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A model of self-regulation

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Abstract

This paper analyses reputation-based incentives for self regulation from a principal-agent perspective. We find scant incentive to monitor quality and expose fraud in self regulation. However, public parallel regulation can enhance the incentives to monitor quality and reduce fraud.

Keywords: Self-regulation; Quality regulation

JEL classification: L51; K20

1. Introduction

Self regulation (SR) abounds in financial and professional services, public institutions, political parties and within firms in general. While SR reduces the problem of informational disadvantage of the regulator, SR also implies by definition *regulatory capture*. Therefore, a fundamental theoretical question is whether Self Regulatory Organisations (SROs) have the correct *incentives* to monitor quality and expose fraud to the public.[1] SR has three key features that have not been addressed in the literature:[2] (i) SROs face an agency problem whereby quality is ultimately determined by the SRO members, (ii) SRO incentives to monitor quality are reputation-based, and (iii) SR usually exists in *credence goods* industries.[3] This work addresses these issues by analysing SRO reputation-based incentives for signalling good quality to consumers who must rely only on SRO disclosure behaviour

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[1]Therefore, the question of how SR comes into existence is not addressed here. However, see Nunez (1999) for a discussion.

[2]Indeed, in most related works quality is observable by consumers. Moreover, quality is typically either exogenous, or a direct choice variable of the principal. See for example Milgrom (1981); Shapiro (1982); Milgrom and Roberts (1986); Gehrig and Jost (1995) and Emons (1997).

[3]Where consumers cannot properly observe product quality either prior or after purchase.

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to infer the SRO type, and where unobservable quality emerges endogenously from the strategic interaction between the SRO and its members. This work also innovates by studying how SRO incentives change when public parallel regulation of quality is introduced.

2. The basic model

The basic model involves a principal (SRO), an SRO agent and consumers of a credence good delivered by the SRO. Unlike consumers, the SRO and the agent know SRO vigilance cost c_i, which can be high (c_H) with prior probability λ, or low ($c_L < c_H$, $i = H,L$). The agent chooses a level of 'fraud' $x \in [0,\infty]$. SRO type i faces two decisions: choose a level of vigilance $y_i \in [0,\infty)$, and choose between exposing fraud to consumers ($e_i = 1$) and cover-up ($e_i = 0$) upon fraud detection. SRO type i can detect fraud with probability $p(x,y_i) \leq 1$, which satisfies partial derivatives $p_x > 0$, $p_y > 0$, $p_x(0,y) = 0$, $p_y(x,0) = \infty$, $p_{xx} > 0$, $p_{yy} < 0$ y $p_{xy} > 0$. The agent benefits linearly from the amount of fraud, and chooses x to maximize the net expected value of fraud;

$$x - p(x,y)T \tag{1}$$

where $T > 0$ is the penalty he faces upon detection by the SRO. The slope of the agent's reaction function is $\mathrm{d}x^*/\mathrm{d}y = -p_{xy}/p_{xx} < 0$. Consumers place value on the SRO type, which affects the SRO's payoff. Let w_i be the value to the SRO of being perceived by consumers as the SRO of type i, with $w_L - w_H = W$, which can accomodate alternative interpretations. We first explore equilibrium for any $W > 0$. This reduced-form assumption provides an 'optimistic' environment for studying SRO vigilance and exposure incentives. Hence, proving non-existence of such incentives under these favourable conditions would constitute a significant 'impossibility' result. Next, we assume consumers care about (unobservable) equilibrium fraud, which they know is determined by the SRO type via the vigilance choice. In this case, $w_i(x^*(y_i^*))$, with $\partial w_i/\partial x < 0$. Upon observing either fraud exposure or no exposure by the SRO, consumers employ Bayes' Rule to update their prior belief λ. Let $p_i = p(x^*(y_i),y_i)$. With equilibrium exposure probabilities for each SRO type denoted by $e_i p_i$, consumers' Bayesian update of λ conditional upon SRO exposure (b_{e}) and no exposure (b_{n}) are given by:[4]

$$b_{\mathrm{e}} = \frac{e_L p_L \lambda}{e_L p_L \lambda + e_H p_H (1-\lambda)}, \quad b_{\mathrm{n}} = \frac{(1 - e_L p_L)\lambda}{(1 - e_L p_L)\lambda + (1 - e_H p_H)(1-\lambda)} \tag{2}$$

Let $R = (b_{\mathrm{e}} - b_{\mathrm{n}})W \in [-W,W]$, which denotes the value of 'reputation change' of voluntary fraud exposure. SRO types choose e_i and y_i to maximise expected value;

$$[e_i p(x,y_i) b_{\mathrm{e}} + (1 - e_i p(x,y_i)) b_{\mathrm{n}}]W - c_i y_i \ = \ W b_{\mathrm{n}} + e_i p(x,y_i) R - c_i y_i \tag{3}$$

To study SRO incentives in a wider context, we analyse both simultaneous and sequential moves between the SRO and the agent (Cournot and Stackelberg-like, respectively). Pursuing both options

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[4] If pooling equilibrium $e_i^* = 0$ occurs, it is assumed that out-of-equilibrium belief $b_{\mathrm{e}} = \lambda$, reflecting that no updating of λ is possible. This is equivalent to assume that exposure can happen, either by mistake or leak, with small probability $\epsilon > 0$ for both SRO types, in which case Bayes' Rule could be applied in all information sets.

sheds light on different incentives, as shown later. The empirical relevance of each approach ultimately depends on the ability of the SRO to commit to a level of vigilance. The FOC of SRO type i in the Cournot and Stackelberg cases are, respectively;

$$\frac{\partial p(x,y_i)}{\partial y_i}R - c_i = 0, \quad \frac{\mathrm{d}p(x^*(y_i),y_i)}{\mathrm{d}y_i}R - c_i = 0 \tag{4}$$

Equilibrium for Cournot and Stackelberg cases consists of strategies x^*, y_i^*, e_i^* and consumer beliefs b_e, b_n satisfying Bayes' Rule in Eq. (2). Equilibrium exists for any fixed point $R^* \in [-W,W]$ such that $R^* = R_t = R_{t+1}$, where R_{t+1} is computed from consumers' beliefs conditional upon the SRO types' and the agent's optimal behaviour for a given R_t. Let $x_{\max} = x^*(y=0)$. Then, the following results hold (see proofs in the Appendix A).

Result 1. Equilibrium exists, and $R^* = y_i^* = 0$, $e_i^* = 0$ and $x^* = x_{\max}$ is a pooling equilibrium in the Cournot and Stackelberg case for all $W \in IR$.

Result 2. If $\mathrm{d}p/\mathrm{d}y \leq 0$ and for any $W \in IR$, pooling equilibrium $R^* = y_i^* = 0$, $e_i^* = 0$ and $x^* = x_{\max}$ constitutes the unique equilibrium in the Cournot and Stackelberg cases.

Result 3. If consumers place value on (unobservable) equilibrium fraud, such that $w_i(x^*(y_i^*))$, pooling equilibrium in Results 1 and 2 implies $W=0$.

Result 4. If $\frac{\mathrm{d}p}{\mathrm{d}y} > 0$, there must be a separating equilibrium in the Cournot case that satisfies $R^* > 0$, $e_L^* = e_H^* = 1$, $y_L^* > y_H^* > 0$ and $x^*(y_L^*) < x^*(y_H^*) < x_{\max}$ for any $W > 0$. However, in the Stackelberg case this equilibrium is possible but cannot be guaranteed.

Result 1 shows that fraud cover-up, no vigilance and maximum fraud is *always* an equilibrium, regardless of W; If the SRO expects no separation of types by consumers, then zero vigilance and no exposure are optimal pooling strategies for both SRO types, which validates consumers' inability to separate types. As a result, fraud is maximum. Moreover, Results 2 to 4 suggest this pooling equilibrium is *unique* regardless of W, unless $\mathrm{d}p/\mathrm{d}y > 0$. Intuitively, if consumers think higher vigilance decreases the chances of fraud detection due to the agent's compensating fraud reduction (i.e. $\mathrm{d}p/\mathrm{d}y < 0$), then Bayesian consumers must place a *lower* probability on the low cost SRO upon observing exposure. Expecting this, neither SRO type will be willing to choose positive vigilance or expose fraud if $\mathrm{d}p/\mathrm{d}y < 0$. Interestingly, this condition is satisfied for a wide range of functional forms of $p(x,y)$. Indeed,

$$\frac{\mathrm{d}p(x^*(y),y)}{\mathrm{d}y} = p_x \frac{\mathrm{d}x^*(y)}{\mathrm{d}y} + p_y = \frac{-p_x p_{xy}}{p_{xx}} + p_y = \mathrm{sign}\frac{\partial[p_x/p_y]}{\partial x} \tag{5}$$

It is entirely possible that $\partial[p_x/p_y]/\partial x < 0$. For example, consider $p(x,y) = f(x)g(y)$. Then, $\mathrm{sign}[\mathrm{d}p(x(y),y)/\mathrm{d}y] = \mathrm{sign}[\mathrm{d}(f_x(x)/f(x))/\mathrm{d}x]$, implying that a *necessary* condition for an equilibrium with positive vigilance, fraud deterrence and fraud exposure is the rather restricted case that $f(x)$ is strictly log-convex. Moreover, condition $\mathrm{d}p/\mathrm{d}y > 0$ is even more implausible if assumption $p(0,y) = 0$

was made, that is, if the SRO cannot discover non-existing fraud, because in this case $dp/dy<0$ at least locally.

3. Public parallel regulation (PPR)

This section examines how SRO reputation-based incentives change in the presence of quality PPR. Let $q(x)$ be the probability of fraud discovery by a Public Regulator (PR), with $q_x>0$. Under PPR consumers can observe three events in order to update their beliefs about the SRO type, namely voluntary SRO exposure, PR exposure, or no exposure at all.[5] Let b_s, b_r and b_n be the Bayesian updates of λ upon observing each of these events, respectively, such that,

$$b_s=\phi\left(\frac{e_L p_L}{e_H p_H}\right),\quad b_r=\phi\left(\frac{q_L(1-e_L p_L)}{q_H(1-e_H p_H)}\right),\quad b_n=\phi\left(\frac{(1-q_L)(1-e_L p_L)}{(1-q_H)(1-e_H p_H)}\right) \tag{6}$$

where $\phi(\rho)=\frac{\lambda\rho}{\lambda\rho+(1-\lambda)}$ is Bayes' Rule slightly transformed from Eq. (2). SRO agent chooses x to maximise,

$$x-[p(x,y)+(1-p(x,y))q(x)]T \tag{7}$$

and the slope of the agent's reaction function is

$$dx^*/dy=-\frac{(1-q)p_{xy}-p_y q_x}{p_{xx}(1-q)-2p_x q_x+(1-p)q_{xx}}<0.$$ [6]

Let $q_i=q(x^*(y_i))$. The Cournot and Stackelberg SRO types choose e_i and y_i to maximise,

$$[e_i p(x,y_i)b_s+(1-e_i p(x,y_i))(q_i b_r+(1-q_i)b_n)]W-c_i y_i=Wb_n+e_i p(x,y_i)R_i+q_i(b_r-b_n)W - c_i y_i \tag{8}$$

where $q_i b_r+(1-q_i)b_n$ is the expectation of SRO type i being perceived by consumers as the low cost SRO, conditional upon cover-up, and where $R_i=[b_s-(q_i b_r+(1-q_i)b_n)]W$. Therefore, unlike the case without PPR, the gain in reputation of voluntary exposure is now type-specific.

Result 5. If $dp/dy<0$ there cannot be an equilibrium with $e_i^*=1$ in the Stackelberg and the Cournot cases.

This result shows that PPR fails to create an equilibrium with voluntary SRO fraud exposure. The intuition is that the low vigilance cost SRO has incentives to cover up fraud and optimally run the risk of public exposure, because this can happen with sufficient low probability for this SRO type.

[5] We rule out joint exposure to accomodate the intuition that the SRO has an 'informational advantage' over PR, such that the latter can expose fraud only if the SRO has not.

[6] $-[p_{xx}(1-q)-2p_x q_x+(1-p)q_{xx}]<0$ because it is equal to the maximisation's SOC. Moreover, assumption $(1-q)p_{xy}-p_y q_x>0$ is made to ensure $dx^*/dy<0$, which is equivalent to assuming $p_{xy}>0$ in the case without PPR.

Result 6. In the Stackelberg case with PPR, an equilibrium $e_i^* = 0$, $y_i^* > 0$ and $x^*(y_i^*) < x_{\max}$ is possible.

Intuitively, the Stackelberg SRO will choose positive vigilance in order to reduce equilibrium fraud and avoid a reputation loss due to public exposure. This incentive is absent in the Cournot case because the SRO does not expect to alter the agent's fraud choice. This suggests that the SRO's ability to commit to a level of vigilance is important to assess the role of PPR.

4. Conclusions

This paper shows that in a variety of circumstances SROs have no incentive either to monitor quality or expose fraud because Bayesian consumers will interpret fraud exposure as a *negative* signal about SRO quality. From a theoretical perspective, separating equilibria often failed to exist because SRO signalling behaviour changes quality choice endogenously, making signalling unfruitful, unlike most signalling models where quality is exogenous. PPR not only reduces the agent's optimal fraud directly, but may also provide enhanced incentives to the SRO to monitor quality, although it fails to create incentives for fraud exposure. This result suggests that a 'mixed' regulatory scheme involving SR and PPR may be superior, as such a scheme may benefit from the SRO's informational advantage regarding quality, while the public regulator can generate the reputation-based incentives to monitor quality that SROs may not have otherwise. There are multiple avenues for future research. For example, SRO reputation-based incentives can be studied assuming that consumers have uncertainty about the nature of the SRO *agents*. Second, agents may also have a reputation of their own to protect, which can provide new incentives for the SRO. Third, there can be side transfers and 'corruption' between the SRO and its members, which may affect SRO vigilance and exposure incentives. Finally, there can be reputation-based competition among many SROs in an industry, or competition for promotion among many principals within an SRO. These extensions could lead to rather different results than those reported here.[7]

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Appendix A

Proof Result 1

If $R_t = 0$, then in the Cournot and Stackelberg cases $y_i^* = 0$, $e_i^* = 0$ and $x^* = x_{\max}$, which leads to $b_e = b_n = \lambda$ and $R_{t+1} = 0$, making $R^* = 0$ a fixed point.

[7]Nunez (1999) presents a discussion on some of these issues.

Proof Result 2

Stackelberg case: By inspection of the SRO FOCs for any $R_t \in [-W,W]$, if $dp/dy \leq 0$, then $y_i^* = 0$ and $x^*(y_i^*) = x_{\max}$. Hence, $b_e - b_n = R_{t+1} = 0$. Therefore, only $R^* = 0$ exists.

Cournot case: If $R_t > 0$, then from the SRO FOCs, $y_L^* > y_H^* > 0$, which implies $p_L < p_H$ if $dp/dy \leq 0$. Hence, $b_e < b_n$ and $R_{t+1} < 0$. Therefore, only $R^* = 0$ exists.

Proof Result 3

It follows trivially from $y_L^* = y_H^* = 0$.

Proof Result 4

Cournot case: For any $R_t > 0$, $y_L > y_H > 0$ and $p_L > p_H$, which follows from $p_y R \to \infty$ as $y_i \to 0$. This implies that $\mathrm{Lim}/R_t \to 0$ $p_L/p_H > 1$, $\mathrm{Lim}/R_t \to 0$ $(1 - p_L)/(1 - p_H) = 1$ and $\mathrm{Lim}/R_t \to 0$ $R_{t+1} > 0$. On the other hand, when $R_t = W$ then $y_L > y_H > 0$, and therefore $b_e < 1$ and $b_n > 0$, implying that $R_{t+1}(R_t = W) < W$. Therefore, an 'intermediate' fixed point $R^* > 0$ must exist, in which $y_i^* > 0$, $e_i^* = 1$ and $x^*(y_i^*) < x_{\max}$.

Stackelberg case: For $R_t > 0$ close to 0, $e_i^* = 1$ but $y_i^* = 0$ because $c_i > 0$. This yields $R_{t+1} = 0$ as $R_t \to 0$. As $R_t > 0$ increases, there is a point from which $y_L^* > y_H^* \geq 0$, and therefore $R_{t+1} > 0$. Therefore a fixed point $R^* > 0$ is possible although it cannot be guaranteed, which would ultimately depend on c_i and dp/dy.

Proof Result 5

Recall that $e_i^* = 1$ requires $R_i > 0$. Assume $e_i^* = 1$. Let $b_n^0 = \phi(k)$, $k = 1 - p_L/1 - p_H$. If $dp/dy \leq 0$ then $b_s \leq b_n^0$. This implies that $R_{L\ t+1} \leq 0$ if $q_L b_r + (1 - q_L) b_n \geq b_n^0$. Dividing the latter inequality by λ and k yields;

$$\frac{q_L^2}{q_L f + q_H g} + \frac{(1-q_L)^2}{(1-q_L)f + (1-q_H)} \geq 1/(f+g) = -\frac{g^2(q_L - q_H)^2}{(q_L\ f + q_H g)[f(q_L - 1) + g(q_H - 1)](f+g)} \geq 0 \tag{A.1}$$

where $f = \lambda k > 0$ and $g = (1 - \lambda) > 0$. Eq. (A.1) holds for all q_i, $p_i \in [0,1)$, which proves that $R_{L\ t+1} \leq 0$.[8] This implies that $e_L^* = 0$, which contradicts initial assumption $e_i^* = 1$.

Proof Result 6

Assume $e_i^* = 0$. Then the relevant maximand of the Stackelberg SRO types is only $q_i(b_r - b_n)W - c_i y_i$. Let $G = (b_r - b_n)W$. For $G_t < 0$ it must be the case that $y_L^* \geq y_H^*$ and $x^*(y_L) \leq x^*(y_H)$, which implies that $G_{t+1} \leq 0$ as G_t decreases. A fixed point $G^* < 0$ is possible but cannot be guaranteed, which would ultimately depend on c_i and $q_x > 0$. Such fixed point would satisfy the initial assumption $e^*_i = 0$ if out-of-equilibrium beliefs b_s, unrestricted by Bayes' Rule, are low enough to make $R_i^* < 0$.

[8] Nunez (1999) provides numerical examples to illustrate and verify this result.

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