ORGANIZATIONAL CAPACITY

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Abstract

Observers have long noted that organizational capacity—the ability of an agency to implement a chosen policy—can be as important to politicians as policy choices themselves. This paper develops a theory of endogenous organizational capacity within a policy-making game between an organization and a political principal. Capacity is modeled as a dimension of output chosen by the agency. It may either be specific to a particular policy or generally applicable across all policies. Importantly, the agency has an advantage in policy expertise that renders capacity uncontractable. As a result, policy choices are constrained by the anticipation of the agency’s capacity investment. The main findings relate the policy specificity of the capacity technology with policy choices and capacity levels. If capacity is not policy-specific, then capacity is decreasing in the divergence in the players’ ideal points. In this case P may delegate policy-making authority to encourage capacity investment. If capacity investments are policy-specific, then capacity may increase in the divergence of ideal points, and the principal does not delegate. In this case, the agent captures more of the benefit from its investment, and capacity levels are higher. The agency therefore prefers policy-specific technology whenever possible.
1. Introduction

Organizational capacity is the ability of an agency to implement policy. While it has received relatively little attention in the formal literature on bureaucratic politics, implementation can matter for agency performance in a variety of obvious ways. Higher capacity might result in greater efficiency. Thus a well-managed driver license agency might serve clients more quickly. High capacity agencies may also produce more. A well-staffed police department might generate more criminal complaints than a poorly-staffed one. Capacity may also manifest itself in the quality of an agency’s production. An environmental protection agency might clean a toxic site more thoroughly when it possesses modern equipment. Finally, capacity might affect an agency’s ability to implement a desired policy at all.

As intuition might suggest, capacity can be costly. The U.S. Internal Revenue Service, for example, annually spends nearly 40% of a budget of approximately $10 billion on “compliance” activities, and even more on “collection” activities.\footnote{Compliance activities are those that are designated by the IRS as “tax law enforcement.” Collection activities are those that are designated as “processing, assistance, and management.” Source: IRS FY2004 Budget in Brief, http://www.irs.gov/pub/irs-utl/budget-brief.pdf, viewed September 8, 2004.} It is thus not unreasonable to view the primary role of many organizations as simply one of providing capacity for various policies.

Given the importance of capacity for outcomes, it is not surprising that accounts of bureaucratic policy-making frequently invoke organizational capacity. For example, Cates (1983) considers the efforts of the early leadership of the Social Security Board in shaping the basic structure of social security. The board developed a high level of capacity in the implementation of a particular kind of social insurance policy, and therefore prevented more redistributive policies from gaining Congressional support. Carpenter (2001) examines the efforts of late 19th-century U.S. Department of Agriculture and Postal Service managers in building capacity to support specific policies. These proved successful enough that Congress subsequently could neither dismantle nor substantially modify the newly created programs. Favorable results for the agency are not inevitable, however. Derthick (1990) documents the introduction of the Supplemental Security Income (SSI) program within the Social Security Administration. While the program enjoyed widespread legislative support, it foundered over poor execution. The problems included inadequacies in the SSI computer systems, which caused thousands of cases to be mishandled in the first year of the program.

The supply of organizational capacity depends on many factors. An agency’s resources, whether in the form of assets, personnel, or budgets, play an important role. The complexity of a task may matter as well, as capacity may be more easily provided for tasks that do not demand the acquisition of new skills or technologies. Other determinants include the lack of corruption and the quality
of a government’s civil service or judicial systems (e.g., Besley and McLaren 1993, Geddes 1994, Evans and Rauch 1999, Rauch 2001).

Perhaps less obviously, capacity can also be affected endogenously by agency choices. Agencies often must prioritize resources to address specific tasks among the many under their jurisdiction. Thus, a police department might have more capacity available for narcotics interdiction than for public security. Agency leaders may also anticipate upcoming policy choices and invest strategically in particular policies. These investments could include the cultivation or promotion of sympathetic personnel, demonstration projects, internal research programs, or the selection of certain types of equipment (e.g., Rosen 1988).

This paper takes a first step toward endogenizing capacity within a theory of bureaucratic policy-making. Specifically, it addresses two questions. First, in the context of a developed state, where effective civil service and judicial systems can be taken as given, what determines the provision of capacity? Second, what effect does capacity provision have on policy?

To date, there have been few direct answers to these questions. Derthick posits one explanation for low capacity levels in the objectives of policy-makers. Since legislators receive credit for passing programs, but do not receive blame for poor execution, they may simply not care about capacity:

The assumption that pervades policymaking is that the agency will be able to do what is asked of it because by law and constitutional tradition it must. It does not occur to presidential and congressional participants that the law should be tailored to the limits of organizational capacity. Nor do they seriously inquire what the limits of that capacity may be. There is a pervasive overestimate of the efficacy of law as a determinant of administrative behavior. (Derthick, 1990: 184)

A second, more recent, approach models capacity as the ability to realize an intended outcome. Capacity is operationalized as the (exogenous) variance of an additive shock to a chosen policy. Thus low-capacity agencies produce “noisier” outcomes, while high-capacity agencies produce their intended outcomes. In Huber and McCarty (2004), high-capacity agencies receive higher levels of delegation. Their model does not consider the sources of capacity provision, but does incorporate multiple principals (e.g., an executive in addition to a legislature). Lewis (2004) finds that presidents try to build high-capacity agencies when they are ideologically friendly, and finds empirical support for this prediction.

Finally, while they do not address questions of capacity specifically, models of informational asymmetry or moral hazard between policy-makers and bureaucrats might explain under-investment by agents. Agents may not have incentives to invest in policy expertise because they worry that
the principal might not use this information in a beneficial way (e.g., Gilligan and Krehbiel 1987). In response, a principal might delegate authority in order induce information revelation, especially if the players’ ideal policies are sufficiently close.\(^2\) Likewise, agencies that cannot be monitored perfectly might have an incentive to underproduce capacity when effort is costly.\(^3\) To counteract this, a principal (or principals) can structure the agent’s contractual incentives to induce effort on the principal’s behalf. In a bureaucratic context, these incentives may include budgets or jurisdictional allocations.

In the model developed here, a politician and an agent endogenously determine both policy and an associated capacity level.\(^4\) The approach departs in several significant ways from the above explanations. First, it assumes that all actors are fully rational and care explicitly about capacity. Thus, legislators may well consider policy to be more important than its administration, but they neither escape blame for poorly-implemented policies, nor fail to claim credit for well-implemented ones. Capacity can then be under- or over-provided, depending on the preferences of the politician and the bureaucrat.

Second, it distinguishes between capacity and policy. In the formal works cited previously, the effects of capacity (or information or effort asymmetries) are felt along the “policy” dimensions. Thus, a low-capacity agency might produce policy results with a higher variance. In such an environment, a regulatory standard might be strict or lax, but it is difficult to distinguish between strict enforcement of a lax standard or lax enforcement of strict one. The model developed here considers capacity to be a distinct output dimension, which contains several features not shared by the policy dimension.

Finally, it addresses the possibility of legislative “renegotiation.” Upon observing the result of an agent’s action, the politician is able to re-write legislation that optimally incorporates her observation. Models such as those cited above typically assume either that renegotiation is impossible, or (as is standard in contracting models) that commitments from a principal to an agent are exogenously credible. By contrast, I assume that actors anticipate the renegotiation of policy and capacity choices.

These features naturally lend themselves to an incomplete contracting framework to characterize the provision of organizational capacity. Incomplete contract models have been used extensively to describe complex contractual arrangements between firms (Grossman and Hart 1986, Hart and

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\(^2\) Variations on this logic can be found in Epstein and O’Halloran (1994, 1999), Huber and Shipan (2002), Gailmard (2002), and Bendor and Meirowitz (2004).


\(^4\) Lewis (2004) also endogenizes capacity and policy, but in a decision-theoretic framework. In it, the president trades off between greater capacity (by using career civil servants) and policy performance (by making political appointments).
Moore 1988), but to date have not been applied to a principal-agent problem in a spatial setting.

The central assumption behind contractual incompleteness is the complexity of a desired agreement. Activities that are critical to an agreement may be so complex that it is impossible for legislation to specify ex ante how they should be performed. The model starts with the assumption that policy is contractible, but that, at least initially, capacity is not. In other words, an agency’s monopoly on policy expertise renders capacity uncontractable. Thus, a legislature can write a statute specifying a policy (e.g., a certain level of enforcement, or a scientific goal) but the bureaucracy can control both the amount to invest in capacity, as well as a policy (or policies) that this capacity is targeted toward.\(^5\)

More specifically, the game has two players, a principal (who might be considered to be Congress, or an executive) and an agent. Both players care about the location of a policy \(x\) in a unidimensional policy space. As is fairly standard in models of bureaucratic politics, the principal can choose a policy \(x\) or leave the choice to the agent. Both players also care about a capacity level, \(c\), which is determined by two uncontractable inputs from the agent. The first is a costly investment vector \(a\) that determines the level of capacity, and the second is a target, or location parameter \(y\) specifying the policy for which \(c\) is at a maximum.

The model imposes a few restrictions on players’ preferences across the two dimensions of output. Both players’ preferences over \(x\) are separable from preferences over \(c\), but preferences over \(c\) are not separable from preferences over \(x\). Thus, for any level of capacity a player would like to have her ideal policy chosen. But as policy moves away from her ideal, capacity becomes less desirable. In particular, the agent’s ideal capacity level drops as policy moves away from her ideal.\(^6\)

As with many models of incomplete contracting, a key feature of the model is a second period of play, during which the level of the agent’s investment becomes contractible. The observation of the technology used in the first period allows the principal to make any investment up to \(a\), but does not allow her to exceed the agent’s investment, or change \(y\). It is assumed that the principal cannot commit to ex post behavior as a function of the agent’s choices.

I consider two variants of the game, which capture polar opposites in the way in which investment is translated into capacity. In the first, the agent cannot target its investment toward a specific policy (i.e., \(y\) is irrelevant). This reflects a “generalist” policy domain where skills such as client service and information technology are fungible. In the second, capacity is at a minimum everywhere except at \(y\). This “specialist” environment might require a certain type of engineering

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\(^5\)In the language of Wilson (2000), the model probably applies best to “coping” or “procedural” agencies, for which actions are difficult to observe.

\(^6\)Thus, capacity is not a “valence” dimension. Calvert, McCubbins, and Weingast (1989) use a similar, but less general utility function in a model of agency discretion and budgeting.
expertise or a large cadre of experienced staff.

The model generates a variety of potentially testable predictions about capacity, policy, and delegation.\(^7\) In equilibrium, the whether an agent is a generalist or specialist matters greatly for capacity levels. In the generalist case, capacity investment is decreasing in the distance between ideal points because the agent’s investment is easily appropriated. The principal thus has an incentive to delegate to encourage short-term investment, but cannot commit not to renegotiate \textit{ex post} from the agent’s policy choice to her own ideal. In the specialist case, the agent’s investment is at less risk of appropriation, and capacity levels are higher. Interestingly, capacity may increase in the distance between ideal points and policy is bounded away from the principal’s ideal. The principal never delegates and therefore policy is not renegotiated.

The model bears a family resemblance to an extensive literature on incomplete contracts.\(^8\) Such models typically examine the contracting relationship between two firms in a joint production environment. As in the model developed here, one party may make a non-contractible investment that is potentially valuable to the relationship between the two. However, the potential investor takes into account the possibility that its share of the \textit{ex post} surplus may be renegotiated away, and thus has an incentive to “hold up” the relationship. There are several noticeable differences, however. They do not consider capacity explicitly, and usually do not have a spatial outcome dimension. Additionally, they give the investing party some bargaining power in the renegotiation stage.\(^9\)

Within this literature, the present model is perhaps most closely related to that of Bernheim and Whinston (1998) and Besley and Ghatak (2001). The former study delegation in a principal-agent relationship. In it, the first mover may choose to specify the second mover’s actions. They find that when the players’ actions are strategic complements, optimal contracts will not specify the second movers’ action beforehand; otherwise, the action will be specified. The latter address ownership issues with uncontractable investments and public goods, and establishes conditions under which in governments should assign ownership rights to non-government organizations and firms.

The paper proceeds as follows. The next section sets up the two basic models. The main results for both games are presented in Section 3. Section 4 explores a number of extensions of the basic model, including delegation, endogenous specialization, and principal-imposed resource constraints. Section 5 discusses the results and concludes.

\(^{7}\)Lewis (2004) suggests a few ways in which hypotheses about capacity may be tested.

\(^{8}\)For an overview, see Tirole (1999).

\(^{9}\)This assumption reflects a rough parity in authority between two firms, which seems less tenable in the relationship between a bureau and a legislature. As an extension for future work, bargaining might be used to incorporate the influence of multiple principals in claiming the \textit{ex post} surplus generated by the agent’s investment.
2. The Model

The model is a game of policy-making with endogenous organizational capacity over two periods. There are two players, P and A, corresponding to a principal and an agent. Except where otherwise noted, time periods are denoted with subscripts and players with superscripts.

The components of the players’ preferences are as follows. Each player cares about policy and the organizational capacity associated with policy choices. A policy is some \( x \in X \), where \( X \subset \mathbb{R} \) is compact and convex. Organizational capacity is determined by a production function, or capacity function \( c : X \times X \times \mathbb{R}^m_+ \to [0, \bar{c}] \), which will be of central interest in the model. The first two arguments of \( c(x, y, a) \) are the chosen policy and a target policy, respectively. Thus capacity production will depend on both the policy chosen as well as whether that policy was targeted. This dependency will be specified in later sections. The last argument is an “input” or “investment” vector, which consists of \( m \geq 1 \) (finite) inputs. For all inputs \( a_j \) (\( j = 1, \ldots, m \)), \( c(\cdot) \) is increasing and weakly concave. Further, \( \frac{\partial^2 c}{\partial a_j \partial a_k} \geq 0 \) for \( j \neq k \), so that inputs may be complementary. Without any investment, the “default” capacity level for any \( x \) is \( c(x, y, 0) = 0 \). Additionally, an input vector \( a \) imposes a cost \( k(a) \) on A, where \( k : \mathbb{R}^m_+ \to \mathbb{R}_+ \) is continuous, increasing, and convex. I assume that \( \frac{\partial^2 k}{\partial a_j \partial a_k} \leq 0 \) for \( j \neq k \), to allow for possible cost efficiencies across inputs.

For player \( i \), utility over policy and capacity is given by \( u_i(x, c(x, x, a); x_i) \), where \( u_i : X \times \mathbb{R}_+ \times X \to \mathbb{R} \) is \( C^2 \) and concave. It will often be convenient to suppress the dependency of \( u_i(\cdot) \) on \( x_i \). For any capacity level \( c \), \( u_i(\cdot, c) \) attains a maximum at \( x_i \in X \). Without loss of generality, let \( x_P < x_A \). For any policy \( x \), \( u^i \) is increasing in \( c(\cdot) \). The extent to which players value capacity may depend on \( x \); i.e., \( \frac{\partial^2 u^i}{\partial c^2} > (\leq) 0 \) for \( x > (\leq) x^i \). Thus, marginal utility from capacity is increasing in proximity to player \( i \)'s ideal point. Note that if \( \frac{\partial^2 u^i}{\partial c^2} = 0 \) for all \( x \), then the agent’s utility over capacity is independent of her utility over policy. This corresponds to the notion of a “neutrally competent” bureaucracy.\(^{10}\)

A’s utility function will naturally suggests the existence of a unique optimal vector of inputs for any policy \( x \) and ideal point \( x^A \). This vector will be used frequently below, and is denoted:

\[
a^o(x; x^A) \equiv \arg \max_a u^A(x, c(x, x, a); x^A) - k(a). \tag{1}
\]

For convenience, when the ideal point is understood, \( a^o(x; x^A) \) will be abbreviated \( a^o(x) \), and if \( x = x^A \), simply \( a^o \) will be used.

To avoid a number of inconvenient corner solutions, several additional technical assumptions are made. First, I adopt some standard Inada-type conditions: \( \frac{\partial k}{\partial a_j}(0) = 0 \) and \( \lim_{a_j \to -\infty} \frac{\partial k}{\partial a_j} = 0 \) for

\(^{10}\)See, e.g., Fesler (1980).
all inputs \( j \), and \( \lim_{c \to \infty} \frac{\partial u^i}{\partial c} = 0 \) for all players \( i \). Second, let \( \pi > c(a^c) \), so that the ideal capacity for \( A \) is always feasible. Finally, assume that \( \frac{\partial^2 u^A}{\partial x^2} \) is bounded away from zero.

The period \( t \) utility functions for \( P \) and \( A \), respectively, can be written as:

\[
U^P_t(x_t, y, a_t) = u^P(x_t, c(x_t, y, a_t); x^P) \\
U^A_t(x_t, y, a_t) = u^A(x_t, c(x_t, y, a_t); x^A) - k(a_t).
\]  

Player \( i \)'s total utility is given by \( U^i_1(\cdot) + \delta^i U^i_2(\cdot) \), where \( \delta^P, \delta^A \geq 0 \). This allows the second period to represent either a discounted second period of interaction, or the reduced form for a stream of future interactions.

Players in the game are completely and perfectly informed. The sequence of the game is as follows.

1. \textit{(Period One)} \( A \) chooses its capacity contribution, \( a_1 \in \mathbb{R}^m_+ \) and a target policy \( y \in X \).

2. \( P \) chooses policy \( x_1 \in X \).

3. \textit{(Period Two)} \( P \) chooses policy \( x_2 \in X \), and \( A \)'s capacity contribution, \( a_2 \in \{ a \mid 0 \leq a \leq a_1 \} \).

Two assumptions about the sequence are central to this game. First, the policy choice follows capacity investment. This assumption might simply represent \( A \)'s anticipation of an upcoming policy choice (or change). Alternately, \( A \)'s investment might play a larger role, by making policy choices along \( X \) feasible for \( P \). As intuition might suggest, this will (under some circumstances) give \( A \) some agenda-setting power. Second, policy is initiated by the principal, who chooses \( x_1 \). This might correspond to a policy arena in which \( P \) writes legislation and assigns \( A \) to execute it.

In an environment in which an agent uses some pre-existing authority to set policy unilaterally, or in which she is explicitly delegated authority, it is possible that the agent might choose \( x_1 \). This possibility is addressed in Sections 4.1 and 4.2.

The sequence also makes clear the game's incomplete contracting structure. In the initial legislation or rule over \( X \), \( P \) cannot specify \textit{ex ante} either the input or target of \( A \)'s capacity investment. However, the revelation of \( A \)'s first period action renders the scale of \( A \)'s capacity contribution contractible \textit{ex post}. \( P \) might, for example, learn of an appropriate monitoring technology that makes writing the proper rule feasible, and can thus impose \( A \)'s capacity contribution up to \( a_1 \). This is analogous to renegotiation in incomplete contracting relationships. She can also re-adjust the policy. The target \( y \) is never contractible: it is "sunk" and cannot be modified.

\[^{11}\text{For example, the acquisition of a particular kind of surveillance device by the military might facilitate its involvement in certain kinds of law enforcement activities.}\]
I characterize subgame perfect equilibria in pure strategies, denoted $s^A$ and $s^P$. For the principal-initiated game, A’s strategy $s^A \in \mathbb{R}^m_+ \times X$ specifies her period 1 capacity contribution and targeted policy. P’s strategy $s^P : \mathbb{R}^m_+ \times X \rightarrow X^2 \times \{a \mid 0 \leq a \leq a_1\}$ maps the capacity contribution and target policy to period 1 and 2 policies and period 2 capacity contribution. It will be notationally convenient to decompose the equilibrium values of $s^A$ and $s^P$ into their components. Thus, let $y^*$ denote the equilibrium target policy, and let $x^*_t$, $a^*_t$, and $c^*_t$ denote the equilibrium period $t$ policy, capacity investment, and capacity level, respectively. As tie-breaking rules, I assume that when they are indifferent, P chooses the lowest feasible level of investment, and that A chooses the closest target policy.

3. Main Results

The game has two variants, which differ only in the form of the capacity function. This technology may be either general expertise (GE) or specialized expertise (SE). In the former, $c(\cdot)$ is independent of $x_t$ and $y$, and so any investment applies equally to all policies. In the latter, the investment applies only toward policy $y$. The two variants therefore capture opposite extremes in the agent’s ability to discriminate in its policy investment.

3.1 General Expertise

Consider first the game in which the capacity function is of the form:

$$c(x_t, y, a_t) = \tilde{c}(a_t). \quad (4)$$

Thus, capacity is independent of both policy choice and the target of A’s capacity investment. It will therefore be convenient to eliminate references to $y$ in the remainder of this subsection.

The subgame perfect equilibrium strategies can be derived very simply by inducting backward from the second period. In period 2, P can revise policy to her liking, as well as specify capacity up to $a_1$, the level previously provided by A. Her objective in period 2 is given by (2). For any capacity level, $x^P$ is her optimal policy. Since $\frac{2u_A}{c^p} > 0$, P also wishes to maximize capacity, which implies a capacity contribution of $a_1$. Therefore, $x^*_2 = x^P$ and $a^*_2 = a_1$.

Because actions in period 1 do not affect period 2 choices, by (2), P’s best response to any $a_1$ is her ideal policy, and thus $x^*_1 = x^P$. A then chooses $a_1$ to maximize:

$$V(a_1; x^A) = (1 + \delta^A) \left[ u^A(x^P, \tilde{c}(a_1); x^A) - k(a_1) \right]. \quad (5)$$

This objective is clearly concave in $a_1$, and the assumptions made on $u^i(\cdot)$ and $k(\cdot)$ ensure that any solutions are interior. Observing that (5) is the same objective function as (1), the
solution $a^*_1 = a^c(x^P)$ is therefore unique and characterized by first-order conditions. It follows that the general expertise game has a unique subgame perfect equilibrium. The first result, on policy choices, follows directly and is stated without proof.

**Proposition 1** Policy under general expertise. The GE game has a unique subgame perfect equilibrium, where $x^*_1 = x^*_2 = x^P$. ■

Combined with non-targetable policy technology, the ability to set policy at $x^P$ in both periods allows $P$ to capture the entire benefit of $A$’s investment. The agent therefore has less incentive to invest in capacity when her preferences do not coincide with $P$’s. As the following result establishes, equilibrium capacity is decreasing in $x^A$ (i.e., as $x^A$ diverges from $x^P$).

**Proposition 2** Capacity under general expertise. In the subgame perfect equilibrium of the GE game:

(i) $a^*_1 = a^*_2 = a^0(x^P)$.

(ii) $a^*_1$ and $c^*_1$ are strictly decreasing in $x^A$. ■

**Proof** All proofs are in the Appendix. ■

This result suggests that when capacity investments are fungible, high organizational capacity might result if players agree on the policy dimension. The comparative statics echo the “ally principal” found in many models of delegation, whereby ideologically close players are more inclined to reveal information or undertake costly effort.

3.2 Specialized Expertise

In this variant of the game, capacity may be targeted completely toward one policy. Accordingly, the capacity function takes the following form:

$$c(x_t, y, a_t) = \begin{cases} \tilde{c}(a_t) & \text{if } x_t = y \\ 0 & \text{otherwise.} \end{cases}$$

where $\tilde{c}(a_t)$ is as in Section 3.1.

In period 2, $P$ has essentially two alternatives. First, she may choose any $x_2 \neq y$. In this case, the optimal policy is clearly $x^P$ (if $x^P \neq y$), which implies an optimal capacity investment of $a_2 = 0$ and $c(x_2, y, 0) = 0$. Second, $P$ may choose $x_2 = y$. $P$ then prefers to maximize capacity, and hence $a_2 = a_1$. $P$ therefore chooses $x_2 = y$ if:

$$u^P(x^P, 0) \leq u^P(y, \tilde{c}(a_1)).$$

\[12\] The technique of the proof can also be used to show that $a^*_1$ is increasing in $u^A(x^P)$.

\[13\] See Huber and Shipan (2004).
P’s policy calculation in period 1 is identical, and thus she chooses $x_1 = y$ if (7) holds.

P therefore accepts policy $y \neq x_P$ if she is “compensated” with a level of capacity sufficient to satisfy (7). To make this idea concrete, let $\mathcal{X} \equiv \{ y \mid \exists c \text{ s.t. } u^P(x_P, 0) = u^P(y, c) \}$ denote the set of policies for which such a capacity level exists. Note that because (7) is satisfied with equality at $y = x_P$ and $c = 0$, $\mathcal{X}$ is a non-empty and convex neighborhood of $x_P$. Next, let $\gamma : \mathcal{X} \rightarrow \mathbb{R}_+$ denote the amount of capacity $c$ that satisfies (7) with equality:

$$\gamma(y) = \{ c \mid u^P(x_P, 0) = u^P(y, \tilde{c}(a_1)) \}. \tag{8}$$

It is obvious that $\gamma(x_P) = 0$. As $y$ moves away from $x_P$, satisfying (7) requires a higher marginal increases in capacity, and thus $\gamma(y)$ is increasing and convex on $\mathcal{X}$ for $y \geq x_P$. As $y$ becomes sufficiently distant from $x_P$, the fact that $\frac{\partial u^P}{\partial c} > 0$ implies that $\gamma(y)$ approaches the upper bound on capacity, so $\lim_{y \to \sup \mathcal{X}} \gamma(y) = \bar{c}$.

While a capacity of $\gamma(y)$ would induce P to choose $y$ over $x_P$, it is not known whether A would willingly invest the resources necessary to produce it. To determine this, note that $\tilde{c}(a^o(y; x^A))$ is the (unique) capacity level that A would optimally provide for policy located at $y$, absent the constraint of renegotiation. It is straightforward to show that this function is decreasing in $|y - x^A|$ and strictly positive. The function is minimized on $[x_P, x^A]$ at $x_P$, where $\tilde{c}(a^o(x_P); x^A)$ is also the equilibrium capacity level in the GE game.

The functions $\gamma(y)$ and $\tilde{c}(a^o(y; x^A))$ are useful for characterizing capacity levels for any given $y$. If $\tilde{c}(a^o(y; x^A)) \geq \gamma(y)$, then A is willing to produce more than the minimum capacity necessary for P not to ignore the investment in $y$. Otherwise, A must produce at least $\gamma(y)$ (and clearly does not wish to produce more). Hence if $x_t = y$ then the equilibrium capacity level $c_t^*$ must satisfy:

$$c_t^* \in \max\{\gamma(y), \tilde{c}(a^o(y; x^A))\} \text{ for some } y. \tag{9}$$

The next result uses this fact to narrow the range of possible equilibrium policies. Intuitively, the proposition rules out the possibility that P could deviate from $y$ and choose $x_P$ (with a capacity of zero), because A would strictly prefer to invest optimally in $x_P$ by providing capacity level $\tilde{c}(a^o(x_P))$. However, there always exists a policy closer to $x^A$ that would allow A to do even better.

**Proposition 3** Policy under specialized expertise. In the SE game, $x_1^* = x_2^* = y^*$ and $y^* \in \mathcal{X} \cap (x_P, x^A]$.

With these general features of A’s target policy and P’s policy response established, it is possible to derive some important features of equilibrium organizational capacity. It will be convenient to identify the policy for which $\gamma(\cdot)$ equals A’s ideal capacity at $x^A$:

$$x_a = \{ x \mid \gamma(x) = \tilde{c}(a^o) \}. \tag{10}$$
Since \( \tilde{c}(-) < c \), it is easily verified that \( x_a \in \text{int } \mathcal{X} \).

There are two types of solutions for \( y^* \). First, if \( x^A \leq x_a \), then (by the fact that \( \gamma(y) \) is increasing) \( \tilde{c}(a^o) = \gamma(x^A) \). This implies a corner solution—the optimal target policy is \( x^A \), and \( A \) invests her optimal amount \( (a^o) \) in it.

Second, if \( x^A \geq x_a \), then \( \tilde{c}(a^o) \leq \gamma(x^A) \). A crucial feature of this case is that for the schedule of target policies and capacity levels implied by \( y \) and \( \tilde{c}(a^o(y; x^A)) \), \( A \) prefers policies closer to \( x^A \); that is, \( U^A_t(\cdot) \) is strictly increasing in \( y \in (y^P, x^A] \) along \( \tilde{c}(\cdot) \). Let \( y' \equiv \max\{ y | \gamma(y) = \tilde{c}(a^o(y; x^A)) \} \) denote the policy closest to \( x^A \) such that \( \gamma(\cdot) \) and \( \tilde{c}(\cdot) \) intersect. Then by the definition of \( \tilde{c}(\cdot) \), \( A \) must prefer the combination of \( y' \) and \( \tilde{c}(a^o(y'; x^A)) \) to any target policy \( y < y' \) and any capacity level. Thus the solution satisfies \( y^* \in [y', x^A] \) and—because \( \gamma(y) > \tilde{c}(a^o(y; x^A)) \) for \( y > y' \)—the equilibrium capacity level must be \( \gamma(y^*) \). Figure 1 illustrates this intuition.

To produce \( \gamma(y) \), \( A \) wishes to choose the lowest-cost investment vector, which is given by:

\[
\mathbf{a}(y) = \arg \min_{\mathbf{a}} \{ \mathbf{a} | \tilde{c}(\mathbf{a}) = \gamma(y) \} \quad k(\mathbf{a}).
\tag{11}
\]

By the concavity of \( \tilde{c}(\cdot) \) and convexity of \( k(\cdot) \), \( \mathbf{a}(y) \) is single-valued. Along with the previous argument, this expression allows A’s objective to be re-written in terms of \( y \):

\[
V(y; x^A) = (1 + \delta^A) \left[ u^A(y, \gamma(y)) - k(\mathbf{a}(y)) \right].
\tag{12}
\]

The concavity of (12) is not guaranteed, and so the uniqueness of subgame perfect equilibria may depend on functional forms. Uniqueness is achieved, however, by invoking the assumption that when indifferent, \( A \) chooses \( y^* \) closest to \( x^A \). This assumption does not affect any of the results of this section.

The next result derives the key properties the equilibrium capacity levels under specialized expertise. Two important variables in the proposition are \( \overline{u}^A_{cx} \) and \( \underline{u}^A_{cx} \), which bound the change in the agent’s marginal utility from capacity as policy (or her ideal point) changes. More formally, \( \overline{u}^A_{cx} \) and \( \underline{u}^A_{cx} \) are the supremum and infimum, respectively, of \( \frac{\partial^2 u^A_{cx}}{\partial c \partial x} \) over all possible \( c, x, \) and \( x^A \).

**Proposition 4** Capacity under specialized expertise. In the SE game:

(i) \( a^*_1 = a^*_2 \).

(ii) There exist \( \overline{c} \) and \( \underline{c} \), where \( \overline{c} > \underline{c} > 0 \), such that if \( \overline{u}^A_{cx} < \overline{c} \) (respectively, \( \underline{u}^A_{cx} > \overline{c} \)), then \( c^*_1 \) is weakly increasing (respectively, decreasing) in \( x^A \), and strictly increasing (respectively, decreasing) in \( x^A \) over some non-empty set of agent ideal points.\(^{14}\)

\(^{14}\)The result for weak monotonicity alone can be obtained much more simply by applying the Monotone Selection Theorem of Milgrom and Shannon (1994).
(iii) $c_1^*$ is strictly higher than in the GE game.

A comparison of Propositions 1-4 reveals the main intuition behind the effects of specialization on policy and capacity. In contrast with the GE game, P compromises on policy in the SE game. This is because P cannot commit to letting A benefit from her investment in the GE game. By contrast, specialized investment in effect “commits” P not to unravel A’s investments. The result is higher investment, and hence organizational capacity.

The effect of policy preferences on capacity are less obvious. As the proof of Proposition 4 shows, if $x^A$ is near $x^P$, then A targets $x^A$ and invests optimally (from her perspective) in it. This results in a constant level of organizational capacity for “friendly” agents. As $x^A$ increases, A must “overpay” and provide capacity $\gamma(y)$ to obtain $y$. The effect on capacity then depends on $\frac{\partial^2u^A}{\partial c \partial x}$. If $\pi_{cx}$ is sufficiently low, then A’s desire for capacity is relatively independent of policy. For such an “apolitical” agent, capacity increases with the divergence of preferences between actors. This is because A receives high marginal utility from capacity even when chosen policies are distant. By contrast, for $u^A_{cx}$ sufficiently high, capacity is decreasing in preference divergence, as A becomes less willing to invest in unfavorable policies.

Interestingly, the proof of Proposition 4 also establishes that policy is not necessarily monotonically increasing in $x^A$. In particular, if $\frac{\partial^2u^A}{\partial c \partial x}$ is sufficiently high, then at the margin A might prefer to shift policy away from $x^A$ in order to reduce the capacity (given by $\gamma(y)$) needed to satisfy P.

4. Extensions

4.1 Agent-Initiated Policy

In many situations, an agent may, instead of the principal, set policy. A political agency may have pre-existing authority to set policy unilaterally, or it might be in a “subgame” in which it has authority explicitly delegated by a principal. This section considers the consequences of agent-initiated policy.

The sequence of the game remains unchanged, with the exception that the period 1 policy choice shifts from A to P. Thus, A’s strategy $s^A \in \mathbb{R}^m_+ \times X \times X$ specifies her period 1 capacity contribution, targeted policy, and period 1 policy choice. P’s strategy $s^P : \mathbb{R}^m_+ \times X \times X \rightarrow X \times \{a \mid 0 \leq a \leq a_1\}$ maps the period 1 history into a choice of period 2 capacity contribution and policy. To avoid confusion about notation when comparing against the previous games, parameters in the agent-initiated model are denoted with a “$\hat{}$” where applicable.

General expertise. In the GE game, the players’ period 2 strategies remain unchanged from the principal-initiated game. P chooses her ideal policy in period 2, and maximizes capacity; thus, $\hat{x}_2^* = x^P$ and $\hat{a}_2^* = a_1$. In period 1, however, A chooses $x_1$ along with $a_1$. For any capacity level,
A's optimal policy response is her ideal policy, and hence \( \hat{x}^*_1 = x^A \). She anticipates, however, that \( a_1 \) will be appropriated for use on policy \( x^P \) in period 2. A’s induced objective is then:

\[
\hat{V}(a_1; x^A) = u^A(x^A, \tilde{c}(a_1)) - k(a_1) + \delta^A \left[u^A(x^P, \tilde{c}(a_1)) - k(a_1)\right].
\] (13)

Like A’s objective in the GE game (5), \( \hat{V}() \) is concave, and thus the subgame perfect equilibrium is unique.

The first result uses (13) to derive properties of equilibrium capacity levels, and is analogous to Proposition 2. As in the principal-initiated game, P’s ability to capture much of the benefit of A’s investment results in capacity decreasing with \( x^A \) (i.e., as \( x^A \) diverges from \( x^P \)). However, capacity is higher in the agent-initiated game, especially if A does not value future payoffs too highly. This is because A can realize her ideal policy in period 1, which induces her to invest a higher amount in capacity.\(^{15}\)

**Proposition 5** Capacity under general expertise and agent-initiated policy. *In the subgame perfect equilibrium of the GE game:*

(i) \( \hat{a}^*_1 = \hat{a}^*_2 \).

(ii) \( \hat{a}^*_1 \) and \( \hat{c}^*_1 \) are strictly decreasing in \( x^A \) and \( \delta^A \).

(iii) \( \hat{a}^*_1 > a^*_1 \) and \( \hat{c}^*_1 > c^*_1 \). ■

Proposition 5 suggests that in addition to similarity in preferences, high organizational capacity under general expertise might occur when a short-lived (i.e., low \( \delta^A \)) agent initially chooses policy. The result is counter-intuitive because it suggests that common “insulating” features of bureaucratic working environments, such as job tenure, can have a negative impact on investment and capacity. This occurs because of renegotiation, as the principal’s ability to overturn a policy and contract on its underlying technology works against the investment incentives of long-term agents. The ability to set policy is critical to this result, as \( \hat{a}^*_1 \) is independent of \( \delta^A \) when the principal chooses \( x^*_1 \).

**Specialized expertise.** In the SE game, the target policy \( y \) affects P’s choice of \( x_2 \) in a manner identical to that of the SE game with principal-initiated policy. In period 1, however, the possibility of disassociating policy from investment gives A three classes of strategies. First, A can match her policy choice with \( y \). In this case, the objective is given by (12), and the results are identical to those in the analogous principal-initiated game.

However, A’s incentives may change in two ways. She may choose \( x_1 \neq y \). In this case, the dominant policy is \( x^A \). Thus A can secure \( x^A \) in period 1 with capacity 0, as well as a policy \( (x_2 = y) \)

\(^{15}\)The technique of the proof can also be used easily to show that at an interior solution, \( \hat{a}^*_1 \) is increasing in \( u^A(x^P) \) for both principal- and agent-initiated games. Additionally, \( \hat{a}^*_1 \) is increasing in \( u^A(x^A) \) only in the agent-initiated game.
more favorable than $x^P$ in period 2. A therefore pays twice for an investment that is realized only in period 2. To characterize this investment, A must also take into account the minimum investment (given by (11)) that would produce capacity $\gamma(y)$, thereby inducing P to choose policy $y$ in period 2. A therefore solves:

$$\hat{a}^o(y; x^A) = \max \left\{ \tilde{a}(y), \arg \max_a u^A(x^A, 0) + \delta^A u^A(y, \tilde{c}(a)) - (1 + \delta^A)k(a) \right\}. \quad (14)$$

Because of the higher marginal cost of producing realized capacity, for any given $y$ A invests no more under this strategy than in the principal-initiated game. A’s objective under this class of strategies is then:

$$u^A(x^A, 0) + \delta^A u^A(y, \tilde{c}(\hat{a}^o(y; x^A))) - (1 + \delta^A)k(\hat{a}^o(y; x^A)). \quad (15)$$

Finally, A might target and choose policy $x$ even if it anticipates that P will overturn it later by choosing $x_2 = x^P$ and $a_2 = 0$. In this class of strategies, A’s dominant action is to choose $x_1 = x^A$ and $a_1 = a^o$, and thus her payoff is:

$$u^A(x^A, \tilde{c}(a^o)) - k(a^o) + \delta^A u^A(x^P, 0). \quad (16)$$

While a general characterization of A’s strategy depends on functional forms, several features are immediately obvious. First, for $x^A$ sufficiently close to $x^P$ (specifically, for all $x^A$ such that $\gamma(x^A) \geq \tilde{c}(a^o))$, the strategy of targeting and choosing $y = x^A$ is clearly optimal. The other strategies are therefore adopted only if preferences are divergent. Second, the strategy of investing $a^o$ in $x^A$ clearly becomes ideal if $\delta^A$ is very low. Finally, the strategy of choosing $y \neq x_1$ is optimal if A cares relatively little about capacity but more so about policy. Thus both of the latter strategies might be observed when highly politicized agencies face a hostile legislature.

Agent-initiated policy opens the possibility of higher organizational capacity, as the initial policy choice might allow an agent to realize greater gains from their investments. These investments might benefit the principal as well. However, agents also face the possibility of renegotiation, which did not occur in the principal-initiated games. Many of the results therefore depend on $\delta^A$.

4.2 Delegation

A substantial literature has examined the question of when agent initiative is intentionally given by principals. This section considers the principal’s delegation problem by adding a choice between agent- and principal-initiated policy prior to A’s choice of $a_1$. The delegation choice simply requires a comparison of payoffs between the two subgames. Note that because the capacity investment becomes contractible in period 2, P has no incentive to delegate in period 2, and so I only consider the question of period 1 delegation.
**General expertise.** Using (2) and rearranging, P delegates if:

\[
\Delta P \left( x^P, \tilde{c}(a^*_1) \right) - \Delta P \left( x^A, \tilde{c}(\hat{a}^*_1) \right) \leq \delta^P \left[ \Delta P \left( x^P, \tilde{c}(\hat{a}^*_1) \right) - \Delta P \left( x^P, \tilde{c}(a^*_1) \right) \right].
\] (17)

Expression (17) states the intuitive condition that delegation occurs if the period 2 gain from capacity investment compensates for the (possible) loss in utility for moving policy from \(x^P\) to \(x^A\). Clearly, the delegation choice depends on the weightings that players place on period 2 payoffs. A invests more if given delegation for low values of \(\delta^A\), and P values investment more for high values of \(\delta^P\). P might therefore be more willing to delegate when an agency is staffed by a higher proportion of political appointees, or in periods of high incumbency advantage.

As \(x^A\) increases, the delegation decision requires P to trade off between the increased investment from delegation and the loss in policy in period 1. Again discount factors play a central role. When \(\delta^A\) is low, A will invest heavily if given delegation, even if \(x^A\) and \(x^P\) are far apart. If additionally \(\delta^P\) is high, then P values this investment and delegates authority. Likewise, if \(\delta^A\) is high and \(\delta^P\) is low, investment in capacity becomes less important to P than immediate policy gains, and P retains policy authority. Note also that in equilibrium, delegation is followed by renegotiation.

**Specialized expertise.** While delegation may sometimes benefit the principal under general expertise, this is not true for generalized expertise. The following result establishes that P cannot benefit from the strategies implied by (15) and (16). This is most clear in (16), where P does worse than simply receiving \(x^P\) with no capacity contributions in both periods. As a result, delegation is weakly dominated in the SE game.

**Proposition 6** Delegation under specialized expertise. *In the SE game, P does not delegate.*

Proposition 6 suggests that highly specialized agencies will rarely receive delegated authority. They may, however, apply discretion remaining from previous legislation to a new area. In this case the principal must react to the agency’s first move in targeting and setting policy.

### 4.3 Endogenous Specialization

The next extension considers another possible “agenda-setting” move: what kind of policy technology do players prefer? A principal might specify a highly specialized agent in legislation, or the agent herself might choose whether to become a specialist or generalist. Again, the model is based on principal-initiated policy.

The primary result is that the agent will unambiguously benefit from specialization, while the principal will not benefit if their ideal points are sufficiently distant. Specialization ensures that the agent’s investment will not be appropriated. But since specialization may result in capacity...
\( \gamma(y^*) \) if \( |x^P - x^A| \) is sufficiently large, which leaves the principal indifferent between a policy at \( x^P \) and zero capacity. This outcome is strictly worse than the outcome under the generalized expertise game.

**Proposition 7** Preferences over specialization. For all \( t \),

(i) \( U^A_t(x^*_t, y^*, a^*_t) \) is strictly higher under specialized expertise than under generalized expertise.

(ii) \( U^P_t(x^*_t, y^*, a^*_t) \) is strictly lower under specialized expertise than under generalized expertise for \( x^A \geq x_a \).

The result implies that agents will, where possible, define their areas of expertise narrowly. Broad policy expertise can leave the agent vulnerable to less desirable policies, even when her marginal utility from capacity is relatively constant (i.e., \( \pi^A_{cx} \) is low). The principal, on the other hand, values the ability to appropriate A’s policy investments when her ideal point is distant. The result does not apply when ideal points are closer. In this case, P may prefer specialization ex ante because the increase in capacity may outweigh the (smaller) loss from moving policy away from \( x^P \).

4.4 Resource Constraints

In all variants of the model studied thus far, the agent retains complete control over the initial inputs into capacity. It is reasonable to suppose, however, that even if a principal cannot specify the content of A’s investment decisions, it may control the aggregate level of resources available to the agent. In other words, A’s initial investment choices might face a budget constraint set by P. This section returns to the model of principal-initiated policy and considers the effects of P’s ability to impose such a constraint on A.

Formally, in each period let P choose a “budget” \( b_t \in \mathbb{R}_+ \) prior to A’s choice of \( a_t \) and \( y \). P has quasilinear utility over \( b_t \), and thus receives \( u^P(x_t, c(x_t, y, a_t); x^P) - b_t \) in period \( t \). A does not have utility over \( b_t \) directly, but faces the constraint \( k(a_t) \leq b_t \).

Under generalized expertise, a budget constraint does not affect the choice of \( x_t \) or \( y \). This follows from the separability of policy utility from capacity utility, as P always chooses \( x^P \). Thus, the budget constraint only affects equilibrium strategies through capacity levels. Since A does not value budgets directly, a high budget cannot raise A’s investment, but a low budget can reduce it. P therefore constrains A’s budget if the marginal utility from increased capacity at \( x^P \) is less than her marginal cost from the budget. A similar result obtains under specialized expertise when \( x^P \) and \( x^A \) are sufficiently close. This happens because P is willing to accept \( y^* = x^A \) as the equilibrium policy, but may also desire a lower budget than \( k(a^\circ) \). The following result formalizes these arguments.
Proposition 8 Principal-imposed budget constraints. In a subgame perfect equilibrium of the games with budget constraints:

(i) $c^*_t$ is weakly lower under generalized expertise.

(ii) there exists $x_b \in (x^P, x_a)$ such that if $x^A < x_b$, then $c^*_t$ is weakly lower under specialized expertise.

Proposition 8 is silent on the case of the SE game in which $x^A > x_b$, so that the players’ ideal points are distant. This case is considerably more complicated because, unlike the others, policy choice is not independent of capacity. As in the equilibrium of the SE game, $y^*$ is chosen to induce indifference by P between $y^*$ and its associated capacity level and $x^P$ with zero capacity. Thus a budget constraint might alter policy along with capacity.

In most cases, however, the result is the intuitive prediction that P’s budgetary control over a hypothetical investment line-item can reduce undesirable over-investment by A. Thus even while $a_1$ is uncontractable, P can exercise a crude form of control over it when her marginal utility from capacity is low.

It is finally worth considering how budget constraints might work under agent-initiated policy. The principal reason why agent-initiated policy could produce outcomes unfavorable for P was A’s ability to “strand” investments, so that $y^* \neq x^*_t$ for some $t$. By exercising budgetary control, P can reduce A’s payoff from such investments relative to the SE game investment strategy. As a result, delegation might become more palatable to P.

5. Conclusions

The models developed here explore an important but under-examined feature of organizational politics. A long-recognized role of organizations is that of providing the resources and expertise—in other words, the capacity—to execute policy, independent of who chooses the policy. To the extent that players value this feature of policy, an agent may have an important source of agenda-setting power.

The games make two central assumptions about organizational capacity—that it is endogenous, and that it is initially uncontractable. Thus non-expert principals cannot specify ex ante the kind or extent of an agent’s capacity investments. This leads naturally to an incomplete-contract framework for the games, wherein principals are able to “learn” and renegotiate capacity over time.

It is tempting to interpret capacity as the source of political autonomy for agencies, whereby political principals acquiesce to agency initiative. The model provides a way of formally distin-

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16 Moreover, P’s utility over $b$ implies that the schedule of target policies and capacity levels is different from $(y, \gamma(y))$, which makes comparisons across the two games difficult.

17 For a discussion, see Carpenter (2001).
guishing between autonomy and delegated authority. When an agency has the exclusive ability to invest in capacity, it may achieve high capacity policies even in the absence of formal delegation. The induced policy will not be overturned and, if the principal’s demand for capacity is high, can be located close to the agent’s ideal.

The results indicate the importance of several variables in determining organizational capacity, including preference divergence, discount factors, and especially the technology underlying the provision of capacity. An agent that cannot target capacity investments anticipates that its investment will be appropriated by P. Thus capacity investment is decreasing in the difference in ideal points. To some extent, P may be able to offset this loss of investment through delegation. By contrast, when capacity investments can be targeted, capacity may increase as the players’ preferences diverge. This happens because A chooses a target policy and investment level that induces P to choose a policy closer to $x^A$.

The predictions of the model will be useful for examining the connection between preferences, delegation, policy choice, agency design, and capacity empirically. For example, Section 4.2 suggests that delegation requires A to be unspecialized and to have a low discount factor. One empirical implication is that agencies with higher proportions of political appointees will be more likely to receive ambiguous policy instructions.
Appendix

Proof of Proposition 2. (i) Derived in the text.

(ii) To conserve on notation, I omit time subscripts throughout. I show that A’s objective

\[ V : \mathbb{R}_+^m \times [x^P, \infty) \to \mathbb{R} \]

satisfies the conditions of Theorem 3 of Edlin and Shannon (1998). The
first is continuity, which is assumed. Second, the choice domain (\( \mathbb{R}_+^m \)) must be a properly partially
ordered lattice, which holds trivially.\(^{18}\) Third, the type space ([x^P, \infty)) must be partially ordered,
which, using the standard order, also holds trivially. Additionally \( V(\cdot) \) must satisfy:

**Supermodularity in \( a \).** For any \( j \neq k \), differentiation yields

\[
\frac{\partial^2 V}{\partial a_j \partial a_k} = (1 + \delta A) \left[ \frac{\partial^2 u^A}{\partial c \partial_a} \frac{\partial c}{\partial a_j} \frac{\partial^2 c}{\partial a_k} - \frac{\partial^2 c}{\partial a_j \partial a_k} \right] \geq 0.
\]

Theorem 6 of Milgrom and Shannon (1994) yields the result.

**Strictly increasing differences in \( (a; -x^A) \).** Noting that \( x^A > x^P \), for any \( j \), differentiation yields

\[
\frac{\partial^2 V}{\partial a_j \partial (-x^A)} = (1 + \delta A) \left[ \frac{\partial^2 u^A}{\partial c \partial_a} \frac{\partial c}{\partial a_j} \frac{\partial^2 c}{\partial (-x^A)} \right] > 0.
\]

Theorem 6 of Milgrom and Shannon (1994) yields the result.

**Increasing marginal returns to some \( a_j \).** This follows from the fact that \( \frac{\partial^2 V}{\partial a_j \partial (-x^A)} > 0 \) over

\( X = \mathbb{R}_+^m \).

Observe that by the assumptions on \( u^A(\cdot) \) and \( k(\cdot) \), \( a^* \in \text{int} \mathbb{R}_+^m \). By the theorem, for any

sublattice \( S \subset \mathbb{R}_+^m \) satisfying \( a^* \in S \) and \( a' = \arg \max_{a \in S} V(a; x^A) \), \( a' > (<) \) \( a^* \) if \(-x^A' > (< \)

\(-x^A \). Thus, \( a^* \) is strictly increasing in \(-x^A \), or strictly decreasing in \( x^A \). The result on \( c^*_1 \) follows
from the fact that \( c(\cdot) \) is increasing in each \( a_j \).

Proof of Proposition 3. In period 1, P chooses policy \( y \neq x^P \) if \( \tilde{c}(a_1) \geq \gamma(y) \). Since \( \tilde{c}(a^*(x^P)) > \gamma(x^P) = 0 \), A always prefers investing in \( x^P \) to letting P choose \( x^P \neq y \). Thus, \( x^*_1 = y^* \). In period

2, P can do no better than choosing \( a_2 = a_1 \), which results in the same calculation as in period 1.

Thus, \( x^*_2 = y^* \).

To show that \( y^* \in \mathcal{X} \), suppose that \( y \notin \mathcal{X} \). Then P chooses \( x^P \) in both periods, contradicting

the previous result.

To show that \( y^* \in (x^P, x^A] \), note that because \( \gamma(y) \) is increasing in \( y \) for \( y > x^P \), and \( \tilde{c}(a^*(y)) \)

\(^{18}\) A partially ordered set \( X \) is a lattice if the least upper bound and greatest lower bound of any two elements
are also elements of \( X \). If \( X = \mathbb{R}_+^m \) and the standard component-wise order is used, then the least upper bound is
simply the component-wise maximum, and the greatest lower bound is the component-wise minimum. \( X \) is properly
partially ordered if all equivalence classes are singletons, which is true for the component-wise order.
is decreasing in $y$ for $y > x^A$, any policy $y > x^A$ is strictly dominated by $x^A$ for both players. Similarly, because $\gamma(y)$ is decreasing in $y$ for $y < x^P$, and $\bar{c}(a^o(y))$ is increasing in $y$ for $y < x^A$, any policy $y < x^P$ is strictly dominated by $x^P$ for both players. Thus, $y^* \in [x^P, x^A]$. Finally, to show that $x^P$ cannot be chosen, note that $\bar{c}(a^o(x^P)) > \gamma(x^P)$. By Berge’s Theorem of the Maximum, $\gamma(y)$ is continuous in $y$, and by that theorem and the continuity of $c(\cdot)$, $\bar{c}(a^o(y))$ is continuous in $y$ as well. This implies the existence of a non-empty neighborhood of $x^P$ within which $\bar{c}(a^o(y)) > \gamma(y)$, and thus there exists some $y > x^P$ such that $\bar{c}(a^o(y)) > \gamma(y)$. Thus, $y^* > x^P$, completing the proof. 

**Proof of Proposition 4.** (i) By Proposition 3, $x_1^* = x_2^* = y^* \in X$. Therefore in period 2, P wishes to maximize capacity, implying $a_2^* = a_1^*$.

(ii) If $x^A \leq x_a$, then A achieves her ideal policy and capacity levels by choosing $y^* = x^A$ and $a_1^* = a^o$, which results in $c_1^* = \bar{c}(a^o) > \gamma(x^A)$. Thus for $x^A \leq x_a$, $c_1^*$ is constant in $x^A$.

Now consider the case where $x^A > x_a$. I show that A’s objective $V(\cdot)$ (given by (12)) satisfies the two conditions of Corollary 1 of Edlin and Shannon (1998). The first is continuity, which is assumed.

The second condition is increasing marginal returns; i.e., $\frac{dV}{dy}$ is increasing in $x^A$ (respectively, $-x^A$) to establish that $y^*$ is increasing (respectively, decreasing) in $x^A$. Differentiating (12) yields:

$$dV \over dy = (1 + \delta^A) \left[ \frac{\partial u^A}{\partial y} + \frac{\partial u^A}{\partial \gamma} \frac{d\gamma}{dy} - \frac{dk}{d\gamma} \frac{d\gamma}{dy} \right].$$  \hspace{1cm} (18)

Of the terms in (18), $\frac{dk}{d\gamma}$ and $\frac{d\gamma}{dy}$ are independent of $x^A$. By concavity of $u^A(\cdot)$, $\frac{\partial u^A}{\partial y}$ is increasing in $x^A$. Finally, $\frac{\partial u^A}{\partial \gamma}$ is decreasing in $x^A$. Thus, $\frac{dV}{dy}$ is increasing (decreasing) in $x^A$ if $-\frac{\partial^2 u^A}{\partial \gamma^2} \frac{d\gamma}{dy} > 0$ or:

$$-\frac{\partial^2 u^A}{\partial \gamma^2} \frac{d\gamma}{dy} > 0 \hspace{1cm} (\frac{d\gamma}{dy})^2$$  \hspace{1cm} (19)

By assumption on $u^A(\cdot)$, the right side of (19) is non-negative. I now show that the left-hand side of (19) is strictly positive, bounded from above, and bounded away from zero. By assumption on $u^A(\cdot)$, $-\frac{\partial^2 u^A}{\partial \gamma^2}$ is strictly positive, bounded from above, and bounded away from zero. By the boundedness of $c(\cdot)$, $\frac{d\gamma}{dy}$ is bounded from above. By the convexity of $\gamma(\cdot)$, $\frac{d\gamma}{dy}$ bounded from below by $\frac{d\gamma}{dy}(x'')$, where $x'' = \inf_{x^A \in X} \{ \min \{ x \mid x \geq x^P, \bar{c}(a^o(x; x^A)) = \gamma(x) \} \}$. Since $\bar{c}(a^o(x^P; x^A)) > \gamma(x)$, $\frac{d\gamma}{dy}(x'') > 0$. Thus, $\frac{dV}{dy}$ is strictly positive, bounded from above, and bounded away from zero.
\( \gamma(x^P) = 0 \) for all \( x^A \in X, x'' > 0 \) and therefore \( \frac{d\gamma}{dy}(x'') > 0 \). Thus \( -\frac{\partial^2 u^A}{\partial y^2} \bigg/ \frac{d\gamma}{dy} \in [\xi, \bar{\xi}] \), where \( \xi > 0 \), \( \tau < \infty \).

Let \( \overline{\pi}_c^A = \sup_{c \in [\overline{\gamma}, x^A \in X} \frac{\partial^2 u^A}{\partial y^2} \bigg/ \frac{d\gamma}{dy} \). If \( \overline{\pi}_c^A < \xi \), then \( \frac{d\gamma}{dy} \) is increasing in \( x^A \) and by the corollary any interior selection from the set \( y^*(x^A) \) of maximizers of \( V(\cdot) \) on the set \( X \) is strictly increasing. By assumption, \( A \) chooses \( y^* = \max y^*(x^A) \). Since \( y^* = x_a \) when \( x^A = x_a \), it is clear that \( y^* \in \text{int } X \) for some neighborhood of \( x^A \). Recall from Proposition 3 that \( y^* \leq x^A \). Thus, \( y^* \) is strictly increasing in \( x^A \) over the (non-empty) region \([x_a, \sup X]\). By increasing marginal returns, if \( y^* \notin \text{int } X \) for some \( x^V \), then \( y^* = \max X \) for all \( x^A > x^V \). Thus \( y^* \) is weakly increasing for all \( x^A \geq x_a \), and strictly increasing for some \( x^A \). Since \( \gamma(y) \) is strictly increasing on \( X \), the same comparative statics apply to \( c^*_1 \).

Likewise, let \( \underline{\pi}_c^A = \inf_{c \in [\overline{\gamma}, x^A \in X} \frac{\partial^2 u^A}{\partial y^2} \bigg/ \frac{d\gamma}{dy} \). If \( \underline{\pi}_c^A > \tau \), then \( \frac{d\gamma}{dy} \) is decreasing in \( y \) and by the corollary, \( y^* \) is strictly decreasing in \( x^A \) when \( y^* \in \text{int } X \). By Proposition 3, \( y^* > x^P \), and hence \( y^* \) is interior for all \( x^A \geq x_a \). Thus \( y^* \) is strictly decreasing for all \( x^A \geq x_a \). Since \( \gamma(y) \) is strictly increasing on \( X \), the same comparative statics apply to \( c^*_1 \).

Finally, to show that weak monotonicity applies for all \( x^A \), recall that \( \gamma(x_a) = \bar{c}(a^0) \). Thus for \( x^A = x_a \), \( A \)'s solution to (12) is \( y^* = x^A \). This implies \( c^*_1 = \gamma(x^A) = \bar{c}(a^0) \), which is the same capacity level as that for the \( x^A \leq x_a \) case.

(iii) Suppose otherwise. By Proposition 3, \( y^* > x^P \). Since \( c^*_1 \geq \bar{c}(a^0(y^*)) \) and \( \bar{c}(a^0(y)) \) is increasing in \( y \), \( \bar{c}(a^0(y^*)) > \bar{c}(a^0(x^P)) \). But \( \bar{c}(a^0(x^P)) \) is the equilibrium capacity level in the GE game: contradiction. ■

**Proof of Proposition 5.** (i) Derived in the text.

(ii) The proofs are virtually identical to those of Proposition 2 and are omitted.

(iii) To conserve on notation, I omit time subscripts throughout. It is sufficient to show the result for \( \hat{a}^* \), as \( \bar{c}(\cdot) \) is strictly increasing in \( a \). The concavity of \( V(\cdot) \) and \( \hat{V}(\cdot) \) imply that first order conditions are sufficient to characterize solutions for both (13) and (5). By the fact that \( \frac{\partial^2 u^A}{\partial x^2} > 0 \) for \( x \in [x^P, x^A] \), \( \frac{\partial \hat{V}}{\partial a_j} > \frac{\partial \hat{V}}{\partial a_j} \) for all \( a_j (j = 1, \ldots, m) \). The result therefore obtains if the solution of the agent-initiated game (13), \( \hat{a}^* \), is interior. That \( \hat{a}^* \) is interior follows from two facts. First,
by assumption on $U^A(\cdot)$, $\frac{\partial U^A}{\partial a}(0) > 0$ for all $j$, and thus $\hat{a}^* > 0$. Second, by assumption, $\tau > \hat{c}(a^\circ)$. Since $\frac{\partial^2 U^A}{\partial a^2}(x^P, x^A) > 0$ for $x \in [x^P, x^A)$, A must choose strictly lower inputs than $a^\circ$, and thus $\hat{a}^* < a^\circ$.

Proof of Proposition 6. It is sufficient to show that P never benefits from any strategy in which A chooses: (i) $x_1 \neq y$, characterized by (15), or (ii) $x_1 = x^A$ and $\gamma(x^A) > \hat{c}(a^\circ)$, characterized by (16).

(i) Note that in period 1, $u^P(x^A, 0) < u^P(x^P, 0)$. For period 2, denote by $y'$ the policy such that $a(y) = \arg\max_a U^A(x^A, 0) + \delta^A u^A(y, \hat{c}(a)) - (1 + \delta^A)k(a)$ (i.e., the lowest $y$ such that $\gamma(y) = \hat{a}^\circ(y)$). For $x^A \leq y'$, $a^\circ(y) > \hat{a}^\circ(y) \geq a(y)$. Thus $x_2^\circ = \hat{x}_2^\circ = x^A$ and $\hat{c}_2 \leq c_2$, and so $u^P(x^A, \hat{c}_2) \leq u^P(x^A, c_2)$. Now suppose that $x^A > y'$. Here $\hat{a}^\circ(y) = a(y)$, and thus $\hat{c}_2 = \gamma(y^*)$, which implies $u^P(\hat{x}_2^\circ, \hat{c}_2) = u^P(x^P, 0)$. Since $c_2 \geq \gamma(y^*)$, $u^P(x_2^\circ, c_2) \geq u^P(x^P, 0)$. Combining results, P’s payoff is strictly lower under the delegated strategy.

(ii) I compare P’s payoffs from these strategies to her reservation payoff under the equilibrium principal-initiated game strategy, whereby A chooses $x_1 = y$. Since $c_1^* \geq \gamma(y^*)$ in this game, the reservation payoff is $r = (1 + \delta^P)u^P(x^P, 0)$. Note that because this strategy implies $\gamma(x^A) > \hat{c}(a^\circ)$, P’s period 1 payoff satisfies $u^P(x^A, \hat{c}(a^\circ)) < u^P(x^P, 0)$. P also receives $u^P(x^P, 0)$ in period 2. Thus P’s payoff is strictly less than $r$.

Proof of Proposition 7. Since there is no renegotiation and $a_2^* = a_1^\circ$ in equilibrium in the GE game, it is sufficient to show the result for $U^i(x_1^*, y^*, a_1^\circ)$. For notational convenience, I omit time subscripts.

(i) By Proposition 2, A receives $U^A(x^P, x^P, a^\circ(x^P))$ in the GE game. In the SE game, since $\frac{\partial U^A}{\partial c}$ is increasing on $[x^P, x^A]$, $U^A(x, x, a^\circ(x)) > U^A(x^P, x^P, a^\circ(x^P))$ for any $x \in [x^P, x^A]$. Then by the fact that $a^\circ(x^P) > 0$, there exists some $y' > x^P$ satisfying $\hat{c}(y') > \gamma(y')$, such that $U^A(y', y', a^\circ(y')) > U^A(x^P, x^P, a^\circ(x^P))$. Thus if A chooses $y'$ and $a^\circ(y')$, P chooses $x = y'$ and does not renegotiate. Hence if A does not choose $y'$, then $U^A(x^*, x^*, a^\circ(x*)) > U^A(y', y', a^\circ(y'))$. Combining inequalities, $U^A(x^*, x^*, a^\circ(x*)) > U^A(x^P, x^P, a^\circ(x^P))$.

(ii) By Proposition 2, P receives $U^P(x^P, x^P, a^\circ(x^P))$ in the GE game. In the SE game, by
\( c^* \in \max\{\gamma(y), \tilde{c}(a^o(y; x^A))\} \). If \( c^* = \gamma(y) \), then \( U^P(x^*, y^*, a^*(x^*)) = U^P(x^P, x^P, 0) < U^P(x^P, x^P, a^o(x^P)) \). Thus it is sufficient to show that \( c^* = \gamma(y^*) \) for \( x^A \geq x_a \). Observe that \( x^A \geq x_a \) implies that there exists some \( x' \) such that \( \gamma(x') = \tilde{c}(a^o(x')) \) and \( \gamma(x) > \tilde{c}(a^o(x')) \) for all \( x \in (x', x^A) \). A prefers \( y = x' \) and \( a = a^o(x') \) to any \( y < x' \) associated with any capacity level, and therefore \( y^* \geq x' \). Thus by (9), \( c^* = \gamma(y^*) \) for \( x^A \geq x_a \).  

\[ \text{Proof of Proposition 8.} \] It is easily verified that there is no renegotiation in the equilibria of the budget-constrained games. Thus, since \( a^*_2 = a^*_1 \) in both the GE and SE games, it is sufficient to show the result for \( t = 1 \). For notational convenience, I omit time subscripts. Additionally, let \( a^o(x, b) \) denote A’s optimal investment vector given policy \( x \) and constraint \( b \):

\[
a^o(x, b) = \arg\max_{a[k(a) \leq b]} U^A(x, x, a).
\]  

Note that the constraint is not binding for \( b \geq a^o(x(x)) \), as \( a^o(x, b) = a^o(x) \).

(i) In the GE game, it is clear that P chooses \( x = x^P \) in response to any \( a \). To show that \( b^* \leq a^o(x^P) \), suppose otherwise. Since \( a^o(x) \) does not depend on \( b \), A chooses \( a = a^o(x^P) \), and thus P does strictly better with \( b^* = k(a^o(x^P)) \).

To establish sufficient conditions for \( b^* < k(a^o(x^P)) \), let \( W(x, y, a, b) \) denote P’s single-period utility function. P’s choice of \( b \) depends on the marginal utility from \( b \), given by:

\[
\frac{\partial W}{\partial b} = \frac{\partial u^P}{\partial c} \left[ \sum_{j=1}^{m} \frac{\partial c}{\partial a_j} \frac{\partial a^o_j}{\partial b} \right] - 1. \tag{21}
\]  

Now if \( \frac{\partial W}{\partial b}(x^P, x^P, a^o(x), k(a^o(x))) < 0 \), then P chooses some \( b^* < k(a^o(x)) \) in equilibrium, and thus \( c^* \) is lower than in the game without a principal-imposed budget constraint.

(ii) I first define an analog to \( \gamma(y) \) for the budget-constrained game. Let \( \mathcal{X}' \equiv \{ y \mid \exists c \text{ s.t. } u^P(x^P, 0) = u^P(y, c) - b \} \) denote the set of policies for which a capacity level exists that makes P indifferent between it and \( x^P \) with \( c = 0 \). Next, let \( \gamma' : \mathcal{X}' \rightarrow \mathbb{R}_+ \) denote the capacity level that satisfies \( u^P(x^P, 0) = u^P(y, c) - b \). Note that \( \gamma'(x^P) = \gamma(x^P) = 0, \gamma'(y) \) is increasing, and \( \gamma'(y) > \gamma(y) \) for all \( y \in \mathcal{X}' \setminus x^P \).

Now let \( x_b \) be the policy that satisfies \( \gamma'(x_b) = \tilde{c}(a^o) \). By an argument analogous to that in the proof of Proposition 3, \( x_b > x^P \). Clearly, P prefers any target policy \( y \in (x^P, x_b) \) and investment.
\( a^o \) to \( x^P \) with zero capacity. Thus if \( x^A \in (x^P, x_b] \) and \( b \geq k(a^o) \), A chooses \( y^* = x^A \) and invests \( a^o \). By the fact that \( \gamma'(y) > \gamma(y), x_b < x_a, \) and thus \( y^* = x^A \) and \( c^* = \tilde{c}(a^o) \) in the game without budget constraints. Applying the argument in part (i), \( b^* \leq k(a^o) \), and therefore \( c^* \) is weakly lower with budget constraints than without. 

\[ \blacksquare \]


Figure 1: Two equilibrium cases under specialized expertise. In the left graph, $\tilde{c}(a^\circ(x^A; x^A)) > \gamma(x^A)$. Thus $A$ is able to invest optimally in her ideal policy without renegotiation by $P$. In the right graph, $\tilde{c}(a^\circ(x^A; x^A)) < \gamma(x^A)$, and $A$ cannot invest optimally in $x^A$ without renegotiation. Since she prefers policy $y'$ and capacity $\tilde{c}(a^\circ(y'; x^A))$ to all policies and capacity levels along the schedule implied by $\tilde{c}(a^\circ(y; x^A))$ for $y < y'$, her solution must lie along the schedule implied by $\gamma(y)$ for some $y \in [y', x^A]$. 