The Regulation and Self-Regulation of a Complex Industry*

Nolan McCarty†

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†Susan Dod Brown Professor of Politics and Public Affairs, Woodrow Wilson School, Princeton University, Princeton, NJ 08544 Email: nmccarty@princeton.edu

Abstract

I develop model of policy making in complex policy domains where regulators are highly dependent on the regulated industry for both policy relevant information and expertise. In the model, a principal decides whether to delegate power to an agency to regulate the activities of a firm. The policy domain is complex in that knowledge of the implications of different policy choices is embedded in the firm. The agency can learn about the policy environment only through monitoring the firm's efforts at self-regulation. Such learning is imperfect, and the information obtained from monitoring declines as the complexity of the policy environment increases. The main result is that as policy becomes more complex, regulatory outcomes are increasingly biased towards those preferred by the firm. When the agency has preferences that diverge from the firm, the firm invests less in its own self-regulatory efforts for fear that its investments will be expropriated.

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In the debates on financial market reform that followed the Financial Crisis of 2008, reformers advocated three distinct approaches. Some argued that governments should fundamentally restructure the financial sector. Large banks should be broken up. Investment and commercial banks should be separated as they had been under the Glass Steagall reforms of the 1930s (or at least the investment activity of commercial banks should be drastically restricted). They promoted limits on the types of financial products that could be marketed and taxes on financial transactions. Opponents of government intervention argued the opposite position. They argued that a government-led reconstruction of the financial marketplace would be counter-productive if not futile. Such actions would impede financial innovation and restrict credit and liquidity. At most, according to the opponents, reform should get the taxpayer off the hook for the failure of financial firms. The middle ground in this debate was held by those who argued that the basic structure of the financial sector should remain intact but that the capacity and powers of regulatory agencies should be enhanced to better monitor the sector for systemic risks, financial fraud, and predatory lending practices. The middle ground, reflected in the Wall Street Reform and Consumer Protection Act (i.e. "Dodd-Frank"), won out.

Although the debate about financial reform centered on economic trade-offs, the question is essentially one of politics and public administration. Can the government effectively regulate a large, complex, and interconnected financial sector? If the answer is yes, then the middle ground of enhanced regulatory supervision seems promising. If the answer is no, then either of the more extreme approaches may be more compelling.

Unfortunately, there are many reasons to believe the answer to this question is no. Financial markets and products may be so complex that agencies lack the capacity to detect systemic risk and fraud. Moreover, regulators may be so dependent on the industry for information, expertise, and talent that they are not able to exercise independent regulatory authority. At best under such conditions, regulation will accommodate the preferences of the financial industry. At worst, regulators may be captured by industry.

Although bureaucratic capacity in complex policy environments are particularly salient to debates about financial reform, this issue manifests itself in a large number of policy domains ranging from rate and service regulation to product and workplace safety to the environment. Despite the centrality of such concerns, political scientists have been slow to develop theories and models of how complexity, capacity, and capture might interact in the regulatory sphere and what policy making trade-offs these interactions induce.

To be sure, political scientists have focused on the role of information and expertise in regulatory settings. Much of political science scholarship on regulation focuses on the decision of elected politicians to delegate policy making authority to the better informed experts employed in the bureaucracy. Because legislators are policy generalists rather than experts, they may find it difficult to select good policies in uncertain environments. Consequently, they grant bureaucratic specialists discretion in policy choice (e.g. Epstein and O'Halloran (1999), Huber and Shipan (2002), and Bendor and Meirowitz (2004).)

But the informational approach to delegation downplays at least three important issues. First, the delegation literature often does not problematize the source of bureaucratic expertise and information. Bureaucratic expertise is often taken as exogenous or as the result of human capital investments by bureaucrats.[1] Likewise, bureaucrats are assumed to have the relevant information or can obtain it at some cost or effort. In this regard, the approach in political science is quite different from that of regulatory economists for whom the regulator's extraction of information from the regulated firm is the central problem (e.g. Baron and Myerson (1982) and Laffont and Tirole (1986).)

Second, much of the work on delegation assumes that bureaucrats can efficiently and effectively implement their policy choices. But as Huber and McCarty (2004) point out, imperfect implementation generates *ex post* control problems for political principals.[2] When

[1]See Gailmard and Patty (2004); Bendor and Meirowitz (2004).
[2]See also Bendor and Meirowitz (2004).

there are errors in policy implementation, political principals find it more difficult to detect when agents attempt to implement policies that the principals disapprove of. This problem enhances the possibility of bureaucratic drift.

Third, this literature often draws no distinction between information and knowledge. Expertise is modeled as the acquisition of missing data to be applied to a known model to generate some desired policy outcome. But expertise also reflects that experts have better knowledge of the true underlying model than do non-experts. As I explain below, treating expertise as missing data can make inferences by non-experts too easy which may in turn undermine the value of expertise. But the more encompassing notion of expertise as both data and the knowledge of what to do with is more likely to lead to deference to experts.

In an attempt to fill in some of the gaps in our understanding of regulatory policy making, I develop a model of policy making in *complex* policy domains. By complex, I mean that bureaucrats find it very difficult to establish autonomous sources of information and expertise about the consequences of different policies. In such cases, regulators are highly dependent on the regulated industry for both policy-relevant information and expertise. The recurring example of financial regulation fits this notion well. In a less complex regulatory environment, the government might mitigate any informational advantages of the regulated industry by hiring its own experts to serve on the staffs of legislative and regulatory agencies. In finance and other complex environments, the wage premium on expertise might be large enough that the government cannot match the expertise of the industry.[3]

Together these features of complex policy environments invariably create trade-offs between expertise and capacity on one hand and autonomy on the other. These trade-offs are central to my model. In the model, a legislative principal decides whether to delegate power to an agency to regulate a firm or industry. The policy domain is complex in that

[3] Philippon and Reshef (2009) have estimated that on the eve of the Financial Crisis, wages in the financial sector were 70% higher than those of comparably skilled and educated workers outside the sector. Governmental pay scales cannot compete with Wall Street for talent.

much of the knowledge of the implications of different policy choices is embedded in the firm. Unless the agency is willing and able to commit significant resources to building its own expertise, it can learn about the policy environment only through monitoring the firm's activities. This learning, however, is imperfect and the information obtained from monitoring declines in the complexity of the policy environment.

My model of policy learning builds upon the observation that public regulation generally supplements and builds upon the efforts of firms and industries to self-regulate. Many industries have trade associations and private regulators who develop, implement, and enforce rules and standards on the industry. One might also think of the modern firm as a private regulator. Managers regulate workers, parent companies regulate divisions, and so on. Moreover, many firms make substantial investments in the creation of self-regulatory institutions such as auditors, human resource managers, and risk managers. A central premise of my model is that public regulatory agencies can both learn from observing these private regulatory efforts and free ride off the expertise that went into designing those efforts.

To illustrate the logic of my model, consider an example from financial regulation. On May 6, 2010, the Dow Jones Industrial Average lost 900 points (or about 9%) in a matter of minutes. The belief that this "flash crash" was caused or exacerbated by high frequency trading led both regulators and the industry to consider new regulations including "circuit breakers" that would stop the trading of securities whose price has fluctuated too much. The exchanges and their private regulator the Financial Industry Regulatory Authority (FINRA) moved first to formulate rules for such circuit breakers. The Securities and Exchange Commission (SEC) therefore had the choice of accepting the FINRA standards, modifying them in various ways, or developing different ones from scratch. Accepting the FINRA standards leads to the regulatory outcome targeted by the industry. But modifying the proposal by adding a more aggressive set of circuit breakers would lead to outcomes that are closer in expectation to the SEC's preferences. Because of the SECs limited expertise and capacity, however, changes in the target outcome may have unintended consequences. Requiring trading halts for smaller price changes may distort markets too much. So the SEC may be hesitant to change the FINRA proposal too much.[4] Anticipation of the SEC's behavior may in turn influence both the standards that FINRA chooses as well the efforts that go into developing them.

My main result is that as policy becomes more complex, regulatory outcomes are increasingly biased towards those preferred by the firm. Although the principal may try to minimize these biases by appointing a regulator whose preferences diverge from those of the firm, doing so reduces the firm's investments in self-regulation. In turn this may lead to greater uncertainty in policy outcomes and unintended consequences. When the principal is unable to sufficiently reduce the pro-firm bias through agency appointments and structural reforms, she may prefer not to delegate power to the agency at all. If the agency is likely to be too deferential to the firm's expertise, the principal may prefer to economize on the fixed cost of regulation and allow the firm to remain unregulated. Alternatively, if the outcomes associated with an unregulated firm are too unfavorable, the principal may decide to ban the firm's activities or select some other bright-line rule that can be implemented by less expert bureaucrats.

[4] In September 2010, the SEC adopted the rules developed by FINRA. See http://www.sec.gov/news/press/2010/2010-167.htm, downloaded July 10, 2011.

The Model

There are three actors in the model: a legislative principal denoted L, a regulatory agency denoted A, and a firm denoted F. In some cases, it might be more productive to think of the firm as an entire industry, a trade association, or some other entity with private regulatory power.

I do not explicitly model the firm's production or the marketing of its output, but assume instead actors have preferences over regulatory outcomes. Let $X \subset \mathbb{R}$ denote the set of outcomes. Outcome x is a measure of the social cost imposed by the firm's activities for a given level of social benefits. Because the firm internalizes social costs and benefits to a lesser degree than the legislator, it is natural to assume that the legislator prefers lower outcomes on this dimension than does the firm. To clarify this notion, consider another example from financial regulation. Suppose regulations are targeted at the degree of economic concentration in the financial sector. Concentration is presumed to have benefits in terms of economies of scale and costs in terms of increased systemic risk. Outcome x reflects a specific trade-off between the benefits of the economy of scale and the reduction of systemic risk. The principal prefers low values of x where the economies of scale are large and the risks are small. The firm might prefer larger values because it captures more of the value from the scale economies and does not fully internalize the risk.

Let l, a, and f be the ideal regulatory outcomes for L, A, and F, respectively. Each player has quadratic preferences over outcomes so that the utility of x for player i is $-(x-i)^2$. Further, I set $l = 0$, $f = 1$, and $a < 1$. Below I consider a variety of assumptions about the preferences of the agency.

Following the literature on delegation, I model expertise as knowledge about how to obtain specific outcomes. Previous models assume that outcomes are generated by a linear combination of policy choices and random shocks.[5] Non-experts know the relationship

[5]See Gilligan and Krehbiel (1987), Epstein and O'Halloran (1999), Gailmard and Patty (2013).

between the shock and the outcome, but do not know the exact value of the shock. Alternatively, experts observe the value of the random shock and are therefore able to choose policy to get a desired outcome.[6] These assumptions imply that the acquisition of expertise is equivalent to learning the missing data. But it may be inappropriate to reduce expertise to information about missing data. While real-world regulators have ample opportunities to obtain data through regulatory reporting requirements and investigatory powers, the larger concern is whether the agency can use the data productively. In other words, expertise is more than information it is the deeper knowledge of the model that links policies and outcomes.

Recently, Callander (2008) identified another limitation of the standard model. Because the standard model implies that the non-expert need only observe one policy and one outcome to become an expert, the principal generally has an *ex post* incentive to renege on its delegation of authority and move policy to its preferred outcome. Callander argues that it is more realistic to assume that the policy choices of experts only reveal *local* information; that is, the principal should be able to make inferences about the effects of policies close to the one chosen by the expert but learn little about the effects of very different policies. This critique is pertinent in those situations where policy information is difficult to obtain and the ability of non-experts to make good decisions based on inferences drawn from the behavior of experts is limited.[7]

The model is developed with these considerations in mind. First, following Callander, the inferences that other agents draw from observing the policy choices of experts are limited and local. A regulator cannot monitor the firm's actions that generated outcome x and use that information to perfectly implement policy outcome x'. Although the agency may observe the actions that implemented x, it does not know how to modify them to

[6]Formally, the link between outcome x and policy p is given by $x = p + \omega$ where ω is a random variable observed by the regulator but not the principal policymaker.

[7]In the standard model, the agency may not be able to makes correct inferences because the firm distorts its behavior.

generate a distinct regulatory outcome with certainty.

Another key assumption is that agents cannot perfectly design and implement policies to get specific outcomes. Rather agents choose *target* policies that are implemented in an uncertain way. In simple policy arenas, the ultimate outcomes are often close to the policy targets. But when policies are complex, there may be large deviations between the target and the ultimate outcome. Moreover, I assume that *expert* agents are better at designing and implementing policies that hit their targets than are less expert agents. In the model, the firm is more expert than the agency.

Formally, if the agency tries to implement target policy x' after observing the firm implement target policy x, the *realized outcome* is $x' + \omega$ where ω has mean 0 and variance that depends on the proximity of x to x' as well as some underlying parameters related to the complexity of the policy arena. The variance of ω takes the form $\frac{\theta c(d)}{1+e}$ where $d(x, x') = |x - x'|$. The parameter θ reflects one aspect of policy complexity: the baseline uncertainty associated with the implementation of a target policy. This is the uncertainty associated with the firm's policy target which is then amplified when the agency revises it. The function $c(d)$ reflects a second aspect of complexity, the extent to which uncertainty increases when the policy target is revised from x to x'. This captures the assumption that the agency can make large revisions to the firm's target, but such revisions lead to more uncertain outcomes. The shape of this function represents another important aspect of complexity. When $c'(d)$ is large, uncertainty increases rapidly as policy targets are revised, and this rate of increase is proportional to θ. In general, I assume that $c(0) = 1$, $c'(d)$ is strictly positive for all d, and that $c(d)$ is concave. To obtain closed form solutions, I use the following functional form for c:

$$c(d) = (d + \kappa)^2 + 1 - \kappa^2 \tag{1}$$

Because $c'(d) = 2(d+\kappa)$, κ determines the rate at which uncertainty expands as policy is revised. When κ is low, policy targets can be revised with minimal increases in uncertainty, whereas large values of κ make revisions quite uncertain. There are two interpretations of κ. The first is as a technological parameter measuring the complexity of policy. Complex policies have large values of κ because revisions of expert targets have more uncertainty and unintended consequences. A second interpretation is that κ is a measure of the relative expertise of the non-expert i.e. with a low value of κ the non-expert can more successfully revise the expert policy target. I use both of these interpretations and extend the model to allow the firm to manipulate the level of κ.[8]

Finally, I assume that the firm can reduce the variability of policy outcomes by investing in *self-regulation*. These investments take the form of a self-regulatory effort $e \geq 0$. These efforts might include research or planning designing to improve the implementation of the firm's own policy. They might also include better monitoring of units in an M-form organization. These investments may also reflect decisions of the firm to increase transparency in ways that might improve implementation through better coordination with other firms or customers. Such efforts at transparency may not only entail direct costs, but may also result in forgone economic opportunities through revealed trade secrets and the like. As an example, consider the regulation of high-frequency securities trading. More effective self-regulation by the securities industry and the exchanges might require traders to reveal more information about their trading platforms and strategies. But revealing this information is costly as it eliminates the advantages that firms obtain from proprietary strategies.

For simplicity, the firm's cost of informational effort is simple and linear: $k(e) = \gamma_f e$. Importantly, the firm's regulatory efforts not only reduce the variance associated with its own policy choice, but also the variance associated with any modifications demanded by

[8] My framework is closely related to several other models where agenda setters make "take-it-or-change-it" offers. These models have been applied to opinion writing on the Supreme Court (Lax and Cameron 2007), presidential bargaining with Congress (Howell and Jackman 2011), executive oversight of rulemaking (Wiseman 2009), and delegation to legislative committees (Hirsch and Shotts 2011).

the agency. For example, should trade associations demand increased transparency for its regulatory efforts, regulators can use that transparency to more effectively modify self-regulations.

The key assumptions of the model are captured in Figure 1. The firm moves first and attempts to implement x at some effort e. The distribution of outcomes following this decision is given by the thick solid curve centered at x. Next the agency decides on a revised policy target x. If the agency chooses a policy target relatively close to x such as x', the outcome variance will be lower than if it chose the more distant policy target x''. The distributions are shown by the solid lines centered at x' and x''. If the firm exerted a lower level of effort, however, the outcome variances at these two policies will be larger. These distributions are shown by the dotted curves. Similarly, the effects of κ can be demonstrated. Suppose there are two values $\kappa_1 > \kappa_2$. When $\kappa = \kappa_1$, modifying the policy to x' or x'' produces the distributions with dotted curves while modification when $\kappa = \kappa_2$ produces the solid curves.

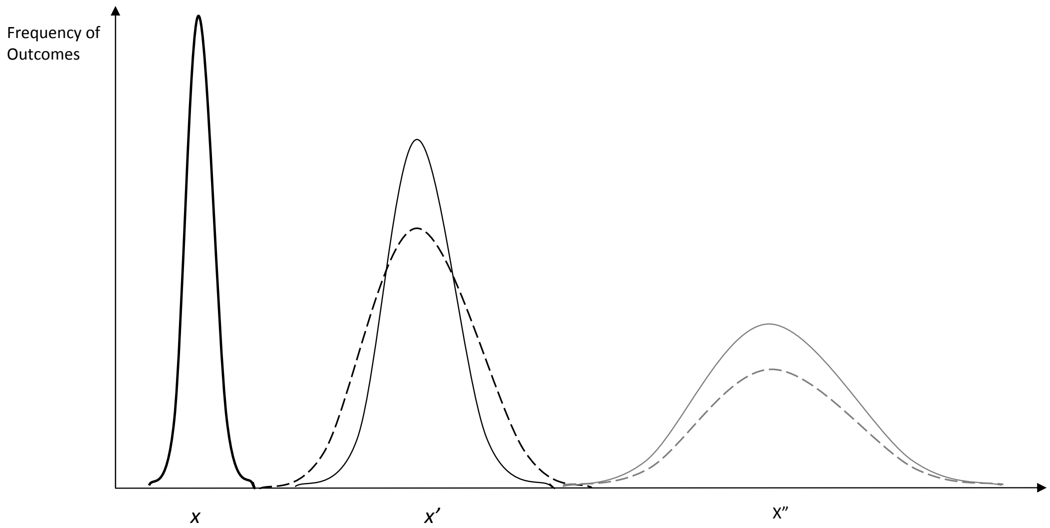

Figure 1: Policy Outcome Distributions

Figure 2 outlines the sequence of play for the game. In the basic model, the ideal point of the agency a is exogenous and known to the principal. I subsequently relax this assumption and allow the principal to directly choose the agency's preferences.[9]

The legislative principal moves first and chooses the regulatory regime from among *banned*, *regulated*, and *unregulated*. In the unregulated regime, the firm self-regulates by implementing a regulatory outcome, and the game ends. Because the firm's decision cannot be amended by an agency, it chooses its ideal outcome as the policy target. Therefore, $x^u = 1$. The firm may also invest effort in reducing the variance of the outcome. It chooses e to maximize:

$$-\frac{\theta}{1+e} - \gamma_f e \tag{2}$$

Optimization reveals that $e^u = max\{0, \sqrt{\frac{\theta}{\gamma_f}} - 1\}$. Intuitively, the firm's regulatory effort is high when policy uncertainty is high and is low when in the marginal cost of effort

[9]The exogenous agency preference model may reflect the effects of the separation of powers where the legislature makes the decision of whether to create the agency but the executive retains the authority for staffing the agency. See McCarty (2004).

is high.[10] The equilibrium level of uncertainty is $\min\{\theta, \frac{\sqrt{\gamma_f}\theta}{\sqrt{\gamma_f}+\theta}\}$ which is increasing in both γ_f and θ.

Second, the principal may ban the firm's activity. If the principal does so, the regulatory outcome is given exogenously by $x_b < 0$. The ban, therefore, is assumed to be inefficient in that it produces a lower social benefit-cost ratio than the principal's ideal (0), but it does so with certainty.[11] The principal prefers the ban to the unregulated case if and only if $-x_b^2 \geq -1 - \sqrt{\theta\gamma_f}$. Consequently, for a given value of x_b, the principal is more likely to prefer a ban to non-regulation for larger values of θ and γ_f. The result for θ is straightforward and obvious. The effect of γ_f reflects the concern that the firm will not invest enough effort in its own regulatory efforts to produce better outcomes than those obtained under the ban. Importantly, I do not allow the firm to precommit to effort levels sufficient to assuage the principal's concerns.

Finally, I turn to the regulation regime. Regulation involves trade-off for the principal. Most obviously, it affords the opportunity to have the firm's policy target modified by the agency. This in turn may cause the firm to accommodate agency preferences. But regulation also affects the firm's investment in self-regulation. In the model, a firm's investment can be partially expropriated by the agency. So the firm may invest less in information for self-regulation when faced by a hostile regulator.

[10] The outcome in this case may not reflect the firm's profit maximization. It may instead reflect the firm's optimal choice under the pressures and constraints of private politics Baron (2001).

[11] The ban could easily be modeled as an uncertain outcome. In that case, x_b would reflect the certainty-equivalent of the lottery induced by the ban. One might also interpret x_b as some bright-line rule other than a ban.

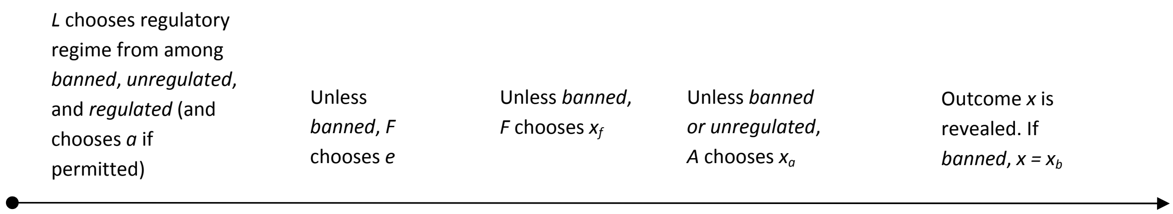

Figure 2: Sequence of Actions

In the regulatory regime, A observes F's policy choice x_f and investment decision e and then makes its investment decision and policy choice. Consider the final stage where A chooses its best response to $\{x_f, e\}$. It chooses x_a to maximize[12]

$$-(x_a - a)^2 - \frac{\theta}{1+e}\left[(|x_f - x_a| + \kappa)^2 + 1 - \kappa^2\right] \tag{3}$$

The agency faces a trade-off between increasing the utility of target outcome and increasing the implementation variance. It can choose a target outcome x_a that is close to its ideal point a in order to maximize its utility from the expected outcome (the first term). But if doing so involves a policy target far from x_f, the uncertainty about the policy outcomes increases (the second term). Lemma 1 characterizes the agency's best response.

Lemma 1. *The agency's best response to $\{x_f, e\}$ is given by*

$$x_a(x_f) = \begin{cases} \frac{(1+e)a+\theta(x_f-\kappa)}{1+e+\theta} & \textit{if } x_f < a - \frac{\theta\kappa}{1+e} \\ \frac{(1+e)a+\theta(x_f+\kappa)}{1+e+\theta} & \textit{if } x_f > a + \frac{\theta\kappa}{1+e} \\ x_f & \textit{otherwise} \end{cases}$$

Lemma 1 demonstrates that when the firm chooses a target policy sufficiently close to

[12]This derivation uses the fact that $E[(a - x - \omega)^2] = E[(a - x)^2] + var(\omega)$ (McCarty and Meirowitz 2006) .

the agency's ideal point, the agency accepts it and does not regulate further. The critical distance between the firm target and agency ideal point that triggers an agency response is $\frac{\theta\kappa}{1+e}$ which is increasing in the policy complexity (in terms of both θ and κ) and decreasing in the firm's investment. Consequently, the firm can avoid agency meddling either by choosing a target close to that preferred by the agency or by investing in less information for its self-regulation.

Alternatively, if the agency modifies the policy target, it chooses a target that is a weighted average of its ideal target and that of the firm. The weight on the agency's ideal point is $\frac{1+e}{1+e+\theta}$, an increasing function of the firm's regulatory investment. The weight on the firm's ideal point is $\frac{\theta}{1+e+\theta}$ which is proportional to the baseline complexity of the policy.

Given the agency's best response to the target outcome of the firm x_f and its information investment e, the firm chooses its policy target optimally. The firm's choice reduces to two options. First, it could set a relatively extreme target that the agency might modify. This is the *revision* case. Alternatively, the firm might choose a policy that sufficiently accommodates the agency such that no regulatory revision is necessary. This is the *accommodation* case.

I begin with the revision case. Because $f > a$ by assumption, the only relevant case is where x_f is greater than a and is sufficiently large to induce the agency to revise the target. From Lemma 1, the revision case requires $x_f > a + \frac{\theta\kappa}{1+e}$. Therefore, the firm's expected utility is given by

$$-\left(1 - \frac{(1+e)a + \theta(x_f + \kappa)}{1+e+\theta}\right)^2 - \frac{\theta}{1+e}\left[(x_f - \frac{(1+e)a + \theta(x_f+\kappa)}{1+e+\theta} + \kappa)^2 + 1 - \kappa^2\right] - \gamma_f e \quad (4)$$

The unique maximizer of Equation 4 is $x_f^* = 1 - \kappa$. This result is counter-intuitive. Rather than make fewer concessions when revising the policy target is difficult, the firm deviates more from its ideal point when the marginal cost of amending its policy target is large. It is increasingly accommodating because it is more difficult for the agency to expropriate its regulatory investment. Thus, by accommodating sufficiently, the agency's revision and consequent increase in uncertainty is small. While one might also expect that the firm's accommodation would be related to the baseline level of uncertainty $\frac{\theta}{1+e}$, it turns out not to be. There are two effects of larger values of $\frac{\theta}{1+e}$ that cancel out. Higher values lead the agency to make fewer adjustments, but any adjustments are more costly to the firm.

Given the firm's choice, it is easy to see that $x_a(x_f^*) = \frac{(1+e)a+\theta}{1+e+\theta}$. This expression also has a straightforward interpretation. The final policy outcome is the weighted average of the ideal points of the agency and the firm where the weight on that of the agency is $\frac{1+e}{1+e+\theta}$. So the firm's regulatory efforts move the equilibrium policy target towards the agency's ideal point. This effect is the expropriation problem.[13] Therefore, whenever the firm makes greater regulatory investments, it trades the reduction in uncertainty against the possibility that the agency will expropriate some of that investment in order to regulate the firm more strictly.

In the accommodation case, the firm chooses its preferred target policy from those that will not be revised by the agency. Given the agency's response function, such a target solves $x_a^* = x_f$ or $x_f = a + \frac{\theta\kappa}{1+e}$. The firm chooses an accommodating target when $a > 1 - \kappa\frac{1+e+\theta}{1+e}$. Logically, the firm is willing to accommodate the agency when its ideal point is close to the firm's and when policies are difficult to amend (high κ, high θ, and low e).

A special sub-case is the case where the firm targets its ideal point and the agency accepts it. This occurs when $a \geq 1 - \frac{\theta\kappa}{1+e}$. If the firm's target of its ideal point is not revised, its investment decision is the same as that in the unregulated case. Therefore, I can define a critical value of the agency ideal point $\bar{a} = 1 - \frac{\theta\kappa}{1+e^u}$. Any agency with ideal

[13] See also Aghion and Tirole (1997) where the principal may precommit to not reversing an agent's decision to assure the agent that her investments in information will not be expropriated.

point $a > \bar{a}$ generates an outcome equivalent to that of the unregulated regime.

Finally I turn to the firm's information investment decision where it chooses e to maximize its expected payoff, given the best response policy target of the agency. First, consider an interior solution where the firm chooses an effort level that is greater than 0 and leads to the agency choosing a revised policy target. In this case, the firm's utility function is

$$-\left(1 - \frac{(1+e)a+\theta}{1+e+\theta}\right)^2 - \frac{\theta}{1+e}\left[\left(1-\kappa-\frac{(1+e)a+\theta}{1+e+\theta}+\kappa\right)^2 + 1-\kappa^2\right] - \gamma_f e \qquad (5)$$

This expression can be rewritten as

$$-\frac{1+e}{1+e+\theta}(1-a)^2 - \frac{\theta}{1+e}(1-\kappa^2) - \gamma_f e. \qquad (6)$$

Equation 6 reveals that the firm's utility has three components. The first is related to the preference difference between the firm and the agency, $(1-a)^2$. Increasing self-regulatory effort increases the coefficient on the term $\frac{1+e}{1+e+\theta}$ and thus lowers the firm's utility. This negative incentive to invest in self-regulation is directly attributable to the possibility that an agency with preferences different from those of the firm would expropriate some of the informational investment and move the policy target away from the firm's ideal point. The second term reflects the costs of uncertainty reflected in θ. Here increasing effort reduces uncertainty and thus increases utility. This second term is multiplied by $1-\kappa^2$ which may either be interpreted as a measure of the agency's expertise or as the simplicity of the policy domain. Either way, it corresponds to the ease with which the agency can expropriate investments in self-regulation. The combined term therefore reflects the increased uncertainty associated with expropriation. The final component is simply the cost of the firm's self-regulatory efforts.

Second, consider the case where the firm chooses a level of effort that leads the agency to accept its policy target. The firm's utility in this case is

$$-\left(1-a-\frac{\theta\kappa}{1+e}\right)^2-\frac{\theta}{1+e}-\gamma_f e \tag{7}$$

The firm faces similar trade-offs as in the revision case. It would like to increase information investment to reduce uncertainty, but if it does it must accommodate the agency more to avoid expropriation. So its investment is again lower than that of the unregulated case. Proposition 1 describes the relationship between the firm's investment and the other parameters of the model.

Proposition 1. *The optimal level of investment by the firm e^* is 1) weakly increasing in the agency's ideal point a 2) increasing in the baseline policy uncertainty θ 3) weakly decreasing in κ in the revision case and for lower values of a in the accommodation case; but increasing in κ for higher values of a in the accommodation case 4) decreasing in the marginal cost of effort γ_f.*

The weak inequalities in Proposition 1 are generated either by the *de facto* unregulated case of $a \geq \bar{a}$ or the corner solution $e^* = 0$. From above we know that x_a^* is an increasing function of a and e^*. This fact combined with Proposition 1 part 1 proves that the total effect (direct and indirect) of a on x_a^* is positive. Higher values of a also decrease the variance of the final outcome. Consider first the revision outcome which occurs for sufficiently low a. In this case, the outcome variance is $\frac{\theta}{1+e}(1-\kappa^2)$ which decreases in e and therefore in a. In the accommodation case, the outcome variance is $\frac{\theta}{1+e}$. Again since the equilibrium outcome variance is decreasing in e, it is also decreasing in a. These results are summarized in Proposition 2.

Proposition 2. *The final target policy is a weakly increasing function of a while the outcome variance is a decreasing function of the agency ideal point a.*

The Principal's Problem

Now consider the preferences of the principal over the ideal point of the agency. Proposition 2 summarizes the principal's trade-offs. By creating an agency with preferences closer to her own, the principal obtains better policy outcomes in expectation but incurs the cost of more uncertainty. This trade-off suggests that the principal may prefer an agency with pro-firm preferences in order to reduce the uncertainty of the final outcome. Proposition 3 provides a sufficient condition for the principal to prefer an agency with preferences more pro-firm than her own.

Proposition 3. *If $1 > \kappa \frac{1+e^*(0)+\theta}{1+e^*(0)}$, the principal's optimal agency ideal point a^* is strictly greater than 0 and weakly lower than $\bar{a}$.*

Proposition 3's sufficient condition insures that an agency with ideal point $a = 0$ revises the firm's target in equilibrium. This condition insures that the marginal effect of increasing a on the outcome variance is larger than the expected policy loss associated with a more pro-firm policy target. This condition is not a necessary one. It is easy to construct examples where it does not hold, yet the principal still prefers to appoint a relatively pro-firm agent.[14]

The result of Proposition 3 highlights the principal's fundamental trade-off. It can obtain an expected policy outcome closer to its ideal point by choosing a close to zero. But doing so is costly. First, it lowers the firm's investment in self-regulation which in turn leads to greater uncertainty. Second, it leads to a larger amount of agency revision of the policy which also increases uncertainty.

To illustrate, consider a numerical example. Let $\theta = 1$, $\gamma = .1$, and $\kappa = .5$. The principal's optimal location of the agency is $a^* = .25$. At the optimal agency location, the equilibrium policy target is .48 and the level of self-regulation investment is 1.22. Had the

[14]Based on an extension of the cheap talk delegation model of Dessein (2002), Gailmard and Patty (2013) make a similar argument. In their model, the principal delegates to an agency close to the firm to facilitate cheap talk communication of the firm's superior information about the state of the world (see also Crawford and Sobel (1982) and Gilligan and Krehbiel (1987)).

principal chosen a faithful agent with $a = 0$, the target policy would have been .35, but the firm would have reduced its regulatory investment to .84. The second effect dominates the first so the principal would have been considerably worse off with $a = 0$.

In the preceding discussion, the principal is willing to delegate to a more pro-firm agency to minimize the expropriation problem even if there are no benefits related to expertise. But there may be a strong correlation between agency preferences and expertise. This occurs when the necessary expertise and training is available only through the industry or in professional schools and training programs were the curriculum is favorable to industry interests. For example, in finance, there are few opportunities to acquire the necessary expertise about financial markets outside of the industry or from business schools. Consequently, financial regulators often share strong social ties to the industry and are more sympathetic on average to the industry's interests and viewpoints[15]

The trade-offs created by a link between preferences and expertise can be analyzed within my framework. Now let κ, interpreted as agency's capacity, be a function of a. Assume that $\kappa(a)$ is a decreasing function so that an agency with preferences close to those of the firm can modify its policies more effectively and focus on the target revision case. The main effect of this change is an enhanced effect of appointing a pro-firm agency on the firm's effort level. As before, there is a positive direct effect of a more pro-firm agency on the firm's information gathering. But now there is an additional indirect effect because the more pro-firm agency has a lower value of κ. The lower κ induces more revision so that the outcome variance increases, which in turn induces more effort from the firm.

So the principal's benefits from a pro-firm agency are increased due to greater levels of firm investment in information and self-regulation. This investment reduces policy uncertainty and mitigates the distributive loss of a more pro-firm agency. But these gains are offset because decreasing κ increases the equilibrium level of policy revision which increases

[15] In debates about financial regulation, this phenomenon has been dubbed *cognitive* capture. See Johnson and Kwak (2010).

uncertainty.

An upshot of Proposition 3 is that an empirical observation that the agency is biased towards the firm and away from the principal may not indicate regulatory capture or undue firm influence. It may instead reflect an optimal agency design where the principal gives up expected policy outcomes for a reduction in uncertainty.

The second part of Proposition 3 demonstrates that the principal always chooses an agency with preferences weakly lower than $\bar{a}$. So absent any fixed costs of regulation, the principal will always weakly prefer regulation to non-regulation. The principal's utility at a^* may be sufficiently low that she prefers a bright-line rule $\boldsymbol{x}_b$ to regulation. The principal is more likely to prefer the bright-line rule when the complexity parameters θ and κ are larger. A larger θ unambiguously reduces the principal's utility from regulation as it leads to a more accommodating policy target and more uncertainty.[16] Similarly, an increase in κ weakly increases the equilibrium policy target and equilibrium uncertainty.[17] So the model suggests that policy complexity should lead to greater reliance on bright-line rules or bans. Higher levels of γ_f also reduce principal welfare through the reduction in e. So bright-line rules or bans are more likely when self-regulation is costly.

[16] Recall that even in the unregulated case where the firm need not fear expropriation, it would not choose e large enough to offset increases in θ. When the expropriation problem is greater, it would be even less likely to do so.

[17] The effects of κ are more subtle than those of θ. In the revision case, the main effect of an increase in κ is the reduction in firm effort which in turn increases the equilibrium policy target. The equilibrium level of uncertainty is given by $\frac{1-a}{1+e+\theta}$. So the reduction in e induced by a higher κ unambiguously increases the level of uncertainty, even though the larger κ does reduce the equilibrium policy revision. In the accommodation case, the first-order effect of an increase in κ is an increase in the equilibrium target policy. While it is possible for an increase in κ to increase e, this effect is more than offset by the effect of κ on the policy target.

Capture

This section adds a very simple model of regulatory capture to the framework. In this extended model, the firm first chooses its self-regulatory investment and then offers the agency a contract $\{x_c, b\}$ where x_c is a policy target and b is a transfer of resources. Although such transfers may not be entirely illicit, I call them "bribes." If the agency accepts the contract, it accepts target x_c and receives the bribe. If it rejects the contract, it chooses x_a optimally given x_c.

Absent the effects of uncertainty and complexity, the equilibrium outcome in a spatial bribery game is $\frac{1+a}{2}$, the midpoint of the firm's and agency's ideal points. Although in the equilibrium of this model the agency does not revise the firm's offer, complexity affects the agency's reservation utility based on its optimal no-bribe response to x_c. Because complexity and uncertainty reduce the agency's utility from revising the target policy x_c, the firm can reduce its equilibrium bribe. This allows the firm to obtain a policy target higher than $\frac{1+a}{2}$ without increasing its bribe.

The following proposition describes the equilibrium to the complexity game when the firm can use material resources to influence the agency.

Proposition 4. *In the subgame perfect Nash equilibrium of the capture model, the following statements are true:*

1. $x_c^* = min\left\{\frac{1+(1-\chi)a+\chi\kappa}{2-\chi}, 1\right\}$ *where* $\chi = \frac{\theta^2+\theta(1+e)}{(1+e+\theta)^2}$ *and* $\chi \in (0,1)$
2. $x_c^* > \frac{1+a}{2}$
3. $\frac{\partial x_c}{\partial \theta} > 0$, $\frac{\partial x_c}{\partial \kappa} > 0$, *and* $\frac{\partial x_c}{\partial e} < 0$

The equilibrium target policy is larger than the equilibrium in the standard bribery game. The extent of this "complexity premium" depends on a factor χ that is a function of the uncertainty level θ and the firm's investment e. As χ increases, the target policy moves toward the firm's ideal point. Because χ is increasing in θ and decreasing in e, the target policy is increasing in the former and decreasing in the latter.

The policy target under capture is decreasing in the firm's investment just as in the original model. Although the firm's policy target is always accepted in the equilibrium of the capture game, the shadow of expropriation looms large. If the firm were to increase its investment, it would have to pay a larger bribe to reduce the agency's incentive to expropriate that information. But this does not mean that opportunities for capture do not make firm investments more secure from expropriation. The responsiveness of the policy target to the levels of investment is considerably lower when the agency is captured. Thus, the firm is more secure in increasing its self-regulation.

Recall the numerical example where $\theta = 1$, $\gamma = .1$, and $\kappa = .5$. Adding the possibility of capture changes the principal's preferences over the best location for the agency. Now the principal prefers $a = 0$. Not surprisingly, the target policies are shifted dramatically in the direction of the firm. Now an agent with $a = 0$ chooses a target policy of .75. Because of this favorable policy target and the agency's relative lack of responsiveness to the firm's investments, the firm chooses a level of investment of 1.87, which is very close to that of the unregulated case 2.16.

This section highlights some empirical difficulties in detecting capture. Because all of the comparative static predictions on the target policy are the same in the capture and no capture cases, correlations between policy targets and measures of policy complexity are unlikely to be very revealing. The prediction that capture increases the equilibrium policy target can in principle be tested only with good proxies for agency preferences. Basing tests on the deviation of the policy target from the principal's ideal point is also complicated by the finding that the principal might actually prefer to delegate to a pro-firm agency. Perhaps the most useful insight, however, is the prediction that capture reduces the principal's incentives to delegate authority to a pro-firm agency.[18]

[18] See Carpenter (2004) for additional arguments about the the observational equivalence of accountable and captured bureaucracies.

Regulatory Investments by the Agency

In the basic model, only the firm makes investments that reduce policy uncertainty. The model may be extended to allow the agency to make similar investments. To this end, assume that $e = e_f + e_a$ where e_f is the firm's investment and e_a is that of the agency. The term γ_a designates the agency's marginal cost of investment. Substantively, γ_a is an additional measure of agency capacity. If γ_a is high relative to γ_f, the agency is a "low capacity" regulator. Conversely, a high capacity agency has a low value of γ_a.

The firm and agency make their investment decisions simultaneously in the first stage of the game. Here I focus on the case where the agency revises the target policy. The expected utility of the agency in the first stage is given by

$$-(x_a - a)^2 - \frac{\theta(1 - x_a)^2}{1 + e_f + e_a} - \gamma_a e_a \tag{8}$$

whereas the firm's utility is

$$-(1 - x_a)^2 - \frac{\theta(1 - x_a)^2}{1 + e_f + e_a} - \gamma_f e_f. \tag{9}$$

An interior subgame perfect Nash equilibrium where both agents make positive contributions must satisfy these two best-response conditions.

$$-2(x_a - a)\frac{\partial x_a}{\partial e} + \left\{ \frac{\theta(1 - x_a)^2}{(1 + e)^2} + \frac{2\theta(1 - x_a)}{1 + e}\frac{\partial x_a}{\partial e} \right\} - \gamma_a = 0 \tag{10}$$

and

$$2(1 - x_a)\frac{\partial x_a}{\partial e} + \left\{ \frac{\theta(1 - x_a)^2}{(1 + e)^2} + \frac{2\theta(1 - x_a)}{1 + e}\frac{\partial x_a}{\partial e} \right\} - \gamma_f = 0. \tag{11}$$

For all values of e, the bracketed terms in the two conditions are identical. From the perspective of uncertainty reduction, the investments are public goods that are valued by both agents equally. Therefore, the best response conditions differ only in terms of the distributive impact of investments and the marginal cost of providing them. With respect to the distributive effects, the agency benefits from higher levels of investment as it moves the optimal target policy closer to her ideal point. Consequently, since $\frac{\partial x_a}{\partial e} < 0$, the first term of the agency's best response condition is positive while the first term of the firm's is negative for all values of e. The final term of these expressions is simply the marginal cost of the investment which may vary across agents.

Note that best response conditions are functions only of e and not e_a and e_f individually. Moreover, except in knife-edge cases, one function is larger than the other for all values of e. Therefore, there are no pair of strictly positive investments e_f and e_a that satisfy the conditions. Consequently, in any subgame perfect Nash equilibrium of the game, only one of the agents makes positive investments.

Because the distributive impact of investment is positive for the agency, the agency will be the investor unless its marginal cost of investment is much higher than that of the firm. But when the firm has much lower marginal costs (a situation most closely aligned with my emphasis on complex policy environments), the firm will be the investor and the results of previous sections will continue to hold.

For comparison purposes, consider the case where the agency is the investor (i.e. γ_a is quite large relative to γ_f). The main implication of this scenario is its effect on the principal's preferences over the location of the agency. Namely, the principal no longer has any incentive to appoint a pro-firm agency. If the agency is the investor, the level of investment falls as the agency's ideal point moves towards that of the firm. So the principal no longer faces a trade-off between expected policy and uncertainty. Moreover, the principal may now prefer $a < 0$ to stimulate even higher levels of investment and to move the equilibrium policy target as close to its ideal point of 0 as possible.

The extended model suggests that in designing a regulatory regime, the principal faces a trade-off between appointing a low capacity pro-firm agency or a high capacity agency at a position at least as low as the principal's ideal point.

Obfuscation by the Firm

To this point, the only regulatory activities of the firm have been investments that might be expropriable by the regulatory agency. But in many situations, firms and industries might also invest in opacity and obfuscation so as to complicate outside regulatory efforts. For example, firms might make choices about products, organization, or accounting designed specifically to increase complexity in order to reduce regulatory burdens. In this section, I extend the model to incorporate such actions. Now the firm may invest in complexity designed to make regulatory revisions more costly. Formally, the firm may take costly actions that raise κ, the marginal uncertainty cost of regulatory revision.

Assume that absent obfuscation by the firm, the level of κ is κ_0. But at a fixed marginal cost of ζ, the firm may set a higher value. As established in previous results, the main effect of raising κ is to reduce the extent of regulatory revision and to make it more likely that the agency will accommodate the firm's policy target. So the firm has a clear incentive to pay the cost of raising κ.

As shown in the proof of Proposition 5 in the appendix, the marginal benefit of obfuscation by the firm is always increasing in κ. Therefore, the firm chooses the corner solution of either no obfuscation ($\kappa^* = \kappa_0$) when ζ is high or obfuscates sufficiently to force the agency to accommodate its policy target when ζ is low.

Recall that the agency will accommodate the firm's policy target if and only if $a > 1 - \kappa \frac{1+e+\theta}{1+e}$ or

$$\kappa > \underline{\kappa} \equiv \frac{(1-a)(1+e)}{1+\theta+e} \tag{12}$$

So in any interior solution to the subgame perfect Nash equilibrium of the obfuscation game, the firm chooses $\kappa^* \geq \underline{\kappa}$. At this interior solution for κ, the firm proposes $x_f = 1 - \frac{\zeta}{2\theta}$ and the agency accommodates. Consequently, the policy bias towards the firm is again increasing the baseline level of uncertainty, but also decreasing in the marginal costs of obfuscation. These and other results are summarized in Proposition 5.

Proposition 5. *Consider the subgame perfect Nash equilibrium of the model with obfuscation.*

Case 1: *If* $\zeta \leq \frac{2\theta(1-a)(1+e)}{1+\theta+e}$*, then*

$$\kappa^* = max\{\kappa_0, \frac{(1+e^*)(2\theta(1-a)-\zeta)}{2\theta^2}\}$$

If $\kappa^* > \kappa_0$*, then*

$$x_f = x_a = 1 - \frac{\zeta}{2\theta}$$

$$e^* = \sqrt{\frac{2\theta^3}{2\theta^2\gamma_f + 2\zeta\theta(1-a) - \zeta^2}} - 1$$

If $\kappa^* = \kappa_0$ *the target policy is* $a + \frac{\theta\kappa_0}{1+e^*}$ *and the comparative statics are described by Propositions 1 and 2.*

Case 2: *If* $\zeta > \frac{2\theta(1-a)(1+e)}{1+\theta+e}$*, then* $\kappa^* = max\{\kappa_0, \underline{\kappa}\}$*. If* $\kappa^* = \underline{\kappa}$*, the policy target is* $\frac{(1+e^*)a+\theta}{1+\theta+e^*}$*. If* $\kappa^* = \kappa_0$ *the target policy is* $a + \frac{\theta\kappa_0}{1+e^*}$*. The comparative statics are described by Propositions 1 and 2.*

One of the major implications of obfuscation is that it greatly increases the principal's incentive to appoint a pro-firm agency. Consider the case where $\kappa^* > \underline{\kappa}$. Here appointing a more pro-firm agency has no effect on the equilibrium policy target. But increasing a has two other effects. First, the level of obfuscation decreases in a, but this only benefits the firm in equilibrium as the agency makes no policy revisions. Second, as in the basic model, the firm's regulatory efforts are an increasing function of a.

Because the principal can induce greater self-regulation without increasing the policy target, she chooses to delegate to an agency with greater bias toward the firm than in the no obfuscation case. But of course obfuscation makes the principal much worse off in utility as it has a large effect on the policy bias. This decline in utility increases the likelihood of a ban or bright-line rule.

To get a sense of the effects of obfuscation, consider again the numerical example. Now let $\kappa_0 = .5$, and $\zeta = .1$. The most dramatic change is that the equilibrium policy target is considerably more biased toward the firm. For all values of a, the target policy is at least .9. This is the direct result of the firm's ability to increase κ in order to forestall regulatory adjustments. A second more subtle finding is that opportunities for obfuscation decrease the firm's investments in self-regulation. While one might imagine that obfuscation helps solve the expropriation problem, there is a countervailing effect. Larger values of e reduce the firm's benefits of a given amount of obfuscation. In equilibrium, the firm reduces e to economize on its obfuscation costs. For example, when $a = .5$, the opportunity to obfuscate reduces e from 1.65 to 1.35. As discussed above, when the firm may obfuscate, the principal gains from appointing a more pro-firm agency. In the non-obfuscation case, the principal's ideal agency was located at .25. With obfuscation and $\zeta = .1$, the principal's optimal agency is located at .79, the point at which the firm chooses zero obfuscation i.e. $\kappa^* = \kappa_0$. So if the principal chooses the agency optimally, we would observe zero obfuscation, but its threat would have a powerful effect on the bias of the agency and the equilibrium policy target.

Conclusions

This paper explores several issues about the role of expertise and complexity in regulatory policy. The most important implications of the model deal with the extent to which there is a policy bias toward the firm that is directly related to complexity. In such situations, regulatory agencies are deterred from more vigorous regulation due to the fear of unintended consequences. While self-regulation might mitigate some degree of policy uncertainty, the model illustrates how the threat of public regulation might dull the firm's incentives to self-regulate. Such a dilemma forces the legislative principal into a set of uncomfortable choices between delegating to pro-firm agencies or simple, but inefficient, bright-line rules or bans.

Extensions to the model reveal new areas of both optimism and concern. On the side of optimism, the extension that allows agency investment demonstrates that if the agency has a strong capacity to reduce the baseline level of policy uncertainty regulatory outcomes improve and the rationale for delegation to pro-firm agencies disappears. But other realistic extensions of the model illustrate how the situation may be far worse for the principal. The capture extension illustrates how complexity makes it easier for the firm to use material incentives to influence the agency while firms have strong incentives that firms have to avoid regulation by increasing complexity.

Beyond the general observations about the role of complexity regulation, the model's comparative statics may prove useful in empirical work. For example, the model suggests a clear set of relationships between policy complexity, bureaucratic capacity, bureaucratic preferences, firm self regulation, and policy outcomes. These might be tested on cross sections across policy areas, cross sections of the same policy across jurisdictions, or time series within a given policy arena.

Ultimately, future theoretical and empirical work along these lines will be crucial in improving our understanding of which forms of private influence can or cannot be justified in terms of democratic control of public agencies.

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Appendix

Proof of Proposition 1

Begin with the case where the agency revises the firm's target policy in equilibrium. As shown above, the firm's utility in this case is $-\frac{1+e}{1+e+\theta}(1-a)^2 - \frac{\theta}{1+e}(1-\kappa^2) - \gamma_f e$. Therefore, the first order condition for an interior solution is

$$FOC = \frac{\theta(1-\kappa^2)}{(1+e)^2} - \frac{\theta(1-a)^2}{(1+e+\theta)^2} - \gamma_f = 0$$

Such an interior solution exists if $(1+\theta)^2 > \frac{(1-a)^2}{1-\kappa^2}$. The sufficient second order condition is

$$\frac{-2\theta(1-\kappa^2)}{(1+e)^3} + \frac{2\theta(1-a)^2}{(1+e+\theta)^3} < 0$$

This condition is satisfied if and only if $\frac{(1+e+\theta)^3}{(1+e)^3} > \frac{(1-a)^2}{(1-\kappa^2)}$. But from the first-order condition and $\gamma_f > 0$ that $\frac{(1+e+\theta)^2}{(1+e)^2} > \frac{(1-a)^2}{(1-\kappa^2)}$. Thus, the second order condition must hold at the optimum for $\theta > 0$. Having established the second-order condition, I can use the implicit function theorem to establish the comparative statics results. Recall that for any parameter β, $sign\left[\frac{\partial e}{\partial \beta}\right] = sign\left[\frac{\partial FOC}{\partial \beta}\right]$. Therefore, the following comparative statics relationships hold.

1. The effect of the agency ideal point on investment

$$sign\left[\frac{\partial e}{\partial a}\right] = sign\left[\frac{2\theta(1-a)}{(1+e+\theta)^2}\right] = +$$

2. The effect of θ on investment

$$sign\left[\frac{\partial e}{\partial \theta}\right] = sign\left[\frac{(1-\kappa^2)}{(1+e)^2} - \frac{(1+e-\theta)(1-a)^2}{(1+e+\theta)^3}\right] = +$$

This sign is positive since the first-order condition implies that $\frac{(1+e+\theta)^2}{(1+e)^2} > \frac{(1-a)^2}{(1-\kappa^2)}$ and that $1+e+\theta > 1+e-\theta$.

3. The effect of the complexity factor (or agency expertise) on investment

$$sign\left[\frac{\partial e}{\partial \kappa}\right] = sign\left[\frac{-2\theta\kappa}{(1+e)^2}\right] = -$$

Now consider the accommodation case which requires that $a > 1 - \frac{\kappa\theta}{1+e} - \kappa$. The firm's utility is given by $-\left(1 - a - \frac{\theta\kappa}{1+e}\right)^2 - \frac{\theta}{1+e} - \gamma_f e$ and the first-order condition (after some algebra) is

$$FOC = \frac{\theta}{(1+e)^2}\left[1 - 2\kappa(1-a) + \frac{2\theta\kappa^2}{1+e}\right] = \gamma_f$$

A necessary condition for an interior solution is $1 > 2\kappa(1 - a - \theta\kappa)$. At the first order condition, the square bracketed term is positive which is sufficient to ensure the second-order condition. Thus the implicit function theorem generates the following results.

1. The effect of the agency ideal point on investment

$$sign\left[\frac{\partial e}{\partial a}\right] = sign\left[\frac{2\theta\kappa}{(1+e)^2}\right] = +$$

2. The effect of θ on investment

$$sign\left[\frac{\partial e}{\partial \theta}\right] = sign\left[-\frac{\theta}{(1+e)^3}\left(1 - 2\kappa(1-a) + \frac{2\theta\kappa^2}{1+e}\right) - \frac{4\theta\kappa^2}{(1+e)^2}\right] = -$$

3. The effect of the complexity factor (or agency expertise) on investment

$$sign\left[\frac{\partial e}{\partial \kappa}\right] = sign\left[\frac{2\theta}{(1+e)^2}\left(a - 1 + \frac{2\theta\kappa}{1+e}\right)\right]$$

The sign of this expression depends on the value of a. For lower values of a, the form's efforts decrease in κ as in the revision case. But the relationship reverses for higher values of a.

Proof of Proposition 3

Denote subgame Nash equilibrium as $x_a^*(a, e^*(a))$, $x_f^*(a)$, and $e^*(a)$. Therefore, the principal's payoffs are

$$-\left(x_a^*(a, e^*(a))\right)^2 - \frac{\theta}{1 + e^*(a)}\left[\left(x_f(a) - x_a^*(a, e^*(a)) - \kappa\right)^2 + 1 - \kappa^2\right]$$

Note that $a < 0$ is dominated by $a = 0$. An agency with an ideal point lower than the principal's would move policy closer to zero. Such an agency, however, would generate a distribution of policy outcomes with more variance because it would revise policy more and the firm would invest less. From the principal's perspective, an agent at $a = 0$ makes its preferred trade-off between mean and variance. Therefore, $a = 0$ makes the correct trade-off and generates more information investment by the firm.

An agency with $a > \bar{a}$ is also dominated by $a = \bar{a}$. An agency with an ideal point $\bar{a}$ accepts the unregulated outcome. An agency with a higher ideal point can only move policy further from the principal's ideal, decrease the firm's investment in information, and increase uncertainty about the outcome. So I focus on the case of $a \in [0, \bar{a}]$.

The principal's first-order condition with respect to a is

$$-2\left\{x_a - \frac{\theta(x_f - x_a - \kappa)}{1 + e}\right\}\left[x_{a1} + x_{a2}\frac{\partial e}{\partial a}\right] - 2\frac{\theta(x_f - x_a - \kappa)}{1 + e}\frac{\partial x_f}{\partial a} + \frac{\theta c(d)}{(1 + e)^2}$$

First, I evaluate the first-order condition at $a = 0$. At this value, the curly bracketed term is the first-order condition for the optimal x_a for an agency with ideal point 0. Therefore, it and the entire first term must equal zero.

Now consider the sign of the second term. Since $1 > \kappa \frac{1+e^*(0)+\theta}{1+e^*(0)}$, the regulatory revision case obtains and $\frac{\partial x_f}{\partial a} = 0$. Therefore, the second term is zero. Because the third term is always positive, the entire first-order condition is positive suggesting that the principal can increase her utility by appointing an agency with $a > 0$.

In is instructive as to why, the principal may prefer $a \leq 0$ if the no-revision case obtains at $a = 0$. As in the revision case, the first term is again zero. Since $x_f = x_a$ in the no-revision case, the second term becomes $\frac{2\kappa}{1+e}\left[x_{a1} + x_{a2}\frac{\partial e}{\partial a}\right]$. But because $x_{a2} < 0$, the sign of the second term is ambiguous.

Proof of Proposition 4

If the agency accepts the contract $\{x_c, b\}$ it receives b in exchange for accepting the firm's target policy x_c. The agency's outside option is to reject the transfer b and set a new target policy based on the firm's target of x_c. Therefore, the firm chooses $\{x_c, b\}$ to solve

$$max\{-(1-x_c)^2 - \frac{\theta}{1+e} - b\}$$

subject to

$$-(x_c - a)^2 - \frac{\theta}{1+e} + b \geq -(x_a(x_c) - a)^2 - \frac{\theta}{1+e}\left[(x_c - x_a(x_c) + \kappa)^2 + 1 - \kappa^2\right]$$

First, consider the case where $\theta = 0$. This is the standard spatial bribery model with complete information. In this model, $x_a(x_c) = a$ so after substituting the always binding constraint the objective function becomes $-(1-x_c)^2 - (x_c - a)^2$. The maximum is obtained at $x_c^* = \frac{1+a}{2}$.

Now return to the case where $\theta > 0$. Because the participation constraint on the agency always binds, I solve the constraint in terms of b and substitute into the objective function. Making this substitution and using the solution for $x_a(x_c)$ from above, the objective function is now:

$$
\begin{aligned}
&-(1-x_c)^2-(x_c-a)^2-\frac{2\theta}{1+e}+\left(\frac{(1+e)a+\theta(x_c+\kappa)}{1+\theta+e}-a\right)^2 \\
&\qquad\qquad\qquad\qquad+\frac{\theta}{1+e}\left[\left(x_c+\kappa-\frac{(1+e)a+\theta(x_c+\kappa)}{1+\theta+e}\right)^2+1-\kappa^2\right]
\end{aligned}
$$

After some algebraic manipulation:

$$
-(1-x_c)^2-(x_c-a)^2-\frac{\theta(1+\kappa^2)}{1+e}+\frac{\theta^2+\theta(1+e)}{(1+\theta+e)^2}(x_c+\kappa-a)^2
$$

Hereafter, let $\chi=\frac{\theta^2+\theta(1+e)}{(1+\theta+e)^2}$. It is easy to verify that $\chi\in(0,1)$ and that $\frac{\partial\chi}{\partial\theta}>0$ and $\frac{\partial\chi}{\partial e}<0$. Note that the revised function is concave in x_c, therefore the optimal target can be computed by standard optimization and the solution is

$$
x_c^*=min\left\{\frac{1+(1-\chi)a+\chi\kappa}{2-\chi},1\right\}
$$

The comparative statics results can be established directly.

Proof of Proposition 5

Consider first the revision case where the firm's payoffs are given by $-\frac{1+e}{1+e+\theta}(1-a)^2-\frac{\theta}{1+e}(1-\kappa^2)-\zeta(\kappa-\kappa_0)$ and the first order condition with respect to κ is $\frac{2\theta\kappa}{(1+e)}-\zeta=0$. Because the marginal benefit of κ is increasing, there is no interior solution in the revision case and the firm will choose κ high enough for the accommodation case.

Now consider the accommodation case which requires that $\kappa>\underline{\kappa}$. The firm's utility is given by $-\left(1-a-\frac{\theta\kappa}{1+e}\right)^2-\frac{\theta}{1+e}-\zeta(\kappa-\kappa_0)$ and the first order condition is $\frac{2\theta}{1+e}\left(1-a-\frac{\theta\kappa}{1+e}\right)=\zeta$. In this case the marginal benefit of κ is always decreasing so there may be interior solutions for κ. The first-order condition is solved at $\kappa = \frac{(1+e)(2\theta(1-a)-\zeta)}{2\theta^2}$.

A subgame perfect Nash equilibrium requires both that $\kappa^* \geq \underline{\kappa}$ and $\kappa^* \geq \kappa_0$. The first inequality will be strict if $\frac{2\theta(1-a)(1+e)}{1+\theta+e} > \zeta$. Therefore, the optimal choice of κ follows

$$\kappa^* = \begin{cases} max\{\kappa_0, \underline{\kappa}\} & \text{if } \frac{2\theta(1-a)(1+e)}{1+\theta+e} < \zeta \\ max\{\kappa_0, \frac{(1+e)(2\theta(1-a)-\zeta)}{2\theta^2}\} & \text{if } \frac{2\theta(1-a)(1+e)}{1+\theta+e} \geq \zeta \end{cases}$$

The policy target is

$$\boldsymbol{x}_f = \begin{cases} 1 - \frac{\zeta}{2\theta} & \text{if } \kappa^* > \underline{\kappa} \\ \frac{(1+e)a+\theta}{1+\theta+e} & \text{if } \kappa^* = \underline{\kappa} \\ a + \frac{\theta\kappa_0}{1+e} & \text{if } \kappa^* = \kappa_0 \end{cases}$$

where the expressions are generated by substituting κ^* into the equilibrium accommodation target $a + \frac{\theta\kappa}{1+e}$.

Now turn to the optimal choice of e. The cases $\kappa^* = \underline{\kappa}$ and $\kappa^* = \kappa_0$ are covered above, so I now focus on $\kappa^* > \underline{\kappa}$. In this case, the firm's utility is $-\left(\frac{\zeta}{2\theta}\right)^2 - \frac{\theta}{1+e} - \zeta\left(\frac{(1+e)(2\theta(1-a)-\zeta)}{2\theta^2} - \kappa_0\right)$ and the first order condition for e is $\frac{\theta}{(1+e)^2} - \zeta\left(\frac{2\theta(1-a)-\zeta}{2\theta^2}\right) = \gamma_f$. From this it is easy to solve for the optimal value of e^*

$$e^* = \sqrt{\frac{2\theta^3}{2\theta^2\gamma_f + 2\zeta\theta(1-a) - \zeta^2}} - 1$$