(t_L, t_H)$. Then the bureaucrat's problem becomes

$$\max_{t_L, t_H} q_L X_L(t_L, t_H) + q_H X_H(t_H) + k(B - q_L t_L - q_H t_H).$$

The first-order conditions with respect to t_L and t_H are

$$\frac{\partial X_L(t_L, t_H)}{\partial t_L} = k, \tag{A5a}$$

$$\frac{q_L}{q_H}\frac{\partial X_L(t_L, t_H)}{\partial t_H} + \frac{\partial X_H(t_H)}{\partial t_H} = k. \tag{A5b}$$

The solutions to the above conditions must be $t_L^N(k)$ and $t_H^N(k)$, characterized in (2). Thus $t_L = \bar{B}(k)$.

Call Δ the total derivative of the funding authority's objective function, $q_L X_L(t_L^N, t_H^N) + q_H X_H(t_H^N) - B$, with respect to B:

$$\Delta = q_L\left(\frac{\partial X_L}{\partial t_L}\frac{\partial t_L}{\partial B} + \frac{\partial X_L}{\partial t_H}\frac{\partial t_H}{\partial B}\right)dB + q_H\frac{\partial X_H}{\partial t_H}\frac{\partial t_H}{\partial B}dB - dB = k\left(q_L\frac{\partial t_L}{\partial B} + q_H\frac{\partial t_H}{\partial B}\right)dB - dB,$$

where the last equality follows from (A5a) and (A5b).

Let us evaluate $\frac{\partial t_L}{\partial B}$ and $\frac{\partial t_H}{\partial B}$ at $B = \bar{B}(k)$. As shown in the proof of Proposition 1, the budget constraint will become binding if the budget decreases from $\bar{B}(k)$. From the binding budget constraint, we have $t_L = B$, implying that

$$\frac{\partial t_L}{\partial B} = 1. \tag{A5c}$$

From the binding (IC_L), which should hold as an identity at equilibrium with respect to B and k:

$$t_L = t_H + \frac{c_L}{2}(X_L^2 - X_H^2)$$

Taking the derivative of the above expression with respect to B gives:

$$\frac{\partial t_L}{\partial B} = \frac{\partial t_H}{\partial B} + c_L\left(X_L\frac{\partial X_L}{\partial B} - X_H\frac{\partial X_H}{\partial B}\right). \tag{A5d}$$

The fact that $\frac{\partial}{\partial B}\left(\frac{X_L}{X_H}\right) > 0$ (from Proposition 3) implies that $\frac{\partial X_L}{\partial B} > \frac{\partial X_H}{\partial B}$. Then the last term in (A5d) is positive as $X_L > X_H$. The fact that $\frac{\partial X_H}{\partial B} > 0$ (shown in the proof of Proposition 3) implies that $\frac{\partial t_H}{\partial B} > 0$ from the binding (IR_H). Thus, from (A5c) and (A5d), we have $0 < \frac{\partial t_H}{\partial B} < 1$, and

$$\Delta = k\left(q_L + q_H \frac{\partial t_H}{\partial B}\right) dB - dB < 0.$$

It implies that, when the budget decreases from $\bar{B}(k)$, the funding authority's objective function increases. Therefore, the funding authority can improve its payoff by decreasing the budget below $\bar{B}(k)$.

We now prove by contradiction that as long as the budget is binding ($\lambda > 0$), the power of incentives in the separating contract is smaller than that in the private procurement contract. Suppose to the contrary that the power of incentives is greater than the private procurement contract:

$$\frac{X_L^S}{X_H^S} \geq \frac{X_L^{PP}}{X_H^{PP}} \Leftrightarrow \frac{\left(\frac{q_L}{kq_Lc_L+\lambda c_L}\right)}{\left(\frac{q_H}{k(q_Hc_H+q_L\Delta c)+\lambda\Delta c}\right)} \geq \frac{\left(\frac{1}{c_L}\right)}{\left(\frac{q_H}{q_Hc_H+q_L\Delta c}\right)} \Leftrightarrow \lambda c_L q_H c_H \leq 0,$$

which is a contradiction.

Finally, it is trivial that the power of incentives is smaller in a pooling contract compared to the case of private procurement. *Q.E.D.*

■ Proof of Proposition 6

Call W the objective function of the funding authority: $W = \max_B E[X] - B$. Using the envelope theorem, we have $\frac{dW}{dk} = \frac{\partial W}{\partial k} = \frac{\partial E[X]}{\partial k} \leq 0$ from Proposition 2 (with a strict inequality in the separating equilibrium). *Q.E.D.*

Appendix B

We present below two sets of simulations to numerically show how the optimal budget (*B*) and the power of incentives (X_L/X_H) vary with *k*. In Table 1, we present the results for different values of c_H when $c_L = 0.1$ and $q_L = 0.5$, and in Table 2, we show the results for different values of q_L when

$c_L = 0.1$ and $c_H = 0.3$. In all the cases, the optimal budget weakly decreases whereas the power of incentives weakly increases with k. We also present simulations that demonstrate that the value of the funding authority's objective function ($E[X] – B$) decreases with k and we prove it formally in Appendix A.

Table 1: Numerical results for different values of c_H when $c_L = 0.1$ and $q_L = 0.5$

	$c_H = 0.15$			$c_H = 0.20$			$c_H = 0.30$		
k	***B***	X_L/X_H	***E*[*X*]-*B***	***B***	X_L/X_H	***E*[*X*]-*B***	***B***	X_L/X_H	***E*[*X*]-*B***
0	3.3333	1.0000	3.3333	2.5000	1.0000	2.5000	1.8760	2.0000	1.8750
0.1	3.3333	1.0000	3.3333	2.4830	1.1045	2.4938	1.8690	2.1533	1.8728
0.2	3.3333	1.0000	3.3333	2.4330	1.2155	2.4764	1.8520	2.3115	1.8667
0.3	3.3333	1.0000	3.3333	2.3620	1.3296	2.4501	1.8280	2.4724	1.8577
0.4	3.3333	1.0000	3.3333	2.2820	1.4444	2.4180	1.8000	2.6344	1.8466
0.5	3.3333	1.0000	3.3333	2.2020	1.5585	2.3826	1.7700	2.7964	1.8341
0.6	2.6200	1.0385	3.2525	2.1250	1.6713	2.3458	1.7400	2.9580	1.8207
0.7	2.4600	1.1233	3.1503	2.0530	1.7824	2.3088	1.7110	3.1188	1.8069
0.8	2.3250	1.2059	3.0552	1.9880	1.8920	2.2726	1.6830	3.2785	1.7931
0.9	2.2110	1.2868	2.9675	1.9300	2.0003	2.2377	1.6570	3.4374	1.7793
1.0	2.1140	1.3662	2.8868	1.8780	2.1074	2.2041	1.6330	3.5955	1.7657
	$c_H = 0.40$			$c_H = 0.50$			$c_H = 0.60$		
k	***B***	X_L/X_H	***E*[*X*]-*B***	***B***	X_L/X_H	***E*[*X*]-*B***	***B***	X_L/X_H	***E*[*X*]-*B***
0	1.6680	3.0000	1.6667	1.5640	4.0000	1.5625	1.5010	5.0000	1.5000
0.1	1.6640	3.2030	1.6654	1.5610	4.2528	1.5616	1.4990	5.3027	1.4993
0.2	1.6540	3.4102	1.6619	1.5540	4.5096	1.5592	1.4940	5.6093	1.4975
0.3	1.6400	3.6199	1.6567	1.5440	4.7687	1.5556	1.4860	5.9179	1.4947
0.4	1.6240	3.8309	1.6503	1.5330	5.0290	1.5511	1.4780	6.2281	1.4914
0.5	1.6060	4.0419	1.6431	1.5210	5.2898	1.5461	1.4690	6.5386	1.4875
0.6	1.5890	4.2530	1.6353	1.5090	5.5505	1.5407	1.4590	6.8486	1.4834
0.7	1.5710	4.4632	1.6272	1.4960	5.8102	1.5351	1.4500	7.1589	1.4791
0.8	1.5540	4.6728	1.6190	1.4840	6.0697	1.5294	1.4400	7.4677	1.4747
0.9	1.5380	4.8817	1.6108	1.4730	6.3289	1.5236	1.4310	7.7764	1.4703
1.0	1.5230	5.0899	1.6027	1.4620	6.5871	1.5178	1.4230	8.0851	1.4659

Table 2: Numerical results for different values of q_L when c_L = 0.1 and c_H = 0.3

	q_L = 0.1			q_L = 0.2			q_L = 0.3		
k	***B***	X_L/X_H	***E*[*X*]-*B***	***B***	X_L/X_H	***E*[*X*]-*B***	***B***	X_L/X_H	***E*[*X*]-*B***
0	1.6667	1.0000	1.6667	1.6667	1.0000	1.6667	1.6667	1.0000	1.6667
0.1	1.6667	1.0000	1.6667	1.6667	1.0000	1.6667	1.6667	1.0000	1.6667
0.2	1.6667	1.0000	1.6667	1.6667	1.0000	1.6667	1.6250	1.0626	1.6583
0.3	1.6667	1.0000	1.6667	1.6667	1.0000	1.6667	1.5600	1.1791	1.6366
0.4	1.6667	1.0000	1.6667	1.6667	1.0000	1.6667	1.4800	1.2987	1.6075
0.5	1.6667	1.0000	1.6667	1.6667	1.0000	1.6667	1.3940	1.4179	1.5732
0.6	1.6667	1.0000	1.6667	1.2930	1.0435	1.6256	1.3100	1.5347	1.5361
0.7	1.6667	1.0000	1.6667	1.1720	1.1371	1.5691	1.2330	1.6487	1.4981
0.8	1.6667	1.0000	1.6667	1.0660	1.2258	1.5126	1.1630	1.7593	1.4603
0.9	1.6667	1.0000	1.6667	0.9740	1.3097	1.4576	1.1000	1.8665	1.4236
1.0	1.6667	1.0000	1.6667	0.8960	1.3903	1.4052	1.0450	1.9716	1.3884

	q_L = 0.4			q_L = 0.5			q_L = 0.6		
k	***B***	X_L/X_H	***E*[*X*]-*B***	***B***	X_L/X_H	***E*[*X*]-*B***	***B***	X_L/X_H	***E*[*X*]-*B***
0	1.7010	1.3333	1.7000	1.8760	2.0000	1.8750	2.2010	3.0000	2.2000
0.1	1.6910	1.4586	1.6966	1.8690	2.1533	1.8728	2.1980	3.1818	2.1989
0.2	1.6620	1.5919	1.6866	1.8520	2.3115	1.8667	2.1900	3.3661	2.1960
0.3	1.6190	1.7298	1.6712	1.8280	2.4724	1.8577	2.1780	3.5519	2.1916
0.4	1.5690	1.8694	1.6518	1.8000	2.6344	1.8466	2.1640	3.7384	2.1863
0.5	1.5160	2.0087	1.6298	1.7700	2.7964	1.8341	2.1490	3.9252	2.1802
0.6	1.4650	2.1470	1.6064	1.7400	2.9580	1.8207	2.1340	4.1120	2.1737
0.7	1.4160	2.2834	1.5825	1.7110	3.1188	1.8069	2.1190	4.2986	2.1668
0.8	1.3700	2.4177	1.5586	1.6830	3.2785	1.7931	2.1040	4.4848	2.1598
0.9	1.3280	2.5502	1.5352	1.6570	3.4374	1.7793	2.0900	4.6707	2.1526
1.0	1.2900	2.6811	1.5125	1.6330	3.5955	1.7657	2.0760	4.8560	2.1456

	q_L = 0.7			q_L = 0.8			q_L = 0.9		
K	***B***	X_L/X_H	***E*[*X*]-*B***	***B***	X_L/X_H	***E*[*X*]-*B***	***B***	X_L/X_H	***E*[*X*]-*B***
0	2.6751	4.6667	2.6750	3.3001	8.0000	3.3000	4.0751	18.0000	4.0750
0.1	2.6740	4.8774	2.6746	3.2999	8.2402	3.2999	4.0751	18.2700	4.0750
0.2	2.6710	5.0892	2.6736	3.2992	8.4807	3.2997	4.0750	18.5401	4.0750
0.3	2.6667	5.3017	2.6720	3.2982	8.7215	3.2993	4.0750	18.8102	4.0750
0.4	2.6615	5.5147	2.6700	3.2970	8.9625	3.2989	4.0749	19.0804	4.0749
0.5	2.6557	5.7280	2.6677	3.2955	9.2036	3.2983	4.0748	19.3505	4.0749
0.6	2.6495	5.9413	2.6652	3.2939	9.4449	3.2977	4.0746	19.6207	4.0748
0.7	2.6432	6.1547	2.6625	3.2922	9.6862	3.2970	4.0745	19.8909	4.0748
0.8	2.6367	6.3681	2.6596	3.2904	9.9275	3.2963	4.0743	20.1612	4.0747
0.9	2.6303	6.5813	2.6567	3.2886	10.1688	3.2955	4.0741	20.4314	4.0746
1.0	2.6240	6.7944	2.6538	3.2867	10.4102	3.2947	4.0739	20.7017	4.0746

Appendix C

▪ Bureaucrat's accountability

In this appendix, we study how the control intensity p affects the bureaucrat's equilibrium payoff. We focus on the separating case as control has no effect under pooling because there is no unspent budget. Note first that, given the funding authority's choice of p, the bureaucrat faces the same problem as in (BP) except that k is now replaced by $\hat{k}$, the effective k. Given B and $\hat{k}$, the bureaucrat solves his maximization problem (BP) to determine the outputs, $\{X_L(B,\hat{k}), X_H(B,\hat{k})\}$.

Anticipating the bureaucrat's choice of outputs, the funding authority chooses B and p to

$$\max_{B,p} \bar{X}(B,\hat{k}) - B - m(p),$$

where $\bar{X} \equiv q_L X_L + q_H X_H$, and $m(p)$ represents the control cost function with $m_p > 0, m_{pp} > 0, m(0) = 0$. The first-order condition with respect to B: $\frac{\partial \bar{X}(B,\hat{k})}{\partial B} = 1$, determines $B(\hat{k})$. Therefore, the control intensity p affects the optimal B only through $\hat{k}$. Note that this allows us to write the bureaucrat's equilibrium utility in terms of $\hat{k}$: $U\left(X_L\left(B(\hat{k}),\hat{k}\right), X_H\left(B(\hat{k}),\hat{k}\right), B(\hat{k}), \hat{k}\right)$.

Now consider a small change in $\hat{k}$ due to an exogenous change in the control cost function $m(\cdot)$ that causes a small change in p. Rewriting the Lagrangian for the bureaucrat's problem in Section 3 with $\hat{k}$, we have by the Envelope theorem:

$$\frac{dU}{d\hat{k}} = \frac{\partial L}{\partial \hat{k}} = (\hat{k} + \lambda)\frac{dB}{d\hat{k}} + q_H\left(B - \frac{c_H X_H^2}{2}\right),$$

where we have used the fact that $B = \frac{c_L X_L^2}{2} + \frac{\Delta c X_H^2}{2}$ in equilibrium. Because $\frac{dB}{d\hat{k}} < 0$, as shown in the simulations, the first term is negative whereas the second term is positive. Thus $\frac{dU}{d\hat{k}}$ can be positive or negative. Note that $\frac{dU}{d\hat{k}}$ can be negative when $\Delta c = c_H - c_L$ is small. This is because B is close to $\frac{c_H X_H^2}{2}$ and therefore the first term dominates.

In the following example, we present a case where $\frac{dU}{d\hat{k}}$ is positive, and a case where it is negative with different values of Δc. We calculate the bureaucrat's utility as a function of $\hat{k}$ with c_L=0.1, q_L=0.5, q_H=0.5.

Table 3: Numerical results of the bureaucrat's utility for different values of Δc.

$\widehat{\boldsymbol{k}}$	$\boldsymbol{\Delta c = 0.1}$	$\boldsymbol{\Delta c = 0.3}$
0	5.0000	3.3347
0.1	4.9891	3.3875
0.2	4.9563	3.4360
0.3	4.9104	3.4816
0.4	4.8606	3.5256
0.5	4.8140	3.5675
0.6	4.7721	3.6106
0.7	4.7363	3.6521
0.8	4.7086	3.6945
0.9	4.6888	3.7377
1	4.6760	3.7818

■ Centralization and sketch of the proof of Proposition 7

We only provide a sketch of the arguments.

The grand contract specifies transfers to the agent and the bureaucrat:

- $t(\hat{c}_i, \hat{X}_j) \equiv t_{ij}$ denotes the transfer from the funding authority to the agent when the agent reports his cost as $\hat{c}_i$ and the bureaucrat reports output as $\hat{X}_j$, where $i \in \{H, L\}$, $j \in \{H, L, O\}$, and $\hat{X}_O$ is $\hat{X} \notin \{\hat{X}_H, \hat{X}_L\}$. Let $t_{ii} \equiv t_i$.
- $s(\hat{c}_i, \hat{X}_j) \equiv s_{ij}$ denotes the transfer from the funding authority to the bureaucrat when the agent reports his cost as $\hat{c}_i$ and the bureaucrat reports output as $\hat{X}_j$. Let $s_{ii} \equiv s_i$.

The bureaucrat offers a side contract to agent. As she can observe output, the side contract specifies the output to be produced and the side transfers. In addition, it specifies the reports to be made to the funding authority:

- $X(\tilde{c}_i) \equiv X_i \in R_+$ denotes the output produced by the agent when the agent reports his cost as $\tilde{c}_i$ to the bureaucrat.
- $y(\tilde{c}_i) \equiv y_i \in R$ denotes the side transfer (which can be either positive or negative) from the bureaucrat to the agent who reports his cost as $\tilde{c}_i$.

- $\phi(\tilde{c}_i, X_j) \equiv \phi_{ij} \in \{c_H, c_L\} \times R_+$ denotes the coalition's manipulation of reports about the cost and output to the funding authority induced by the side contract when the agent reports to the bureaucrat having cost $\tilde{c}_i$ and produces X_j. Let $\phi_{ii} \equiv \phi_i$.

The optimal grand contract can be either separating or pooling. We start with the separating case.

□ **The separating case (X_L > X_H):** We can prove that $X_L > X_H$ if and only if $q_L \Delta c > q_H c_H$. We consider the bureaucrat's problem before solving for the grand contract. We denote by $R(c_i) \equiv R_i$ the i-type agent's payoff when he rejects the side contract and plays the grand contract non-cooperatively.

The bureaucrat's problem:

$$\max_{X,y,\phi} \; q_L X_L + q_H X_H + \; k\{q_L[s(\phi_L) - y_L] + q_H[s(\phi_H) - y_H]\}$$

$$s.t.$$

$$t(\phi_L) + y_L - \frac{c_L}{2} X_L^2 \geq t(\phi_H) + y_H - \frac{c_L}{2} X_H^2 \qquad (IC_L^S)$$

$$t(\phi_H) + y_H - \frac{c_H}{2} X_H^2 \geq \; t(\phi_L) + y_L - \frac{c_H}{2} X_L^2 \qquad (IC_H^S)$$

$$t(\phi_L) + y_L - \frac{c_L}{2} X_L^2 \geq R_L \qquad (IR_L^S)$$

$$t(\phi_H) + y_H - \frac{c_H}{2} X_H^2 \geq R_H \qquad (IR_H^S)$$

$$s(\phi_L) \geq y_L \qquad (BG_L^S)$$

$$s(\phi_H) \geq y_H \qquad (BG_L^S)$$

Ignoring (IC_H^S) and using the binding (IR_H^S), we can write the Lagrangian for the bureaucrat's problem, where the non-negative Lagrange multipliers for the relevant constraints are: μ_1 for (IC_L^S), μ_2 for (IR_L^S), λ_1 for (BG_L^S) and λ_2 for (BG_H^S).

The first order condition with respect to ϕ_i implies that the bureaucrat and agent would make a report to the funding authority to maximize the sum of transfers in each state. In equilibrium, this translates into the following non-manipulation condition.

$$s_L + t_L = s_H + t_H. \qquad (NM^G)$$

This condition and the other first-order conditions of the bureaucrat's problem become constraints in the optimal grand contract problem.

The funding authority's problem: As in Laffont and Martimort (1997, 1998) and Faure-Grimaud et al. (2003), there is no loss of generality in restricting attention to collusion-proof mechanisms where the side contract offered by the bureaucrat and accepted by both types of agent entails no manipulation of their reports ($\phi\left(\tilde{c}_i, X_j\right) = \left(c_i, X_j\right)$) and zero side transfers ($y_i = 0$).

Using a two-step procedure as in Faure-Grimaud et al. (2003), we first solve for the transfers t_i and s_i for any given λ_1, λ_2, μ_1, μ_2, and then we solve λ_1, λ_2, μ_1, μ_2. A key result that we use below is:

$$\mu_2 > 0 \textit{ if and only if } k > 0. \tag{C1a}$$

Having solved the optimal grand contract, we can show that the following off-the-equilibrium path transfers support our equilibrium outcome:

$$t_{LL} = t_L = \frac{c_L}{2} X_L^2 + \Delta c X_H^2;\;\; t_{HH} = t_H = \frac{c_H}{2} X_H^2;\; t_{LH} = t_{LO} = t_{HL} = t_{HO} = 0,$$

$$s_{LL} = s_L = s_{LH} = s_{LO} = 0;\; s_{HH} = s_H = s_{HL} = s_{HO} = t_L - t_H = \frac{c_L}{2}\left(X_L^2 - X_H^2\right)$$

where the subscript *O* represents a bureaucrat's report different from *L* or *H*.

□ **The pooling case ($X_L = X_H$):** We can show that the optimal grand contract will involve pooling when $q_L \Delta c \le q_H c_L$. We can also show:

The funding authority can implement the first best pooling output, $X = \frac{1}{c_H}$, *by offering the pooling contract* $t = \frac{c_H}{2} X^2$, $s = 0$. (C1b)

Off-the-equilibrium path, if the bureaucrat's output report differs from $\frac{1}{c_H}$, all transfers are zero.

□ **Comparison between centralization and delegation:** We now compare centralization with delegation according to the power of incentives and then the funding authority's payoff. After solving for the multipliers, we can show:

The power of incentives under centralization is lower than under delegation, and therefore it is lower than under private procurement case.

The first step is to prove that the power of incentives under centralization is independent of k and the same as under delegation when $k = 0$. The second step is to show that the power of incentives under delegation is strictly lower when $k > 0$.

We can also derive the result that:

Delegation is equivalent to centralization when k = 0, or when there is pooling under delegation. Otherwise, delegation is strictly dominated.

In the separating case, the difference between centralization and delegation is the extra Lagrange multiplier associated with (IR_L^S), μ_2, under centralization. The funding authority under centralization can always mimic the outcome under delegation by setting $\mu_2 = 0$, implying that centralization is weakly better. It also implies that centralization becomes strictly better if $\mu_2 > 0$. Because, by (C1a), we have $\mu_2 > 0$ iff $k > 0$, centralization is equivalent to delegation if $k = 0$ and it dominates delegation otherwise.

In the pooling case, under centralization, the funding authority can implement the first best (by (C1b)), and thus centralization can dominate delegation.

Finally, we can show that delegation can match centralization if the bureaucrat offers a pooling contract under delegation. This is because the bureaucrat also implements the first best output in that case.

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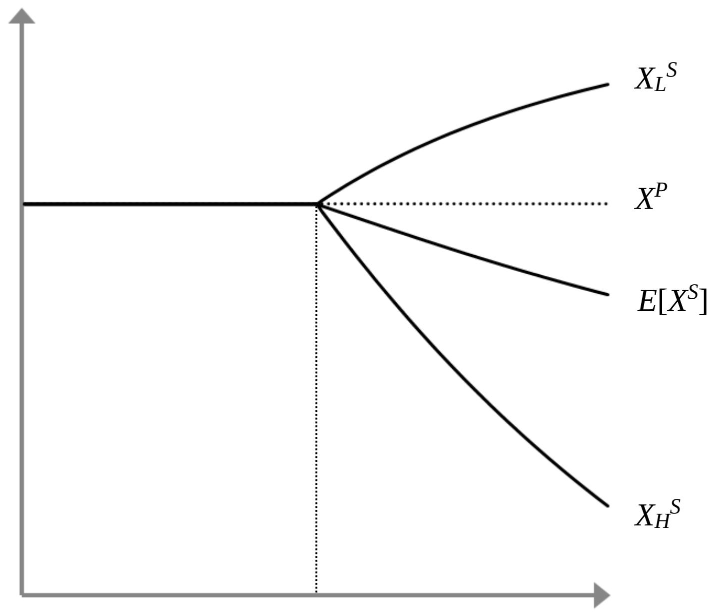

Figure 1. Changes in the optimal outputs
as a function of *k* for a given *B*

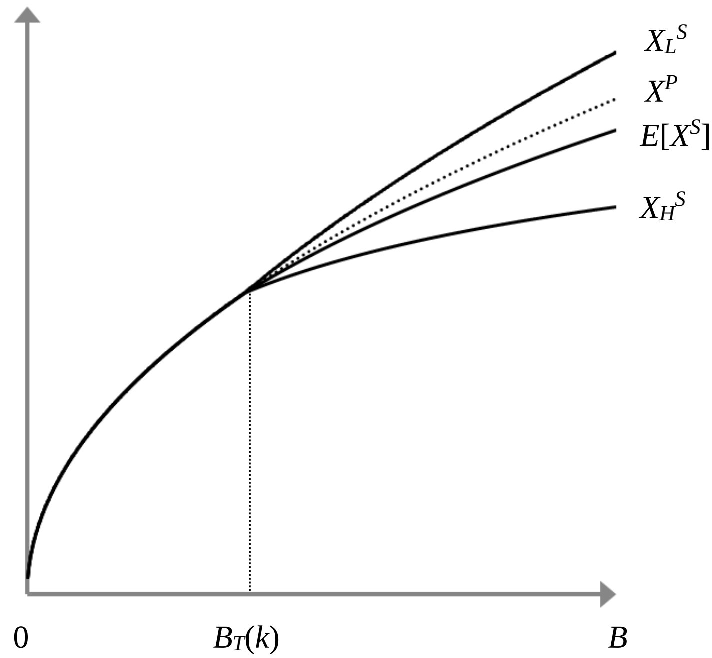

Figure 2. Changes in the optimal outputs
as a function of B for a given k