Bureaucratic Minimal Squawk: Theory and Evidence*

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Abstract

Regulators appointed on finite contracts have an incentive to signal their worth to the job market. This paper shows that, if contracts are sufficiently short, this can result in "minimal squawk" behaviour. Regulated firms publicise the quality of unfavourable decisions, aware that regulators then set favourable policies more often to keep their professional reputation intact. Terms of office vary across US states, prompting an empirical test using firm-level data from the regulation of the US electric industry. Consistent with the theory, we find that shorter terms are associated with fewer rate of return reviews and higher residential prices.

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‘a regulatory commission of members who serve for finite periods must be expected to engage in a great deal of “minimal squawk” behaviour’. Hilton (1972), pp.48.

1. Introduction

Noting that regulators’ terms of office were limited, but generally longer than those of the politicians that appointed them, Hilton (1972) suggested that the organisation of the US regulatory profession was unlikely to encourage best practice. The probability of re-appointment could not be evaluated very highly, while employment in the regulated industry was an obvious alternative. As a result, regulators were likely to set policy with an eye on the job market: pacifying regulated firms to maintain a favourable reputation and hence secure future employment. In short, Hilton conjectured that finite contracts resulted in “minimal squawk” behaviour.

Today, 30 years later, this issue is as salient as ever. First, finite contracts remain commonplace in regulatory agencies. In the US, every state that appoints its public utility commissioners does so for a term of between 5 and 8 years. Similarly, in the UK, the Director General of every independent body created to regulate the newly privatised entities has been appointed for a fixed term of 5 years or less. Second, the common justification given for the use of such contracts is that they are necessary to *limit* collusion between firms and their regulators, otherwise known as regulatory capture.[1] Accordingly, this paper revisits Hilton’s conjecture, asking if the use of finite contracts might simply be replacing one source of political failure with another.

In doing so we develop a theoretical model of, as well as an empirical test for, “minimal squawk” behaviour in the context of utility regulation. Over the last 30 years, however, legislation has largely closed the revolving door between regulatory office and industry job.[2] Meanwhile, increasing media exposure has ensured that regulators pay attention to the reputation their policies earn them in wider, non-industry circles in the hope of securing desirable future employment.[3] We therefore ask if career concerns in general, rather than prospects of future industry employment, might prompt regulators to pacify their regulatees.

Our theoretical model focuses on the following setting. A regulator is appointed

[1] Replacing the post of Director General of the National Lottery with a National Lottery Commission, where the post of chairperson would be held for just 12 months, the UK government claimed ‘its introduction will reduce the risk, actual or perceived, of conflicts of interest and regulatory capture’. Taken from Hansard Written Answers, 1st April 1998, available at http://www.parliament.the-stationary-office.co.uk.

[2] In the UK former public servants must seek clearance before joining private companies for two years after leaving office. See the reports of The Committee for Standards in Public Life, availiable at http://www.public-standards.gov.uk/. The annual reports published by the National Association of Regulatory Utility Commissioners list similar restrictions for the US.

[3] For instance, Phillips (1988) notes that in the 1970’s ‘the media, after years of neglect, began to cover utility hearings, often giving them top coverage’, pp. 13. Similarly, Anderson (1980) remarks that ‘regulators, who a few years before had enjoyed the relative obscurity of technical debates...now saw those same debates recast in emotional terms before a wide audience’, pp. 24.

for a fixed term to regulate a firm facing a cost state that is either 'low' or 'high'. The regulator can either set a policy that is 'tough' or one that is 'generous'. Only 'tough' when costs are 'low' and 'generous' when costs are 'high' are considered to be good regulatory decisions. Regulators are either 'smart' or 'dumb', where smart regulators receive a more informative private signal of the true cost state. *Ex ante* both types seek to make good decisions but, since ability is valued by the job-market, there is also an incentive to send a positive signal to future employers. Observing the cost state, the firm finds it is uniquely placed to reveal the quality of the regulator's decision-making. It therefore seeks to ensure that the regulator is 'generous' by *squawking* - i.e. by strategically divulging the quality of the regulator's decision-making to the job market.

This simple model shows that regulatory career concerns may indeed result in socially undesirable policies. To see why suppose that the firm squawks when the regulator is 'tough' but stays silent when she is 'generous'. Smart regulators relish the opportunity to demonstrate their superior decision-making skills. However, dumb regulators recognise 'tough' policies expose their poor decision-making to the market's scrutiny. Dumb regulators therefore have an incentive to hide behind 'generous' policies to ensure that their professional reputation remains intact.

Of course, if the market thinks dumb regulators are *always* 'generous' it will simply treat 'tough' policies as evidence that the regulator is smart. (But then dumb regulators have an incentive to be 'tough'). Accordingly, we establish that the regulator will strike a balance between these two effects. Formally, when career concerns are sufficiently important, a hybrid sub-game equilibrium exists in which smart regulators try to make good decisions but dumb regulators mix between attempting to make good decisions and simply being 'generous'. Moreover, given dumb regulators hide behind *tough* policies when the firm squawks on generous, but attempt to make good decisions when the firm always squawks or always stays silent, this constitutes an equilibrium of the whole game. The firm optimally squawks only on 'tough' policies, aware that 'generous' policies will then be set in *all* cost states with positive probability.

Performing comparative statics we find that "minimal squawk" behaviour (i.e. the probability with which dumb regulators set 'generous' policies) is increasing in the strength of career concerns. Given the length of a regulator's appointment term is a natural (exogenous) indicator of the strength of her career concerns, we test this model by exploiting variation in terms of office across US state public utility commissions (PUCs). Specifically, we equate 'generous' policies with failing to initiate a rate review and 'low' cost signals with a fall in lagged operating expenses (hereafter $\Delta opex$), allowing us to formulate three testable hypotheses: rate reviews should be more likely the longer PUC terms of office; rate reviews should be more likely the higher $\Delta opex$; and finally the effect of term length should be greater when $\Delta opex$ is negative rather than positive.

Estimating Logit and Conditional (Fixed Effects) Logit models of the probability that a firm faces a rate review using firm-level panel data from the regulation of the US electric industry, we find evidence in favour of all three hypotheses. We therefore conclude that short regulatory appointments may not be the panacea that some have hoped for. Rather, in appointing their regulators on ever shorter contracts, governments may indeed be replacing one source of regulatory capture with another.

Politicians typically observe the realisation, but not the *quality,* of bureaucratic decision-making. Moreover, such information often lies with the recipients of their decisions. Our results therefore have implications for wider bureaucratic behaviour. If bureaucrats care about their decision-making reputation, their 'consumers' have an incentive to reveal the quality of some, but crucially not all, decisions; not because decisions can then be over-turned, but rather because this preempts "minimal squawk" behaviour. In this sense our paper echoes Prendergast's (2000) claim that the nature of bureaucratic goods ensures bureaucrats accede to consumer demands to avoid 'complaints'. In both papers bureaucracies are, by definition, inefficient.

The remainder of the paper is organised as follows. The next section presents the theoretical model, characterises all equilibria and performs comparative statics. Section 3 outlines the empirical hypotheses that follow from the theory and econometric models used to test them. Section 4 presents our empirical results and Section 5 concludes. Formal proofs, where necessary, are given in an appendix together with a full description of all data sources.

2. Theory

2.1. The Model

Description A legislator seeks to regulate a firm which has private information over an exogenous cost parameter. For simplicity, we assume this cost state is either 'low' or 'high', denoted $\omega \in \{l, h\}$, and restrict attention to policies that are either 'tough' or 'generous', denoted $k \in \{t, g\}$. The four possible regulatory outcomes are shown in the table below.

Table 1: The Four Regulatory Outcomes

		Regulatory Policy (k)	
		tough	generous
True Cost state (ω)	low	(l, t)	(l, g)
	high	(h, t)	(h, g)

The applicability of such a set up to rate of return regulation is discussed in Section 3.1 and, for now, we simply assume it is common knowledge that (l, t) and (h, g) are *good* decisions and (h, t) and (l, g) are *bad* decisions.

The legislator retains the common prior $\Pr(\omega = l) = \Pr(\omega = h) = \frac{1}{2}$ but knows specialist regulators can conduct experiments which generate informative cost signals, denoted $s \in \{l, h\}$ where $\Pr(s = \omega \mid \omega) > \frac{1}{2}$. The accuracy of a regulator's cost signal is private information and is determined by her innate ability to process information. For simplicity, we assume regulators are either 'smart' S or 'dumb' D, where smart regulators receive more accurate signals than dumb regulators in the sense that $\Pr(s = \omega \mid \omega, \theta_S) =$

$\theta_S > \Pr(s = \omega \mid \omega, \theta_D) = \theta_D$ and, for convenience, $\theta_i < 1\ \forall i = S, D$.[4] In an attempt to improve social welfare, the legislator therefore delegates regulatory decision-making to a regulator for a fixed period y. We assume this regulator is drawn from a pool that contains an equal proportion of each type and thus, while the regulator knows her type, all other interested parties share the prior $\Pr(\theta_S) = \Pr(\theta_D) = \frac{1}{2}$.

The appointed regulator derives utility from two sources: directly from her policy choice, which we term her *policy preferences,* as well as from the effect that such decisions have on her future job prospects, which we term her *career concerns.* For reasons given below, we assume both types derive utility H_r from making a good decision and hence denote the regulator's policy preferences by $u(l, t) = u(h, g) = H_r > u(l, g) = u(h, t) = 0$, where $u(\omega, k)$ denotes her pay-off to choosing price cap k in cost state ω.

All future private sector employers - with the exception of the regulated firm which is forbidden from employing the regulator - are subsumed into a single player called 'the market'. We assume decision-making ability is relevant in the private sector and, moreover, that the market offers the regulator a wage *equal* to its posterior beliefs μ over θ_i at information sets determined by the regulator's equilibrium choice of k and any action taken by the regulated firm. Note that the market's beliefs therefore completely characterise its actions and hence regulatory career concerns. We restrict attention to a single policy choice k and wage offer μ, introducing dynamic considerations by weighting the utility that the regulator receives from her future wage by the term $\delta(y)$, where $d\delta/dy < 0$. Adopting a simple additive specification, the regulator's objective function is therefore denoted by $U = u(\omega, k) + \delta\mu$.

The firm (weakly) prefers 'generous' policies in all cost states and hence its direct pay-offs are given by $v(l, g) = H_f > v(h, g) = v(l, t) = L_f > v(h, t) = 0$, where $v(\omega, k)$ denotes the firm's utility when the regulator chooses k in cost state ω. To enable us to focus on alternative sources of regulatory capture, the firm is forbidden from offering direct transfers or policy relevant information. It is aware, however, that the market will use Bayes's Rule and the regulator's strategy to update μ when it observes ω. The firm therefore seeks to influence k indirectly by *squawking.* That is, it publicly commits to a disclosure rule which states when it will stay silent and when it will reveal cost information to the market. We assume such revelation is costless and that, following any regulatory decision, the firm has just two possible actions: silence or reveal ω. We denote these actions by $a \in \{\emptyset, \omega\}$ and the firm's strategy by $d \in \mathcal{D}$, where $\mathcal{D}$ denotes the set of possible disclosure rules defined by these two actions and the four outcomes given in Table 1.

Formally, the model contains four possible types of regulator: a smart regulator that receives a low signal, a smart regulator that receives a high signal and so on. However, in order to focus on whether career concerns induce each ability type to attempt to make good decisions, we adopt the following convention. Let $\sigma_i = (p_i, q_i)$ denote the probability that a regulator with ability θ_i sets t, where p_i denotes the probability that she sets t when $s = l$, q_i the probability that she sets t when $s = h$ and $i = S, D$ as

[4] The imposition of the upper bound implies incorrect signals are received with positive probability, thereby reducing the number of occasions on which information sets are off the equilibrium path.

before. We may now define four pure strategies for any $i = S, D$ and $d \in \mathcal{D}$:

i) 'follow': $\sigma_i = (1, 0)$, t if $s = l$ and g if $s = h$.

ii) 'contradict': $\sigma_i = (0, 1)$, g if $s = l$ and t if $s = h$.

iii) 'always tough': $\sigma_i = (1, 1)$, t $\forall s = l, h$.

iv) 'always generous': $\sigma_i = (0, 0)$, g $\forall s = l, h$.

Note playing 'follow' is analogous with attempting to make good decisions. Moreover, in the first two cases the regulator *uses* the information content of her signal, while in the latter two cases she *ignores* it.

In light of the above, an equilibrium strategy for a regulator with ability θ_i, σ_i^o,[5] is defined by the solution to

$$\max_{p_i, q_i} E[U_i] = E[u(\omega, k) + \delta\mu(d, k, a) \mid s, \theta_i, p_i, q_i], \tag{1}$$

where the expectations operator reflects her uncertainty over ω. While an equilibrium strategy for the firm, d^o, is defined by the solution to

$$\max_{d \in \mathcal{D}} E[v(\omega, k(\theta_i, s, d)], \tag{2}$$

where the expectations operator reflects its uncertainty over the regulator's ability θ_i.

It should now be clear that this dynamic game of incomplete information has three stages. In the first stage the firm chooses a disclosure rule $d \in \mathcal{D}$ to induce a sub-game between the regulator and market. Within this sub-game the regulator moves first choosing $k \in \{t, g\}$. Given the cost state ω, this choice of k induces an action $a \in \{\emptyset, \omega\}$ as stipulated by the disclosure rule d. The market has the final move offering the regulator a wage equal to its expectation of the regulator's talent conditional on d, k and a.

The solution concept we use is perfect Bayesian equilibrium (PBE). As Lizzeri (1999) notes, the fact that the disclosure rule is observable implies that a PBE for such a game is a list of PBE in every sub-game induced by each $d \in \mathcal{D}$ together with the requirement that d solves (2). Since the market's action is completely characterised by its beliefs we solve for such a PBE by backwards induction.

Discussion of Assumptions Several of the above assumptions warrant further discussion. To enable us to pin down equilibria in the event that the market pays the same wage for any policy choice, we assume the regulator derives utility from making good decisions. As a possible justification suppose the legislator offers the regulator a wage contract contingent on information revealed later in the game. Providing the regulator has limited liability, one would expect the optimal scheme to pay a bonus if she is shown to have made a good decision. Alternatively, one could take a more traditional view and assume that regulators attach some weight to maximising social welfare.

[5] Throughout the superscript o is used to denote an equilibrium value.

We restrict attention to single 'on the job' and 'post-agency' periods, incorporating dynamic considerations by weighting the regulator's future wage with a factor that is decreasing in the length of appointment term. This modelling choice captures the intuitive notion that career concerns should play a greater role in determining policy choices in regimes where regulators are appointed for shorter periods of time. Moreover, it permits simple comparative statics which can then be taken to the data.

Finally, we assume that the firm cannot lie to the market about its cost realisation thereby greatly reducing its strategy space. While this assumption suggests that it may be possible to find a contractual solution to this regulatory problem, we abstract from the possibility of mechanism design. In doing so our aim is to draw attention to the fact that common place regulatory institutions, such as short appointments and price caps or rate reviews, may actually foster alternative sources of regulatory capture.

2.2. The Policy Selection Sub-Game

We define a PBE of any sub-game between the regulator and the market induced by the firm's choice of disclosure rule d as a pair of strategy functions σ_S^o, σ_D^o and a set of beliefs μ^o such that: i) at information sets on the equilibrium path these beliefs are derived via Bayes's' Rule from the firm's choice of disclosure rule d and the regulator's strategy and ii) σ_S^o and σ_D^o solve (1) given μ^o. Given our aim is to highlight that career concerns may result in inefficient decision-making, we assume it is common knowledge that the market retains its prior beliefs at information sets off the equilibrium path.[6] We refer to a PBE of any sub-game that satisfies this restriction simply as a 'sub-game equilibrium'.

In attempting to establish all possible sub-game equilibria we exploit the fact that $\mathcal{D}$ may be partioned into four generic classes of disclosure rule - 'no disclosure', 'silent on tough', 'silent on generous' and 'full disclosure' - according to the information sets that each rule induces. Since sub-games in which the market has the same information sets share equilibria, this enables us to restrict our analysis to each class of disclosure rule rather than every $d \in \mathcal{D}$.[7]

No disclosure Under a policy of 'no disclosure' the market simply learns that the regulator chose t or g. Let $\widetilde{\sigma}_i = (\widetilde{p}_i, \widetilde{q}_i)$ denote the strategy function that the market believes the regulator is playing. Given $\Pr(\omega = l) = \Pr(\omega = h) = \frac{1}{2}$, the Total Probability Rule implies $\Pr(s = l) = \Pr(s = h) = \frac{1}{2}$. The market may therefore deduce from $\widetilde{\sigma}_i$ that $\Pr(t \mid \theta_i, \widetilde{\sigma}_i) = \frac{1}{2}(\widetilde{p}_i + \widetilde{q}_i)$ and $\Pr(g \mid \theta_i, \widetilde{\sigma}_i) = \frac{1}{2}(2 - \widetilde{p}_i - \widetilde{q}_i)$. Moreover, given

[6]Che (1995) adopts an analogous approach, assuming that "the regulator's out-of-equilibrium monitoring performance is signal free; i.e., the firm does not update its beliefs off the equilibrium path", p. 386. In making this assumption we remove the possibility that both S and D *ignore* their signals. Given such equilibria are a possibility under any disclosure rule this does not change the essence of our results.

[7]Take the example of 'silent on tough' and suppose the market is aware that the firm will reveal ω on, say, (h, g) but not (l, g). If $k = g$ then $\emptyset$ is as informative as ω,while if $k = t$, $\emptyset$ contains no new information. Thus under any disclosure rule that is 'silent on tough' the market's information sets are $\{l; h; \theta_\mathsf{S}; \theta_\mathsf{D}; t\}$, $\{l; \theta_\mathsf{S}; \theta_\mathsf{D}; g\}$ and $\{h; \theta_\mathsf{S}; \theta_\mathsf{D}; g\}$.

$\Pr(\theta_S) = \Pr(\theta_D) = \frac{1}{2}$, Bayes' Rule implies that the market's posterior belief that the regulator is smart is given by

$$\begin{aligned}\mu(t) &= \frac{\Pr(t \mid \theta_S, \widetilde{\sigma}_S) \cdot \Pr(\theta_S)}{\Pr(t \mid \theta_S, \widetilde{\sigma}_S) \cdot \Pr(\theta_S) + \Pr(t \mid \theta_D, \widetilde{\sigma}_D) \cdot \Pr(\theta_D)} \\ &= \frac{\widetilde{p}_S + \widetilde{q}_S}{\widetilde{p}_S + \widetilde{q}_S + \widetilde{p}_D + \widetilde{q}_D} \end{aligned} \tag{3}$$

at the information set following a choice of t and

$$\mu(g) = \frac{2 - \widetilde{p}_S - \widetilde{q}_S}{4 - \widetilde{p}_S - \widetilde{q}_S - \widetilde{p}_D - \widetilde{q}_D} \tag{4}$$

following a choice of g.

To verify whether $\widetilde{\sigma}_i$ is indeed an equilibrium strategy $\forall i = S, D$ we must establish the probability with which a regulator with ability θ_i will expect to receive H_r, $\mu(t)$ and $\mu(g)$. Clearly, given $\sigma_i = (p_i, q_i)$, she will expect to receive $\mu(t)$ with $\Pr(t \mid \theta_i, \sigma_i) = \frac{1}{2}(p_i + q_i)$ and $\mu(g)$ with $\Pr(g \mid \theta_i, \sigma_i) = \frac{1}{2}(2 - p_i - q_i)$. However, to establish the probability with which she will expect to receive H_r we must first derive $\Pr(l, t \mid \theta_i, \sigma_i)$ and $\Pr(h, g \mid \theta_i, \sigma_i)$. Note that Bayes' Rule implies $\Pr(\omega = s \mid s, \theta_i) = \theta_{i.}$ Thus, upon receipt of $s = l$, the regulator may deduce that $\Pr(l, t \mid l, \theta_i, \sigma_i) = p_i\theta_i$ - i.e. the probability that she sets $k = t$ when $s = l$ given $\sigma_i(p_i, q_i)$ times the probability that her signal was correct. Similarly she may deduce that $\Pr(h, g \mid l, \theta_i, \sigma_i) = (1 - p_i)(1 - \theta_i)$. Alternatively, if she receives $s = h$ she may deduce that $\Pr(l, t \mid h, \theta_i, \sigma_i) = q_i(1 - \theta_i)$ and that $\Pr(h, g \mid h, \theta_i, \sigma_i) = (1 - q_i)\theta_i$. Therefore, given $\Pr(s = l) = \frac{1}{2}$, the regulator will expect to make a good decision with probability

$$\Pr(l, t \mid \theta_i, \sigma_i) + \Pr(h, g \mid \theta_i, \sigma_i) = \tfrac{1}{2}\left(1 + p_i(2\theta_i - 1) + q_i(1 - 2\theta_i)\right).$$

When the firm plays '*no disclosure*' we may therefore restate our definition of σ_i^o as the solution to

$$\max_{p_i, q_i} \tfrac{1}{2}\left(1 + p_i(2\theta_i - 1) + q_i(1 - 2\theta_i)\right) H_r + \delta\left[\tfrac{1}{2}(p_i + q_i)\mu(t) + \tfrac{1}{2}(2 - p_i - q_i)\mu(g)\right]. \tag{5}$$

Solving (5) for every set of beliefs defined by (3) and (4) yields our first preliminary result:

Lemma 1. *When the regulated firm adopts a policy of 'no disclosure', for any δ, there exists a unique 'follow' pooling sub-game equilibrium in which $\sigma_i^o = (1, 0)$ $\forall i = S, D$.*[8]

Given the market never observes the quality of regulatory decision-making, D can mimic any favourable action. Pooling behaviour is therefore the only possibility. If the market thinks both types *use* their signals it will believe that they are equally likely to set t (and hence by definition equally likely to set g) and will therefore pay the same wage

[8] The market's equilibrium beliefs, together with a formal proof, may be found in the appendix.

following both t and g. However, given the market retain its priors at information sets off the equilibrium path, the market also pays the same wage for both t and g when both types *ignore* their signals. Career concerns are therefore irrelevant under any strategy and thus both S and D seek to further their policy preferences by attempting to make good decisions.

Silence on tough Under a policy of 'silent on tough' the market learns either that the regulator chose t, that she made the bad decision (l, g) or that she made the good decision (h, g). Following the procedure outlined above (i.e. establishing the market's beliefs $\mu(t)$, $\mu(l, g)$ and $\mu(h, g)$ via Bayes's Rule, restating our definition of σ_i^o and solving for every set of beliefs defined by $\sigma_i(p_i, q_i)$), we establish our second preliminary result:

Lemma 2. *When the regulated firm adopts a disclosure rule that is 'silent on tough' there exist δ_f, $\overline{q}_D$, δ_c, $\underline{p}_D$ and $\overline{p}_D$ such that:*[9]

i) *iff $\delta \leq \delta_f$ then there exists a 'follow' pooling sub-game equilibrium with $\sigma_i^o = (1, 0)\ \forall i = S, D$;*

ii) *iff $\delta > \delta_f$ then there exists a 'follow, always tough' hybrid sub-game equilibrium with $\sigma_S^o = (1, 0)$ and $\sigma_D^o = (1, q_D)$, for some $q_D(\theta_S, \theta_D, H_r, \delta) \in (0, \overline{q}_D)$;*

iii) *iff $\delta \geq \delta_c$ then there exists a 'contradict, always tough' hybrid sub-game equilibrium with $\sigma_S^o = (0, 1)$ and $\sigma_D^o = (p_D, 1)$, for some $p_D(\theta_S, \theta_D, H_r, \delta) \in (\underline{p}_D, \overline{p}_D]$.*

No other sub-game equilibria exist for any δ.

The market now observes the quality of the regulator's decision if she sets g. If S *ignores* her signals, as above, D will mimic favourable actions when the market thinks she plays a separating strategy, while career concerns are again irrelevant under a pooling strategy. The story changes, however, if S elects to *use* her signals.

Suppose the market thinks both S and D attempt to make good decisions. Bayes's rule implies that - independent of the cost and ability state - the regulator is as likely to receive $s = l$ as $s = h$. The market therefore expects to observe t as often as g. By Bayes's rule, the market must therefore deduce that the regulator is as likely to be smart following t as g - i.e. $\mu(g) = \mu(t)$. However, the firm reveals its true costs if (but only if) the regulator sets g and thus the market actually observes either t, (l, g), (h, g). Given the regulator's strategy, the market expects S (D) to make the good decision (h, g) with probability θ_S (θ_D) and the bad decision with the converse probability. Thus, by Bayes's rule, the market must deduce that the regulator is more likely to be smart following (h, g) than (l, g) - i.e. $\mu(h, g) > \mu(l, g)$.

The firm's decision to stay silent on 'tough' effectively splits the wage offer $\mu(g)$ into a reward for making a good decision and a punishment for making a bad decision. Since

[9] For a definition of δ_f and $\overline{q}_D$ see the formal proof of Lemma 2 in the appendix. Definitions of δ_c, $\underline{p}_D$ and $\overline{p}_D$ can be established in a similar manner.

the market does not observe the appointed regulator's ability it expects to see a good decision with probability $\frac{1}{2}(\theta_S+\theta_D)$ and a bad decision with probability $\frac{1}{2}(2-\theta_S-\theta_D)$. Accordingly, the market's three possible wage offers satisfy

$$\mu(t)=\tfrac{1}{2}(\theta_S+\theta_D)\mu(h,g)+\tfrac{1}{2}(2-\theta_S-\theta_D)\mu(l,g).$$

Now put yourself in the shoes of the regulator. Since ability is private information, S knows for sure that she is an above average decision-maker. Thus, upon receipt of $s=h$, she is aware that if she sets g she will make the good decision (h,g) with higher probability than the market expected and, likewise, the bad decision (l,g) with lower probability than the market expected. Setting g upon receipt of $s=h$ therefore yields her a higher expected wage than setting t. In contrast, D knows that she is a below average decision-maker. She therefore finds that setting t upon receipt of $s=h$ yields her the higher expected wage. Consequently, if career concerns are sufficiently important, D deviates from attempting to making good decisions.

Now suppose that the market thinks that S attempts to make a good decision but D plays 'always tough'. Since D *never* sets g the market can be certain that the regulator is smart following either (h,g) or (l,g). But, given these new wage offers, D finds that setting g upon receipt of $s=h$ now yields a higher expected wage than setting t. Accordingly, D deviates from playing 'always tough'.

Alternatively, then, suppose the market thinks that D plays a mixed strategy, setting t with positive, but not certain, probability. The more likely the market thinks D is to set t, the lower the wage it offers after such an observation and the higher the wage it offers after observing *either* (h,g) or (l,g); i.e. the lower her incentive to set t upon receipt of $s=h$ actually becomes. Eventually the market's beliefs will be such that D's *career concern* incentive to set t exactly offsets her *policy preference* to set g. At this point she will indeed be willing to mix and hence such an equilibrium exists.

In essence, when career concerns are sufficiently important, decision-making ability acts as a sorting mechanism: if able regulators *use* their signals, less able regulators have a career concern incentive to *ignore* their signals to keep their professional reputation intact. Since regulators can also use their signals to increase the probability of bad decisions, analogous logic supports the possibility of 'mirror' equilibria.

Silence on generous Under a policy of 'silent on generous' the market learns either that the regulator made the good decision (l,t), that she made the bad decision bad (h,t) or that she chose g. Following the procedure outlined above, we establish our third preliminary result:

Lemma 3. *When the regulated firm adopts a disclosure rule that is 'silent on generous' there exist* δ_f, δ_c, $\underline{p}_D$, $\underline{q}_D$ *and* $\overline{q}_D$ *such that:*[10]

i) *iff* $\delta\leq\delta_f$ *then there exists a 'follow' pooling sub-game equilibrium with* $\sigma_i^o=(1,0)\ \forall i=S,D$;

[10] $\underline{p}_D$, $\underline{q}_D$ and $\overline{q}_D$ can be derived in a similar manner to their counterparts in Lemma 2.

ii) *iff* $\delta > \delta_f$ *then there exists a 'follow, always generous' hybrid sub-game equilibrium with* $\sigma_S^o = (1, 0)$ *and* $\sigma_D^o = (p_D, 0)$, *for some* $p_D(\theta_1, \theta_2, H_r, \delta) \in (\underline{p}_D, 1)$;

iii) *iff* $\delta \geq \delta_c$ *then there exists a 'contradict, always generous' hybrid sub-game equilibrium with* $\sigma_S^o = (0, 1)$, $\sigma_D^o = (0, q_D)$, *for some* $q_D(\theta_1, \theta_2, H_r, \delta) \in [\underline{q}_D, \overline{q}_D)$.

No other sub-game equilibria exist for any δ.

The intuition here is exactly analogous to Lemma 2. If career concerns are weighted sufficiently highly, D sets g (rather than t) more often in an attempt to protect her professional reputation.

Full Disclosure Finally, under a policy of 'full disclosure' the market always learns the quality of the regulator's decision-making. Again, following the same procedure as above, we establish our final preliminary result:[11]

Lemma 4. *When the regulated firm adopts a policy of 'full disclosure' there exists* δ_m *such that:*[12]

i) *for any* δ *there exists a 'follow' pooling sub-game equilibrium with* $\sigma_i^o = (1, 0)$ $\forall i = S, D$;

ii) *iff* $\delta > \delta_m$ *then there exists a 'contradict' pooling sub-game equilibrium with* $\sigma_i^o = (0, 1)$ $\forall i = S, D$.

No other sub-game equilibria exist for any δ.

The market now observes the quality of the regulator's decision regardless of whether she sets t or g. Suppose D receives the signal $s = l$. If she sets g she will make the good decision (h, g) with lower probability than the bad decision (l, g) and hence she is better off setting t. In short, if S *uses* her signals to make good (bad) decisions, D will follow suit since the market treats bad (good) decision-making as evidence of low ability.

2.3. The Firm's Choice of Disclosure Rule

Having established a list of sub-game equilibria for every $d \in \mathcal{D}$, all that remains is to solve for the optimal disclosure rule d^o. In the following empirical analysis we abstract from the possibility that smart regulators attempt to signal their ability via *bad* decision-making (i.e. we ignore the possibility of mirror equilibria). It is easy to show that, for given δ, the firm is indifferent between equilibria *within* each sub-game. For

[11] As we discuss below, Levy (2000) studies a similar setting. This result extends, albeit for two types, her benchmark results by allowing for the possibility of 'asymmetric strategies'. See Levy (2000) pp. 6-7.

[12] δ_m can be derived in a similar manner to δ_f.

convenience, then, our remaining results are stated allowing only for the possibility that smart regulators attempt to make good decisions.

From above the definition of d^o may be restated as the solution to

$$\max_{d \in \mathcal{D}} \sum_{i=S,D} \Pr(\theta_i) \left[\sum_{\omega,k} \Pr(\omega, k \mid \theta_i, \sigma_i(d,.)\, v(\omega,k) \right]. \tag{6}$$

Given the above restriction, solving (6) yields:

Proposition 1. *In the game defined by* $\{\mathcal{D}, \sigma, \mu, U, v\}$*:*

i) *if* $\delta \leq \delta_f$ *the firm is indifferent between disclosure rules (i.e.* $d^o \in \mathcal{D}$*) since* S *and* D *always attempt to make good decisions.*

ii) *if* $\delta > \delta_f$ *the firm is 'silent on generous' since this ensures* D *sets generous policies in all cost states with positive probability.*

If the firm expects both S and D to play 'follow' then $E[v(\omega,k) \mid s = l] = \theta_i L_f$ and $E[v(\omega,k) \mid s = h] = (1-\theta_i)H_f + \theta_i L_f$. Without loss of generality let $L_f = \frac{1}{2}H_f$. The firm's expected pay-off under the 'follow' pooling equilibrium therefore simplifies to L_f. Since the firm holds the common priors $\Pr(\theta_S) = \Pr(\theta_D) = \frac{1}{2}$, the firm's expected pay-off were S to play 'follow' and D to play 'always tough' would be $\frac{3}{4}L_f$. Thus, given D's strategy in the 'follow, always tough' hybrid equilibrium is a convex combination of 'follow' and 'always tough' the firm's pay-off must lie between L_f and $\frac{3}{4}L_f$. Analogously, under the 'follow, always generous' hybrid equilibrium the firm's pay-off must lie between L_f and $\frac{3}{2}L_f$. Proposition 1 then follows immediately from Lemmas 1 - 4 and comparison of these pay-offs.

From Lemma 3 and Proposition 1 it is now easy to establish the (*ex ante*) probability that an appointed regulator will make a good regulatory decision.

Corollary 1.

i) *If* $\delta \leq \delta_f$ *then* $\sigma_i^o = (1,0)\ \forall i = S, D$ *and thus* $\Pr(\textit{good decision}) = \frac{1}{2}(\theta_S + \theta_D)$;

ii) *if* $\delta > \delta_f$ *then* $\sigma_S^o = (1,0)$ *and* $\sigma_D^o = (p_D^o, 0)$ *and thus* $\Pr(\textit{good decision}) = \frac{1}{2}\left(\theta_S + p_D^o\theta_D + (1-p_D^o)\frac{1}{2}\right)$.

Providing career concerns are sufficiently unimportant, both S and D attempt to make good decisions. The *ex ante* probability of a good decision is therefore simply the average of their decision-making ability. Thus, since the legislature can only make good decisions with probability $\frac{1}{2} < \theta_i\ \forall i = S, D$, delegating regulatory decision-making achieves the second best. However, if $\delta > \delta_f$, S attempts to make good decisions but D mixes between 'follow' and 'always generous'. Recall p_D^o denotes the probability with which D sets t when $s = l$. The lower p_D^o, the more often D plays 'always generous' and thus the closer she is to making good decisions with the same probability as the legislator. Delegation therefore offers a Pareto improvement but not the second best.

2.4. Comparative Statics

Proposition 2.

i) *S plays 'follow' $\forall\delta$;*

ii) *the probability with which D plays 'always generous' (i.e. $1 - p_D^o$) is (weakly) increasing in δ;*

iii) *the level of δ necessary to induce D to set g with any given probability is increasing in H_r and θ_D but is decreasing in θ_S.*

Aware that she is an above average decision-maker, S attempts to make good decisions irrespective of the strength of her career concerns. In contrast, as δ increases above δ_f, the below average decision-maker, D, has a stronger career concern incentive to set g when $s = l$. The market must therefore believe that D sets g with higher probability since this *decreases* her career concern incentive to play 'always generous', thereby ensuring that she will continue to mix.

As H_r increases, D has a stronger policy preference incentive to set t when $s = l$, implying the level of δ necessary to exactly offset this effect - and hence induce her to mix - must also increase. On the other hand, as θ_S increases S is more likely to make good decisions when following her signals. Given the market will take a good (bad) decision to be stronger (weaker) evidence that the regulator is smart, D therefore has a stronger career concern incentive to set g when $s = l$. Accordingly, the level of δ necessary to induce her to mix decreases with θ_S.

An increase in θ_D has two separate effects. First, D is more likely to make good decisions when following her signals, implying that the market will take a good (bad) decision to be weaker (stronger) evidence that the regulator is smart. Accordingly, D has a weaker career concern incentive to set g when $s = l$. Second, given D makes a good decision with higher probability when she follows her signals, she also has a stronger policy preference incentive to set t when $s = l$. These two effects combine to ensure that the level of δ necessary to induce her to mix is increasing in θ_D.

2.5. Related Literature

Our finding that regulatory career concerns foster sub-optimal decision-making is driven by two factors: first, that ability is private information and second that the information structure - i.e. the market's ability to update over ability - lies with a strategic player. In this section we briefly outline how these assumptions relate our theoretical results to others in the literature.

To date, only Le Borgne and Lockwood (2000) have studied the effect of public sector career concerns when ability is private information.[13] In contrast to our approach,

[13] Papers that study public sector career concerns under *symmetric* information include Dewatripont et al (1999) and Persson and Tabellini (2000, Chp. 4), who build on Holmström's (1982, 1999) seminal model of managerial career concerns.

however, they focus on a setting in which a politician can exert costly effort in an attempt to convince the electorate of her ability to add to future physical productivity. Interestingly, under their set up, career concerns ensure *all* types increase effort levels.

Both Scharfstein and Stein (1990) and Levy (2000) examine how managers motivated by reputational concerns resolve decisions under uncertainty. In these papers, however, the market observes the quality of *all* managerial decisions. Focusing on sequential decision-making under symmetric information, Scharfstein and Stein show that managers may ignore their substantive private information and simply mimic earlier decisions - a phenomenon they describe as 'herd behaviour'. In contrast, Levy (2000) shows that, when ability is private information, career concerns can result in 'anti-herding'; i.e. in the benchmark case *all* types attempt to make good decisions but, given the opportunity to seek advice, decision-makers can signal by claiming to be better sources of information. In endogenising the market's ability to update, our paper therefore highlights an alternative reason why career concerns may prompt decision-makers to ignore informative signals.

Prendergast (2000) focuses on a setting in which an evaluator can observe the quality of some, but not all, bureaucratic decisions and finds, as we do, that such an information structure prompts bureaucrats to minimise the probability of 'complaints' rather than to pursue optimal policies. In this paper, however, we provide a microfoundation for such behaviour by introducing a formal model of bureaucratic career concerns. Moreover, we show that such asymmetry can be derived *endogenously* by modelling the recipients of bureaucratic decisions as formal players in the game.

In doing so, we also offer an insight into political influence seeking. Epstein and O'Halloran (1995) suggest that regulatory agencies may silence an interest group to limit the possibility of congressional veto. Our paper therefore demonstrates that career concerns, as well as policy preferences, may offer bureaucrats an incentive to silence possible critics. Dal Bó and Di Tella (2000) present a reduced form model of capture by 'threat'. Our paper could therefore be seen as a micro-founded model of precisely *how* interest groups can (perfectly legally) threaten policy-makers into concessions by exploiting their concerns for a future career.

3. Empirical Framework

In the US, responsibility for intra-state regulation lies with state public utility commissions (PUCs). PUCs were formed over a period of 125 years and hence regulatory institutions differ markedly from state to state. In particular, states have established very different terms of office for PUC commissioners.[14] Given statutory terms of office are an obvious exogenous indicator of the strength of career concerns (i.e. δ), a natural way to test the above model is therefore to compare regulatory outcomes across state PUCs.

[14]For example, in 1982 commissioners in Pennsylvania were to serve for 10 years but commissioners in the District of Columbia for just 3 years, while in 1985 Pennsylvannia halved its term of office to just 5 years. Source: NARUC yearbooks (see appendix for details).

3.1. "Minimal squawk" under Rate Regulation

Offering his own slant on the "minimal squawk" hypothesis, Joskow (1974) suggests that regulatory agencies seek to minimise conflict and therefore "do nothing" if none of the actors in the regulatory process are complaining. Consequently, 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'.[15]

While lacking a micro-foundation for *why* regulators might seek to minimise conflict, Joskow therefore highlights that, if it exists, "minimal squawk" behaviour should be reflected in the relationship between cost conditions and the incidence of formal rate reviews.

To see that we can exploit this prediction to test our theoretical model, it is helpful to outline the basic features of the rate of return framework. As Phillips (1988) notes, rate regulation has two aspects: regulation of the rate level (earnings) and control of the rate structure (prices). Regulation of the rate level can be summarised by the formula $R = O + Ar$. That is, public utilities are entitled to earn a level of revenue R, sufficient to cover allowable operating costs O and earn a "fair" rate of return r on the asset base A. Crucially, given the context of this paper, either the firm *or* the PUC can file for a rate review if R proves too tight or too loose. Following such a request, the PUC will typically suspend the proposal for a set period, while the firm (with the PUC's consent) proposes a 'test year' to enable the PUC to determine O and hence ascertain an estimate for R. At this point the case is set down on the PUC's docket and the firm, PUC and / or any intervenors prefile 'canned' testimony. When the case is called an administrative law judge makes a recommended decision which is subject to appeal by the PUC or firm.

It should therefore be clear that this system gives firms both the motive and opportunity to file for a rate review to increase R when input costs are rising, but an incentive to stay silent when they are falling. Given initiating a review expends PUC resources, it is efficient for regulators to restrict attention to the possibility that input costs are falling or constant ('low' and 'high' cost signals respectively) and to contemplate either filing for a review to decrease R or to simply do nothing ('tough' or 'generous' respectively). Thus, since it is socially sub-optimal for the firm to be granted a revenue requirement that more than covers O, 'file' when costs are falling and 'do nothing' when costs are constant represent the only 'good' decisions. Moreover, if the PUC has initiated a review, squawking can be thought of as filing canned testimony or haranguing witnesses, while if the PUC has done nothing, the firm can squawk by supplying information to a media eager for regulatory news.

In short, then, Propositions 1 and 2 directly predict that, even in periods of falling input costs, PUCs will initiate few reviews and that such "minimal squawk" behaviour should be more pronounced in states where regulators are appointed for shorter terms.

[15] Joskow (1974), pp. 299, Proposition 1.

3.2. Data

The above discussion suggests that the relevant dependent variable is the incidence of formal rate reviews *initiated by PUCs.* Until 1990 the National Association of Regulatory Utility Commissioners (NARUC) provided a brief summary of ongoing utility rate cases in its annual reports. Although these yearbooks record the requests and outcomes of rate cases by PUC and utility and, crucially, list the date filed, they do not consistently report consistently whether it was the PUC or the firm that initiated each rate case. Consequently, our available dependent variable is the incidence of all formal rate reviews.

Our first independent variable of interest is expected firm input costs. Detailed microeconomic data on gas utilities is hard to obtain and thus we restrict attention to the US electric industry. The Energy Information Agency (EIA) classifies US electric utilities as either major (or non-major) investor owned, publicly owned or a cooperative. Since PUCs only have jurisdiction over the rates of investor-owned utilities, it is this class that is relevant in a study of regulatory outcomes. Until 1996 the EIA published an annual digest of firm-level financial information, including a breakdown of each firm's total electric operating expenses together with a list of states served, sales and total revenue. We therefore use these yearbooks to construct our expected input cost measure - specifically lagged change in operating expenses (hereafter $\Delta opex$) - for the 162 major investor-owned electric utilities serving at least one state during our sample period.

Our second independent variable of interest is the statutory term of office for PUC commissioners in the 48 states and District of Columbia served by at least one major investor-owned utility.[16] PUC term lengths are available from a variety sources. Since the NARUC yearbooks report annually and provide the information for the other volumes, our term length variables, together with all PUC controls, are taken from this source.

3.3. Hypotheses

Data limitations imply that our empirical framework must admit the possibility that an observed review could have been initiated either by the PUC or the firm. However, recall that we have assumed that the regulator can (efficiently) rely upon the firm to initiate reviews when input costs are rising. Accordingly, career concerns should only bite (and hence foster "minimal squawk" behaviour) when input costs are falling. In light of this assumption, Propositions 1 and 2 suggest three hypotheses that we can take to the available data:

Hypothesis 1. *Formal reviews should be more likely the longer the term of office served by commissioners (the marginal effect of term length).*

Hypothesis 2. *Formal reviews should be more likely the higher $\Delta opex$ (the marginal effect of $\Delta opex$).*

Hypothesis 3. *The effect of term length should be greater when $\Delta opex$ is negative rather than positive (the interaction effect of $\Delta opex$).*

[16] Alaska is not recorded in the EIA yearbooks and Nebraska is not served by an investor-owned utility.

From Proposition 2, irrespective of $\Delta opex$, the longer term length, the higher the probability reviews will be initiated, hence Hypothesis 1. Small drops (or rises) in $\Delta opex$ effectively signal that input costs are constant. Thus, from Proposition 1, irrespective of term-length, the larger the drop in $\Delta opex$ the fewer reviews we should expect the PUC to initiate. Recall that we have assumed that the regulator's signal is positively correlated with the true cost state. Thus, the larger the rise in $\Delta opex$, the more reviews we should expect firms to initiate. Hence Hypothesis 2. Finally, given regulators never initiate reviews when $\Delta opex$ is positive, Propositions 1 and 2 suggest that the effect of term length should be greater conditional on a drop in $\Delta opex$ than a rise in $\Delta opex$, hence Hypothesis 3.

3.4. Estimation

A natural starting point is to ask whether these hypotheses are borne out in the raw data. Section 4 therefore begins by reporting cross-tabulations of the number of reviews by term length and $\Delta opex$. To control for other factors likely to influence the incidence of formal reviews, however, we also estimate a regression model.

One possibility is to estimate a Poisson (count data) model of the fraction of firms serving state s with a rate case filed in year t. Such an approach has two shortcomings. First, firms face very different input cost conditions over the sample period and thus a state-level cost index would fail to exploit this variation. Second, the relationships between firms and PUCs may well be shaped by a variety of unobservable factors which can only be controlled for by including individual firm-level effects. In light of these considerations we take a *firm-level* panel data approach.

Our dependent variable is a binary choice variable which takes the value 1 if a review of firm is initiated in state s in year t and 0 otherwise. To identify both firm *and* state fixed effects we would have to restrict attention to the 44 firms that serve more than one state and hence discard over half of the available data. Instead, we include a dummy for each of the 236 firm-state pairs in our sample and hence effectively control for the possibility that some regulatory relationships are more difficult than others.[17] Our dependent variable is therefore denoted by y_{it}, where i denotes a firm-state pair, $i = 1, .., N = 236$ and $t = 1, ...T$ where $T \leq 9$ for some i.

As is standard in the case of discrete dependent variables, we posit the existence of an underlying (true) model

$$y_{it}^{*} = \boldsymbol{\beta}'\mathsf{x}_{it} + u_{it} \tag{7}$$

where x_{it} is a vector of k regressors and a constant α, $\boldsymbol{\beta}$ is a vector of $k+1$ coefficients and u_{it} is an error term. Given our data set contains the entire population of major investor-owned electric utilities, we assume individual effects are fixed across firms. Accordingly, we assume $u_{it} = \alpha_i + \upsilon_{it}$, where α_i is a constant and $\upsilon_{it} \sim IID(0, \sigma_{\upsilon}^2)$. This underlying

[17] In Section 5 we confirm that our results are robust to approach by dropping multi-state firms.

variable y_{it}^* is defined such that we observe

$$y_{it} = \begin{cases} 1 & \text{if } y_{it}^* > 0 \quad (\upsilon_{it} > -\alpha_i - \boldsymbol{\beta}'\mathsf{x}_{it}) \\ 0 & \text{if } y_{it}^* \leq 0 \quad (\upsilon_{it} \leq -\alpha_i - \boldsymbol{\beta}'\mathsf{x}_{it}) \end{cases}$$

and thus the probability that a firm faces a review is given by

$$\Pr[y_{it} = 1] = \Pr[y_{it}^* > 0] = \Pr[\upsilon_{it} > -\alpha_i - \boldsymbol{\beta}'\mathsf{x}_{it}] = F(\alpha_i + \boldsymbol{\beta}'\mathsf{x}_{it}), \tag{8}$$

where F is some cumulative distribution function and the last equality holds as long as F is symmetric around zero.

The Probit model is unsuitable for estimating models with fixed effects and thus we restrict attention to the Logit model. When u_{it} follows a Logistic distribution, (8) is given by

$$\Pr[y_{it} = 1] = F(\alpha_i + \boldsymbol{\beta}'\mathsf{x}_{it}) = \frac{\exp(\alpha_i + \boldsymbol{\beta}'\mathsf{x}_{it})}{1 + \exp(\alpha_i + \boldsymbol{\beta}'\mathsf{x}_{it})} \tag{9}$$

But for the addition of N fixed effects (α_i), this is a standard Logit model. Estimates of the vector of coefficients $\boldsymbol{\beta}$ in (9) can therefore be derived by maximum likelihood estimation (MLE) and are reported (for our variables of interest) in Table 3 below.

In any panel data model with fixed effects the number of parameters to be estimated increases with N. Consequently, for large N and fixed T, MLE produces inconsistent estimates of α_i. More worringly, under MLE, this results in inconsistent estimates of $\boldsymbol{\beta}$.[18] This 'incidental parameter problem' can be resolved in a linear regression model by performing the Within transformation. In a discrete choice model, however, this transformation fails to remove the α_i's since $\boldsymbol{\beta}$ and α_i are no longer asymptotically independent. An alternative way to sweep away the α_i's from the model to be estimated, suggested by Chamberlain (1980), is to maximise the likelihood function *conditional* on $\sum_{t=1}^{T} y_{it}$ (in our case to condition the likelihood for each set of T_i observations on the number of reviews in this set). Given estimates from such a Conditional Logit model are consistent they are also reported in Table 4.

Hypotheses 1-3 suggest the following structural form for the underlying model given in (7)

$$\begin{aligned} y_{it}^* &= \alpha + \alpha_i + \beta_1 term_{it} + \beta_2 \Delta opex_{it} + \beta_3 D_{it} \cdot term_{it} + \\ &\quad \beta_4 t + \boldsymbol{\gamma}'\mathsf{z}_{it} + \upsilon_{it} \end{aligned} \tag{10}$$

where α is a constant term and z_{it} is a vector of PUC controls.[19] From Hypotheses 1 and 2, β_1 and β_2 should be positive since they capture the marginal effects of term-length and $\Delta opex$, respectively.[20] Hypotheses 3 suggests that the coefficient on the interaction

[18] For a simple illustration of how the inconsistency of MLE of α_i is transmitted into inconistency of $\widehat{\beta}_{MLE}$ see Hsiao (1986).

[19] Definitions of all variables are given in the appendix.

[20] Of course, since $\Pr[y_{it} = 1]$ is a non-linear function of x_{it}, the estimated coefficients reported in Tables 3 and 4 do not have a straight forward interpretation as marginal effects.

term $D_{it} \cdot term_{it}$, β_3, should be positive since longer terms should exert a greater positive effect on the probability of a review when costs are falling ($D_{it} = 1$) than when costs are rising ($D_{it} = 0$).

The model given in (10) controls for unobservable heterogeneity via the inclusion of firm-state fixed effects α_i and for the fact that both the number of reviews and term-length follow a downward trend during our sample period via the inclusion of a simple time trend t. Besides term length, PUCs vary in a number of other ways that might plausibly be expected to affect the probability of review.[21] Given our aim is to test Hypotheses 1-3, these institutional variables are 'nuisance parameters' and hence we include the vector z_{it} simply to isolate the role played by $\Delta opex_{it}$, $term_{it}$ and $D_{it} \cdot term_{it}$.

4. Empirical Results

4.1. Incidence of Rate Reviews

We first ask whether the theoretical predictions detailed above are borne out in the raw data. Table 2 reports cross-tabulations of the number of reviews by $\Delta opex_{it}$ and $term_{st}$.

Table 2: Formal Rate Reviews of Major US Investor-owned Electric Utilities by state PUCs (1982-90).

			$\Delta opex_{it}$		
			Negative	Positive	Total
$term_{st}$	Short	Reviews	30	142	172
		Observations	162	519	681
		% Reviewed	18.5	27.4	25.3
	Long	Reviews	69	335	404
		Observations	265	1052	1317
		% Reviewed	26.0	31.8	30.7
	Total	Reviews	99	477	576
		Observations	427	1571	1998
		% Reviewed	23.2	30.4	28.2

Cutting the data in this way offers broad support in favour of the "minimal squawk" model. First, consistent with Hypothesis 1, the percentage of firms-state pairs facing a review in any given year is lower in states where the statutory term of office is strictly less than the sample mean of 6 years (25.3% relative to 30.7%). Second, consistent with Hypothesis 2, the percentage of firms-state pairs facing a review in any given year is lower when input costs have been falling, and hence cost expectations are low, (23.2%

[21] To cite just two, if fuel costs can be passed through automatically one would expect both firms and PUCs to initiate fewer reviews. While if a PUC has more staff relative to the size of its population one might expect it to be better placed to initiate more reviews.

relative to 30.4%). Finally, consistent with Hypothesis 3, the effect of term length on the incidence of reviews is greater when input costs are falling. Specifically, while 18.5% of firm-state pairs with falling inputs costs and *short* terms face a review in any given year, 26% of firms-state pairs with falling input costs face a review when terms are *long* - an increase of 40.5%. In contrast, when input cost are rising, moving from short to long terms only increases the fraction of firms facing a review by 16% (i.e. 27.4% to 31.8%).

Of course, there are many other factors which should be controlled for when testing the "minimal squawk" hypotheses and thus we now report the results of the Logit model given in (9).

Table 3: Logit Estimation of the Probability of Formal Review[22]

	(i)	(ii)	(iii)	(iv)
$term_{it}$	0.100** (2.20)	0.064 (1.20)	0.340** (2.75)	0.276** (2.30)
$\Delta opex_{it}$	$2.50e^{-06}$** (4.44)	$2.22e^{-06}$** (3.66)	$1.08e^{-06}$ (1.51)	$1.11e^{-06}$ (1.55)
$D_{it} \cdot term_{it}$	0.031 (1.27)	0.023 (0.89)	0.032 (1.07)	0.037 (1.18)
t	-0.228** (10.50)	-0.257** (10.74)	-0.289** (10.96)	-0.281** (9.01)
PUC Contols	*No*	*Yes*	*No*	*Yes*
Fixed Effects	*No*	*No*	*Yes*	*Yes*
Log L	-1119.225	-1052.828	-871.036	-832.985
Pseudo R^2	0.067	0.096	0.199	0.208
No. of pairs	236	236	194	193
Observations	1998	1942	1701	1646

All regressions include a constant and use robust standard errors; absolute value of z statistics in parentheses. ** denotes significance at the 5% level.

Regression (i) reports $\widehat{\beta}_1$- $\widehat{\beta}_3$ in the absence of PUC controls and firm-state fixed effects. Simply controlling for a time trend does little to alter the story from the raw data. $term_{it}$ and $\Delta opex_{it}$ are positive and significant at 5% respectively, while $D_{it} \cdot term_{it}$ is positive, although not significant at conventional inference levels. Note that introducing the vector of PUC controls z_{it} (Regression (ii)) renders $term_{it}$ insignificant.

[22] All regressions were repeated using alternative cost measures from the EIA's breakdown of operating expenses (specifically operation and maintenance, power and fuel costs). In each case, $\Delta opex$ explained more of the variation in the probability of review. Similarly, using *real* $\Delta opex$ ($\Delta opex$ deflated by the US GDP deflator in 1996 chained dollars) left the coefficients on all variables of interest unchanged.

However, these results are overturned if we exploit the unique feature of our data set, namely our ability to allow for unobservable firm-level heterogeneity. Regression (iii) reports $\widehat{\beta}_1$-$\widehat{\beta}_3$ with firm-state dummies but without PUC controls. The significance of $\Delta opex_{it}$ drops markedly, while $term_{it}$ is once again significant at the 5% level and $D_{it} \cdot term_{it}$ is insignificant at standard levels but retains the correct sign. If we then re-introduce PUC controls (Regression (iv)), $term_{it}$ remains significant at 5% while $\Delta opex_{it}$ and $D_{it} \cdot term_{it}$ remain insignificant but retain the correct signs.

We interpret these results as follows. Consistent with our theory, firms are more likely to face a formal review the longer the term of office served by their regulators and the greater the lagged rise in their input costs. The fact that the latter effect is insignificant following the introduction of firm level effects is unsurprising given $\Delta opex_{it}$ is, itself, highly firm idiosyncratic. Moreover, we also find weak evidence of an interaction effect between our proxies for career concerns and cost signals. That this interaction effect is insignificant, in addition to the level effects, is also unsurprising given the relative small size of our sample.

As mentioned above, however, for large N and fixed T MLE of the Logit model given in (9) yields inconsistent estimates of the vector of coefficients $\boldsymbol{\beta}$. Thus we now report the results of the Conditional (Fixed Effects) Logit model.

Table 4: Conditional (Fixed Effects) Logit Estimation of the Probability of Formal Review

	(iii)	Full Sample (iv)	Single-state Firms (iv)	Appointing states (iv)
$term_{st}$	0.288** (2.36)	0.234* (1.93)	0.270* (1.86)	0.227* (1.87)
$\Delta opex_{it}$	$9.53e^{-07}$ (1.41)	$9.75e^{-07}$ (1.43)	$9.20e^{-06}$ (1.04)	$1.20e^{-06*}$ (1.66)
$D_{it} \cdot \Delta opex_{it}$	0.029 (0.98)	0.032 (1.06)	0.052 (1.25)	0.028 (0.87)
t	-0.255** (10.52)	-0.247** (8.54)	-0.236** (5.82)	-0.230** (7.51)
PUC Controls	*No*	*Yes*	*Yes*	*Yes*
Log L	-649.544	-705.870	-315.881	-526.127
Pseudo R^2	0.109	0.107	0.138	0.133
No. of pairs	194	193	97	166
Observations	1701	1646	847	1441

Absolute value of z statistics in parentheses. ** and * denote significance at the 5% and 10% levels respectively.

Regressions (iii) and (iv) in Table 4 show that the (qualitative) results reported in Table 3 are robust to conditioning on the total number of reviews. $term_{it}$ is positive as predicted and drops in significance following the introduction of PUC controls, while $\Delta opex_{it}$ and $D_{it} \cdot term_{it}$ are positive as predicted but insignificant at standard levels.

Table 4 also confirms that our results are not driven by our decision to use firm-state effects rather than firm dummies to control for unobservable heterogeneity. That is, repeating Regression (iv) for the subset of single-state firms (i.e. firms for which the two fixed effects coincide) we obtain similar results. We also repeat Regression (iv) for the subset of appointing states. Again we obtain similar results, suggesting Hilton (1972) was indeed correct to conjecture that *appointed* regulators engage in "minimal squawk" behaviour.

4.2. Prices

An obvious extension to the above test is to ask whether a PUC's unwillingness to initiate reviews in the face of career concerns feeds through into higher average revenue. That is, do firms regulated by commissioners with shorter terms of office charge higher prices?[23] The EIA yearbooks list sales and revenue by head-office state and thus we do not have a breakdown of prices in each state served. To control for the possibility that PUC institutions in other states affect this measure of average revenue we therefore restrict attention to the 109 firms that serve customers in their 'head-office', *but no other*, state.

We assume that prices are determined by three groups of variables: PUC institutions, supply-side factors and demand-side factors. Specifically, we posit the existence of the following linear model

$$p_{it} = \alpha + \alpha_i + \alpha_t + \beta_1 term_{it} + \boldsymbol{\varphi}' \mathsf{s}_{it} + \boldsymbol{\psi}' \mathsf{d}_{it} + \boldsymbol{\gamma}' \mathsf{z}_{it} + v_{it}, \tag{11}$$

where definitions of the elements of the vectors s_{it}, d_{it} and z_{it}, are given in the appendix. Hypothesis 1 (the marginal effect of term-length) suggests that the coefficient β_1 should be negative. That is, the longer their term of office, the more likely PUC commissioners are to initiate a review to reduce the allowable *rate level* which should be reflected in the *rate structure* as lower prices.

The model given in (11) maintains the assumption that firm effects are fixed but also introduces a year effect to control for inflation and year specific shocks. The error term u_{it} is therefore decomposed into two constants, α_i and α_t, in addition to the random variable $v_{it} \sim IID(0, \sigma_v)$. On the supply-side we include $avopex_{it}$ as a proxy for per unit costs, $land_{it}$ to reflect possible scale (dis-) economies associated with serving larger states and census region dummies to isolate geographic factors such as terrain or climate. We also include $stpop_{it}$ and $stdpcy_{it}$ to control for inter and intra-state variation in the demand for electricity.

As in (9) above, the number of parameters to be estimated in (11) increases with N. In contrast to MLE of (9), however, performing ordinary least squares (OLS) on (11)

[23] The rate structures set by firms often allow for quantity discounts and thus calculating prices from revenue and sales may not always reflect the price per kwh paid by all customers.

yields estimates of $\boldsymbol{\beta}$ that are efficient and consistent, even for fixed T. Thus Table 5 below reports OLS estimates of β_1 from the model given in (11).

Table 5: Least Squares (Fixed Effects) Residential Price Regressions[24]

	(i)	(ii)	(iii)	(iv)
$term_{it}$	-0.015 (0.43)	0.005 (0.11)	-0.060** (2.18)	-0.058** (2.07)
PUC Controls	*No*	*Yes*	*No*	*Yes*
Fixed Effects	*No*	*No*	*Yes*	*Yes*
$F(k, n-k-1)$	107.57	86.01	271.01	286.98
R_2	0.727	0.747	0.939	0.941
No. of pairs	109	109	109	109
Observations	952	931	952	931

All regressions include a constant, α_t, s_{it} and d_{it} and use robust standard errors.
Absolute t statistics in parentheses. ** denotes significance at the 5% level.

Regression (i) reports $\widehat{\beta}_1$ in the presence of supply and demand controls. Prior to controlling for variation in PUC institutions and firm-state effects, $term_{it}$ displays the correct sign but is highly insignificant. Introducing the vector of PUC controls (Regression (ii)), reduces the significance of $term_{it}$. Again, fixed effects overturn these results: in Regressions (iii) and (iv) $term_{it}$ is negative and significant at 5%. Our results therefore suggest that firms do indeed charge higher prices when regulated by commissioners serving shorter terms.

4.3. Discussion

The above results clearly support the predictions of our theoretical model. As this section briefly highlights, our firm-level approach also offers some more general insights into the determinants of regulatory outcomes.

We find that firm-level fixed effects play a pivotal role. It is possible to test for the presence of such heterogeneity (i.e. $\alpha_i \neq \alpha$) in our rate regressions via a Likelihood Ratio test. With Regression (iii) in Table 3 as the unrestricted model and Regression (i) the restricted model $\chi^2(192) = 264.80$ ($p = 0.0004$). Similarly, with Regression (iv) as the unrestricted model and Regression (ii) the restricted model (i.e. with PUC controls), $\chi^2(191) = 234.58$ ($p = 0.0173$).[25] These critical values are significant at 5%, allowing us to reject the null hypothesis of homogeneity. Similarly, joint significance tests on the

[24] Regressions (i)-(iv) were repeated using commercial and industrial prices (the two remaining sectors of note). In every case the coefficient on $term_{it}$ was negative, as predicted, but was insignificant at standard levels.

[25] In both cases the restricted regressions were run for the estimation sub-sample from the unrestricted regression to maintain parity in sample sizes.

fixed effects in the price regressions yields strongly significant F-statistics of 72.23 and 54.80, for Regressions (iii) and (iv) respectively.

These findings suggest that unobservable firm-level factors are important determinants of regulatory outcomes. It is perhaps unsurprising, then, that previous *state-level* panel data studies such as Besley and Coate (2001), who focus on prices or Navarro (1982), who focuses on regulatory climate, have concluded that term length is not important. Indeed, we find that term length exerts a significant positive effect on the probability of rate review and a significant negative effect on prices only in the presence firm-state dummies.

Our results also suggest that previous papers may have over-stated the importance of other PUC institutions such as the method of commissioner selection. For instance, taking a cross-sectional approach, Crain and McCormick (1984), Primeaux and Mann (1986) and Smart (1994) find weak evidence that consumers in electing states face lower utility prices. While, allowing for state effects, Besley and Coate (2001) find strong evidence of such an effect. In contrast, as Table A3 in the appendix shows, once we control for *firm-level* effects, there is little evidence that selection methods matter.

Focusing on PUC institutions more generally, a Likelihood Ratio test on z_{it} using Regressions (i) and (ii) in Table 3 yields $\chi^2(11) = 46.84$ ($p = 0$), implying these controls are jointly significant. However, such a test using Regressions (iii) and (iv) yields a $\chi^2(11)$ statistic of 13.21 ($p = 0.2801$), suggesting firm effects render these controls jointly insignificant. Similarly, a test of joint significance on z_{it} in Regression (ii) in Table 5 yields an F-statistics of 4.19, which is significant at 1% but such a test using Regression (iii) yields an F-statistics of 1.14 which is insignificant at standard levels. As Table A3 highlights, in addition to *select*, the variables that are rendered insignificant in the price regressions are aam, $test$, $valst$, and $qual$. One possible conclusion, then, is that these institutions evolve in response to the type of firms regulated. For example, faced by a particularly obstreperous firm, a PUC may require better qualified commissioners.

5. Conclusion

Governments are appointing their regulators on short fixed term contracts, often in response to fears that long contracts facilitate collusion between regulators and regulatees. Yet Hilton (1972) suggested that regulators appointed on finite contracts would pacify firms to maintain favourable reputations. Accordingly, this paper revisits Hilton's "minimal squawk" conjecture to ask if such a policy stance might actually be replacing one source of political failure with another.

We show that if the job market cannot observe the quality of regulatory decisions, career concerns are irrelevant, leaving regulators free to follow any *ex ante* desire to make good decisions. While if the market observes the quality of every decision, career concerns encourage good decision-making, since bad decisions act as evidence of low ability. Regulated firms therefore have an incentive to reveal the quality of unfavourable decisions. This is not in the hope of having regulatory decisions overturned, but rather because this ensures less able regulators set favourable policies more often to ensure the firm stays silent and their professional reputation remains intact.

Given statutory terms of office are a natural exogenous indicator of the strength of regulatory career concerns, we test this hypothesis by exploiting variation in term-length across state PUCs. We find strong evidence in favour of our theoretical model. In particular, controlling for firm-level fixed effects, we find that firms are less likely to face a rate review and also earn more per kwh from residential customer, the shorter the term of office served by their regulators.

Our results suggest short terms of office may not be the panacea that some have hoped for. Rather, governments may need to strike a balance between alternative sources of regulatory capture, appointing their regulators - and arguably bureaucrats in general - on longer, if not permanent contracts. In concluding, however, we note that it may be possible to limit this trade off. Our comparative statics results suggest that the extent to which career concerns result in sub-optimal decision-making may be limited by a) the regulator's *ex ante* desire to make a good decision and b) an increase in the ability of the least able regulators and/or a decrease in the ability of the most able. While we leave a formal analysis to future research, this suggests that shorter terms of office might be desirable if accompanied by explicit incentive schemes or by changes in the composition of the regulatory pool.

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Appendix

1. Proofs

Proof of Lemma 1. Differentiating (5) wrt to p_i and q_i yields

$$\frac{\partial E[U_i]}{\partial p_i} = (\theta_i - \tfrac{1}{2})H_r + \delta\left[\tfrac{1}{2}\mu(t) - \tfrac{1}{2}\mu(g)\right] \tag{A1}$$

and

$$\frac{\partial E[U_i]}{\partial q_i} = (\tfrac{1}{2} - \theta_i)H_r + \delta\left[\tfrac{1}{2}\mu(t) - \tfrac{1}{2}\mu(g)\right]. \tag{A2}$$

Note that

$$\begin{aligned} \frac{\partial E[U_S]}{\partial p_S} - \frac{\partial E[U_D]}{\partial p_D} &= \frac{\partial E[U_D]}{\partial q_D} - \frac{\partial E[U_S]}{\partial q_S} \\ &= (\theta_S - \theta_D)H_r > 0. \end{aligned} \tag{A3}$$

(a) Existence. Suppose $\mu(t) = \mu(g) = \frac{1}{2}$. Since $(\theta_i - \frac{1}{2})H_r > 0\ \forall i$, (A1) is strictly positive and (A2) is strictly negative $\forall i = S, D$. It therefore follows that (5) has a unique solution characterised by $\sigma_i^o = (1, 0)\ \forall i$. Given $\sigma_i^o = (1, 0)\ \forall i$, (3) and (4) imply that the market's beliefs are indeed as stated and hence that such an equilibrium exists.

(b) Uniqueness. Suppose that $\mu(t) > \mu(g)$. From (3) and (4) we require $\widetilde{p}_S + \widetilde{q}_S > \widetilde{p}_D + \widetilde{q}_D$. Given these beliefs, (A1) is strictly positive, implying $p_i^o = 1\ \forall i = S, D$. While (A2) is strictly positive for any δ, 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, (3) and (4) imply that $\widetilde{p}_S = \widetilde{p}_D$, $\widetilde{q}_S = \widetilde{q}_D$ and $2 > \widetilde{p}_S + \widetilde{q}_S > 0$. Moreover $\mu(t) = \mu(g) = \frac{1}{2}$. Recall that the market is assumed to retain its prior belief $\Pr(\theta_S) = \frac{1}{2}$ at information sets off the equilibrium path. Thus $\mu(t) = \mu(g) = \frac{1}{2}$ for any $\widetilde{p}_S = \widetilde{p}_D$, $\widetilde{q}_S = \widetilde{q}_D$. However we know from part (a) that, given these beliefs, $\sigma_i^o = (1, 0)\ \forall i = S, D$ is the unique solution to (5). ■

Proof of Lemma 2. Given the market observes t, (l, g) or (h, g), (1) can be re-written as

$$\begin{aligned} &\max_{p_i, q_i} \tfrac{1}{2}\left(1 + p_i(2\theta_i - 1) + q_i(1 - 2\theta_i)\right) H_r + \\ &\delta\left[\begin{array}{c} \tfrac{1}{2}(p_i + q_i)\mu(t) + \tfrac{1}{2}\left(1 - q_i - (p_i - q_i)\theta_i\right)\mu(l, g) \\ +\tfrac{1}{2}\left(1 - p_i + (p_i - q_i)\theta_i\right)\mu(h, g) \end{array}\right]. \end{aligned} \tag{A4}$$

Differentiating (A4) yields

$$\frac{\partial E[U_i]}{\partial p_i} = (\theta_i - \tfrac{1}{2})H_r + \delta\left[\tfrac{1}{2}\mu(t) - \tfrac{1}{2}\theta_i\mu(l, g) - \tfrac{1}{2}(1 - \theta_i)\mu(h, g)\right] \tag{A5}$$

$$\frac{\partial E[U_i]}{\partial q_i} = (\tfrac{1}{2} - \theta_i)H_r + \delta\left[\tfrac{1}{2}\mu(t) - \tfrac{1}{2}(1 - \theta_i)\mu(l, g) - \tfrac{1}{2}\theta_i\mu(h, g)\right]. \tag{A6}$$

Note that

$$\frac{\partial E[U_i]}{\partial p_i} - \frac{\partial E[U_j]}{\partial q_j} = (\theta_i + \theta_j - 1)H_r + \delta\left[\tfrac{1}{2}(\theta_i + \theta_j - 1)(\mu(h,g) - \mu(l,g))\right] \tag{A7}$$

for $i, j = S, D$ while

$$\begin{aligned} \frac{\partial E[U_S]}{\partial p_S} - \frac{\partial E[U_D]}{\partial p_D} &= \frac{\partial E[U_D]}{\partial q_D} - \frac{\partial E[U_S]}{\partial q_S} \\ &= (\theta_S - \theta_D)H_r + \delta\left[\tfrac{1}{2}(\theta_S - \theta_D)(\mu(h,g) - \mu(l,g))\right]. \end{aligned} \tag{A8}$$

Moreover, application of Bayes's rule yields

$$\mu(l,g) = \frac{1 - \widetilde{q}_S - (\widetilde{p}_S - \widetilde{q}_S)\theta_S}{2 - \widetilde{q}_S - \widetilde{q}_D - (\widetilde{p}_S - \widetilde{q}_S)\theta_S - (\widetilde{p}_D - \widetilde{q}_D)\theta_D} \tag{A9}$$

and

$$\mu(h,g) = \frac{1 - \widetilde{p}_S + (\widetilde{p}_S - \widetilde{q}_S)\theta_S}{2 - \widetilde{p}_S - \widetilde{q}_D + (\widetilde{p}_S - \widetilde{q}_S)\theta_S + (\widetilde{p}_D - \widetilde{q}_D)\theta_D}. \tag{A10}$$

(a) Existence of the 'follow' pooling equilibrium. Suppose that

$$\mu(t) = \tfrac{1}{2},\ \mu(l,g) = \frac{1 - \theta_S}{2 - \theta_S - \theta_D} \text{ and } \mu(h,g) = \frac{\theta_S}{\theta_S + \theta_D} \tag{A11}$$

and $\delta \leq \delta_f$, where

$$\delta_f = \frac{2(2\theta_D - 1)H_r(2 - \theta_S - \theta_D)(\theta_S + \theta_D)}{(\theta_S - \theta_D)^2}.$$

Substituting for (A11) in (A5) yields,

$$\frac{\partial E[U_S]}{\partial p_S} = (\theta_S - \tfrac{1}{2})H_r + \delta\left[\frac{(\theta_S - \theta_D)(3\theta_S + \theta_D - 2)}{4(2 - \theta_S - \theta_D)(\theta_S + \theta_D)}\right] > 0$$

and

$$\frac{\partial E[U_D]}{\partial p_D} = (\theta_D - \tfrac{1}{2})H_r + \delta\left[\frac{(\theta_S - \theta_D)(\theta_S + 3\theta_D - 2)}{4(2 - \theta_S - \theta_D)(\theta_S + \theta_D)}\right] > 0.$$

Similarly, substituting for (A11) in (A6) yields,

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

and

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

which may be positive or negative depending on δ.

Given $\delta \leq \delta_f$, it follows that $\sigma_i^o = (1, 0)$ is a solution to (A4) $\forall\, i = S, D$. From (3), (A9) and (A10) the market's beliefs are indeed as stated and hence such an equilibrium exists.

(b) Existence of the 'follow, always tough' hybrid sub-game equilibrium. Suppose that

$$\begin{aligned} \mu(t) &= \frac{1}{2+\widetilde{q}_D},\ \mu(l,g) = \frac{1-\theta_S}{(1-\theta_S)+(1-\widetilde{q}_D)(1-\theta_D)} \\ \text{and } \mu(h,g) &= \frac{\theta_S}{\theta_S+(1-\widetilde{q}_D)\theta_D}, \end{aligned} \tag{A12}$$

for some $\widetilde{q}_D \in (0, \overline{\overline{q}}_D)$ and $\delta > \delta_f$, where $\overline{\overline{q}}_D$ solves

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

Note that (A11) and (A12) are equivalent if $\widetilde{q}_D = 0$. Thus, given $\delta > \delta_f$, it follows from part (a) that when $\widetilde{q}_D = 0$ (A6) is strictly positive for $i = D$. In contrast,

$$\frac{\partial E[U_D]}{\partial q_D} \Big|_{\widetilde{q}_D = 1} = (\tfrac{1}{2} - \theta_D)H_r - \delta\left[\tfrac{1}{3}\right] < 0.$$

It is easy to show that

$$\frac{\partial^2 E[U_D]}{\partial q_D\, \partial \widetilde{q}_D} < 0,$$

(i.e. D's incentive to choose t following $s = h$ decreases the more likely the market thinks she is to play 'always tough'). Thus there must exist a unique value of $\widetilde{q}_D \in (0, \overline{\overline{q}}_D)$, $\widetilde{q}_D^*(\theta_S, \theta_D, H_r, \delta,)$, such that

$$\frac{\partial E[U_D]}{\partial q_D} \Big|_{\widetilde{q}_D^*} = 0$$

thereby supporting $q_D^o = \widetilde{q}_D$.

It now remains to verify that, at $\widetilde{q}_D^*$, (A5) is strictly positive $\forall i$ (supporting $p_i^o = 1$ $\forall i = S, D$) and (A6) is strictly negative for $i = S$ (supporting $q_S^o = 0$). From (A10)

$$\mu(h,g) - \mu(l,g) = \frac{(1-\widetilde{q}_D)(\theta_S - \theta_D)}{(\theta_S + (1-\widetilde{q}_D)\theta_D)(1-\theta_S+(1-\widetilde{q}_D)(1-\theta_D))}$$

is strictly positive for any $\widetilde{q}_D \in [0, 1)$. Thus for $i = S, D$, $j = D$ (A6) is strictly positive for any $\widetilde{q}_D^*$. Likewise for (A7).

Given the definition of $\widetilde{q}_D^*$, it therefore follows that $p_S^o = 1$, $q_S^o = 0$ is a solution to (A4) for $i = S$ and $p_D^o = 1$, $q_D^o = \widetilde{q}_D^*$ is a solution to (A4) for $i = D$. From (3), (A9) and (A10) the market's beliefs are indeed as stated and hence such an equilibrium exists. The 'contradict, always tough' hybrid sub-game equilibrium can be proved in a similar manner.

Establishing uniqueness is possible along similar, if more long-winded, lines to Lemma 1. (Full details are available upon request). ■

Proof of Lemma 3. This is exactly analogous to the proof of Lemma 2. ■

Proof of Lemma 4. Given the market observes the quality of all decisions (1) can be re-written as

$$\max_{p_i, q_i} \tfrac{1}{2}\left(1 + p_i(2\theta_i - 1) + q_i(1 - 2\theta_i)\right) H_r + \delta \left[\begin{array}{c} \tfrac{1}{2}\left(q_i + (p_i - q_i)\theta_i\right)\mu(l,t) + \tfrac{1}{2}\left(p_i - (p_i - q_i)\theta_i\right)\mu(h,t) + \\ \tfrac{1}{2}\left(1 - q_i - (p_i - q_i)\theta_i\right)\mu(l,g) + \tfrac{1}{2}\left(1 - p_i + (p_i - q_i)\theta_i\right)\mu(h,g) \end{array} \right]. \tag{A13}$$

Differentiating (A13) wrt to p_i and q_i yields

$$\frac{\partial E[U_i]}{\partial p_i} = (\theta_i - \tfrac{1}{2})H_r + \delta \left[\begin{array}{c} \tfrac{1}{2}\theta_i \mu(l,t) + \tfrac{1}{2}(1-\theta_i)\mu(h,t) \\ -\tfrac{1}{2}\theta_i \mu(l,g) - \tfrac{1}{2}(1-\theta_i)\mu(h,g) \end{array} \right] \tag{A14}$$

$$\frac{\partial E[U_i]}{\partial q_i} = (\tfrac{1}{2} - \theta_i)H_r + \delta \left[\begin{array}{c} \tfrac{1}{2}(1-\theta_i)\mu(l,t) + \tfrac{1}{2}\theta_i \mu(h,t) \\ -\tfrac{1}{2}(1-\theta_i)\mu(l,g) - \tfrac{1}{2}\theta_i \mu(h,g) \end{array} \right]. \tag{A15}$$

Note $\mu(l,g)$ and $\mu(h,g)$ are given by (A9) and (A10), while application of Bayes's rule yields

$$\mu(l,t) = \frac{\widetilde{q}_S + (\widetilde{p}_S - \widetilde{q}_S)\theta_S}{\widetilde{q}_S + (\widetilde{p}_S - \widetilde{q}_S)\theta_S + \widetilde{q}_D + (\widetilde{p}_D - \widetilde{q}_D)\theta_D} \tag{A16}$$

and

$$\mu(h,t) = \frac{\widetilde{p}_S - (\widetilde{p}_S - \widetilde{q}_S)\theta_S}{\widetilde{p}_S - (\widetilde{p}_S - \widetilde{q}_S)\theta_S + \widetilde{p}_D - (\widetilde{p}_D - \widetilde{q}_D)\theta_D}. \tag{A17}$$

Existence of the 'follow' pooling sub-game equilibrium. Suppose that

$$\begin{aligned} \mu(l,t) &= \mu(h,g) = \frac{\theta_S}{\theta_S + \theta_D} \text{ and} \\ \mu(l,g) &= \mu(h,t) = \frac{1 - \theta_S}{2 - \theta_S - \theta_D}. \end{aligned} \tag{A18}$$

Substituting for (A18) in (A14) yields

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

Similarly substituting for (A18) in (A15) yields

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

It therefore follows that, for any δ, $\sigma_i^o = (1,0)$ is a solution to (A13). From (A9), (A10), (A16) and (A17) the market's beliefs are indeed as stated and hence such an equilibrium exists. Note existence of the 'contradict' pooling equilibrium can proved in a similar manner, while establishing uniqueness is again possible along the lines given in the proof of Lemma1. ■

Proof of Proposition 2. Let the function $\delta_{mix\ p}(\theta_S, \theta_D, H_r, \widetilde{p}_D)$ denote the values of δ such that D is willing to mix on $s = l$, given $\widetilde{p}_S = 1$ and $\widetilde{q}_i = 0\ \forall i$. Note $\delta_f = \delta_{mix\ p}(\theta_S, \theta_D, H_r, 1)$, implying δ_f gives the value of δ beyond which D mixes on $s = l$.

Part (i). This follows immediately from Lemma 3; S has no career concern incentive to deviate from setting t when $s = l$ for any $\widetilde{p}_D$.

Part (ii). From above, for D to mix on $s = l$, we require

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

Define the function

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

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

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

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

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

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

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

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

Part (iii). Let $\underline{\widetilde{p}}_D$ solve $\mu(g) = \theta_D\mu(l,t) + (1-\theta_D)\mu(h,t))$ when $\widetilde{\sigma}_S = (1,0)$ and $\widetilde{\sigma}_D = (\widetilde{p}_D, 0)$. It then follows that Z must be strictly positive for any $\widetilde{p}_D \in (\,\underline{\widetilde{p}}_D, 1]$ and hence that $\delta_{mix\ p}$ is increasing in H_r as stated.

Differentiating Z wrt to θ_S yields, after some re-arrangement,

$$\tfrac{\partial Z}{\partial \theta_S} = \frac{\widetilde{p}_D(\theta_S-\theta_D)(\theta_S+\theta_D-2\theta_S\theta_D+2\widetilde{p}_D(1-\theta_D)\theta_D)}{(\theta_S+\widetilde{p}_D\theta_D)^2((1-\theta_S+\widetilde{p}_D(1-\theta_D))^2}$$

which by inspection is strictly positive for any $\widetilde{p}_D \in (0,1]$. Thus $\delta_{mix\ p}$ must be decreasing in θ_S.

Differentiating Z wrt to θ_D yields, after some re-arrangement,

$$\tfrac{\partial Z}{\partial \theta_D} = \frac{\widetilde{p}_D(\theta_S-\theta_D)(\widetilde{p}_D(2\theta_S\theta_D-\theta_S-\theta_D)-2(1-\theta_S)\theta_S)}{(\theta_S+\widetilde{p}_D\theta_D)^2((1-\theta_S+\widetilde{p}_D(1-\theta_D))^2}$$

which by inspection is strictly negative for any $\widetilde{p}_D \in (0,1]$. Thus, given the definition of $\delta_{mix\ p}$, it follows that $\delta_{mix\ p}$ is increasing in θ_D. ■

2. Data

Table A1: Definition of Variables used in Rate Review Regressions

Variable	*Description*
α_i	Firm-state fixed effect; $i = 1, ..., 236$
$term_{it}$	Term of office of PUC commissioners (years)
$opex_{it}$	Firm i total electric operating expenses (000$)
$\Delta opex_{it}$	$opex_{it-1} - opex_{it-2}$
D_{it}	1 if $\Delta opex_{it} < 0$; 0 if otherwise
t	Time trend; $t = 1, .., 9$
z_{it}	PUC Controls
$select_{it}$	1 if commissioners are appointed; 0 if elected
aam_{it}	1 if automatic adjustment mechanism for fuel costs; 0 if otherwise
$test1_{it}$	1 if historic test year; 0 if otherwise
$test2_{it}$	1 if full forecast; 0 if otherwise
$test3_{it}$	1 if combination of historic and future test years; 0 if otherwise
$valst_{it}$	1 if valuation standards are pure original cost; 0 if otherwise
$staffpc_{it}$	Total commission staff per 10,000 state population.
$numcom_{it}$	Number of commissioners
$stag_{it}$	1 if commissioner's terms are staggered; 0 if concurrent
$minrep_{it}$	1 if minority party representation by law or practice; 0 if otherwise
$qual_{it}$	1 if specific qualifications required by statute; 0 if otherwise
$postoc_{it}$	1 if time restrictions on industry employment; 0 if otherwise
$ntreg_{it}$	Number of regulated energy utilities

Table A2: Definition of Variables used in Price Regressions

Variable	*Description*
p_{it}	Electric operating revenue / sales to residential customers (cents per kwh)
α_t	Year effect; $t = 1, ..., 9$
s_{it}	Supply Controls
$avopex_{it}$	$opex_{it}$ / total sales to customers (cents per kwh)
$land_{it}$	State land area (square miles)
$rg1_i - rg9_i$	Census region dummies
d_{it}	Demand Controls
$stpop_{it}$	State population
$stdpcy_{it}$	State disposable per capita income ($)

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, along with $land_{it}$, was taken from *The Book of the States, (*Council of State Governments), Washington

(1982/3-1990/1). All firm variables were taken from the EIA yearbooks (DOE/EIA-0437), published under a number of titles, most recently "*Financial Statistics of Major US 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. Finally, 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.

3. Further Regression Estimates

Table A3: PUC Controls From Review and Residential Price Regressions

	Table 3 (ii) No FE	Table 3 (iv) FE	Table 4 (iv) Full Sample	Table 5 (ii) No FE	Table5 (iv) FE
select	0.644*** (3.38)	0.434*** (0.16)	n/a[1]	-0.570*** (3.95)	5.736 (1.43)
amm	0.078 (0.65)	0.304 (0.67)	0.254 (0.66)	0.370*** (4.33)	0.209** (2.19)
test1	0.062 (0.46)	2.051 (1.39)	1.625 (1.39)	0.732*** (5.55)	0.226 (1.25)
test2	0.225 (1.22)	-0.118 (0.27)	-0.104 (0.26)	0.418** (2.49)	-0.152 (1.02)
valst	-0.039 (0.24)	-0.449 (1.05)	-0.395 (0.74)	-0.240** (2.31)	-0.001 (0.01)
staffpc	1.011*** (4.28)	-0.693 (0.77)	-0.574 (0.74)	0.117 (0.59)	0.039 (0.13)
numcom	0.088** (1.97)	-0.241 (1.09)	-0.203 (0.95)	0.008 (0.21)	0.045 (0.70)
stag	0.010 (0.04)	-0.804 (0.89)	-0.716 (0.86)	0.094 (0.60)	0.181 (1.42)
minrep	-0.365*** (2.83)	-0.749 (0.50)	-0.690 (0.47)	-0.183* (1.65)	-0.563** (2.06)
postoc	0.460*** (3.14)	0.599 (1.31)	0.543 (1.35)	0.030 (0.27)	0.151 (1.08)
qual	0.346*** (2.89)	-0.095 (0.21)	-0.085 (0.22)	0.186*** (2.89)	0.119 (1.26)
ntreg	0.001 (1.10)	0.002 (0.19)	0.001 (0.18)	0.008*** (4.08)	-0.005** (2.22)

Absolute value of z and t-stats in parentheses.
*, ** and *** denote significance at 10%, 5% and 1%, respectively.
[1] $select_{it}$ does not vary within-group during our sample period and therefore cannot be identified in a Conditional Logit regression.