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**BUREAUCRATIC MINIMAL SQUAWK BEHAVIOR:  
THEORY AND EVIDENCE FROM REGULATORY AGENCIES**

**Clare Leaver**

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Manor Road Building, Oxford OX1 3UQ

# Bureaucratic Minimal Squawk Behavior: Theory and Evidence from Regulatory Agencies\*

Clare Leaver<sup>†</sup>

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## Abstract

This paper argues that bureaucrats are susceptible to ‘minimal squawk’ behavior. I develop a simple model in which a desire to avoid criticism can prompt, otherwise public-spirited, bureaucrats to behave inefficiently. Decisions are taken to keep interest groups quiet and mistakes out of the public eye. The policy implications of this behavior are at odds with the received view that agencies should be structured to minimise the threat of ‘capture’. I test between theories of bureaucratic behaviour using a matched panel of U.S. State Public Utility Commissions and investor-owned electric utilities. The data soundly reject the capture hypothesis and are consistent with the minimal squawk hypothesis: longer PUC terms of office are associated with an increase in the incidence of rate reviews in periods of falling input costs and, in turn, lower household electricity bills.

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Keywords: bureaucratic behavior, professional pride, career concerns, regulatory capture, dynamic panel data models.

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<sup>†</sup>Department of Economics and Nuffield College, University of Oxford, CEPR and CMPO. Address for correspondence: Department of Economics, University of Oxford, Manor Road, Oxford, OX1 3UQ, UK. Email: clare.leaver@economics.ox.ac.uk. Tel: 44 (0)1865 271952.

## 1. Introduction

What makes bureaucrats tick? Among positive theories of government there are, broadly speaking, two schools of thought. One, due to William Niskanen, emphasizes the relation between bureaus and their legislative sponsors. Bureaucrats exploit their monopoly power to pursue bigger budgets or greater slack. The other, due to George Stigler, emphasizes the possibility of capture by special interests. Bureaucrats are driven by pecuniary gain and simply sell their policies to the highest bidder.

These theories of bureaucratic motivation are hard to square with surveys of public sector employees however. When asked, bureaucrats repeatedly cite doing, and being seen to do, a good job as their key occupational rewards. An illuminating example is Schofield's (2001) study of British National Health Service managers. Drawing on extensive interviews, Schofield suggests that NHS managers have "dual accountability". They report an intrinsic sense of vocation to the centre but also an extrinsic desire to protect their professional reputation as exemplified by one manager's candid admission: 'I have done nearly 20 years in the NHS and I have no intentions of falling over and making a mistake that someone can criticize me on'.<sup>1</sup>

The notion that bureaucrats are socially motivated but, being human, also care about their personal reputation seems to fit with introspection. Take Stigler's (1971) example of regulatory agencies. Being an industry watchdog is a high profile job; policy changes rarely pass unnoticed and mistakes create substantial controversy. Since few of us like being shown to have made a mistake, particularly in public, it seems likely that agency heads will strive to avoid being cast in a bad light. Indeed, given such exposure, it would be a remarkable public servant that did *not* take her reputation into account when setting policy.

One might initially think that this dual accountability is all to the good: reputational concerns will ensure that bureaucrats try even harder not to make a mistake. In fact, Schofield draws this conclusion from her interviews with NHS managers.<sup>2</sup> However, such a conclusion overlooks Stigler's point that bureaucrats often operate in an environment populated by special interests. Since these interest groups have a vested interest in policy and are typically better placed to spot mistakes than the public at large, it seems possible that reputational concerns may actually bias policy.

In this paper I develop a simple model of bureaucratic behavior that draws on these observations. I show that a desire to avoid criticism can prompt, otherwise public-spirited, bureaucrats to behave inefficiently. The desire to maintain a favourable reputation results in what I term *minimal squawk behavior*: bureaucrats take decisions to keep interest groups quiet and mistakes out of the public eye.

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<sup>1</sup>Schofield (2001) p. 90.

<sup>2</sup>'The public have reason to be thankful that there is this degree of bureaucratic obedience, whether it is due to vocational fealty in the form of public service or self interest and the desire to please superiors and keep one's job', Schofield (2001) p. 91.

This model has three key features. First, doing a (socially) good job requires knowledge of some underlying state of the world. For instance, Public Utility Commissioners should initiate a rate review if and only if a firm's costs have changed. Likewise, Immigration and Naturalization service workers should 'find and expel illegal immigrants but not break up families, impose hardships, violate civil rights, or deprive employers of low-paid workers'.<sup>3</sup> Second, bureaucrats differ in their decision making ability: more able bureaucrats receive more accurate signals of the state of the world. Third, bureaucrats have dual accountability: they care about doing a good job but also about their reputation with an external evaluator (professional peers and/or future employers).

In this set up, reputational concerns bias bureaucratic decision making under two relatively weak assumptions over the information structure. Bureaucrats have private information over their decision making *ability* but interest groups have private information over the state of the world and hence decision making *quality*.

The intuition behind this inefficiency runs as follows. Suppose that an interest group threatens to draw attention to a mistake (squawk) if a bureaucrat has been tough but to stay silent if she has been generous. For instance, a regulated utility might threaten to issue critical press releases if its regulator imposes a tough price cap when its costs have risen but otherwise stay silent. As long as the evaluator believes that bureaucrats are trying to make good decisions, good decisions will be seen as an indication of high ability and bad decisions an indication of low ability. Able bureaucrats relish the opportunity such selective disclosure gives them to demonstrate their superior decision making skills. In contrast, less able bureaucrats recognize that tough decisions expose their poor decision making skills to the evaluator's scrutiny. Less able bureaucrats therefore have an incentive to hide behind generous decisions to ensure that their professional reputation remains intact.

Of course, if the evaluator believes that less able bureaucrats are *always* generous it will simply treat tough decisions as evidence that the bureaucrat is able. But then less able bureaucrats have an incentive to be tough. I establish that less able bureaucrats strike a balance between these two effects. In equilibrium, the interest group commits itself to criticizing unfavourable mistakes (squawking on tough), able bureaucrats try to make good decisions but less able bureaucrats mix between attempting to make good decisions and always being generous. From a social point of view, generous decisions occur too often; a *generosity bias* that increases as reputational concerns become more important relative to public service.

The policy implications of the squawk model are at odds with the received wisdom that agencies should be structured to minimise the threat of capture. Rather than limiting opportunities for capture by imposing short fixed-term contracts and post agency employment restrictions, the squawk model suggests mitigating destructive reputational concerns with longer contracts and fewer appointments of mid-career "professionals" with strong employment and

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<sup>3</sup>Wilson (1989), p. 158.

peer concerns.<sup>4</sup>

I test between theories of bureaucratic behavior using data from regulatory agencies (a matched panel of U.S. State Public Utility Commissions and investor-owned electric utilities). The squawk model predicts that longer PUC terms of office should *increase* the probability that PUCs file for rate reviews in periods of falling operating costs. I term this positive interaction effect the ‘minimal squawk hypothesis’. Modifying the model in line with the capture paradigm – regulators are corruptible, firms find it cheaper to bribe regulators on long contracts – I obtain a competing prediction: longer PUC terms of office should *decrease* the probability that PUCs file for rate reviews in periods of falling operating costs. I term this negative interaction effect the ‘capture hypothesis’.

To test between these hypotheses, I estimate the partial effect of PUC term length on the probability that an electric utility faces a rate review in a given year. In doing so, I allow for firm-level unobserved effects and dynamics (including learning by PUCs) and instrument for the potential endogeneity of PUC term length and firm operating costs. The data soundly reject the capture hypothesis: PUC term length never exerts a negative effect on the probability of review. Moreover, the data appear to be consistent with the minimal squawk hypothesis. In all but the static fixed effect specifications, PUC term length has a significantly stronger positive effect during periods of falling operating costs.

Since unobserved firm effects prove unimportant throughout, I explore economic significance using a dynamic pooled Probit specification. At the mean of all other variables, moving from 5 to 6 year terms of office is associated with a large impact (.1244) at the bottom percentile of operating expenses but no effect at the top percentile. Averaging over the distribution of operating expenses the partial effect is .0634. Moreover, such behavior appears to have had a real impact on residential customers. Firm-level price regressions provide a robustness check and further evidence of economic significance. An additional year of PUC term length is associated with a decrease in average revenue from residential customers by .0666 cents per kwh. During the sample period the average U.S. household consumed 105 Million BTU of electricity, suggesting an economic effect in the region of \$20 per household year.

The paper concludes with a discussion of implications for governance and institutional design. The most obvious point is that short terms of office may not be the panacea that some have hoped for. To cite a topical example, the new five year contract for the Governor of the Banca d’Italia – introduced to solve the “Fazio problem” (alleged insider dealing and abuse of office in the regulation of the banking industry) – might worsen minimal squawk behavior which is itself a component of perceived corruption.

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<sup>4</sup>I use the word “professional” in the sense defined by Wilson (1989). ‘A professional is someone who receives important occupational rewards from a reference group whose membership is limited to people who have undergone specialized formal training and have accepted a group defined code of proper conduct’, p. 60.

## 1.1. Related Literature

The claim that regulators might set policy with an eye on the job market was first made by Hilton (1972). With PUC and gubernatorial terms of office generally out of sync, Hilton argued (informally) that regulators will deem re-appointment unlikely and hence pacify firms in an attempt to land a job in the regulated industry, first coining the phrase “minimal squawk” to describe such behavior. Since legislation has now largely closed the revolving door between regulatory office and industry job, I explore how *wider* reputational concerns (peer respect or career concerns for a non-industry job) shape policy decisions.

Formally, the model is one of career concerns for experts. Numerous papers have built on the basic set up developed by Scharfstein and Stein (1990).<sup>5</sup> Closest to this paper is Levy (2004) who assumes that ability is private information and shows that, when decision makers can seek advice, career concerns can produce anti-herd behavior. I also assume that decision makers know their type but, motivated by the bureaucratic setting, add a third player with a vested interest in actions. The evaluator then observes the quality of some but not all decisions, producing a generosity bias as less able decision makers attempt to hide their mistakes.<sup>6</sup>

The addition of this third player links my approach to the literature on special interests. The most closely related papers are Epstein and O’Halloran (1995) and Dal Bó and Di Tella (2003). The former suggests that regulatory agencies accede to interest groups to limit their “fire alarms” and hence congressional veto. I point out that reputational concerns, rather than policy preferences, can also create incentives to silence possible critics. The latter presents a reduced form model of capture by threat. Here, I model one (legal) channel through which interest groups might threaten policy-makers into concessions.

Turning to the empirics, Joskow (1974) argues (again informally) that regulatory agencies seek to minimise conflict. In particular, he conjectures that formal rate of return reviews will be triggered by firms attempting to raise the level of their rates and hence that ‘during periods of falling average cost, we should expect to observe virtually no regulatory rate of return reviews’ (Joskow (1974), pp. 299). Having modelled *why* regulators might seek to minimise conflict, I test this conjecture using State PUC data. The research possibilities created by cross-state variation in PUC institutions have certainly not gone unnoticed. By far the most popular question has been whether electing rather than appointing PUC commissioners results in lower utility prices (see Besley and Coate (2003) and the references therein). Alternative regulatory outcomes studied include the cost of capital, rates of return, regulatory climate, percentage of rate requests granted and systematic risk. To my knowledge, this paper is the first to investigate the impact of PUC institutions on the incidence of rate reviews.

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<sup>5</sup>See, for instance, Prendergast and Stole (1996), Levy (2004), Fingleton and Raith (2005) and Prat (2005). Alternative approaches to modeling career concerns in government are discussed in Persson and Tabellini (2000).

<sup>6</sup>Prendergast (2003) develops a model with different timing and actions but also highlights that bureaucracies may be inefficient because clients point out a sub-set of mistakes.

## 2. A Model of Minimal Squawk Behaviour

### 2.1. The Model

The model is the simplest needed to show that reputational concerns can bias bureaucratic decision making: all choice sets are binary, state variables are binary and occur with equal probability. Key assumptions are discussed after the model description.

**Description** There are three players: a bureaucrat (she), an informed interest group and an evaluator (he). Anticipating the empirical analysis, I focus on the example of regulatory agencies and refer to the first two players as regulator and firm. The evaluator can be thought of as future private sector employers or, interchangeably, a professional peer group.

The regulatory problem is one of hidden information. The firm faces unavoidable input costs (wage/fuel costs determined by competitive forces or costs involved in meeting environmental legislation) that are either ‘low’ or ‘high’ with equal probability. This cost state of the world is denoted by  $\omega \in \{l, h\}$  and is observed perfectly only by the firm. The regulator must take a decision that is ‘tough’ or one that is ‘generous’. This action space is denoted by  $a \in \{t, g\}$  and is observed by all players. Under rate of return regulation (RoR) this choice can be thought of as ‘file for a formal rate review to decrease the firm’s revenue requirement’ or ‘do nothing’. Under incentive regulation (IR) it can be thought of as a ‘low’ or ‘high’ cost-past through factor in the  $RPI - x + k$  formula.

The socially optimal decision depends on the cost state of the world. A tough decision maximises social welfare if input costs are low but a generous decision maximises social welfare if input costs are high. This assumption is easy to motivate under both RoR and IR. Under RoR, state-dependency arises because the formal rate review process creates an administrative deadweight loss. Under IR, firms are likely to shave on socially desirable investment if they are unable to pass-through unavoidable costs. The four possible regulatory outcomes are defined in Table 2.1. It is common knowledge that the outcomes  $(l, t)$  and  $(h, g)$  are ‘good’ and  $(h, t)$  and  $(l, g)$  are ‘bad’.

The regulator can conduct an experiment which generates an informative private cost signal  $s \in \{l, h\}$ . The accuracy of this signal is termed her decision making ability. There are two ability types: well informed or ‘smart’ ( $S$ ) and less well informed or ‘dumb’ ( $D$ ). It is assumed that the regulator knows her ability for certain, while the firm and evaluator know only that either type may have been appointed with equal probability. This ability state of the world is denoted by  $\theta \in \{\theta_S, \theta_D\}$ , where  $\theta_S = \Pr(s = \omega \mid \omega, \theta_S)$ ,  $\theta_D = \Pr(s = \omega \mid \omega, \theta_D)$  for  $\omega = l, h$  and  $\frac{1}{2} < \theta_D < \theta_S < 1$ .

The regulator has dual accountability: she wants to achieve a good outcome but, being human, also cares about her reputation. Formally, she derives utility from two sources: the regulatory outcome (*policy preferences*) and her reputation with the evaluator (*reputational*

Table 2.1: The Four Regulatory Outcomes

|                                 |      | Regulatory Decision ( $a$ ) |          |
|---------------------------------|------|-----------------------------|----------|
|                                 |      | tough                       | generous |
| True Cost<br>State ( $\omega$ ) | low  | $(l, t)$                    | $(l, g)$ |
|                                 | high | $(h, t)$                    | $(h, g)$ |

Table 2.2: A Typical Disclosure Rule ('squawk on tough')

|                                 |      | Regulatory Policy ( $a$ ) |                 |
|---------------------------------|------|---------------------------|-----------------|
|                                 |      | tough                     | generous        |
| True Cost<br>State ( $\omega$ ) | low  | $r = \emptyset$           | $r = \emptyset$ |
|                                 | high | $r = h$                   | $r = \emptyset$ |

*concerns*). Policy preferences are given by  $u(l, t) = u(h, g) = W > u(h, t) = u(l, g) = 0$ , where  $u(\omega, a)$  denotes her pay off to choosing policy  $a$  in cost state  $\omega$  and  $W$  the warm glow she gets from making a good decision, hereafter her intrinsic motivation. Reputational concerns are given by the evaluator's posterior belief  $\mu$  that the regulator is smart. Adopting a simple additive specification, the regulator's objective function is  $u(\omega, a) + \delta\mu$ , where  $\delta > 0$  is a weighting term that reflects the relative importance of reputation.

The firm weakly prefers a generous decision in all cost states, receiving  $H$  if the regulator is generous when its costs are low,  $L$  if she makes a good decision and nothing if she is tough when its costs are high. Its policy preferences are therefore given by  $v(l, g) = H > v(h, g) = v(l, t) = L > v(h, t) = 0$ , where  $v(\omega, a)$  denotes its pay off when the regulator chooses  $a$  in cost state  $\omega$ .

Aware that the regulator cares about her reputation, the firm attempts to persuade her to be generous by strategically threatening to 'squawk' (publicise the quality of her decision making). Formally, the firm takes the first move and publicly announces a disclosure rule  $d$  that states how it will behave after each regulatory outcome. To maintain tractability, I assume that the firm can either (costlessly) reveal the true quality of the regulator's decision, or stay silent.<sup>7</sup> This action is denoted by  $r \in \{\omega, \emptyset\}$ . A typical strategy  $d$  is given in Table 2.2.

Formally, there are four types of regulator: a smart regulator that receives a low signal, a smart regulator that receives a high signal and so on. Let  $\sigma_i = (p_i, q_i)$  denote the probability that a regulator  $i$  chooses  $a = t$ , where  $p_i$  denotes the probability that she chooses  $t$  when

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<sup>7</sup>The implication that  $\omega$  is hard information suggests a relatively straightforward contractual solution to the regulatory problem. I abstract from the possibility of mechanism design in an attempt to show how minimal squawk behaviour might arise under real world institutions such as RoR or IR.

$s = l$ ,  $q_i$  the probability that she chooses  $t$  when  $s = h$  and  $i = S, D$ . With some abuse of terminology, there are four pure strategies for each ability type: ‘follow’ ( $\sigma_i = (1, 0)$ ), ‘contradict’ ( $\sigma_i = (0, 1)$ ), ‘always tough’ ( $\sigma_i = (1, 1)$ ) and ‘always generous’ ( $\sigma_i = (0, 0)$ ). I will say the regulator *uses* her signal if she plays either of the first two strategies and that she *ignores* it if she plays either of the last two strategies.

To summarise, the timing of the game is as follows:

*Stage 1.* The firm publicly announces a disclosure rule  $d$ . At the end of this stage nature chooses the cost state  $\omega$  and the ability state  $\theta$ .<sup>8</sup>

*Stage 2.* Observing  $d$ ,  $\theta$  and her signal  $s$ , the regulator chooses  $a$  according to  $\sigma_i$ .

*Stage 3.* Given  $\omega$  and  $a$ , the firm carries out the revelation decision  $r$  stipulated by  $d$ .

*Stage 4.* Observing  $d$ ,  $a$  and  $r$ , the evaluator forms the posterior belief  $\mu$  over  $\theta$ .

The solution concept is perfect Bayesian equilibrium (PBE). As Lizzeri (1999) notes, an observable disclosure rule implies that a PBE in a game of this structure is a list of PBE in every sub-game together with the requirement that  $d$  maximises the firm’s expected utility.

**Discussion of Assumptions** The disclosure rule is assumed to be public for convenience. Minimal squawk behavior is also part of an equilibrium when the disclosure rule is private but, in this case,  $\mu$  must be derived from the firm’s, as well as the regulator’s, strategy. Costless revelation eases notation and also ensures that the existence (although not uniqueness) results are robust to the firm’s ability to commit. The eagerness of the media to attend regulatory hearings and report regulatory news suggests that such costs are likely to be low.

If revelation costs are positive then, as the model stands commitment is essential. The usual ‘reputation in a repeated game argument’ applies (see Lizzeri 1999) with one caveat: since the regulator does not observe  $\omega$  she will only be able to apply an effective punishment if the firm squawks on both  $(l, a)$  and  $(h, a)$ . This concern is mitigated by the fact that evaluators are often better informed about the quality of tough decisions for reasons beyond a firm’s control. For instance, under RoR, third parties are better placed to judge the quality of the tough decision ‘file for a review’ than the generous decisions ‘do nothing’ because cost data necessarily comes out in court.

The bilateral relationship between the regulator and firm is an obvious simplification. Collective action problems suggest that environmental and consumer interests may struggle to form and hence counteract a firm’s threat. All the same, it seems likely that minimal squawk behavior would diminish as the number of informed interests increases.

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<sup>8</sup>Assuming nature moves at the end of this stage eases notation by ruling out type-dependent disclosure rules. Given the firm weakly prefers  $g$  in all cost states, cost types induced by an earlier move would pool on their choice of disclosure rule.

## 2.2. Analysis

The aim of this section is to establish conditions under which the firm can exploit the regulator's reputational concerns to bias policy in its favour. As a benchmark, I begin by characterising the regulator's behavior when she is motivated solely by her policy preferences.

**Benchmark** ( $\delta = 0$ ) Bayes' rule implies  $\Pr(\omega = s \mid s, \theta) = \theta$ . Upon receipt of  $s = l$ , regulator  $i = S, D$  therefore knows that  $\Pr(\omega = l, a = t \mid s = l, \theta = \theta_i, \sigma_i) = p_i \theta_i$  (i.e. the probability that she chooses  $t$  and her signal is correct) and  $\Pr(\omega = h, a = g \mid s = l, \theta = \theta_i, \sigma_i) = (1 - p_i)(1 - \theta_i)$  (i.e. the probability that she chooses  $g$  and her signal is incorrect). Similarly, if she receives  $s = h$ , she knows that  $\Pr(\omega = l, a = t \mid s = h, \theta = \theta_i, \sigma_i) = q_i(1 - \theta_i)$  and  $\Pr(\omega = h, a = g \mid s = h, \theta = \theta_i, \sigma_i) = (1 - q_i)\theta_i$ . By the Law of Total Probability  $\Pr(s = l) = \Pr(s = h) = \frac{1}{2}$ . Letting  $\Pr(\text{good}) = \Pr(\omega = l, a = t) + \Pr(\omega = h, a = g)$ , we have

$$\Pr(\text{good} \mid \theta = \theta_i, p_i, q_i) = \frac{1}{2} (1 + p_i(2\theta_i - 1) + q_i(1 - 2\theta_i)). \quad (2.1)$$

Substituting for the four pure strategies:  $\Pr(\text{good} \mid \theta = \theta_i, 1, 0) = \theta_i$ ,  $\Pr(\text{good} \mid \theta = \theta_i, 0, 0) = \Pr(\text{good} \mid \theta = \theta_i, 1, 1) = \frac{1}{2}$  and  $\Pr(\text{good} \mid \theta = \theta_i, 0, 1) = (1 - \theta_i)$ . Thus, in the absence of reputational concerns, both smart and dumb regulators play 'follow' since this maximises the probability of making a good decision.

**When Reputation Matters** ( $\delta > 0$ ) In games of hard information revelation, saying nothing can often be informative. Here such unraveling partitions the set of possible disclosure rules into four classes - 'no disclosure', 'squawk on tough', 'squawk on generous' and 'full disclosure' - according to the information sets that each rule induces. For instance, if the firm plays a rule that requires it to squawk only on tough, irrespective of whether it actually squawks on  $(l, t)$ ,  $(h, t)$  or both, the evaluator can deduce the quality of the regulator's decision making if she is tough but not if she is generous.

Letting  $o$  denote an equilibrium value, a PBE in such a sub-game is a pair of strategy functions  $\sigma^o = (\sigma_S^o, \sigma_D^o)$  and a set of beliefs  $\mu^o$  such that (i) at information sets on the equilibrium path these beliefs are derived by Bayes' Rule from the regulator's strategy and (ii)  $\sigma_S^o$  and  $\sigma_D^o$  maximise the regulator's objective function given  $\mu^o$ . To ease the exposition, I assume that the evaluator has passive beliefs off the equilibrium path and ignore equilibria in which  $S$  tries to signal her ability by attempting to make *bad* decisions.<sup>9</sup>

It will prove helpful to illustrate the steps involved in solving for such sub-game equilibria with the case of 'squawk on tough'. Let  $\tilde{\sigma} = (\tilde{\sigma}_S, \tilde{\sigma}_D)$  denote the strategy function that the evaluator believes the regulator is playing. Since the evaluator observes the regulator's actions,

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<sup>9</sup>The full set of equilibria are characterised in Leaver (2001). Since minimal squawk behaviour is a feature of both the 'good' and 'bad' equilibria ignoring the latter does not change the qualitative nature of the results.

he can deduce that  $\Pr(a = t \mid \theta_i, \tilde{\sigma}) = \frac{1}{2}(\tilde{p}_i + \tilde{q}_i)$  and  $\Pr(a = g \mid \theta_i, \tilde{\sigma}) = \frac{1}{2}(2 - \tilde{p}_i - \tilde{q}_i)$ . Using Bayes' Rule, his beliefs following each action are therefore given by

$$\mu(t) = \frac{\Pr(a = t \mid \theta = \theta_S, \tilde{\sigma}_S) \cdot \Pr(\theta = \theta_S)}{\Pr(a = t)} = \frac{\tilde{p}_S + \tilde{q}_S}{\tilde{p}_S + \tilde{q}_S + \tilde{p}_D + \tilde{q}_D} \quad (2.2)$$

and

$$\mu(g) = \frac{2 - \tilde{p}_S - \tilde{q}_S}{4 - \tilde{p}_S - \tilde{q}_S - \tilde{p}_D - \tilde{q}_D}. \quad (2.3)$$

Under 'squawk on tough', the evaluator also learns the quality of the regulator's decision making if she chooses  $t$ . Since the evaluator can deduce that  $\Pr(\omega = l, a = t \mid \theta_i, \tilde{\sigma}) = \frac{1}{2}(\tilde{p}_i\theta_i + \tilde{q}_i(1 - \theta_i))$  (i.e. the probability that the regulator chooses  $t$  when  $s = l$  and this signal is correct plus the probability that she chooses  $t$  when  $s = h$  and this signal is incorrect) and  $\Pr(\omega = h, a = t \mid \theta_i, \tilde{\sigma}) = \frac{1}{2}(\tilde{p}_i(1 - \theta_i) + \tilde{q}_i\theta_i)$ , his posterior beliefs at the information sets  $(\omega = l, a = t)$  and  $(\omega = h, a = t)$  are given by

$$\mu(l, t) = \frac{\tilde{p}_S\theta_S + \tilde{q}_S(1 - \theta_S)}{\tilde{p}_S\theta_S + \tilde{q}_S(1 - \theta_S) + \tilde{p}_D\theta_D + \tilde{q}_D(1 - \theta_D)} \quad (2.4)$$

and

$$\mu(h, t) = \frac{\tilde{p}_S(1 - \theta_S) + \tilde{q}_S\theta_S}{\tilde{p}_S(1 - \theta_S) + \tilde{q}_S\theta_S + \tilde{p}_D(1 - \theta_D) + \tilde{q}_D\theta_D}. \quad (2.5)$$

Notice that a regulator of ability  $\theta_i$  will deduce that  $\Pr(\omega = l, a = t \mid \theta_i, \sigma_i) = \frac{1}{2}(p_i\theta_i + q_i(1 - \theta_i))$ ,  $\Pr(\omega = h, a = t \mid \theta_i, \sigma_i) = \frac{1}{2}(p_i(1 - \theta_i) + q_i\theta_i)$  and  $\Pr(g \mid \theta_i, \sigma_i) = \frac{1}{2}(2 - p_i - q_i)$ . Using these probabilities, together with the probability of a good decision given in (2.1), the regulator's problem is

$$\max_{p_i, q_i} \frac{1}{2} (1 + p_i(2\theta_i - 1) + q_i(1 - 2\theta_i)) W + \delta \left[ \begin{array}{c} \frac{1}{2}(p_i\theta_i + q_i(1 - \theta_i))\mu(l, t) + \\ \frac{1}{2}(p_i(1 - \theta_i) + q_i\theta_i)\mu(h, t) + \frac{1}{2}(2 - p_i - q_i)\mu(g) \end{array} \right]. \quad (2.6)$$

Solving (2.6) for every set of beliefs defined by (2.3)-(2.5), gives the set of sub-game equilibria when the firm plays 'squawk on tough'. Repeating this procedure for the three remaining sub-games and solving for the firm's optimal choice of disclosure rule, yields the following result.

**Proposition 1.** *There exists a critical value of  $\delta$ ,  $\delta^*$ , such that:*

- (i) *if reputation is of low importance ( $\delta \leq \delta^*$ ), then the firm plays any disclosure rule and both smart and dumb regulators play 'follow' ( $\sigma_S^o = \sigma_D^o = (1, 0)$ ).*
- (ii) *if reputation is of high importance ( $\delta > \delta^*$ ), then the firm plays 'squawk on tough', smart regulators play 'follow' ( $\sigma_S^o = (1, 0)$ ) but dumb regulators mix between 'follow' and 'always generous' ( $\sigma_D^o = (p_D^o, 0)$  where  $p_D^o \geq \underline{p}_D > 0$ ).*

A proof of this and all other results can be found in Appendix A. The intuition is simple. When both  $S$  and  $D$  follow their signals, the evaluator expects to see a good decision more often than  $D$  expects to make one. It is this failure to live up to expectations that opens the door for interest group influence and biased regulatory decision making.

To see why, consider the evaluator's beliefs when he thinks that both  $S$  and  $D$  follow their signals. Since a low cost signal is (unconditionally) as likely as a high cost signal, the evaluator expects to see a tough action with the same probability as a generous action. Moreover, since cost signals are correct with a probability equal to the regulator's ability, he expects to see a good decision with a probability equal to expected ability  $\frac{1}{2}(\theta_S + \theta_D)$ . Together these observations imply

$$\mu(g) = \mu(t) = \frac{1}{2}(\theta_S + \theta_D)\mu(l, t) + \frac{1}{2}(2 - \theta_S - \theta_D)\mu(h, t), \quad (2.7)$$

where  $\mu(l, t) > \mu(t) > \mu(h, t)$ .

Consistent with the information sets in (2.7), suppose that the firm is playing 'squawk on tough'. When  $S$  and  $D$  receive a signal that the firm's costs are high, reputational concerns reinforce intrinsic motivation. The same is true when  $S$  receives a signal that the firm's costs are low. Being above average ability,  $S$  knows that she can make a good decision with a higher probability than the evaluator expected. Relishing the opportunity to demonstrate her superior decision making skills, she therefore follows her signal. In contrast,  $D$  faces a trade off. A tough action is good for warm glow but, with  $D$  being a below average ability, is bad for reputational concerns since she can only make a good decision with lower probability than the evaluator expected. Formally,

$$\theta_S\mu(l, t) + (1 - \theta_S)\mu(h, t) > \mu(g) > \theta_D\mu(l, t) + (1 - \theta_D)\mu(h, t). \quad (2.8)$$

So, if reputational concerns are sufficiently important,  $D$  deviates from following her signals.

Suppose instead that the evaluator thinks that  $S$  follows her signals but that  $D$  ignores her signals and is always generous. Since  $D$  is *never* tough the evaluator can be certain that a tough regulator is smart. But, given these beliefs,  $D$  sees that being tough after a low cost signal now yields a higher expected pay off than being generous and so deviates from ignoring her signals. Alternatively, then, suppose that the evaluator thinks that  $D$  is generous with positive, but not certain, probability. The more likely the evaluator thinks  $D$  is to be generous, the lower  $\mu(g)$  and the higher both  $\mu(l, t)$  or  $\mu(h, t)$  become. Eventually the evaluator's beliefs will be such that  $D$ 's reputational incentive to be generous exactly offsets her policy preference to be tough. At this point she will be willing to mix, thereby supporting such an equilibrium.

Similar logic shows that the firm can induce a toughness bias by committing to 'squawk on generous'. Under the two symmetric disclosure policies – 'no disclosure' and 'full disclosure' – decision making is unbiased. In the former case this is because reputational concerns are irrelevant, while in the latter case  $D$  effectively has no safe place to hide. Since the firm prefers a generosity bias, it plays 'squawk on tough' whenever reputation is of high importance ( $\delta > \delta^*$ ).

Proposition 1 shows that reputational concerns can prompt, otherwise public-spirited, bureaucrats to behave inefficiently. Defining the row vector of parameters  $z \equiv (\theta_S, \theta_D, W)$ , the key comparative statics result can be stated as follows.

**Proposition 2 (Minimal Squawk Hypothesis).** *The probability of a tough decision conditional on a high cost signal is  $\Pr(a = t|s = h, \delta, \mathbf{z}) = 0$  for all  $\delta$ . The probability of a tough decision conditional on a low cost signal is  $\Pr(a = t|s = l, \delta, \mathbf{z}) = \frac{1}{2}(1 + p_D^o(\delta, \mathbf{z}))$ , where*

$$\frac{\partial \Pr(a=t|s=l, \delta, \mathbf{z})}{\partial \delta} \leq 0 \text{ and } \frac{\partial^2 \Pr(a=t|s=l, \delta, \mathbf{z})}{\partial \delta^2} \geq 0.$$

As  $\delta$  increases above  $\delta^*$ ,  $D$  has a stronger reputational incentive to be generous when  $s = l$ . To ensure that  $D$  continues to mix, the evaluator must believe that she is generous with higher probability since this decreases her incentive to do so. The equilibrium probability  $p_D^o$  – and in turn  $\Pr(a = t|s = l, \delta, \mathbf{z})$  – is therefore decreasing in  $\delta$ . Since  $S$  has a stronger incentive to be tough when  $s = l$ , while both  $S$  and  $D$  have a stronger incentive to be generous when  $s = h$ , all other equilibrium behavior remains unchanged.

### 3. Regulatory Capture

The squawk model stands in sharp contrast to the capture paradigm inspired by Stigler (1971). In formal models of regulatory capture (e.g. Laffont and Tirole 1991) regulators are driven by pecuniary gain and simply sell their policies to the highest bidder. In the squawk model regulators are cast in a less malevolent light; regulatory policy becomes biased in favour of firms, not because regulators are inherently corrupt, but because, like most people, they are keen to avoid criticism. To facilitate an empirical test between these different views of regulator motivation, I now adapt the model of Section 2 to deliver a competing capture hypothesis.

The first change is obvious: the regulator derives utility from bribes offered by the firm. The second change is that she has private information over her intrinsic motivation (to ensure continuity of  $\Pr(a = t)$ ) but not her decision making ability (to remove reputational concerns). Formally,  $W$  is a random variable uniformly distributed on  $[0, 1]$  with realisation  $w$  observed only by the regulator, while decision making ability is a known constant  $\theta$ . The third change is that, in Stage 1, the firm commits to pay a non-negative bribe  $B$  for the outcome  $(l, g)$ .<sup>10</sup> The regulator's pay off is  $B$  when  $\omega = l$  and  $a = g$ , and  $u(\omega, a)$  otherwise. The firm's pay off is  $H - (1 + \lambda)B$  when  $\omega = l$  and  $a = g$ , and  $v(\omega, a)$  otherwise, where  $\lambda$  denotes the shadow cost of transfers.

The resulting game between the firm and regulator is simple to solve. In equilibrium, the firm offers a positive bribe if the shadow cost of transfers is sufficiently small. Low motivational types ( $w < \theta B^o / (2\theta - 1)$ ) then play 'always generous' while high motivational types ( $w \geq$

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<sup>10</sup>Bribes for outcomes other than  $(l, g)$  are ruled out to ease notation. This assumption is inessential as it is straightforward to show that, for all  $\lambda$ , the firm will never commit to reward other outcomes.

$\theta B^o/(2\theta - 1)$ ) play ‘follow’. The intuition is obvious. When  $\lambda$  is large, the cost of bribing even the lowest motivational type to take a generous action when  $s = l$  is too high. When  $\lambda$  is lower, the firm bribes at least some fraction of the motivational types and therefore receives a generous decision when  $s = h$  and, with positive probability, when  $s = l$ . The key comparative statics result is stated below.<sup>11</sup>

**Proposition 3 (Capture Hypothesis).** *The probability of a tough decision conditional on a high cost signal is  $\Pr(a = t|s = h, \lambda, \theta) = 0$  for all  $\lambda$ . The probability of a tough decision conditional on a low cost signal is  $\Pr(a = t|s = l, \lambda, \theta) = \max\{0, \min\{1, 1 - \frac{\theta B^o(\lambda)}{2\theta - 1}\}\}$ , where*

$$\frac{\partial \Pr(a=t|s=l, \lambda, \theta)}{\partial \lambda} \geq 0 \text{ and } \frac{\partial^2 \Pr(a=t|s=l, \lambda, \theta)}{\partial \lambda^2} \leq 0.$$

The firm’s equilibrium bribe decreases with  $\lambda$  because a higher shadow cost of transfers increases the expected cost of rewarding ( $l, g$ ) but leaves the expected benefit unchanged. In turn, this lower equilibrium bribe increases the probability of observing a tough decision conditional on  $s = l$ ,  $\lambda$  and  $\theta$ . The probability of observing a tough decision conditional on  $s = h$ ,  $\lambda$  and  $\theta$  is independent of  $\lambda$  because the firm never offers a bribe when interests are aligned.

## 4. Evidence From Regulatory Agencies

I now attempt to distinguish between the ‘squawk’ and ‘capture’ models using matched panel data from U.S. State Public Utility Commissions (PUCs) and investor-owned electric utilities. Section 4.2 sets out how the theory can be applied to rate of return regulation and proposes a test that requires estimation of the partial effect of term length on the incidence of formal rate level reviews. Before doing so, it will be useful to outline the salient features of PUCs and the rate regulation framework.

### 4.1. Institutional Background

State PUCs consist of a board of Commissioners and their permanent support staff. Commissioners serve fixed terms under the direction of a chairperson and are jointly responsible for the regulation of the intra-State activities of investor-owned electric, gas, telecommunications and water utilities. They were established by State legislatures over a period of 137 years (from Massachusetts in 1804 to New Mexico in 1941) and, as discussed in Section 4.3 below, differ markedly from State to State, as well as over time.

One institution that PUCs have had in common is their use of rate regulation. As Phillips (1988) notes rate regulation consists of rate level (earnings) and rate structure (price) control.

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<sup>11</sup>Since the firm’s objective function is sub-modular in  $B$  and  $\lambda$  the comparative statics result holds for a general class of distribution functions for  $W$ .

Rate level regulation can be summarized by the formula

$$R = O + rA. \tag{4.1}$$

That is, public utilities are entitled to earn a rate level  $R$  (the total revenue requirement) sufficient to cover allowable operating expenses  $O$  and earn a ‘fair’ rate of return  $r$  on the asset base  $A = (V - D)$ , where  $V$  is the gross value of tangible and intangible property and  $D$  is accrued depreciation. Rate structure regulation is used to ensure that firms set prices that cover  $R$  subject to being ‘just and reasonable’ and showing ‘no undue discrimination’.

In sum, PUCs are charged with four tasks: (i) to determine allowable operating expenses (opex); (ii) to determine the appropriate valuation of the asset base; (iii) to decide upon a fair rate of return; and (iv) to decide upon the appropriate rate structure given (i)-(iii). These duties are fulfilled via formal rate reviews.<sup>12</sup> The rate review process may be initiated by a firm or PUC and, following Phillips (1988), is summarized below.

A firm or PUC files for a rate change. The PUC suspends the proposed change for a set period and, in many cases, proscribes an interim rate that grants a fraction of the rate requested. The firm, with the PUC’s consent, then proposes a ‘test year’ (typically the latest 12-month period for which complete data are available). The test year is intended to facilitate estimation of  $O$  and  $A$ . Commissioners are, of course, expected to exercise their judgement rather than simply allow the firm to pass through last year’s cost or earn on last year’s asset base. For instance, they must decide whether costs determined by the firm (advertising, R&D, charitable contributions) should be passed through to consumers in addition to costs determined by competitive forces (wages, salaries, fuel). Moreover, they must decide whether the relationships between revenue, cost and net investment during the test year will continue to hold into the future. After the test year has been agreed the case is set down on the PUC’s docket and customers notified. Before the case is called the firm, PUC and any intervenors prefile ‘canned’ testimony. The case is subsequently heard by an administrative law judge who makes a recommended decision that is subject to review by the PUC and appeal by the firm. Finally, following the resolution of any appeals, rate structures are adjusted to ensure that the firm earns the agreed rate of return

## 4.2. Interpreting the Theory

A crucial step in the empirical analysis is, obviously, to find an appropriate proxy for the strength of reputational concerns  $\delta$  and the shadow cost of transfers  $\lambda$ . The variable I elect to use as a proxy for both  $\delta$  and  $\lambda$  is a *U.S. State Public Utility Commissioner’s statutory term of office*. My justification is two-fold. First, there are strong theoretical reasons to think that

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<sup>12</sup>There are also informal regulatory proceedings. However, while Federal Commissions use both formal and informal proceedings for rate determination, PUCs only use informal proceedings to deal with customer complaints.

both  $\delta$  and  $\lambda$  are related to statutory PUC term length. Second, in contrast to actual term served, statutory PUC term length is likely to be at least sequentially exogenous conditional on other PUC institutions since it is chosen by State Governments rather the Commissioners themselves.

To see the relationship between  $\delta$  and statutory PUC term length, suppose that Commissioners serve for a total of  $T$  periods, where  $T$  varies across PUCs, but that all Commissioners chair their PUC, and hence resolve their policy decision, after  $t$  periods in office. Moreover, suppose that Commissioners derive utility  $u$  in each of the remaining  $T - t$  periods that they are in office (prolonged warm glow) and utility  $\mu$  in each period forever after (future salary or immutable peer recognition). Applying a discount factor of  $\gamma = 1/(1 + i)$ , the present discounted value of a policy decision in period  $t + 1$  is then

$$PV = u \left( \frac{1 - \gamma^{T+1}}{1 - \gamma} \right) + \mu \left( \frac{\gamma^{T+1}}{1 - \gamma} \right). \quad (4.2)$$

Equation (4.2) is clearly proportional to  $u + \delta\mu$ , where

$$\delta(i, T) = \frac{1}{[(1 + i)^{T+1} - 1]} \quad (4.3)$$

and immediately reveals that reputational concerns  $\mu$  should weigh more heavily in a Commissioner's decision problem the shorter her term of office  $T$ . More specifically,

$$\delta_T(i, T) < 0, \delta_{TT}(i, T) > 0 \delta(i, 0) = 1/i \quad \text{and} \quad \lim_{T \rightarrow \infty} \delta(i, T) = 0. \quad (4.4)$$

The notion that long terms of office facilitate capture of reward-seeking bureaucrats is widely accepted. Indeed, there is clear evidence of an organizational response towards short fixed-term contracts in regulatory agencies beset by allegations of corruption (see, e.g., the U.K. National Lottery Commission after the Camelot affair and the Banca d'Italia after the Fazio affair). From a more theoretical perspective, Tirole (1986) sketches an argument for why long contracts facilitate capture, suggesting that collusion should increase over the course of a contractual relationship as: (i) trust builds up and facilitates higher stakes and (ii) past collusion offers each side the opportunity to 'blackmail' the other into future collusion. Drawing on these observations, it seems reasonable to take  $\lambda$  to be a function of  $T$  with

$$\lambda_T < 0, \lambda_{TT} > 0, \lambda(0) = \infty \quad \text{and} \quad \lim_{T \rightarrow \infty} \lambda(T) = 0. \quad (4.5)$$

To take the theory to the data, I also require a suitable proxy for the action space  $a \in \{t, g\}$ . A natural candidate suggested by the discussion in Section 4.1 (and noted by Joskow (1974)) is the PUC-level decision 'file for a rate decrease' ( $file = 1$ ) or 'do nothing' ( $file = 0$ ). To see this more clearly, suppose that social welfare in period  $t$  is given by the loss functions

$$SW(\text{review}) = -|R_t - (O_t + rA_t)| - C \quad (4.6)$$

$$SW(\text{no review}) = -|R_{t'} - (O_t + rA_t)| \quad (4.7)$$

where  $R_t$  denotes the revenue requirement chosen in the event of a review (initiated either by the firm or PUC) in period  $t$ ,  $R_{t'}$  the prevailing revenue requirement (chosen in period  $t' < t$ ),  $O_t + rA_t$  the true revenue revenue requirement in period  $t$  and  $C$  the administrative deadweight loss arising from the formal review process. Assuming that PUCs expect review outcomes to be correct (i.e.  $R_t = E[O_t + rA_t]$ ), they will anticipate social welfare levels of

$$E[SW(\text{review})] = -C \quad (4.8)$$

$$E[SW(\text{no review})] = -|R_{t'} - E[O_t + rA_t]|. \quad (4.9)$$

If a PUC elects to file whenever (4.8) minus (4.9) is positive it runs the risk of making two mistakes: an inefficient filing for a rate decrease ( $R_{t'} - E[O_t + rA_t] > C > R_{t'} - O_t + rA_t$ ) and an inefficient filing for a rate increase ( $E[O_t + rA_t] - R_{t'} > C > O_t + rA_t - R_{t'}$ ). Since the firm faces a lower (private) cost of initiating a review, a simple and efficient way to rule out the latter mistake is to let the firm file for rate increases. Consequently, the *effective* choice facing PUCs is whether to file for a rate decrease (play tough) or do nothing (play generous) given that the true state of the world may be either ‘low’ ( $R_{t'} - (O_t + rA_t) > C$ ) or ‘high’ ( $R_{t'} - (O_t + rA_t) < C$ ).

This decision problem is a close analogue of the model of Section 2. The optimality of the PUC’s choice is state-dependent (tough when the true cost state is ‘low’ and generous when the true cost state is ‘high’ are the only good decisions), while firms weakly prefer generous in every cost state. Moreover, future employers/peer groups are highly likely to observe the quality of tough, but not generous, decisions. If the PUC does nothing, the firm has no incentive to squawk and third parties will remain no wiser. However, if the PUC files for a review, test year data and pre-filed canned testimony will necessarily come out in court revealing the quality of the PUCs decision to a wide audience. Having argued that the formal review process offers a suitable testing ground, all that remains is to draw out the precise empirical predictions from the ‘squawk’ and ‘capture’ models.

**Squawk** A simple way to proceed is to estimate the probability that a PUC initiates a review ( $file = 1$ ) conditional only on PUC term length ( $term$ ) and a row vector of variables ( $\mathbf{z}$ ) likely to be correlated with term length and the incidence of reviews. From Proposition 2

$$\begin{aligned} \Pr(file = 1 | term, \mathbf{z}) = & \Pr(\theta = \theta_S, s = l | term, \mathbf{z}) \cdot 1 + \\ & \Pr(\theta = \theta_D, s = l | term, \mathbf{z}) \cdot p_D^o(\delta(term), \mathbf{z}). \end{aligned} \quad (4.10)$$

Notice that  $\partial \Pr(file = 1 | term, \mathbf{z}) / \partial term$  will aggregate two forces: an incentive effect that was the focus of the theoretical model ( $p_D^o$  is increasing in  $term$ ) and a selection effect that was abstracted from in the theoretical model ( $\Pr(\theta = \theta_D)$  may be increasing or decreasing in  $term$ ). Fortunately, as Figure 4.1 illustrates, the minimal squawk hypothesis yields an unambiguous prediction for the sign of the partial effect of PUC term length in the presence

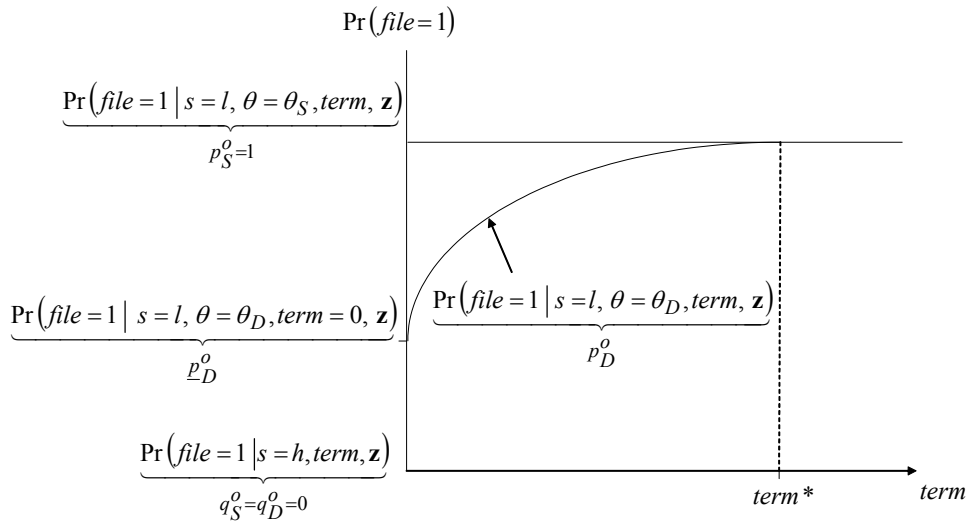


Figure 4.1: The Minimal Squawk Hypothesis

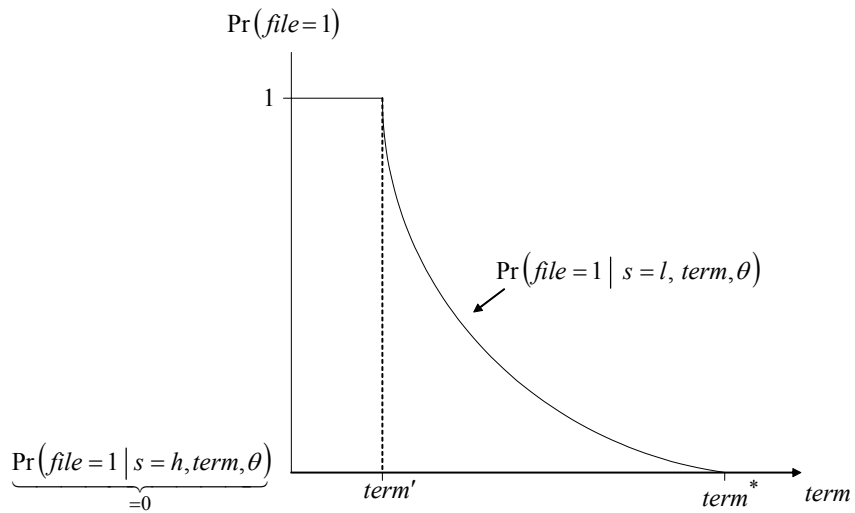


Figure 4.2: The Capture Hypothesis

of both effects.<sup>13</sup> True, if less able regulators have a tendency to self-select into PUCs with longer terms of office there should be a lower partial effect. All the same, term-length should still exert an unambiguously positive impact on the conditional probability of review. Letting  $\beta$  denote the (aggregate) partial effect of term length, I write the estimable analogue of (4.10) as

$$\Pr(\text{file} = 1 \mid \text{term}, \mathbf{z}) = G(\beta \text{term} + \mathbf{z}\boldsymbol{\gamma}). \quad (4.11)$$

An alternative strategy that offers a more demanding test of the minimal squawk hypothesis is to attempt to estimate the interaction effect between a PUC's cost signal and term length. I will discuss two proxies for the cost signal state in Section 4.3 below. Assuming for the moment that a valid proxy exists, Proposition 2 implies

$$\begin{aligned} \Pr(\text{file} = 1 \mid \text{term}, s = l, \mathbf{z}) &= \Pr(\theta = \theta_S \mid \text{term}, s = l, \mathbf{z}) \cdot 1 + \\ &\quad \Pr(\theta = \theta_D \mid \text{term}, s = l, \mathbf{z}) \cdot p_D^o(\delta(\text{term}), \mathbf{z}) \end{aligned} \quad (4.12)$$

$$\Pr(\text{file} = 1 \mid \text{term}, s = h, \mathbf{z}) = 0. \quad (4.13)$$

Defining the variable  $\text{low} = 1$  if the PUC receives a signal that the true cost state is low ( $R_t - (O_t + rA_t) > c$ ) and  $\text{low} = 0$  otherwise, this yields the potentially estimable equation,

$$\begin{aligned} \Pr(\text{file} = 1 \mid \text{term}, \text{low} * \text{term}, \mathbf{z}) &= \\ &\quad G(\alpha_1 \text{term} + \alpha_2 \text{low} * \text{term} + \alpha_3 \text{low} + \mathbf{z}\boldsymbol{\zeta}). \end{aligned} \quad (4.14)$$

Appealing to the same ‘self-selection’ logic as before, Proposition 2 implies that: (i)  $\alpha_1$  should be zero since term length should have no effect in a high cost signal state; (ii)  $\alpha_2$  should be positive since, averaging over both smart and dumb PUCs, term length should have a positive effect in a low cost signal state resulting in a positive difference in slopes; and (iii)  $\alpha_3$  should be positive since the intercept given a low cost signal should, averaging over both smart and dumb PUCs, be greater than the intercept given a high cost signal. I discuss a variety of estimation procedures for (4.11) and (4.14) in Section 4.5.

**Capture** There are again two ways to take the theoretical model to the data. From Proposition 3, the probability that a PUC initiates a review conditional on  $\text{term}$  and  $\theta$  is

$$\Pr(\text{file} = 1 \mid \text{term}, \theta) = \Pr(s = l \mid \text{term}, \theta) \left[ 1 - \frac{\theta B^o(\lambda(\text{term}))}{(2\theta - 1)} \right]. \quad (4.15)$$

Assuming that  $\Pr(s = l)$  is independent of PUC term length, the partial effect of term length depends only on an incentive effect (the equilibrium bribe is increasing in  $\text{term}$  and so the probability of a tough decision is decreasing in  $\text{term}$ ). The estimable equation is therefore given in (4.11). As Figure 4.2 illustrates, under the capture hypothesis  $\beta$  should be negative.

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<sup>13</sup>In Figure 4.1, concavity follows from convexity of  $p_D^o$  in  $\delta$  and of  $\delta$  in  $T$ . From (4.3)  $\text{term}^* = \frac{\log[1 + \frac{1}{\delta^*}]}{\log[1 + i]} - 1$ . Such a term length therefore exists iff  $\delta^*(\mathbf{z}) > 1/i$ .

The probability that a PUC initiates a review conditional on  $term$ ,  $\theta$  and the proxy for PUC's cost signal is given by

$$\Pr(file = 1 | s = l, term, \theta) = 1 - \frac{\theta B^\circ(\lambda(term))}{(2\theta-1)} \quad (4.16)$$

$$\Pr(file = 1 | s = h, term, \theta) = 0 \quad (4.17)$$

yielding the estimable equation given in (4.14). Proposition 3 implies that: (i)  $\alpha_1$  should be zero since term length continues to have no effect in a high cost signal state; (ii)  $\alpha_2$  should now be negative since term length should have a negative effect in a low cost signal state resulting in a negative difference in slopes; and (iii)  $\alpha_3$  should be positive since the intercept given a low cost signal should, again, be greater than under a high cost signal.

### 4.3. The Data

Both my dependent variable and key independent variable, PUC term length, are taken from the rich, but unfortunately historical, annuals published by the National Association of Regulatory Utility Commissioners (NARUC) between 1974-1990. These yearbooks list a filing date for all ongoing rate cases but do not consistently report who (firm or PUC) filed. Since the PUCs that provided this information are unlikely to represent a random sample, I use all reported reviews and control for variables likely to be correlated with a firm's propensity to initiate a review and the variables of interest. For clarity, I refer to this dependent variable as  $review_{it}$ , where  $review_{it} = 1$  if firm  $i$  faces a new review in year  $t$  and 0 otherwise.

The firm-level data needed to construct a cost-signal proxy is most readily available for the electric industry. The Energy Information Agency (EIA) published financial statistics by major investor-owned electric utility and calendar year although, unfortunately, not by State served until 1996. To minimise mistakes in attributing cost signals, I focus on the 99 firms that served residential customers in a single State for the 10 years back from 1990.<sup>14</sup> Recalling the earlier claim that a PUC receives a 'low' signal iff  $E(O_t + rA_t) < R_t - C$ , a simple cost signal proxy is the binary variable  $neg_{it}$ , where  $neg_{it} = 1$  if firm  $i$ 's operating expenses have been falling ( $O_{i,t-1} - O_{i,t-2} < 0$ ) and 0 otherwise. Given  $neg_{it}$  is a valid proxy only if  $r$  and  $A_t$  are constant and  $C$  is small, I also consider the continuous proxy lagged percentage change in operating expenses,  $Opch_{it}$ . If variation in  $A_t$  and the size of  $C$  are proportional to firm size, PUCs should be most likely to receive a low (respectively high) signal following large percentage falls (rises) in operating expenses. Since all firms are paired with a single PUC,  $term_{it}$  denotes the statutory term length at firm  $i$ 's PUC recorded in the NARUC yearbook at time  $t$ . The data set used to estimate (4.11) and (4.14) is a balanced panel of 99 electric utilities serving 39 States between 1982-1990 ( $NT = 891$ , where  $t = 1980, 1981$  are lost in construction of the cost signal proxies).<sup>15</sup>

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<sup>14</sup>I exclude 10 firms that enter or leave the EIA yearbooks for innocuous reasons.

<sup>15</sup>The dataset does not include observations for Arkansas, Arizona, District of Columbia, Delaware, Hawaii,

#### 4.4. Descriptive Analysis

Before turning to the regression analysis, I provide some preliminary evidence from two cuts of the raw data.

**Differences-in-Differences** The 39 sample states can be divided into three categories (see Table 4.1). The first category is the set of 5 *switching* states that changed their statutory PUC term lengths between 1982-1990. As Table 4.2 illustrates, in 1982 the average term length in switching states was 6.6 years, dropping to 4.8 years in 1990. Over the sample period none of the switching states experienced a net gain in PUC term length and 4 experienced net losses. By far the biggest change occurred in Pennsylvania, where PUC term length was slashed from 10 to 5 years in 1986. The second category is the set of 10 *non-switching-short* states that did not change their statutory term lengths away from 4 years during the sample period. The third category is the set of 24 *non-switching-long* states that did not change their statutory term lengths away from 6 years (or in the case of North Carolina 8 years).

It is possible to use this categorization to perform a difference-in-difference ‘test’ of the theoretical models. Suppose that between 1982 and 1990 the regulatory environment in switching states and non-switching-long states was identical except that the former were treated with a reduction in PUC term length. Table 4.2 provides evidence that this assumption is not too far fetched. (In 1982, only 2 of the 14 variables listed,  $appoint_{it}$  and  $stdpcy_{it}$ , have significantly different means across groups. In 1990, aside from the treatment and outcome variables  $term_{it}$  and  $review_{it}$ , only one additional variable  $numcom_{it}$  has a significantly different mean across groups.) Given the overall downward time trend in reviews, if the capture hypothesis is correct we should observe a smaller fall in reviews in switching relative to non-switching-long states (a negative difference-in-difference), while the reverse should be true under the minimal squawk hypothesis (a positive difference-in-difference).

As Table 4.2 shows, in switching states the mean of  $review_{it}$  fell from .636 in 1982 to .046 in 1990, while in non-switching-long states the mean of  $review_{it}$  fell from .571 in 1982 to .245 in 1990. The resulting difference-in-difference estimate of .264 is positive and (with a standard error of .146) significant at 10%, providing some (suggestive) evidence in favour of the minimal squawk hypothesis rather than the alternative capture hypothesis.

**An Event Study** Another way to cut the raw data is to compare the incidence of reviews around the “event” of a reduction in PUC term length. Figure 4.3 plots the percentage of sample firms reviewed in state  $s$  at normalised time  $t$  (number of years before and after reduction in PUC term length). To maximise the number of observations, I use the entire series of data available in the NARUC yearbooks and therefore include the 5 switching states plus 6 pre-sample switching states (Connecticut, Kentucky, Louisiana, Massachusetts, Maine and New Idaho, Montana, North Dakota, Nebraska, Utah, Virginia or Wyoming).

Jersey). The first event occurs in 1976 when Massachusetts cut its PUC term length from 7 to 5 years and the last in 1988 when Colorado cut its PUC term length from 6 to 4 years.

The evidence in Figure 4.3 is clear cut: the incidence of reviews falls after the event of a reduction in PUC term length. Indeed, comparing the two regression lines, there is a large significant difference in intercepts ( $-19.82$  with a  $p$ -value .01) but only a small, insignificant difference in slopes ( $-.234$  with a  $p$ -value of .084) with neither slope significantly different from zero.<sup>16</sup> Since the incidence of reviews *shifts* down, it is hard to argue that causality runs from the incidence of reviews to PUC term length.<sup>17</sup> As such, Figure 4.3 provides further (suggestive) evidence in favour of the minimal squawk rather than the capture hypothesis.

#### 4.5. Estimation

The positive correlation between PUC term length and the incidence of reviews discussed in Section 4.4 may, of course, be driven by other factors. This section outlines three regression techniques intended to control for such omitted variable bias.

**Static Unobserved Effects Models** I begin by allowing for a row vector of controls  $\mathbf{z}_{it}$  (firm, PUC and State socioeconomic/political controls and region dummies), year effects  $c_t$  and unobserved firm-level effects  $c_i$ . The latter could, for instance, reflect the presence of confrontational managers/regulators who enjoy reviews or good regulatory relationships that stave off formal reviews. Letting  $\mathbf{x}_{it}$  denote the row vector of all explanatory variables, these models require strict exogeneity of  $\mathbf{x}_{it}$  conditional on  $c_i$  for consistency. Adopting the notation  $\mathbf{x}_i \equiv (\mathbf{x}_{i1}, \mathbf{x}_{i2}, \dots, \mathbf{x}_{iT})$ , the estimable analogues of (4.11) and (4.14) are therefore

$$\begin{aligned} \Pr(\text{review}_{it} = 1 \mid \mathbf{x}_i, c_i) &= \Pr(\text{review}_{it} = 1 \mid \mathbf{x}_{it}, c_i) \\ &= G(\beta \text{term}_{it} + \mathbf{z}_{it}\boldsymbol{\gamma} + c_i + c_t), \end{aligned} \quad (4.18)$$

and

$$\begin{aligned} \Pr(\text{review}_{it} = 1 \mid \mathbf{x}_i, c_i) &= \Pr(\text{review}_{it} = 1 \mid \mathbf{x}_{it}, c_i) \\ &= G(\alpha_1 \text{term}_{it} + \alpha_2 \text{low} * \text{term}_{it} + \mathbf{z}_{it}\boldsymbol{\zeta} + c_i + c_t), \end{aligned} \quad (4.19)$$

for  $t = 1982, \dots, 1990$ . The parameters of interest are  $\beta$ ,  $\alpha_1$  and  $\alpha_2$ .<sup>18</sup>

To exploit the variation in term length between firms, I first estimate Random Effects (RE) Linear Probability and Probit Models. The RE LPM takes  $G$  to be the index function and requires the zero conditional mean assumption  $E(c_i \mid \mathbf{x}_i) = E(c_i) = 0$  for consistency. The RE

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<sup>16</sup>The difference in means (before-after) is  $-26.19$  with a  $p$ -value .00.

<sup>17</sup>Since PUCs were regulating gas, telecoms and water utilities in addition to electric firms, even *a priori* it is hard to imagine causality running entirely from the incidence of electric reviews to PUC term length.

<sup>18</sup>A proxy for  $\text{low}_{it}$  is always included in included  $\mathbf{z}_{it}$  but, since cost conditions may influence both firms and PUCs, I make no attempt to interpret  $\alpha_3$ .

Probit Model restricts fitted values to the unit interval by taking  $G$  to be the standard Normal CDF but requires the stronger assumption that  $c_i \mid \mathbf{x}_i \sim N(0, \sigma_c^2)$  together with the assumption that  $review_{i1982}, \dots, review_{i1990}$  are independent conditional on  $\mathbf{x}_i$  and  $c_i$  for consistency.

To relax the assumption that  $c_i$  is uncorrelated with  $\mathbf{x}_{it}$ , I also consider Fixed Effects (FE) Linear Probability and Logit models. When  $G$  is linear, a time-demeaning transformation can be used to remove the  $c_i$  from the estimating equation. The FE LPM then yields unbiased estimates under strict exogeneity. When  $G$  is non-linear such a transformation is no longer possible. An alternative strategy is to take  $G$  to be the Logistic CDF and maximise the log likelihood conditional on  $\mathbf{x}_i$ ,  $c_i$  and  $\sum_{t=1982}^T y_{it}$  since this conditional distribution does not depend on  $c_i$  (see, for instance, Honoré 2002). The downside of this approach is that it also requires conditional independence of  $\{review_{it}\}$  in addition to strict exogeneity and, since the distribution of  $c_i$  is left unrestricted, fails to deliver estimates of the average partial effect of term length.

**Dynamic Pooled Probit** Omitting lags of the dependent variable is undesirable since the probability of review in year  $t$  is highly likely to depend on the incidence of past reviews. For instance, firms or PUCs that have recently incurred the administrative burden of a review may be less willing to initiate the process afresh. Alternatively, firms or PUCs may “learn by doing” resulting in a positive, cumulative effect of past reviews. The simplest way to allow for such path dependence is to estimate the dynamic pooled Probit Models,

$$\Pr(review_{it} = 1 \mid review_{i,t-1}, \mathbf{x}_{it}) = \Phi(\rho review_{i,t-1} + \beta term_{it} + \mathbf{z}_{it}\boldsymbol{\gamma} + c_t) \quad (4.20)$$

and

$$\begin{aligned} \Pr(review_{it} = 1 \mid review_{i,t-1}, \mathbf{x}_{it}) \\ = \Phi(\rho review_{i,t-1} + \alpha_1 term_{it} + \alpha_2 low * term_{it} + \mathbf{z}_{it}\boldsymbol{\zeta} + c_t) \end{aligned} \quad (4.21)$$

for  $t = 1982, \dots, 1990$ . In the absence of unobserved effects, partial maximum likelihood estimation yields consistent estimates without the need for an assumption of strict exogeneity (see Wooldridge 2002, Ch. 13). In particular, feedback from past reviews into current PUC terms of office is perfectly admissible.

**Linear Dynamic Panel Data Models** Allowing for dynamics and unobserved effects in a non-linear model with additional explanatory variables is complex (see Honoré 2002). For this reason I check the robustness of my dynamic pooled Probit results using linear DPDMs. In error component form, these models are given by

$$review_{it} = \rho review_{i,t-1} + \beta term_{it} + \mathbf{z}_{it}\boldsymbol{\gamma} + (c_i + c_t + v_{it}) \quad (4.22)$$

and

$$review_{it} = \rho review_{i,t-1} + \alpha_1 term_{it} + \alpha_2 low * term_{it} + \mathbf{z}_{it}\boldsymbol{\zeta} + (c_i + c_t + v_{it}), \quad (4.23)$$

for  $t = 1983, \dots, 1990$ , where  $v_{it}$  is an idiosyncratic error term.<sup>19</sup>

It will be helpful to review why pooled OLS, RE and FE estimation of (4.22) and (4.23) is inappropriate. First,  $review_{i,t-1}$  is necessarily positively correlated with  $c_i$  having previously been on the LHS of (4.22). This precludes a random effects analysis and implies that a pooled OLS approach will produce inconsistent parameter estimates.<sup>20</sup> Second,  $v_{it}$  is necessarily correlated with future values of the lagged dependent variable. Thus, while the Within (fixed effects) transformation successfully removes  $c_i$ , failure of strict exogeneity results in estimates of  $\rho$  that are biased downwards, at least for small  $T$  (see Bond 2002).

Consistent estimation of  $\beta$ ,  $\alpha_1$  and  $\alpha_2$  therefore requires a transformation to remove  $c_i$  and instrumentation for pre-determined and endogenous explanatory variables. I follow Arellano and Bond (1991) in first differencing to remove  $c_i$  and, assuming that  $\{v_{it}\}$  is serially uncorrelated, using lagged levels as instruments in a GMM procedure. Taking (4.22) as an example, first differencing yields

$$\Delta review_{it} = \rho \Delta review_{i,t-1} + \beta \Delta term_{it} + \Delta \mathbf{z}_{it} \boldsymbol{\gamma} + \Delta c_t + \Delta v_{it} \quad (4.24)$$

for  $t = 1984, \dots, 1990$ . A valid instrument for  $\Delta review_{i,t-1}$  must be correlated with  $\Delta review_{i,t-1}$  and orthogonal to  $\Delta v_{it}$ . Providing that  $review_{i1}$  is pre-determined and  $\{v_{it}\}$  is serially uncorrelated, I can exploit the moment condition  $E(review_{is} \Delta v_{it}) = 0$  for  $s = 1, 2, \dots, t-2$  and hence, at time  $t$ , use up to  $t-2$  instruments for  $\Delta review_{i,t-1}$ . Different instruments are available for  $\Delta term_{it}$  and  $\Delta \mathbf{z}_{it}$  depending on their correlation with  $v_{it}$ . I take a parsimonious approach and allow for contemporaneous correlation.

Since first-differencing controls for unobserved firm-level effects and contemporaneous correlation is admissible, I drop  $\mathbf{z}_{it}$ . Despite this, the relatively long series for  $review_{it}$  still gives rise to a large number of over-identifying restrictions. Given GMM estimators using many overidentifying restrictions are known to have poor finite sample properties (see Wooldridge 2002, Ch. 11), I focus on instrument sets that use lagged levels no earlier than  $t-3$ . One-step estimates with robust standard errors are used for inference but two-step results are used to conduct a Sargan test of the validity of the moment conditions (see Bond 2002). I also test the key identifying assumption of no serial correlation in  $\{v_{it}\}$ .

## 4.6. Results

It is straightforward to test between the minimal squawk and capture hypotheses: a finding that  $\beta > 0$  and/or  $\alpha_2 > 0$  ( $\alpha_2 < 0$  if  $Opch_{it}$  is used in place of  $neg_{it}$ ) permits a rejection of the

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<sup>19</sup>The Stata command for linear dynamic panel data drops  $t = 1982$  when constructing the lagged dependent variable. To facilitate a comparison across models, I drop observations for 1982 when estimating the static LPMs (see Tables 4.3-4.5).

<sup>20</sup>If  $review_{i,t-1}$  alone is correlated with  $c_i$ , pooled OLS estimates of  $\rho$  should be biased upwards. Standard results for omitted variables bias imply that  $\beta$  is also likely to be inconsistently estimated.

capture hypothesis in favour of the minimal squawk hypothesis and vice versa. Throughout this Section I focus on statistical tests of these coefficients, postponing a discussion of their economic significance to Section 5.

**Linear Probability Models** Table 4.3 reports static and dynamic LPM estimates of  $\beta$ . In the absence of controls (columns a and b), the difference between the Static OLS and FE is small. With controls (c and d), OLS and FE yield practically identical estimates, while RE collapses back to OLS. This suggests that  $\mathbf{z}_{it}$  does a reasonable job of mopping up unobserved firm-level effects.<sup>21</sup> Further evidence is apparent in the OLS residuals. The column (a) residuals exhibit second order, but no obvious first order, serial correlation, while the column (c) residuals exhibit no second order, but significant *negative* first order, serial correlation. Again, this suggests that  $\mathbf{z}_{it}$  removes a positively autocorrelated component from the error term.

The existence of negative serial correlation in the column (c) residuals indicates that a dynamic specification may be more appropriate. Columns (f)-(j) report dynamic OLS, FE and Diff GMM estimates of  $\beta$  and  $\rho$  with year effects but without  $\mathbf{z}_{it}$ . Two results confirm that the Diff GMM models in columns (h)-(j) are well-specified. First, the Diff GMM estimates of  $\rho$  lie between the OLS and FE estimates as the theory predicts. Second, the first differenced residuals exhibit significant first, but not second, order serial correlation as required by the identifying assumption of no serial correlation in  $\{v_{it}\}$ .

Columns (h)-(j) consider different instrument sets. The increase in the Sargan statistic moving from column (h) to (i) provides some evidence that PUC term length is not *strictly* exogenous (conditional only on  $c_i$  and year effects). However, a difference Sargan test of the Sargan statistics in columns (i) and (j) fails to reject the null hypothesis that  $term_{it}$  is pre-determined rather than endogenous. For comparison, column (e) reports dynamic OLS estimates with full controls. If one buys the assertions that  $\mathbf{z}_{it}$  mops up  $c_i$  and that  $term_{it}$  is at least sequentially exogenous, then this simple specification should yield a consistent estimate of  $\beta$ . The estimates in columns (e) and (i) are very similar (as are the implications of the serial correlation tests), while the lower standard errors (reflecting the efficiency of pooled OLS in the absence of  $c_i$ ) ensure that the positive coefficient on  $\beta$  is significant at 1% against a two tailed test.

Columns (e) and (i) are my preferred specifications. Allowing for unobserved effects and dynamics, as well as instrumenting for the potential endogeneity of PUC term length, does little to change the message from the raw data. Consistent with the minimal squawk hypothesis but not the alternative capture hypothesis, the partial effect of PUC term length  $\beta$  is always

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<sup>21</sup>The vector of controls  $\mathbf{z}_{it}$  includes: (i) factors likely to affect a firm's propensity to initiate rate reviews (lagged  $\Delta opex$ , fuel costs as a proportion of opex, lagged profit and, as a proxy for scale effects, log sales to residential customers); (ii) other PUC institutions; (iii) PUC practice and workload (adjustment mechanisms, valuation standards, test years and the number of regulated utilities); (iii) State socioeconomic/political controls; and (iv) for OLS, region effects.

positive and significant (if only weakly so in the case of the GMM specification).

Tables 4.4 and 4.5 repeat this exercise including the binary and continuous cost signal proxies. Beginning with Table 4.4 (binary proxy), Static OLS and FE with full controls (c and d), again yield similar estimates, while there is (weak) evidence that the OLS errors exhibit negative first order serial correlation. Similarly, the Diff GMM estimates of  $\rho$  in columns (h)-(k) lie between the OLS and FE estimates, while the first and second order test statistics for serial correlation are consistent with no correlation in  $\{v_{it}\}$ .

The Sargan statistics suggest that  $term_{it}$  is best modelled as pre-determined as before but that  $neg_{it}$ , and hence  $neg*term_{it}$ , are best modelled as endogenous. Dynamic OLS with full controls, column (e), yields similar estimates to Diff GMM with a pre-determined instrument set, column (h). However, the differences between columns (e) and (i) suggests that  $neg_{it}$  is also endogenous conditional on  $z_{it}$ . Interestingly, this correlation actually appears to mute the interaction effect, with  $\alpha_2$  almost trebling in the presence of instruments for  $neg_{it}$ . Column (i) is my preferred specification. Consistent with the minimal squawk hypothesis but not the alternative capture hypothesis, the partial effect of PUC term length on the probability of review is positive when a firm's PUC is likely to have received a low cost signal ( $neg_{it} = 1$ ) and zero when a firm's PUC is likely to have received a high cost signal ( $neg_{it} = 0$ ) exactly as the theory predicts.

Table 4.5 (continuous proxy) tells a broadly similar story. The main difference is that a difference Sargan test for columns (i) and (j) fails to reject the null hypothesis that  $Opch_{it}$  and  $Opch*term_{it}$  (as well as  $term_{it}$ ) are pre-determined rather than endogenous. For this reason, columns (e) and (i) are my preferred specifications. Both yield similar estimates of  $\alpha_1$  and  $\alpha_2$ . Consistent with the minimal squawk hypothesis but not the alternative capture hypothesis, the partial effect of term length when  $Opch_{it}$  is zero - plausibly still a low cost signal - is positive and significant at 5% against a two tailed test. More importantly,  $Opch_{it}$  exerts a statistically significant negative effect on the partial effect of term length; term length has a smaller positive impact on the probability of review as a firm's lagged percentage change in operating expenses rises.

**Non-linear Models** The non-linear results tell a very similar story to the LPM results. The static pooled Probit estimates in columns (b) are identical to RE Probit but both specifications are dynamically incomplete invalidating usual inference procedures. The FE logit estimates in columns (c) and (d) are also similar to the FE LPM results; the mean effect of term length ( $\beta$ ) is positive, while the signs of the interaction terms are consistent with the minimal squawk hypothesis but are insignificant. Turning to the dynamic pooled Probit estimates in columns (e) and (f), the vector of controls  $\mathbf{z}_{it}$  again reduces the upwards bias of  $\rho$ . Since term length should be at least sequentially exogenous conditional on  $\mathbf{z}_{it}$  (given the LPM results) and every dynamic specification is dynamically complete, column (f) in Table 4.6 and 4.8 offer reasonably

reliable estimates of  $\beta$  and  $\alpha_2$ .<sup>22</sup> In contrast, the apparent endogeneity of  $neg_{it}$  suggests that column (f) in Table 4.7 is likely to *understate* the magnitude of the interaction effect. As discussed in Section 5.1, the additional controls  $npuc_{i,t-1}$  and  $ppuc_{it-1}$  are included as a proxy for PUC experience. Interestingly, they actually serve to strengthen the interaction effect.

#### 4.7. A Robustness Check: Revenue Regressions

An obvious concern is that firm-side responses to PUC term length (or variables correlated with PUC term length) are driving the above results. I explore this possibility using average revenue data. If firm-side responses (more reviews to increase  $R'_t$ ) are the dominant effect, then PUC term length should have a *positive* partial effect on a firm's average revenue ( $pres_{it}$ ). Since unobserved firm-level, rather than dynamic, effects are likely to be important in determining a firm's average revenue, I estimate Static UEMs. In error component form, the estimating equation is

$$pres_{it} = \phi term_{it} + \mathbf{z}_{it}\boldsymbol{\xi} + (c_i + v_{it}) \quad (4.25)$$

for  $t = 1982, \dots, 1990$ . The parameter of interest is  $\phi$ : a finding that  $\phi < 0$  suggests that PUC-side, rather than firm-side, responses likely to be driving the previous results.

The first two columns in Table 4.9 report pooled OLS estimates of  $\phi$  with and without PUC and State-level controls. In both cases  $\phi$  is negative and significant at 5%. However, as expected, the OLS residuals exhibit strong correlation ( $corr(\hat{u}_{i,t}, \hat{u}_{i,t-1}) = 0.92$ ) that is persistent over time indicating the presence of unobserved firm-level heterogeneity. The RE estimate of  $\phi$  in column (iii) is also negative and significant at 5%, while the FE estimate in column (iv) is very similar but only significant at 10%. The RE estimates in column (iii) are preferred since the Hausman test fails to reject the null hypothesis of no correlation between  $\mathbf{x}_{it}$  and  $c_i$  ( $p = .37$ ). Accordingly, it seems reasonable to conclude that firm-side responses are unlikely to be driving the results in Section 4.7.

## 5. Concluding Remarks

### 5.1. Squawk, Capture or Learning Effects?

The descriptive and regression results tell a consistent story: longer PUC terms of office do *not* appear to be associated with softer regulatory decision making. As such, it seems fair to reject the capture hypothesis. A thornier question is whether the empirical analysis has really unearthed any evidence of minimal squawk behavior. The data are certainly consistent with the minimal squawk hypothesis. In particular, there is evidence of a positive and significant

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<sup>22</sup>All models are dynamically complete - i.e.  $\hat{u}_{i,t-1} \equiv review_{it} - \Phi(\hat{p}review_{i,t-1} + \hat{\beta}term_{it} + \mathbf{z}_{it}\hat{\boldsymbol{\gamma}})$  is insignificant in the auxiliary pooled probit of  $review_{it}$  on  $\mathbf{x}_{it}$  and  $\hat{u}_{i,t-1}$  - ensuring that standard inference procedures are valid (see Wooldridge 2002, Ch. 15).

interaction effect between term length and falling operating costs. The effect of term length when  $neg_{it} = 1$  ( $\alpha_2$ ) is positive and significant in all but the static FE analysis, while the effect of term length when  $neg_{it} = 0$  ( $\alpha_1$ ) disappears to zero, as predicted, once the apparent endogeneity of  $neg_{it}$  is accounted for.

The obvious concern, however, is that these results are due to learning. For instance, new Commissioners may take time to “learn the ropes”. If so, then the positive correlation between PUC term length and rate reviews could be due to lower Commissioner turnover. Similarly, Commissioners may “learn by doing”. If the marginal cost of filing for review decreases with past reviews, then a positive correlation between term length and rate reviews could be due to scale effects.

The cleanest solution to this problem is to track individual decision-makers over time and identify  $\beta$  and  $\alpha_2$  off variation in time left in office, holding experience constant. The construction of such an individual-level data set is beyond the scope of this paper and is therefore left for future research. In the meantime, I highlight two observations that suggest that minimal squawk behavior may still be at work.

Holding the percentage of firms reviewed in period  $t - 1$  ( $ppuc_{i,t-1}$ ) constant to account for negative serial correlation, the absolute number of firms reviewed in period  $t - 1$  ( $npuc_{i,t-1}$ ) should act as a crude proxy for experience. That is, reviewing 3 of 6 firms gives greater scope for learning than reviewing 1 of 2. Consistent with this, in column (i) in Tables 4.6-4.8  $ppuc_{i,t-1}$  is negative and  $npuc_{i,t-1}$  is positive. More importantly, the inclusion of a proxy for experience decreases the mean effect of term length (compare (f) and (i) in Table 4.6) but increases the interaction effect (compare (f) and (i) in Tables 4.7 and 4.8). This suggests that learning effects, or at least factors correlated with experience, increase the incidence of reviews in high cost signal states and actually obscure the observation of minimal squawk behavior.

Further evidence is apparent in Figure 4.3. In steady-state, PUCs with shorter terms of office should display stronger reputational concerns and weaker learning effects. Immediately after a decrease in term length, however, only the former should matter. Commissioners will immediately face more imminent unemployment but will not have lost experience. Clearly, if learning is all that matters, it is hard to explain why the incidence of reviews *shifts* rather than trends downwards.

## 5.2. Economic Significance

Of course, establishing exactly why longer PUC terms of office are associated with fewer rate reviews is irrelevant if the effect is economically insignificant. Both the Diff GMM and dynamic pooled Probit models have their disadvantages here. The obvious problem with the LPM estimates is the assumed linearity of the coefficients. Since firm-level effects appear unimportant after controlling for  $\mathbf{z}_{it}$ , I focus on the dynamic pooled Probit estimates.

Table 4.10 reports impact effects on the predicted probability of formal review as PUC term length increases, other things equal, around the sample mean from 5 to 6 years using the estimates dynamic pooled Probit estimates in column (i) in Table 4.8. There is clear evidence of an economically, as well as statistically, significant interaction effect. Moving from 5 to 6 year terms of office has a large impact (.1244) at the bottom percentile of  $Opch_{it}$  but no effect at the top percentile. Averaging over the distribution of  $Opch_{it}$  the effect is .0634. Moreover, such behavior appears to have had a real impact on residential customers. An additional statutory year of office is associated with an increase in average revenue from residential customers by .0666 cents per kwh. Between 1980-1990 average U.S. household electricity consumption was 105 million BTU, implying that a one year reduction in PUC term length could have cost the average family an extra \$20.50 per year.<sup>23</sup>

### 5.3. An Application to Central Banks

The minimal squawk model has so far been couched in terms of utility regulation but may also apply to other, very different, bureaucracies, as illustrated by the example of central banks.<sup>24</sup>

In the wake of the scandals that rocked the Banca d'Italia during 2005 (allegations of insider trading and abuse of office against ex-Governor Fazio), the Italian Economy Minister tabled a raft of legislative changes including: limiting the term of governor to 5 years; giving parliament the power to select a new supervisory committee; and transferring the bank's regulatory and oversight role in banking mergers to the Italian competition authority. Whether these reforms actually improve the governance of the Banca d'Italia remains to be seen, but the minimal squawk model certainly sounds a cautionary note.

A core task facing many central banks (including the post-reform Banca d'Italia) is financial regulation of the banking sector. The model outlined in Section 2 fits this policy context reasonably well. In her role as a financial regulator, a central bank governor must take a stance on capital requirements. Raising banks' capital requirements ( $a = t$ ) when financial health is low ( $\omega = l$ ) but doing nothing ( $a = g$ ) when financial health is high ( $\omega = h$ ) are good decisions, doing the reverse is a bad decision. Equally importantly, individual banks are presumably best placed to observe their financial health. With the basic model building blocks in place, it seems possible that, despite (and perhaps even because of) reform, central banks may be susceptible to minimal squawk behavior. In short, financial regulation may be unduly lenient leading to scandals reminiscent of Parmalat in Italy and Weltecke in Germany (Frisell et al 2006).

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<sup>23</sup>1kwh = 3412 BTU. Figures taken from the EIA's Annual Energy Review 2002, available at [www.eia.doe.gov/emu/aer/pdf/pages/sec2.pdf](http://www.eia.doe.gov/emu/aer/pdf/pages/sec2.pdf)

<sup>24</sup>I am grateful to Giancarlo Spagnolo and Torsten Persson for suggesting this application. Errors in its execution are entirely my own.

As Frisell et al (2006) stress, central banks are typically multi-task agencies. While perhaps a little harder, it is also possible to apply the squawk model to another of these functions, namely monetary policy. In her function as inflation guardian, a central bank governor must take a stance on interest rates. Raising rates ( $a = t$ ) when the risk of recession vs. inflation is low ( $\omega = l$ ) but doing nothing ( $a = g$ ) when the risk is high ( $\omega = h$ ) are good decisions, doing the reverse is a bad decision. Again equally importantly, vested business interests may be well placed to verify the state of the economy. Now with the building blocks in place, it seems possible that monetary policy may be subject to an inflation bias that runs in the same direction as the traditional Kydland-Prescott effect but that stems from criticism avoidance rather than time-inconsistency.

#### 5.4. Implications for Governance and Institutional Design

The above analysis suggests two broad principles for the governance of regulatory agencies. The first is the need to create balance in the evaluation of policy. One strategy would be to try to give voice to squawkers with opposing interests. Subsidizing user forums, for instance, might increase the chances of consumers bringing (firm-favourable) mistakes to light. Another strategy would be to make greater use of independent public audits with a view to publicizing good policy making, as well as the inevitable mistakes.

The second principle is the need to keep reputational concerns in check. While career/peer concerns will not always be destructive, this paper highlights a potential downside to appointing mid-career “professionals” to short-term posts. Academics, for instance, may bring independence and expertise to the boards of regulatory agencies but most will also be driven by a strong desire to maintain peer respect, not to mention future jobs. Contrary to current vogue, appointments of older career civil servants may therefore have their place.

It is important to stress that this second principle is not an advocacy for *permanent* appointments. The data appear to reject one motivational extreme (briable, no reputational concerns). They cannot, however, distinguish between the other extreme (not briable, reputational concerns) and a world where both motives are present but, given the prevailing institutions, firms found it optimal to ‘squawk’ rather than ‘capture’. When both motives are present comparative statics are likely to be non-monotonic. Absent further analysis, it would certainly be presumptive to argue in favour of “jobs for life”.

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## Appendix

### A. Proofs

To prove Proposition 1 it will be helpful to first state a series of Lemmas characterising equilibrium behavior in the four sub-games between the regulator and evaluator induced by the firm's choice of disclosure rule.

**Lemma 1.** *When the firm plays ‘no disclosure’, for any  $\delta$ , there exists a unique pooling sub-game equilibrium with  $\sigma_S^o = \sigma_D^o = (1, 0)$ .*

**Proof.** Under ‘no disclosure’ the evaluator observes either  $t$  or  $g$ . The regulator's problem is therefore given by

$$\max_{p_i, q_i} \frac{1}{2} (1 + p_i(2\theta_i - 1) + q_i(1 - 2\theta_i)) W + \delta \left[ \frac{1}{2}(p_i + q_i)\mu(t) + \frac{1}{2}(2 - p_i - q_i)\mu(g) \right], \quad (\text{A.1})$$

where  $\mu(t)$  and  $\mu(g)$  are given in (2.2) and (2.3). Differentiating (A.1) wrt to  $p_i$  and  $q_i$  yields

$$\frac{\partial E[U_i]}{\partial p_i} = (\theta_i - \frac{1}{2})W + \delta \left[ \frac{1}{2}\mu(t) - \frac{1}{2}\mu(g) \right] \quad (\text{A.2})$$

$$\frac{\partial E[U_i]}{\partial q_i} = (\frac{1}{2} - \theta_i)W + \delta \left[ \frac{1}{2}\mu(t) - \frac{1}{2}\mu(g) \right]. \quad (\text{A.3})$$

and

$$\frac{\partial E[U_S]}{\partial p_S} - \frac{\partial E[U_D]}{\partial p_D} = \frac{\partial E[U_D]}{\partial q_D} - \frac{\partial E[U_S]}{\partial q_S} = (\theta_S - \theta_D) W > 0. \quad (\text{A.4})$$

**Existence.** Suppose  $\mu(t) = \mu(g) = \frac{1}{2}$ . Since  $(\theta_i - \frac{1}{2})W > 0 \forall i$ , (A.2) is strictly positive and (A.3) strictly negative  $\forall i$  and hence (A.1) has a unique solution characterised by  $p_i^o = 1, q_i^o = 0 \forall i$ . Substituting for these strategies in (2.2) and (2.3) the evaluator's beliefs are as stated and hence such an equilibrium exists.

**Uniqueness.** Suppose that  $\mu(t) > \mu(g)$ . From (2.2) and (2.3) we require  $\tilde{p}_S + \tilde{q}_S > \tilde{p}_D + \tilde{q}_D$ . Given these beliefs, (A.2) is strictly positive  $\forall i$  implying  $p_S^o = p_D^o = 1$ . However, (A.4) is also strictly positive implying  $q_D^o \geq q_S^o$ . Thus  $p_S^o + q_S^o \leq p_D^o + q_D^o$  inducing a contradiction. Analogous reasoning rules out  $\mu(t) < \mu(g)$ . Alternatively, suppose  $\mu(t) = \mu(g)$ . If these beliefs have been derived from Bayes' Rule then, from (2.2) and (2.3), we require  $\tilde{p}_S = \tilde{p}_D, \tilde{q}_S = \tilde{q}_D$  and  $2 > \tilde{p}_S + \tilde{q}_S > 0$  which implies that  $\mu(t) = \mu(g) = \frac{1}{2}$ . Thus, given passive beliefs,  $\mu(t) = \mu(g) = \frac{1}{2}$  for any  $\tilde{p}_S = \tilde{p}_D, \tilde{q}_S = \tilde{q}_D$ . But then we know from above that  $p_i^o = 1, q_i^o = 0 \forall i = S, D$  is the unique solution to (A.1) given these beliefs. ■

**Lemma 2.** *When the firm plays ‘squawk on tough’ there exists a critical value of  $\delta$ ,  $\delta^* > 0$ , such that:*

- (i) *iff  $\delta \leq \delta^*$  then there exists a pooling sub-game equilibrium with  $\sigma_S^o = \sigma_D^o = (1, 0)$ ;*

(ii) iff  $\delta > \delta^*$  then there exists a hybrid sub-game equilibrium with  $\sigma_S^o = (1, 0)$  and  $\sigma_D^o = (p_D^o, 0)$  for some  $p_D^o > 0$ .

**Proof.** Under ‘squawk on tough’ the regulator’s decision problem is given by (2.6) and the evaluator’s beliefs by (2.3)-(2.5). Differentiating (2.6) wrt to  $p_i$  and  $q_i$  yields

$$\frac{\partial E[U_i]}{\partial p_i} = (\theta_i - \frac{1}{2})W + \delta \left[ \frac{1}{2}\theta_i\mu(l, t) + \frac{1}{2}(1 - \theta_i)\mu(h, t)\frac{1}{2} - \mu(g) \right] \quad (\text{A.5})$$

$$\frac{\partial E[U_i]}{\partial q_i} = (\frac{1}{2} - \theta_i)W + \delta \left[ \frac{1}{2}(1 - \theta_i)\mu(l, t) + \frac{1}{2}\theta_i\mu(h, t)\frac{1}{2} - \mu(g) \right] \quad (\text{A.6})$$

$$\frac{\partial E[U_i]}{\partial p_i} - \frac{\partial E[U_j]}{\partial q_j} = (\theta_i + \theta_j - 1)W + \delta \left[ \frac{1}{2}(\theta_i + \theta_j - 1)(\mu(l, t) - \mu(h, t)) \right] \quad (\text{A.7})$$

for  $i, j = S, D$  and

$$\begin{aligned} \frac{\partial E[U_S]}{\partial p_S} - \frac{\partial E[U_D]}{\partial p_D} &= \frac{\partial E[U_D]}{\partial q_D} - \frac{\partial E[U_S]}{\partial q_S} \\ &= (\theta_S - \theta_D)W + \delta \left[ \frac{1}{2}(\theta_S - \theta_D)(\mu(l, t) - \mu(h, t)) \right]. \end{aligned} \quad (\text{A.8})$$

**Existence (pooling).** Suppose that the evaluator’s beliefs are given by

$$\mu(g) = \frac{1}{2}, \quad \mu(l, t) = \frac{\theta_S}{\theta_S + \theta_D} \quad \text{and} \quad \mu(h, g) = \frac{1 - \theta_S}{2 - \theta_S - \theta_D} \quad (\text{A.9})$$

and  $\delta \leq \delta^*$ , where

$$\delta^* = (\theta_i - \frac{1}{2})W \left( \frac{4(2 - \theta_S - \theta_D)(\theta_S + \theta_D)}{(\theta_S - \theta_D)^2} \right).$$

Substituting for (A.9) in (A.5) yields,

$$\frac{\partial E[U_S]}{\partial p_S} = (\theta_S - \frac{1}{2})W + \delta \left[ \frac{(\theta_S - \theta_D)^2}{4(2 - \theta_S - \theta_D)(\theta_S + \theta_D)} \right] > 0$$

and

$$\frac{\partial E[U_D]}{\partial p_D} = (\theta_D - \frac{1}{2})W + \delta \left[ \frac{(\theta_S - \theta_D)^2}{4(2 - \theta_S - \theta_D)(\theta_S + \theta_D)} \right]$$

which may be positive or negative depending on  $\delta$ . Similarly, substituting for (A.9) in (A.6) yields,

$$\frac{\partial E[U_S]}{\partial q_S} = (\frac{1}{2} - \theta_S)W + \delta \left[ \frac{(\theta_S - \theta_D)(3\theta_S + \theta_D - 2)}{4(2 - \theta_S - \theta_D)(\theta_S + \theta_D)} \right] < 0$$

and

$$\frac{\partial E[U_D]}{\partial q_D} = (\frac{1}{2} - \theta_S)W + \delta \left[ \frac{(\theta_S - \theta_D)(\theta_S + 3\theta_D - 2)}{4(2 - \theta_S - \theta_D)(\theta_S + \theta_D)} \right] < 0.$$

Given  $\delta \leq \delta^*$ , it follows that  $p_i^o = 1, q_i^o = 0 \forall i$  is a solution to (2.6). From (2.3)-(2.5) the evaluator’s beliefs are indeed as stated and hence such an equilibrium exists.

**Existence (hybrid).** Suppose that the evaluator's beliefs are given by

$$\begin{aligned}\mu(g) &= \frac{1}{3 - \tilde{p}_D}, \quad \mu(l, t) = \frac{\theta_S}{\theta_S + \tilde{p}_D \theta_D} \\ \text{and } \mu(h, g) &= \frac{1 - \theta_S}{(1 - \theta_S) + \tilde{p}_D(1 - \theta_D)},\end{aligned}\tag{A.10}$$

and  $\delta > \delta^*$ .

When  $\tilde{p}_D = 1$  (A.10) is the same as (A.9). So, from above, given  $\delta > \delta^*$ ,  $\frac{\partial E[U_D]}{\partial p_D} < 0$  implying  $p_D = 0$ . In contrast, when  $\tilde{p}_D = 0$ ,  $\mu(l, t) = \mu(h, t) = 1$  and  $\mu(g) = \frac{1}{3}$ . Substituting for these beliefs in (A.5) yields  $\frac{\partial E[U_D]}{\partial p_D} > 0$  implying  $p_D = 1$ . It is straight forward to show that

$$\frac{\partial^2 E[U_D]}{\partial p_D \partial \tilde{p}_D} < 0,$$

(i.e.  $D$ 's incentive to choose  $g$  following  $s = l$  decreases the more likely the market thinks she is to play 'always generous'). Thus there must exist a unique value of  $\tilde{p}_D$ ,  $\tilde{p}_D^*(\delta, \mathbf{z})$  such that

$$\frac{\partial E[U_D]}{\partial p_D} \Big|_{\tilde{p}_D^*} = 0$$

thereby supporting  $p_D^o = \tilde{p}_D$ . Note that  $\tilde{p}_D^* \in (\underline{\tilde{p}}_D, 1)$  where  $\underline{\tilde{p}}_D$  solves

$$\mu(g) = \theta_D \mu(l, t) + (1 - \theta_D) \mu(h, g).$$

Given the beliefs in (A.10) we have

$$\mu(l, t) - \mu(h, t) = \frac{\tilde{p}_D (\theta_S - \theta_D)}{(\theta_S + \tilde{p}_D \theta_D)(1 - \theta_S + \tilde{p}_D(1 - \theta_D))}$$

which is strictly positive for any  $\tilde{p}_D \in [0, 1)$ . Thus, using the definition of  $\tilde{p}_D^*$ , it follows from (A.8) that (A.5) must be strictly positive for  $i = S$  supporting  $p_S^o = 1$ . Similarly, it follows from (A.7) that (A.6) must be strictly negative for  $i = D$  and hence from (A.8) that (A.6) strictly negative for  $i = S$  supporting  $q_S^o = q_D^o = 0$ . From (2.3)-(2.5) the evaluator's beliefs are therefore as stated and hence such an equilibrium exists. ■

**Lemma 3.** *When the firm plays 'squawk on generous' there exists a critical value of  $\delta$ ,  $\delta^* > 0$ , such that:*

- (i) *iff  $\delta \leq \delta^*$  then there exists a pooling sub-game equilibrium with  $\sigma_S^o = \sigma_D^o = (1, 0)$ ;*
- (ii) *iff  $\delta > \delta^*$  then there exists a hybrid sub-game equilibrium with  $\sigma_S^o = (1, 0)$  and  $\sigma_D^o = (1, q_D^o)$  for some  $q_D^o < 1$ .*

**Proof.** This is exactly analogous to the proof of Lemma 2. ■

**Lemma 4.** *When the firm plays 'full disclosure', for any  $\delta$ , there exists a pooling sub-game equilibrium with  $\sigma_S^o = \sigma_D^o = (1, 0)$ .*

**Proof of Lemma 4.** Under ‘full disclosure’ the evaluator may observe an of the four regulatory outcomes. The regulator’s problem is therefore given by

$$\max_{p_i, q_i} \frac{1}{2} (1 + p_i(2\theta_i - 1) + q_i(1 - 2\theta_i)) W + \delta \left[ \begin{array}{l} \frac{1}{2} (q_i + (p_i - q_i)\theta_i) \mu(l, t) + \frac{1}{2} (p_i - (p_i - q_i)\theta_i) \mu(h, t) + \\ \frac{1}{2} (1 - q_i - (p_i - q_i)\theta_i) \mu(l, g) + \frac{1}{2} (1 - p_i + (p_i - q_i)\theta_i) \mu(h, g) \end{array} \right] \quad (\text{A.11})$$

where the evaluator’s beliefs are given in (2.4) and (2.5) and by Bayes’ Rule,

$$\mu(l, g) = \frac{(1 - \tilde{p}_S)\theta_S + (1 - \tilde{q}_S)(1 - \theta_S)}{(1 - \tilde{p}_S)\theta_S + (1 - \tilde{q}_S)(1 - \theta_S) + (1 - \tilde{p}_D)\theta_D + (1 - \tilde{q}_D)(1 - \theta_D)} \quad (\text{A.12})$$

and

$$\mu(h, g) = \frac{(1 - \tilde{p}_S)(1 - \theta_S) + (1 - \tilde{q}_S)\theta_S}{(1 - \tilde{p}_S)(1 - \theta_S) + (1 - \tilde{q}_S)\theta_S + (1 - \tilde{p}_D)(1 - \theta_D) + (1 - \tilde{q}_D)\theta_D}. \quad (\text{A.13})$$

Differentiating (A.11) wrt to  $p_i$  and  $q_i$  yields

$$\frac{\partial E[U_i]}{\partial p_i} = (\theta_i - \frac{1}{2})W + \delta \left[ \begin{array}{l} \frac{1}{2}\theta_i\mu(l, t) + \frac{1}{2}(1 - \theta_i)\mu(h, t) \\ -\frac{1}{2}\theta_i\mu(l, g) - \frac{1}{2}(1 - \theta_i)\mu(h, g) \end{array} \right] \quad (\text{A.14})$$

$$\frac{\partial E[U_i]}{\partial q_i} = (\frac{1}{2} - \theta_i)W + \delta \left[ \begin{array}{l} \frac{1}{2}(1 - \theta_i)\mu(l, t) + \frac{1}{2}\theta_i\mu(h, t) \\ -\frac{1}{2}(1 - \theta_i)\mu(l, g) - \frac{1}{2}\theta_i\mu(h, g) \end{array} \right]. \quad (\text{A.15})$$

Suppose that

$$\begin{aligned} \mu(l, t) &= \mu(h, g) = \frac{\theta_S}{\theta_S + \theta_D} \text{ and} \\ \mu(l, g) &= \mu(h, t) = \frac{1 - \theta_S}{2 - \theta_S - \theta_D}. \end{aligned} \quad (\text{A.16})$$

Substituting for (A.16) in (A.14) yields

$$\frac{\partial E[U_i]}{\partial p_i} = (\theta_i - \frac{1}{2})H_r + \delta \left[ \frac{(2\theta_i - 1)(\theta_S - \theta_D)}{2(2 - \theta_S - \theta_D)(\theta_S + \theta_D)} \right] > 0 \forall i.$$

Similarly substituting for (A.16) in (A.15) yields

$$\frac{\partial E[U_i]}{\partial q_i} = (\frac{1}{2} - \theta_i)H_r - \delta \left[ \frac{(2\theta_i - 1)(\theta_S - \theta_D)}{2(2 - \theta_S - \theta_D)(\theta_S + \theta_D)} \right] < 0 \forall i.$$

It therefore follows that, for any  $\delta$ ,  $p_i^o = 1, q_i^o$  is a solution to (A.11). From (2.4), (2.5), (A.12) and (A.13) the evaluator’s beliefs are as stated and hence such an equilibrium exists.

Having characterised equilibrium behavior in the four sub-games, all that remains is to solve for the firm’s optimal choice of disclosure rule.

**Proof of Proposition 1.** The firm's problem can be written as

$$\max_d E[v(\omega, a(d, \theta_i))] = \sum_{i=S,D} \Pr(\theta_i) \left[ \sum_{\omega,a} \Pr(\omega, a | \theta_i, \sigma_i(d)) v(\omega, a) \right].$$

Suppose that  $\sigma_S^o = \sigma_D^o = (1, 0)$ . Then  $E[v(l, a)] = \frac{1}{2}(\theta_S + \theta_D)L + \frac{1}{2}(2 - \theta_S - \theta_D)H$  and  $E[v(h, a)] = \frac{1}{2}(\theta_S + \theta_D)L$ . W.l.o.g, let  $H = 2L$ , yielding  $E[v(\omega, a)] = L$ . Now suppose that  $\sigma_S^o = (1, 0)$  and  $\sigma_D^o = (1, 1)$ . Given  $E[v(\omega, a) | \theta_D] = \frac{1}{2}L$  we have  $E[v(\omega, a)] = \frac{3}{4}L$ . Thus when  $\sigma_S^o = (1, 0)$  and  $\sigma_D^o = (1, q_D^o)$   $E[v(\omega, a)] \in (\frac{3}{4}L, L)$ . Analogously, when  $\sigma_S^o = (1, 0)$  and  $\sigma_D^o = (p_D^o, 1)$   $E[v(\omega, a)] \in (L, \frac{3}{2}L)$ . Given Lemmas 1- 4, the firm will be indifferent between disclosure rules when  $\delta \leq \delta^*$  but will play 'squawk on tough' when  $\delta > \delta^*$ , since this disclosure rule biases regulatory policy in its favour. ■

**Proof of Proposition 2.** Let the function  $\delta_{mix\ p}(\theta_S, \theta_D, W, \tilde{p}_D)$  denote the values of  $\delta$  such that  $D$  is willing to mix on  $s = l$ , given  $\tilde{p}_S = 1$  and  $\tilde{q}_S = \tilde{q}_D = 0$ . Note  $\delta^* = \delta_{mix\ p}(\theta_S, \theta_D, W, 1)$ , implying that  $\delta^*$  gives the value of  $\delta$  beyond which  $D$  mixes on  $s = l$ . First note from Lemma 2 that  $S$  has no reputational incentive to deviate from setting  $t$  when  $s = l$  for any  $\tilde{p}_D$ . From above, for  $D$  to mix on  $s = l$ , we require

$$\frac{\partial E[U_D]}{\partial p_D} = (\theta_D - \frac{1}{2})W + \delta \left[ \frac{1}{2}\theta_D\mu(l, t) + \frac{1}{2}(1 - \theta_D)\mu(h, t) - \frac{1}{2}\mu(g) \right] = 0.$$

Define the function

$$Z(\theta_S, \theta_D, \tilde{p}_D) = \mu(g) - \theta_D\mu(l, t) - (1 - \theta_D)\mu(h, t).$$

Substituting for the market's beliefs when  $\tilde{\sigma}_S = (1, 0)$  and  $\tilde{\sigma}_D = (\tilde{p}_D, 0)$  yields

$$Z = \frac{1}{(3 - \tilde{p}_D)} - \frac{(1 - \theta_S)(1 - \theta_D)}{(1 - \theta_S - \tilde{p}_D(1 - \theta_D))} - \frac{\theta_S\theta_D}{(\theta_S + \tilde{p}_D\theta_D)}.$$

Differentiating  $Z$  wrt to  $\tilde{p}_D$  gives

$$\frac{\partial Z}{\partial \tilde{p}_D} = \frac{1}{(3 - \tilde{p}_D)^2} + \frac{(1 - \theta_S)(1 - \theta_D)^2}{(1 - \theta_S - \tilde{p}_D(1 - \theta_D))^2} + \frac{\theta_S\theta_D^2}{(\theta_S + \tilde{p}_D\theta_D)^2} > 0.$$

Given the definition of  $\delta_{mix\ p}$  we have

$$\delta_{mix\ p} = \frac{(2\theta_D - 1)W}{Z(\theta_S, \theta_D, \tilde{p}_D)}$$

implying  $\delta_{mix\ p}$  must be decreasing in  $\tilde{p}_D$ . Thus  $\tilde{p}_D$  - and hence the probability that the unable regulator plays 'follow' - decreases as  $\delta$  increases. ■

**Proof of Proposition 3.** I proceed in two steps, first deriving the equilibrium bribe described in the text and then differentiating wrt to  $\lambda$  to obtain the comparative statics result.

*Step 1.* Aware that the firm offers a bribe  $B$  for the outcome  $(l, g)$ , a type  $w$  regulator solves

$$\begin{aligned} \max_{p,q} \Pr(s = l) \{p\theta w + (1-p)[\theta B + (1-\theta)w]\} + \\ \Pr(s = h) \{q(1-\theta)w + (1-q)[\theta w + (1-\theta)B]\} \end{aligned} \quad (\text{A.17})$$

and hence plays ‘always generous’ ( $p = q = 0$ ) iff  $w \leq \frac{\theta B}{2\theta-1}$  and ‘follow’ ( $p = 1, q = 0$ ) otherwise.

Anticipating the regulator’s strategy, the firm anticipates that

$$\Pr(a = g \mid s = l, \theta, B) = F\left(\frac{\theta B}{2\theta-1}\right) = \frac{\theta B}{2\theta-1} \quad (\text{A.18})$$

$$\Pr(a = g \mid s = h, \theta, B) = 1. \quad (\text{A.19})$$

The firm’s problem can therefore be expressed as

$$\begin{aligned} \max_B E[V] = & \Pr(\omega = l) \underbrace{\left[ \theta \left( \frac{\theta B}{2\theta-1} \right) + (1-\theta) \right]}_{\Pr(l,g)} [H - (1+\lambda)B] + \\ & \Pr(\omega = l) \underbrace{\left[ \theta \left( 1 - \frac{\theta B}{2\theta-1} \right) \right]}_{\Pr(l,t)} L + \\ & \Pr(\omega = h) \underbrace{\left[ \theta + (1-\theta) \left( \frac{\theta B}{2\theta-1} \right) \right]}_{\Pr(h,g)} L \end{aligned} \quad (\text{A.20})$$

subject to the non-negativity constraint  $B \geq 0$  and the inequality constraint  $\frac{\theta B}{2\theta-1} \leq 1$ .

This problem yields two Kuhn-Tucker necessary conditions for a maximum

$$\frac{\theta[\theta(H-L)+(1-\theta)L-(\theta B)2(1+\lambda)]}{2(2\theta-1)} - \frac{(1-\theta)(1+\lambda)}{2} \leq \frac{\gamma\theta}{2\theta-1} \text{ and } B \geq 0 \quad (\text{A.21})$$

$$\frac{\theta B}{2\theta-1} \leq 1 \text{ and } \gamma \geq 0 \quad (\text{A.22})$$

each with complementary slackness, where  $\gamma$  denotes the Lagrange multiplier on the inequality constraint. It is straightforward to rule out any candidate optimum with  $B = 0$  and  $\gamma > 0$  as this violates (A.22). This leaves three possibilities: (i)  $B = \gamma = 0$ ; (ii)  $B > \gamma = 0$ ; and (iii)  $B > 0$  and  $\gamma > 0$ . Candidate (i) satisfies (A.21)-(A.22) if

$$\frac{\theta[\theta(H-L)+(1-\theta)L]}{2(2\theta-1)} - \frac{(1-\theta)(1+\lambda)}{2} \leq 0 \Leftrightarrow \lambda \geq \frac{1+\theta^2(2+H-2L)+\theta(L-3)}{3\theta+2\theta^2-1} \equiv \lambda'. \quad (\text{A.23})$$

Candidate (ii) satisfies (A.21)-(A.22) if

$$B = \frac{1+\lambda+\theta^2(H+2(1+\lambda-L))+\theta(L-3(1+\lambda))}{2\theta^2(1+\lambda)} \leq \frac{2\theta-1}{\theta} \Leftrightarrow \lambda \geq \frac{1+\theta[\theta(H-2)-(2\theta-1)L-1]}{2\theta^2+\theta-1} \equiv \lambda'', \quad (\text{A.24})$$

where  $\lambda'' < \lambda'$  given  $\theta > \frac{1}{2}$  and  $H \geq L$ . Finally, Candidate (iii) satisfies (A.21)-(A.22) if

$$B = \frac{2\theta-1}{\theta} \text{ and} \quad (\text{A.25})$$

$$\gamma = \frac{1+\lambda+\theta^2(H-2(1+\lambda+L))+\theta(L-(1+\lambda))}{2\theta} > 0 \Leftrightarrow \lambda < \lambda''. \quad (\text{A.26})$$

The firm's equilibrium bribe is therefore

$$B^o = \begin{cases} 0 & \text{if } \lambda \geq \lambda' \\ \frac{1+\lambda+\theta^2(H+2(1+\lambda-L))+\theta(L-3(1+\lambda))}{2\theta^2(1+\lambda)} & \text{if } \lambda \in [\lambda'', \lambda') \\ \frac{2\theta-1}{\theta} & \text{if } \lambda < \lambda''. \end{cases}$$

*Step 2.* Differentiating  $B^o$  wrt  $\lambda$  yields

$$\begin{aligned} \frac{\partial B^o}{\partial \lambda} &= \begin{cases} 0 & \text{if } \lambda \geq \lambda' \text{ or } \lambda < \lambda'' \\ -\frac{H\theta-(2\theta-1)L}{2\theta(1+\lambda)^2} < 0 & \text{if } \lambda \in [\lambda'', \lambda') \end{cases} \\ \frac{\partial^2 B^o}{\partial \lambda^2} &= \begin{cases} 0 & \text{if } \lambda \geq \lambda' \text{ or } \lambda < \lambda'' \\ \frac{H\theta-(2\theta-1)L}{2\theta(1+\lambda)^3} > 0 & \text{if } \lambda \in [\lambda'', \lambda'). \end{cases} \end{aligned}$$

From above, a type  $w$  regulator sets  $a = t$  when  $s = l$  iff  $w < \frac{\theta B^o}{2\theta-1}$ . The probability of a tough decision conditional on a low signal is therefore

$$\Pr(a = t | s = l, \lambda, \theta) = \begin{cases} 0 & \text{if } \lambda \geq \lambda' \\ 1 - \frac{\theta B^o}{2\theta-1} & \text{if } \lambda \in [\lambda'', \lambda') \\ 1 & \text{if } \lambda < \lambda'' \end{cases}$$

which is clearly weakly increasing in  $\lambda$  given  $\frac{\partial B^o}{\partial \lambda} \leq 0$ . Note that a type  $w$  regulator never sets  $a = t$  when  $s = h$ . This implies that  $\Pr(a = t | s = h, \lambda, \theta) = 0$  for all  $\lambda$  and, in turn, completes the proof. ■

## B. Data

The variables included in regressions are listed in Table 4.2. Data sources are as follows.

**PUC variables.** All PUC variables were obtained from *Annual Report on Utility and Carrier Regulation of the National Association of Regulatory Utility Commissioners*, (K. Bauer ed.), Washington: NARUC (1982-1990), except for  $staffpc_{it}$  which was taken from *The Book of the States*, (Council of State Governments), Washington (1982/3-1990/1).

**Firm variables.** All firm variables were taken from the EIA yearbooks (DOE/EIA-0437), published under a number of titles, most recently “*Financial Statistics of Major U.S. Investor Owned Electric Utilities*” until the series was discontinued in 1996. For more details see [http://www.eia.doe.gov/cneaf/electricity/invest/invest\\_sum.html](http://www.eia.doe.gov/cneaf/electricity/invest/invest_sum.html).

**State variables.** The state variables  $stpop_{it}$  and  $stdpcy_{it}$  were taken from the Bureau of Economic Analysis Regional Accounts Data available at <http://www.bea.doc.gov/bea/regional/spi>. The variables  $land_{it}$  and  $govparty_{it}$  were taken from *The Book of the States*. The variable  $house_{it}$  was taken from *The Statistical Abstract of the United States* (U.S. Census Bureau), (1982-1990).