A Regulator's Exercise of Career Option To Quit and Join A Regulated Firm's Management with Applications to Financial Institutions *

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Abstract

One of the issues that arose during *post-mortem* of the financial crisis of 2008 is claim of regulatory capture and revolving doors for regulators and political operatives transitioning to lobbying firms or financial firms they once regulated. Several papers claim that lax enforcement by regulators, and excessive risk taking by financial firms are key ingredients that led to the crisis. This paper fills a gap in the literature by posing the revolving door hypothesis in the context of managerial compensation, and labor market mobility, for regulators who design mechanism(s) that affect firm capital structure, and who subsequently exercise career options to quit and join firm management or lobbying firm. Our theory predicts that regulatory signals embedded in firm capital structure provide a common thread between managerial compensation for former regulators, firm leverage, excessive volatility, and bankruptcy risk. We identify early warning signals for firm bankruptcy from critical time points in managerial stock option vega-leverage space. We find support for several aspects of our theory in a sample of US commercial banks. Data show that prior to the 2008 financial crisis, when the trend in average bank leverage and managerial compensation in commercial banks via stock option grants began to increase, high subprime interest rates on bank loans became tax deductible. Ex-regulators in their capacity as bank lobbyists induced tax revenue transfers which fueled financial institutions leverage and *de facto* banks' managerial compensation. Furthermore, based on a sample of bank CEO vega between 1994 and 2006, our managerial vega-leverage theory predicts an *out-of-sample critical time point* in 2007, and a range of critical time points for commercial bank failures thereafter. So our model would have predicted the 2008 financial crisis.

Keywords: career option, revolving door, capital structure, leverage, vega, managerial compensation

JEL Classification Codes: G01, G18, G28, G38, J24, J44-45, L51

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1 Introduction

Government market interventions to mitigate the effects of financial market failure during the Great Recession of 2008, spawned a large literature on the bailout of financial firms. One strand of that literature examines the revolving door phenomenon[1] characterized by labour market mobility of financial regulators and their pre and post bailout relationships with financial firms in general (Shive and Forster, 2014; Bond and Glode, 2014; Acemoglu et al., 2013; DeHaan et al., 2015; Sobel and Graefe-Anderson, 2014), and banks specifically Braun and Raddatz (2010); Lucca et al. (2014); Lambert (2015).

This paper contributes to the literature with a theory of managerial compensation and labor market mobility for a regulator who designs mechanism(s) that affect firm value, and who subsequently exercises a career option to quit and join the firm's management or a consultancy.[2] Our theory predicts that regulatory signals embedded in firm capital structure provides a nexus between managerial compensation for former regulators, firm leverage and bankruptcy risk. In particular, our model predicts that the growth of managerial vega and firm leverage provides early warning signals that are dispositive of firm bankruptcy. This prediction was upheld upon application to a sample of US commercial banks. Lucca et al. (2014); Lambert (2015) also provide empirical studies of revolving doors in the banking sector, and their impact on bank leverage and risk taking.

Lucca et al. (2014) finds that regulators with higher human capital have shorter regulatory spells because of higher outflow to the private sector. Furthermore, they find strong countercyclical net worker flows into regulatory jobs, driven largely by higher gross

[1] Refer to Che (1995); Salant (1995) for early theories of revolving doors in the public policy literature.

[2] In this paper, "regulator" includes former politicians, former key staff members, and former employees of regulatory agencies. By "firm" we mean either a lobbying agency or an ongoing concern. The inclusion of lobbying organizations under rubric of "firm" is motivated by the Honest Leadership and Open Government Act of 2007 (Pub. L. No. 110-81, 121 Stat. 735, enacted September 14, 2007) which amended the Lobbying Disclosure Act of 1995 to prohibit former U. S. congressmen from lobbying Congress within a given period after they leave office. See "Ex-Congressmen Cash in on K Street," available at http://www.newsmax.com/Politics/Ex-CongressmenCashinonKStreet/2011/04/15/id/392978. Che (1995) provides a taxonomy of examples of public to private sector moves including but not limited to procurement officials in the Department of Defense, anti trust unit in U. S. Dep't Justice, IRS officials, etc. See e.g., Procurement Integrity Act (41 U.S.C. §423, as amended); FINalternatives.com (2012); and Khan (2011)

out flows into the private sector during booms. We provide a theoretical model of career mobility for regulators with application to the banking sector. We treat a regulator's career option to quit and join a regulated firm as a contingent claim on future labor income. The price of the career option is affected by uncertain future states of the world, and regulatory signals embedded in a firm's capital structure.

Lambert (2015) studies the impact of bank lobbying on bank supervision. He finds decreased performance and increased default and credit risk at lobbying banks. For example, lobbying decreases the probability of sever action taken against the lobbying bank by 52.1 percent. Meanwhile the default risk for such banks increases by 13.7 percent. Braun and Raddatz (2010) studies the connection between former high-ranking politicians who are hired as bank directors. They find that such banks are larger and more profitable despite having less leverage and less risk. Shive and Forster (2014) find similar results in their study of financial firms. Our theory sheds light on the mixed empirical results by providing conditions under which each result is plausible.

Even though human capital is a nontraded asset (Bodie et al., 1992), human capital risk can be priced using financial securities (Jagannathan and Wang, 1996; Cadogan and Cole, 2014). This provides a nexus for managerial compensation of former regulators in firms they once regulated. The main predictions of our model are:

- Regulator signals embedded in firm capital structure induce a price signal ratio which informs the firm *ex ante* about regulator induced pricing strategies consistent with profit maximization. This supports discrete pricing regimes for the firm, and regulator trade-off of consumer welfare for firm profit, in order to increase the value of regulators' career option.

- The value of a regulator's career option increases with firm leverage. So regulator's have career incentives to embed leverage inducing regulatory signals in the firm's capital structure. This explains why strategically levered firms obtain better regulatory outcomes.

- The vega [3] for regulator career option on regulated firms indicates that firm value-at-risk in bad states of nature is greater than it would be in non-regulatory capture[4] regimes. Moreover, the rate of change of vega and leverage portend warning signals about firm

[3] See (Hull, 2006, pp. 359-360) for examples of vega as the sensitivity of option price to change in volatility.

[4] (Baxter, 2011, pg. 177) characterized "regulatory capture" thus: "There is often another complicating and more

bankruptcy. We find empirical support for aspects of our theory for commercial banks insured by the FDIC.

1.1 Motivation

This paper is motivated by the following considerations. For firms in a regulated industry, the public sector often define their operating parameters. Thus firms' profit opportunities are constrained. Moreover, regulatory agencies provide oversight and enforce those constraints which are delegated to regulators who interact with firm management. Thus, there are risks in the process. If regulators fail to enforce the constraints as expected, there are moral hazard costs that the public may bear. By contrast, if regulators exceed the intended constraints, then firm profitability is affected and that may lead to firm inefficiency. In that context, for the duration of their careers, regulators hold a range of valuable options which, depending on how they are exercised, may benefit the regulated firms and their shareholders at the expense of the public or vice versa. Hence, the regulator problem is imbedded with moral hazard risk that the public may wish to curtail Kane (2009).

Consider the American banking sector. Within established parameters and guidelines, commercial bank franchises are intended to meet public credit needs while providing returns to their shareholders. Monitoring and examining the bank "franchises" in the U.S. give rise to a range of regulators - depending on whether the institutions are federally or state chartered. Further, regulations arise with respect to protections for depositors. Other related considerations of risk and return drive further monitoring and restrictions in banking. For example, financing activities and asset acquisitions are also constrained (e.g. no common stock investments); prices may be regulated or not (e.g. Regulation Q); capital adequacy may be proscribed both with respect to quantity and to mix of debt and equity; asset growth may be facilitated or not (e.g. appropriate collateral, and margin requirements on stock purchases etc). It is normal in banking for regulations to produce push - pull ten-

fundamental factor at play: it might be that the regulatory regime appears "captured" because the legislature that created this regime was itself captured by "special interests" and, as a result, has produced a regime predestined to captured results favoring those interests".

sions, with management desiring greater degrees of freedom than may be allowed under the status quo.

Such tensions provide opportunities wherein regulators might exercise their discretion to support the management "push" or the public "pull" in their reports to bank management, to policy makers, and the public. For example, it is a regulator's responsibility to evaluate management and bank performance on such things as earnings and financial leverage and to assign comparative institutional rankings (e.g. CAMELS scores). In that process, the regulator builds a career whose market value changes with the exercise of their discretion. This process is known, and as a result, costly departure barriers are established to restrain regulators and minimize conflicts of interest. However, it is likely that market for [ex]regulators discount such departure costs.[5]

In our model, a regulator designs an abstract mechanism that embeds regulatory signals in the firm's capital structure to induce the firm to engage in some desired action. For instance, she may engage in regulatory forbearance for highly levered firms, or [s]he may favor tax cuts on capital gains or tax deduction of interest expense or deregulation of an industry because a particular firm that [s]he intends to join after leaving her regulatory position is an industry leader.[6] So [s]he designs a mechanism to facilitate that purpose. However, agency conflicts arise from information asymmetry when the regulator has information about career options[7] [s]he plans to exercise in the future, and stake holders in the firm or members of the public do not.[8]

With fully revealing information, our regulator could enter a contract, with the regulated firm, in which she is compensated with stock options [s]he can exercise after joining the firm if the value of the firm attains a certain level. However, due to agency conflicts

[5]Refer to http://www.propublica.org/article/ny-fed-fired-examiner-who-took-on-goldman

[6]In fact, a recent study by Tahoun (2014) found that stock ownership by members of the U.S. Congress is correlated to legislation they introduce

[7]Treussard (2007) career option model is motivated by exotic reset options, and not by contract theory considerations we employ in this paper.

[8]In extant literature, information asymmetry in signalling games typically involves the firm having more information than outsiders. See Baron and Myerson (1982) and Myers and Majluf (1984). However, our reverse game feature is consistent with abstract mechanism design.

and possible illegality such a contract would be prohibited.[9] Therefore the regulator's career intention is unobservable. However, she is very interested in the firm's equity value because she intends to quit the regulatory role at an unknown future date. [S]he therefore takes an interest in the firm's capital structure, designs career options, and plays a signaling game through the firm's capital structure.[10]

The regulator is implicitly compensated with stock options or other equity when [s]he quits her regulatory position and joins the firm. For instance, if the value of the firm increases by virtue of favorable regulatory action [or inaction] that impacts capital structure, then the regulator's ultimate compensation is tantamount to a career call option. If the value of the firm decreases, then the regulator may have the "white knight" syndrome and come to the rescue as a consultant to peddle influence and navigate the minefield of regulation in the mechanism [s]he designed. Accordingly, it is a career put option. Because the regulator can exercise her option to resign and take up employment with the firm at any time, the issue of liquidity and under pricing of the *de facto* stock option is mitigated.[11]

The rest of the paper proceeds as follows. In section 2 we introduce the model. In section 3 we apply aspects of our theory to FDIC insured commercial banks over the period 1934-2010. Finally, in section 4 we conclude with perspectives and conjectures for further research.

2 The Model

The outline of our model begins with regulatory signals that affect the firm's admissible pricing strategy space–which is revealed by welfare considerations involving the firm's capital

[9]Samuel Myers pointed out that legal prohibition may mitigate some of the agency conflicts. See Epstein (2009) for a comprehensive review. However, the language in the law suggests that there are still sufficiently large loopholes. See e.g., Pankowski (2012) And banks are creating special purpose vehicles to circumvent regulation. See Kwak (2009)

[10]Arguably, "firm value" may be a better "variable" since one could possibly use a Modigliani and Miller (1958) type argument to allege capital structure irrelevancy in determining firm value. But compare Merton (1974) and Bradley et al. (1984) who posit the existence of an optimal capital structure.

[11]See e.g., Chance and Yang (2007) who examine the impact of illiquidity on the pricing of executive stock options, and the underlying accounting problem of expensing those items in the firm's balance sheet.

structure in subsection 2.1. The main advantage of this approach is that it allows us to plug in select variables in the reduced form so that we can examine a taxonomy of regulator signals. The regulator's abstract career option is defined in the context of the firm's capital structure in subsection 2.2. Finally, we show how to evaluate such an option, and examine its effect on tail risk and bankruptcy for the firm in subsection 2.3. To the extent that revolving doors in the banking sector exists (Lucca et al., 2014), this provides theoretical insight to Lambert (2015) who finds that lobbying banks, i.e., banks that influence regulators, are associated with higher risk taking and poorer performance. Such banks increase their default risk by 13.7% of its mean. We summarize this model with the following

Proposition 2.1 (Regulator's abstract career option on regulated firms)**.** *Let* Ω *be a sample space for states of nature,* Θ *be a type space for regulators,* G *a strategy space, and* $\mathcal{M} = (G, C)$ *be an abstract mechanism in Definition A.1, and* s *be a regulatory signalling function such that* $s : \Omega \times \Theta \to G$*. Let* f *signify the regulator's unobservable choice function. So that* $f : \Omega \times \Theta \to X$ *is a stochastic choice function mapped into outcome space. Specifically, let* C *be the regulator's career [call] option on regulated firms. We claim that the abstract value of the option is given by the mechanism:*

$$f(\omega, \theta) \cong (C \circ s)(\omega, \theta)$$

where $\cong$ *represents an isomorphism.*

Proof. See Appendix A. □

Remark 2.1. Technically, the mechanism is supposed to induce the firm to engage in some action for the regulator's benefit. As we will see in the sequel, that "something" is profit maximization and or leverage–especially in financial firms. □

2.1 Welfare effects of embedding regulator signals in capital structure

Without loss of generality, for the purpose of exposition, in this subsection our analysis is based on deterministic parameterizations. Furthermore, we assume that the form is monopolistically competitive so it can execute a pricing strategy. Here, the regulator wants to maximize her social welfare function, i.e. value function, comprised of consumer surplus (CS) and the firm profits (Π) [s]he affects by embedding regulatory signals θ in the firm's capital structure. That is, through choices and regulatory decisions the regulator attempts to affect firm equity values. Our motivation for the welfare function is based on (Spiegel and Spulber, 1994, pg. 427) who states:

> [T]he regulator establishes the regulated price by maximizing a welfare function, taking the firm's investment and capital structure as given. The balancing of consumers' and investors' interests is made explicit by assuming that the welfare function is a weighted sum of consumers' surplus and firm profits. Then, the regulated firm produces its output and the regulated market clears. The focus of this article is on characterizing the subgame equilibrium of the regulatory game.

See also (Baron and Myerson, 1982, pg. 916). However, in our model capital structure is embedded with regulatory signals and our equilibrium is based on a reversed game theory, i.e. mechanism design approach.[12] This is a source of "market friction" consistent with the tradeoff hypothesis of capital structure theory, i.e., "tradeoff theory looks at how businesses balance the pros and cons of different forms of financing" (Kwan, 2009). We show below, that that is indeed the case as regulators tradeoff welfare for firm profit.

Consistent with (Spiegel and Spulber, 1994, pg. 429, equation (6)) we identify the following promitives used to construct our criterion function.

Primitives

$p \triangleq$ price of firm output

$k \triangleq$ firm capital investment

$D \triangleq$ nominal amount of debt owed to bondholders

$E \triangleq$ market value of the firm equity

[12] We thank Gary Dymski for motivating clarification of this point.

Unlike (Spiegel and Spulber, 1994, pg. 428) who let E be the market value of new equity, and B be the market value of bonds, we let the firm's capital k be its value $V(\theta)$ which is a combination of debt $D(\theta)$, and market value of equity $E(\theta)$. In that way, the market value of equity is transmitted through firm value for a given amount of debt. Assuming no transfers or taxes, (Spiegel and Spulber, 1994, pg. 429, equation (6)) posited a "utilitarian welfare function" which constitutes our regulator value function written as

$$W(p, V(\theta), D(\theta)) = CS(p) + b\Pi(p, V(\theta), D(\theta)) \tag{2.1}$$

$$V(\theta) = D(\theta) + E(\theta) \tag{2.2}$$

where $CS(p)$ is consumer surplus; $0 < b < 1$ is a welfare weight; and $\Pi(p, V(\theta), D(\theta))$ is firm profits.

Assumption 2.2.

A.1 The firm's debt $D(\theta)$ is fixed.

A.2 Regulator signals favor firm capital and profits, i.e. $\frac{\partial \Pi}{\partial \theta} > 0$ *and* $\frac{\partial V}{\partial \theta} > 0$

A.3 Consumer surplus decreases in price $\frac{\partial CS(p)}{\partial p} < 0$

□

Under Assumption 2.2 A1, for $D(\theta)$ fixed,[13] the effective total differential of (2.1) is given by

$$d(W(p, V(\theta), D(\theta))) = \frac{\partial CS(p)}{\partial p} dp + b\Big(\frac{\partial \Pi(p, V(\theta))}{\partial p} dp + \frac{\partial \Pi(p, V(\theta))}{\partial \theta} \frac{\partial V(\theta)}{\partial \theta} d\theta\Big) \tag{2.3}$$

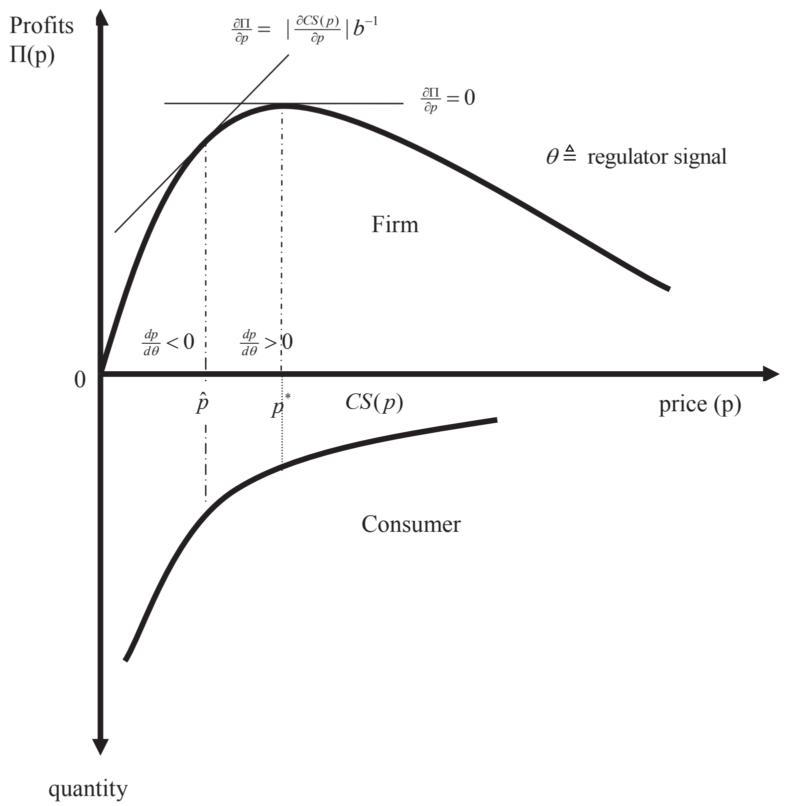
[13] Arguably, $E(\theta)$ should be fixed. In either case, the results that follow would be the same since $D(\theta) = V(\theta) - E(\theta)$ is tantamount to $V(\theta)$ in the differential for fixed $E(\theta)$.

Equate left hand side to 0, and let subscript correspond to differential with respect to variable, so that

$$(CS_p + b\Pi_p)dp + b\Pi_\theta V_\theta d\theta = 0 \tag{2.4}$$

$$\Rightarrow \frac{dp}{d\theta} = p_\theta = \frac{\Pi_\theta V_\theta}{|CS_p| - b\Pi_p} \tag{2.5}$$

Figure 1: Impact of regulator signal θ on price (p) and firm profits Π



In regulator induced price strategy space $G_{low} = \{0 < p \leq \hat{p}\}$ the rate of price change p_θ relative to regulator signal θ is decreasing. For $G_{high} = \{\hat{p} < p \leq p^*\}$ the rate of price change is increasing (and consumer surplus is falling), and firm profits are ultimately maximized at p^*. An admissible [price] strategy space for consumer welfare firm profit tradeoffs is the support $G = G_{low} \cup G_{high}$.

The price-signal ratio induced by regulator signal θ in (2.5), informs the firm about admissible pricing strategies and profits depicted in Figure 1 on page 9. There, in the price range $G_{low} = \{0 < p \leq \hat{p}\}$ the rate of price change p_θ relative to θ is decreasing. This implies that consumer surplus is increasing. However, firm profits are not being maximized. In the range $G_{high} = \{\hat{p} < p \leq p^*\}$ the rate of price change is increasing (and consumer surplus is falling), and firm profits are ultimately maximized at p^*. At which point the darker shaded region is the loss in consumer surplus $CS(p)$ or consumer welfare sacrificed for firm profits. Thus, regulator signals allow the firm to adopt a pricing strategy in either one of the price ranges according to whether the regulator's focus is on maximizing consumer welfare at the expense of firm profits or vice versa.[14] In other words, an admissible [price] strategy space is the support $G = G_{low} \cup G_{high}$.

Since the value of the regulator's career option is tied to firm profit, we should expect regulators who plan to exercise that option to send signals that support pricing in the range G_{high}. This prediction is borne out in the empirical literature where (Dal Bó, 2006, pp. 217-218) report that former FCC commissioners who take industry employment "increase their support for industry interest by nearly 11 percent during their last year in office". In which case, consumer welfare is sacrificed for regulator career goals. See e.g. (Kane, 2011, pg. 8) who summarized a related issue thus: "The importance of political, bureaucratic, and *career interests in regulatory decision- making* allows such firms to screen regulatory appointments and to distort regulatory policies *ex ante* and to reshape their enforcement *ex post*" (emphasis added). We summarize these results in

Proposition 2.3 (Regulator's career goal and tradeoff between consumer welfare and firm profit). *Assume that there are no transfer payments. Let θ be a regulator signal, and $W(p, V(\theta), D(\theta)) = CS(p) + b\Pi(p, V(\theta), D(\theta))$ be the regulator's value function, where p is the price of the firm's product, $CS(p)$ is consumer surplus, Π is a profit function as indicated, $V(\theta)$ is firm value with embedded regulator signal, and debt $D(\theta)$ is fixed. Then*

[14] Zimper and Hassan (2012) introduced a model in which regulators learn about firms' price collusion strategies through dynamic price dividend ratios.

regulator signals induce dichotomous decreasing and increasing price regimes in strategy space $G = G = G_{low} \cup G_{high}\}$*, where* $G_{low} = \{(0, \hat{p}]\}$ *and* $G_{high} = \{(\hat{p}, p^*]\}$*. Moreover, regulators will trade consumer welfare for firm profits in increasing price regimes* G_{high} *in order to enhance the value of their career option to quit and join firm management.* □

In section 3, *infra*, we show that when the firm is a financial institution, the price p corresponds to the interest rate on loans or mortgages. So consumer welfare decreases from high interest rates. Ironically, Congressional efforts to alleviate that by allowing tax deduction of interest expense exacerbated the bank leverage problem.

2.2 Stock options with regulatory signalling

In this section, we apply Proposition 2.1 in the context of what we now know about the firms capital structure embedded with regulator signals. Where possible we suppress the ω notation since it is acknowledged by the probability distributions in the formulae that follow. We retain Assumption 2.2 A2 as it pertains to firm debt through V. With few exceptions, the assumptions below are consistent with (Merton, 1974, pg. 450).

We note in passing that regulator signals is a source of market friction that affects capital structure. For example, Kwan (2009) finds that bank(s) (a type of firm) favor issuing preferred shares in private markets over government financing. Since the firm responds to the signal(s) it receives from the regulator, let $V(s(\theta))$ be the value of the firm. The notation here is slightly more general than (2.2). Suppose that the regulator's potential "managerial compensation" with the firm would be the equity stake αV, $0 < \alpha < 1$, upon a career change. If $K \in X$ is the "value" of the regulators compensation package in her current position as regulator, then [s]he may want to exercise a career [call] option at time t. The "abstract" topological lifting in Figure 11 on page 32 shows that the choice function at time t reduces to

$$f(t;\theta) = (\alpha V(t, s(\theta)) - K)^+ \tag{2.6}$$

More formally, that abstract [call] option compensation scheme takes the form

$$C(t; s(\theta^*)) = \max_{\theta}(\alpha V(t; s(\theta)) - K, 0)^+ \tag{2.7}$$

or in the alternative

$$C(\tau^*; s(\theta)) = \sup_{\tau \in \mathcal{T}, \theta \in \Theta} (\alpha V(\tau, s(\theta)) - K)^+ \tag{2.8}$$

where, θ^* is the type of regulator who maximizes her option, $\tau \in \mathcal{T}$ is a stopping time and τ^* is the optimal stopping time in the set $\mathcal{T}$ of all possible quitting times for the regulator. The foregoing is summarized in the following

Lemma 2.4 (Regulator's career call option)**.** *The regulator's career call option $C(t, s(\theta))$ increases when embedded regulatory signals increases firm value $V(s(\theta))$.* □

Of course $V(s(\theta)|\mathcal{F}_t)$ is the value of the firm at time t given the "filtration" of information $\mathcal{F}_t$, and it has to be discounted from some "terminal date" T. To keep it simple, assume that the option is a European type[15] so that it will be exercised at a "known" terminal date, and that the strike price is K. The regulator exercises a call option based on her type with the premium as indicated. It should be noted in passing that on the other side of the regulator's call option contract is a third party guarantor who holds an offsetting put contract. Namely, the regulating agency or taxpayers. See e.g. Merton (1977). Since firm value is reflected by the price of the firms stocks, the regulator's action is functionally equivalent to a stock option[16]. In this case, the stock price reflects the signals from the regulator. More on point, from (2.2) we find that the firm's equity is given by:

$$E(s(\theta)) = V(s(\theta)) - D(s(\theta)) \tag{2.9}$$

[15]For the purpose of this paper, the added complexity of American style option pricing may cause us to loose sight of the forest for the trees. See e.g., Myneni (1992) for a taxonomy of American option pricing.

[16]See Hall and Murphy (2000).

So the regulator's virtual call option is based on

$$\alpha E(s(\theta))^{+} = \max\{\alpha V(s(\theta)) - \alpha D(s(\theta)), 0\} \tag{2.10}$$

This implies that the strike price in (2.7) based on the value of the regulator's pre-industry compensation package, must be compared to the firm's debt before [s]he exercises her option. Specifically, we must consider whether

$$K \gtreqqless \alpha D(s(\theta)) \tag{2.11}$$

This implies that we also need a model of dynamic stock prices with information signalling. That issue is addressed in the sequel.

2.3 Valuation of regulator career option and capital structure of the firm

Consistent with (2.10), (Merton, 1974, pp. 453-454) showed that the option value of the equity in a firm with value V and debt D is given by

$$f(V, \tau) = V\Phi(x_1) - D\exp(-r\tau)\Phi(x_2) \tag{2.12a}$$

$$x_1 = \frac{\log\frac{V}{D} + (r + \frac{\sigma^2}{2})\tau}{\sigma\sqrt{\tau}} \tag{2.12b}$$

$$x_2 = x_1 - \sigma\sqrt{\tau} \tag{2.12c}$$

where $f(V, \tau)$ is option value of firm equity, r is a risk free rate, $\tau = T - t$ for exercise date T for a European call option priced at time t; and Φ is the cumulative normal. From the outset we note that

$$\alpha f(V, \tau) = \alpha V\Phi(x_1) - \alpha D\exp(-r\tau)\Phi(x_2) \tag{2.13}$$

The right hand side of that equation is isomorphic to a call option

$$C(\cdot) = (\alpha V - \alpha D, 0)^{+} \tag{2.14}$$

So the regulator's valuation rests on comparing his current compensation package K to the psuedo-strike price αD that depends on the firm's debt. That is, the exercise of her career option rests on the evaluation

$$(\alpha V - K, 0)^{+} \gtreqless (\alpha V - \alpha D, 0)^{+} \tag{2.15}$$

Here, we assumes that the regulator knows V, K and α but she does not know what D will be on the strike date. Thus, in (2.11) if the regulator believes that $K < \alpha D$ so that $(\alpha V - K, 0)^{+} > (\alpha V - \alpha D, 0)^{+}$, then her valuation of the firm is greater than its actual value. Arguably, at this stage the regulator would be interested in a mechanism that induces the firm to report its debt truthfully. So she would be inclined to exercise her career option to quit and join the firm or she would stay otherwise. What is more, the regulator now has incentive to design a mechanism that increases firm leverage. So she looks more favorably at levered firms because a highly levered firm increases the value of her career option. This prediction is consistent with the empirical evidence which finds that privately controlled firms use leverage strategically to obtain better regulatory outcomes. See s.g. Bortolotti et al. (2011). More important, it explains the finding in (Dal Bó, 2006, pp. 217-218) which finds that regulators increase their support for industry interest during their last year in office. Therefore, in the sequel we assume that $K < \alpha D$.

2.3.1 Regulator career option pricing with signalling

Because θ is unobservable, its presence in firm value, i.e. stock price, implies that the latter may follow a hidden Markov process. Guo (2001) and Shepp (2002) introduced an information based stock price model on the canonical probability measure space $(\Omega, \mathcal{F}, \mathrm{F}, P)$

with filtration F, which, in the context of our model, is parameterized as

$$\frac{dV(t,\omega)}{V(t,\omega)} = \mu(s(t,\theta))dt + \sigma(s(t,\theta))dW(t,\omega) \tag{2.16}$$

where $s(t,\theta)$ is itself an unobservable [hidden] Markov process. However, to simplify matters we will assume that $s(t,\theta) = s(\theta)$. That is, the signal is not time dependent. In that case, the problem is reduced to one of an American style option where the regulator embeds a deterministic signal in the value of the firm, and she can exercise her option to join the hitherto regulated firm at any time. Thus, firm value dynamics in (2.16) is given by

$$\frac{dV(t,\omega)}{V(t,\omega)} = \mu(s(\theta))dt + \sigma(s(\theta))dW(t,\omega) \tag{2.17}$$

More on point, (Shepp, 2002, pg. 1373) and Guo (2001) introduce evidence that information asymmetry is dispositive of volatility dynamics, and the activity of insiders leads to increased volatility. In which case we assume that regulator signals increases volatility of firm value. That is

Assumption 2.5. $\sigma(s(\theta)) > \sigma$ □

This assumption is consistent with Boyle et al. (2011) who find that high volatility firms should use more stock options to compensate their executives. In our model, regulators "game" the system by sending signals that increase volatility of firm value and hence their anticipated career option package. Thus, using the formulae in (2.12), we find that

$$f(V(s(\theta)),\tau) = V(s(\theta))\Phi(x_1(\theta)) - D(s(\theta))\exp(-r\tau)\Phi(x_2(\theta)) \tag{2.18a}$$

$$x_1(s(\theta)) = \frac{\log\frac{V(s(\theta))}{D(s(\theta))} + (r + \frac{\sigma(s(\theta))^2}{2})\tau}{\sigma(s(\theta))\sqrt{\tau}} \tag{2.18b}$$

$$x_2(s(\theta)) = x_1(s(\theta)) - \sigma(s(\theta))\sqrt{\tau} \tag{2.18c}$$

Thus we must compare the value of the option on the firm with embedded regulator signal to the value without signal. To do that we turn to option Greeks by examining the vega (ϑ) of the option on the firm.[17] That is, for the mean zero normal distribution function ϕ, let

$$\vartheta(0) = \frac{\partial f(V,\tau)}{\partial \sigma} = V\phi(x_1)\sqrt{\tau} \tag{2.19}$$

$$\vartheta(s(\theta)) = \frac{\partial f(V(s(\theta),\tau)}{\partial \sigma(s(\theta))} = V(s(\theta))\phi(x_1(\theta))\sqrt{\tau} \tag{2.20}$$

According to Assumption 2.5 information based vega is larger than plain vanilla vega.[18] Thus,

$$\vartheta(s(\theta)) > \vartheta(0) \Rightarrow V(s(\theta))\phi(x_1(\theta))\sqrt{\tau} > V\phi(x_1)\sqrt{\tau} \tag{2.21}$$

$$\Rightarrow \frac{V(s(\theta))}{V} > \frac{\phi(x_1)}{\phi(x_1(\theta))} \tag{2.22}$$

Under Lemma 2.4 a more levered firm with embedded regulator signals enhances regulator career option. Thus, we have

$$\frac{\phi(x_1)}{\phi(x_1(\theta))} > 1 \Rightarrow \exp\left(-\left(\frac{x_1^2}{2} - \frac{x_1(s(\theta))^2}{2}\right)\right) > 1 \tag{2.23}$$

$$\Rightarrow -x_1(\theta) < -x_1 \text{ and } x_1(\theta) > x_1 \tag{2.24}$$

(Gropp et al., 2006, pp. 405-406) defined $-x_1$ as the "distance to default" and found that it was a predictor of bank stability. In fact, they report that "the banks that were downgraded * * * had a significantly higher mean value of $[x_1]$ than those that did not" in the 6-18 months prior to downgrade. The analysis below provides a theoretical explanation.

2.3.2 Bankruptcy warning signals: Firm vega and leverage

The foregoing arguments show that the information based vega for the option value of the firm is dispositive of regulator incentive to leverage regulated firms. Cf. Armstrong and

[17] See (Hull, 2006, pg. 361) for derivation of formula for vega.
[18] Chesney et al. (2012) also introduced the concept of "asset volatility vega" which is higher than plain vanilla "equity volatility vega".

Vashishtha (2012). According to Kolmogorov Inequality, see e.g. (Athreya and Lahiri, 2006, Thm. 8.3.1, pg. 249), under Assumption 2.5, if φ is the proportion of total tail probability in the lower tail, then for some threshold value λ and assuming maximal probability thresholds we have the nonparametric result

$$\Pr\Big(\max_{\theta}\{x_1(\theta)\} < -\lambda\Big) = \varphi\frac{\mathrm{Var}(x_1(\theta))}{\lambda^2} \tag{2.25}$$

$$= \varphi\frac{\tilde{\sigma}^2_{x_1}(\theta)}{\lambda^2} > \varphi\frac{\mathrm{Var}(x_1)}{\lambda^2} = \varphi\frac{\tilde{\sigma}^2_{x_1}}{\lambda^2} \tag{2.26}$$

where $\tilde{\sigma}^2_{x_1}(\theta)$ and $\tilde{\sigma}^2_{x_1}$ are the variances of $x_1(\theta)$ and x_1 respectively. The result in (2.26) is important because it says that the "large deviation probability" for firm value at risk included in $x_1(\omega_b,\theta)$, i.e. tail risk in bad states $\omega_b \in \Omega$, is greater than the corresponding probability if there was no regulatory signals or "regulatory capture" embedded in capital structure. To see this rewrite $V(s(\theta))$ in (2.18) as $V(\theta)$ so that after algebraic reduction we have

$$\lim_{\sigma(\theta)\to\infty} \Pr\Big\{\max_{\theta} V(\theta) < \max_{\theta} D(\theta)\exp\Big(-\lambda\sigma(\theta)\sqrt{\tau} - \Big(r + \tfrac{\sigma^2(\theta)}{2}\Big)\tau\Big)\Big\} > \varphi\frac{\tilde{\sigma}^2_{x_1}}{\lambda^2} \tag{2.27}$$

$$\Rightarrow \Pr\{\max_{\theta} V(\theta) < 0\} > \varphi\frac{1}{\lambda^2\sigma^2\tau}\mathrm{Var}\Big(\ln\frac{V}{D}\Big), \quad |\lambda| < \left(\frac{\mathrm{Var}\Big(\ln\frac{V}{D}\Big)}{\sigma^2\tau}\right)^{\frac{1}{2}} \tag{2.28}$$

where $\tilde{\sigma}^2_{x_1} = \frac{1}{\sigma^2\tau}\mathrm{Var}(\ln\frac{V}{D})$ by virtue of our hypothesis for rewriting $V(\theta)$ for $V(s(\theta))$ in (2.18) . The relationship in 2.28 is equivalent to a bankruptcy condition involving leverage $\frac{D}{V}$. It says that if regulator signals θ induce too much volatility, i.e. uncertainty, in firm value $V(\theta)$, then the probability that the value of the firm is negative, i.e. it goes bankrupt when $V(\theta) < 0$, is greater than a given threshold without regulator signals. This result characterizes Lehman Brothers bankruptcy where regulators signalled that they were not going to provide liquidity for a highly levered bank (Adrian and Shin, 2010).

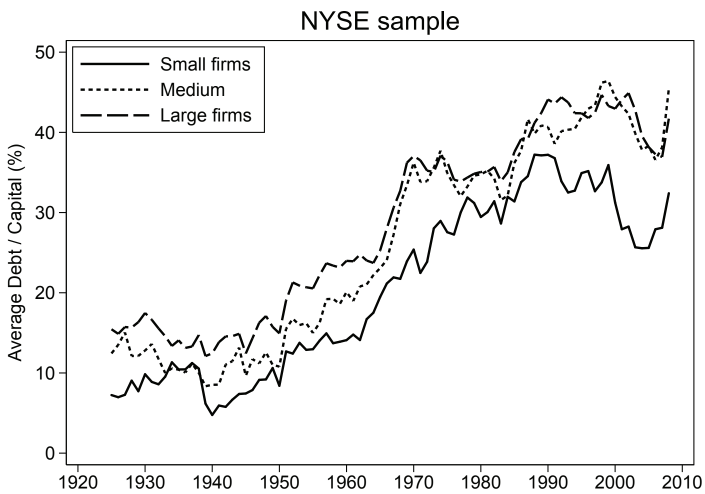
Thus we have proven the following

Proposition 2.6. *[Bankruptcy condition] Assume that regulatory capture exists so that regulators embed regulatory signals θ in firm capital structure. Then firm value-at-risk $x_1(\omega_b, \theta)$ in bad states of nature is greater than $x_1(\omega_b)$–the value it would be in non-regulatory capture regimes–and the probability of bankruptcy is higher than it would be in the absence of regulator signals.* □

Remark 2.2. This proposition should not be interpreted to mean that in a world with no regulation, firm value-at-risk will be lower than if there is regulation. The proposition is based on an assumption of "regulatory capture". The absence of regulatory capture though necessary, is not a sufficient condition to support deregulation. □

The vega ($\vartheta(t|\sigma(\theta))$ curve sketched in Figure 3 was motivated by (DeYoung et al., 2013, Fig. 2 CEO Vega). The firm leverage ($L(t|\sigma(\theta))$ sketch is motivated by the distribution of average leverage over time for a sample of firms on the NYSE depicted in Figure 2.

Figure 2: Average leverage for sample of firms
listed on NYSE: 1920-2010

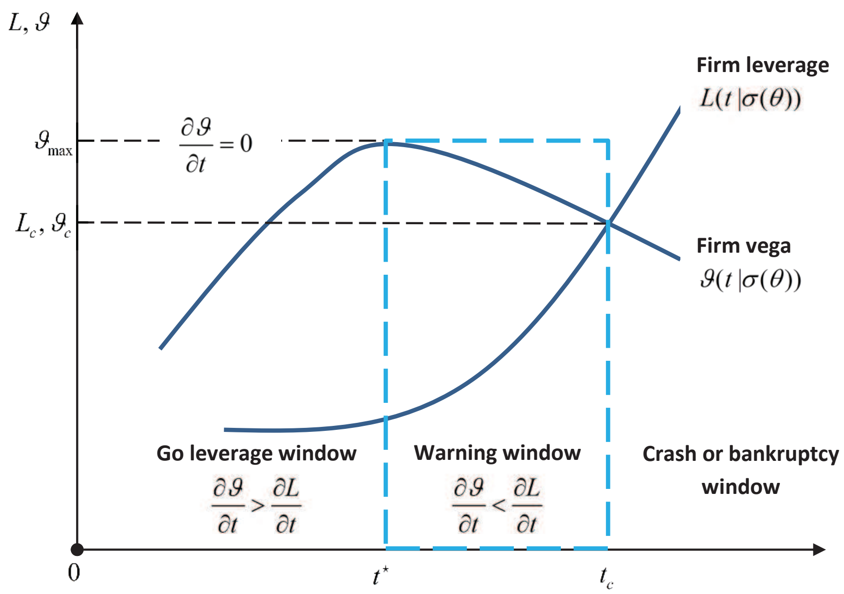


Source: (Graham et al., 2014, Fig. 3B)

The sketched curves are based on the assumption that the vertical axis is suitably scaled. We assume that the vega for managerial compensation is tied to firm performance and that it is rolled over the life of the firm. The relationship between vega and firm leverage $L = \dfrac{D}{V}$ is implied by (2.19) and (2.20). Thus, critical time points occur where $\vartheta(L(t|\,\sigma(\theta))) = L(t|\,\sigma(\theta))$ in vega-leverage space. Vega attains a maximum for some value of L. The roots of the equations in (2.19) and (2.20) can be obtained by superimposing a plot of ϑ and L on the same diagram. Figure 3 provides a sketch of that procedure for a root at $t^\star$.

The sketch suggests that the rate of increase in firm leverage $\frac{dL}{dt}$, and the rate of increase of firm vega $\frac{d\vartheta}{dt}$ conditioned on regulator signal dependent risk $\sigma(\theta)$, may be dispositive of bankruptcy as well. It shows that the rate of diminishing returns to vega begins

Figure 3: Firm vega (ϑ) and leverage L for given risk signal $\sigma(\theta)$ with early warning and bankruptcy windows



L_c, ϑ_c are the critical points for firm leverage and vega. Beyond that the firm's stock price crashes or it goes bankrupt. At $t^\star$ vega is at a maximum. In time period $(0, t^\star]$ leverage is encouraged. In period $(t^\star, t_c]$ leverage should proceed with caution. At time $t > t_c$ the firm is at risk for bankruptcy.

just after maximum vega ϑ_{max}, at t^*, even though the rate of firm leverage is increasing. However, beyond some critical point (L_c, ϑ_c) (a root of say (2.20)) the firm is so highly levered that it goes bankrupt. So the period $(t^*, t_c]$ is a time when warning signals of possible bankruptcy takes place. These artifacts of vega and leverage are summarized thus:

Proposition 2.7 (Menu of firm response to leverage induced regulator signals). *Let $(L(t|\sigma(\theta))$ and $\vartheta(L(t|\,\sigma(\theta)))$ be time dependent firm leverage and vega respectively for a given risk profile $\sigma(\theta)$ induced by regulator signal θ. Critical time points are given by the solution to $\vartheta(L(t|\,\sigma(\theta))) = L(t|\,\sigma(\theta))$, and induce the following menu of firm response to leverage and regulator signal:*

A1 Go leverage window: $\frac{d\vartheta}{dt} > \frac{dL}{dt}$ *and* $L < \vartheta$

A2 Early warning window: $\frac{d\vartheta}{dt} < \frac{dL}{dt}$ *and* $L < \vartheta$

A3 Crash or bankruptcy window: $\frac{d\vartheta}{dt} < \frac{dL}{dt}$ *and* $L > \vartheta$

□

3 Applications to commercial banks

In order to illustrate some of the salient characteristics of our model, we switch gears and treat the "firm" as a bank. We examine statistics extrapolated from publicly available data on commercial banks[19] insured by the FDIC[20] to ascertain whether stylized facts support aspects of our theory. With the exception of the public utilities industry, the banking industry is arguably the most regulated industry.[21] As a result, it has one of the most powerful lobbies in the United States, and by extension the world.[22] By virtue of what banks do, collect deposits (so called [short] transaction liquidity), and provide loans (a bank asset based on transformation of [long] illiquid asset) with mismatched duration relative to deposits, they are highly leveraged and fragile. See Diamond and Dybvig (1983); Berger and Bouwman (2009). The data depicted in Figure 4 show a steady decline in the number

[19]Even though the capital structure for banks is different from that for firms our model is robust enough to apply here. Cf. Diamond and Rajan (2000).

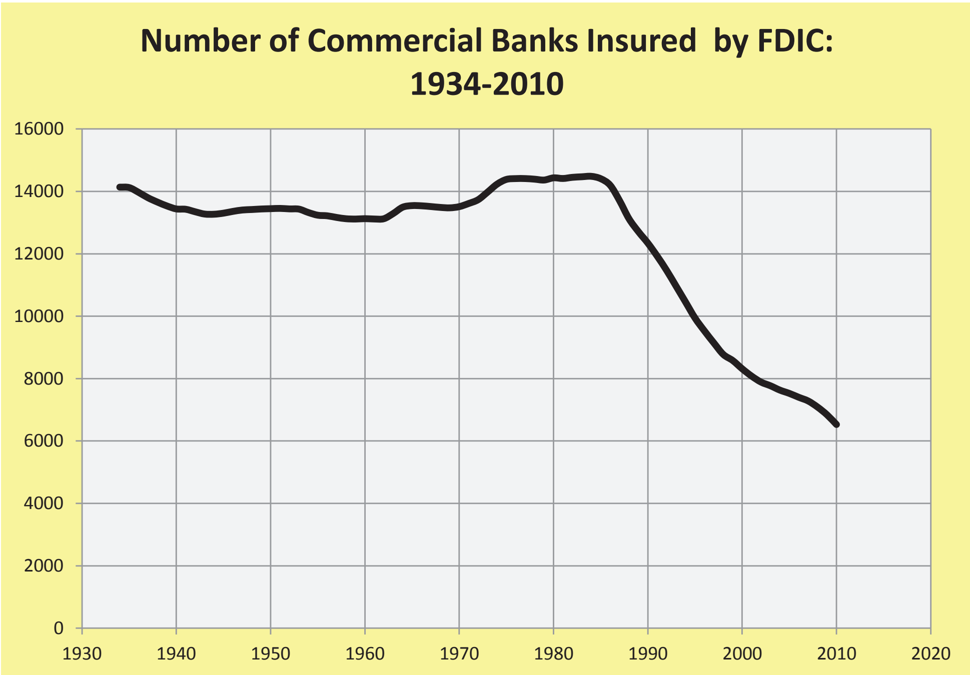
[20]See FDIC web site at http://www2.fdic.gov/hsob/HSOBNotes.asp#CB14. Last visited 2/29/2012

[21]See Basel Accord I, II and III specifying capital requirements for domestic and foreign banks.

[22]See Dunn (2012) and Goldfarb and Schneider (2012) (local and foreign governments protests against Volker rule negative externality on bank participation in municipal and soverign bond market).

of commercially insured banks starting around the mid 1980's. This suggests that a lot of banks were being acquired or consolidated.[23]

Figure 4: Trend in Commercial Banks Insured by FDIC: 1934-2010



3.1 The Adrian and Shin (2010) leverage factor

We estimated average leverage based on the [scaled] formula

$$Leverage = \frac{Tot.\ Liab.}{Tot.\ Liab.\ +\ Tot.\ EquityCap.} \tag{3.1}$$

$$Avg.\ \ Leverage = 10000 \times \frac{Leverage}{Num.\ of\ Banks} \tag{3.2}$$

The scale factor 10000 in (3.4) was arbitrarily chosen to amplify the leverage numbers. It does not affect the shape of the curve. Denis and McKeon (2012) used a similar formula for leverage. However, his study excluded financial firms and utilities. Moreover, their study

[23] According to the FDIC website, around 1990 FIRREA enabled thrifts to change their charter and become commercial banks. Also, the definition of commercial bank was extended to include, *inter alia*, national banks and state chartered banks. Thus, we should have seen more, not less, commercial banks in the data.

finds that observed leverage increases are mostly driven by firms need for funds related to changes in their investment opportunity set.[24]

(Adrian and Shin, 2010, pp. 420-421) used a different formula for leverage which we define as follows:

$$Leverage\ AS = \frac{Tot.\ Liab.\ +\ Tot.\ Equity\ Cap.}{Tot.\ Equity\ Cap.} \tag{3.3}$$

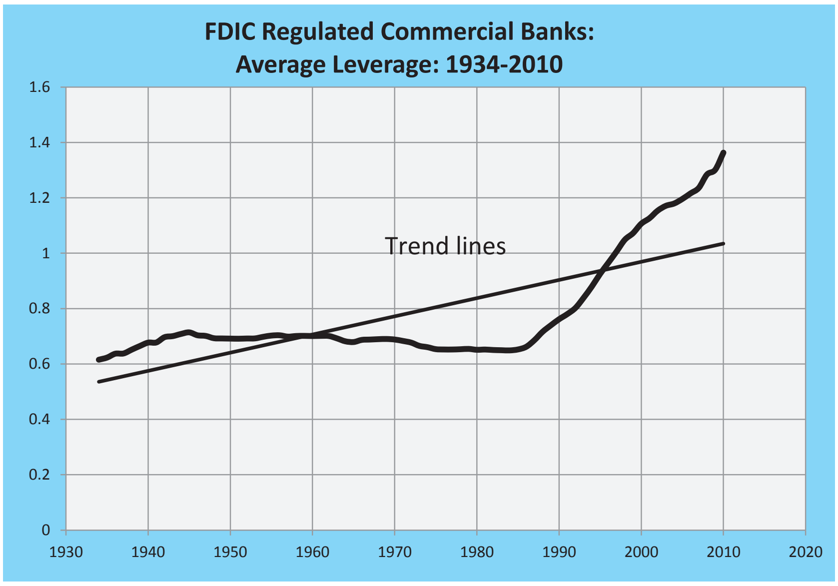
$$Avg.\ Leverage\ AS = \frac{Leverage\ AS}{Num.\ of\ Banks} \tag{3.4}$$

Those formulae capture commercial banks targeting a fixed leverage ratio. The Adrian-Shin (AS) leverage formula is sensitive to securities trading activity by banks. So it is more suited to the analysis that follow.

Figure 5 depicts the average leverage for commercial banks in the United States insured by the FDIC between 1934-2010.

[24] Graham et al. (2014) also used a leverage formula similar to (3.1) in their study.

Figure 5: Annual Trend in Leverage for FDIC Insured Commercial Banks: 1934-2010



Leverage is measured using the formula in Denis and McKeon (2012) and Graham et al. (2014). $Leverage = \frac{Tot.\ Liab.}{Tot.\ Liab. + Tot.\ EquityCap.}$ and $Avg.\ Leverage = 10000 \times \frac{Leverage}{Num.\ of\ Banks}$

One indication of the trend in bank consolidation, and steady growth in average leverage, is that there may have been a lot of quiet bank failures or consolidation of distressed banks. More on point, by 1990 the market for asset securitization and collateralized debt obligation (CDO) began to take off.[25] Refer to Tavakoli (2003) for institutional and technical details on CDOs. Thus, the growth in average leverage paralleled the growth in highly leveraged financial derivative products. According to our model, this was a great time for regulator exercise of career options. With respect to subprime lending, that period was characterized thusly:

> Many factors have contributed to the growth of subprime lending. Most fundamentally, it became legal. The ability to charge high rates and fees to borrowers was not possible until the Depository Institutions Deregulation and Monetary Control Act (DIDMCA) was adopted in 1980. It preempted state interest rate caps. The Alternative Mortgage Transaction Parity Act (AMTPA) in 1982 per-

[25](Berger and Bouwman, 2013, pg. 151) characterized the early 1990s as a period of credit crunch. So the market for derivatives may have been a response to liquidity constraints.

> mitted the use of variable interest rates and balloon payments. These laws opened the door for the development of a subprime market, but subprime lending would not become a viable large-scale lending alternative until the Tax Reform Act of 1986 (TRA). The TRA increased the demand for mortgage debt because it prohibited the deduction of interest on consumer loans, yet allowed interest deductions on mortgages for a primary residence as well as one additional home. This made even high-cost mortgage debt cheaper than consumer debt for many homeowners.

(Chomsisengphet and Pennington-Cross, 2006, pg. 38). Figure 6 depicts superimposed leverage and average leverage as indicated. Even though aggregate leverage appear to fall starting around 1980, average leverage was increasing. That curve is isomorphic to a call option curve for firm leverage in the sense of Merton (1974, pg. 454). Thus, confirming the call option like prediction of our regulation theory. See also, Kane (2011, pg. 7) who states: "Most existing measurement strategies incorporate the pioneering perspective of Nobel Prize Winner Robert Merton. Studies using his approach show that regulators could have tracked the growing correlation of institutional risk exposures and used it as an early warning system for the increase in systemic risk that resulted in the current crisis".

Figure 7 provides an analogous chart for leverage using the Adrian-Shin formula. Data show that around the early to mid 1980s trends in bank consolidation began to emerge, and average bank leverage began to increase. Thus we have an inverse relationship between the number of FDIC insured commercial banks, and their average leverage. Comparison of Figure 7 and Figure 6 show that the latter provides a smoother curve that reflects persistent increase in average leverage. While the former reflects the "hockey stick" pattern attributed to the Federal Reserve's injection of liquidity into the financial system in the advent of the Great Recession of 2008. In fact, the similarities between Figure 5 and Figure 8 imply that the Federal Reserve's injection of liquidity was a delayed response to the increasing average leverage by commercial banks which began many years before.

Figure 6: FDIC Insured Commercial Banks Leverage and Average Leverage: 1934-2010

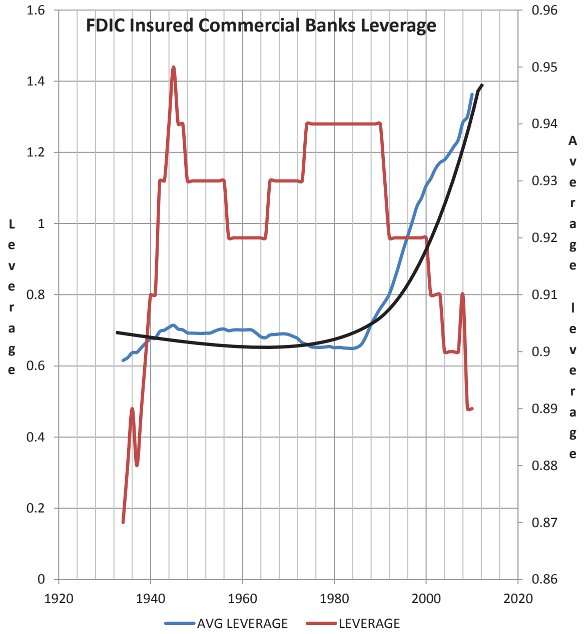
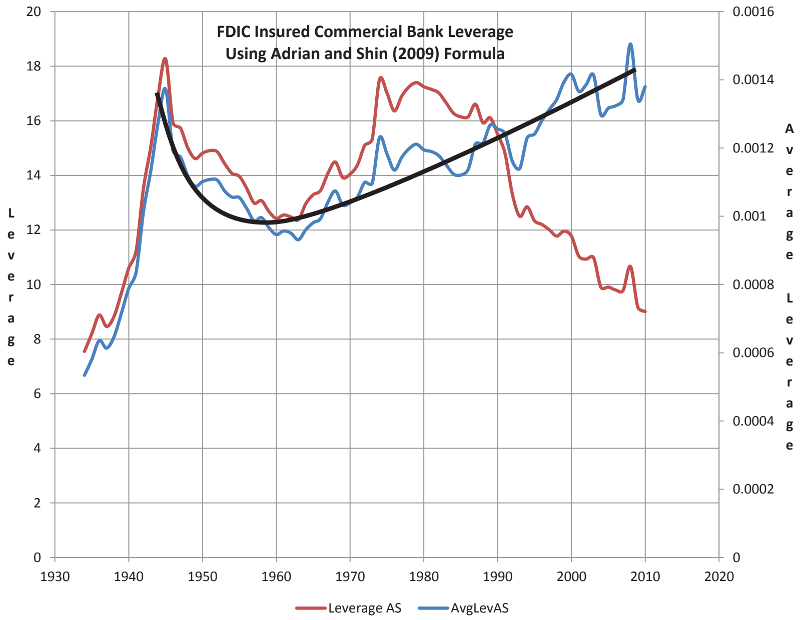


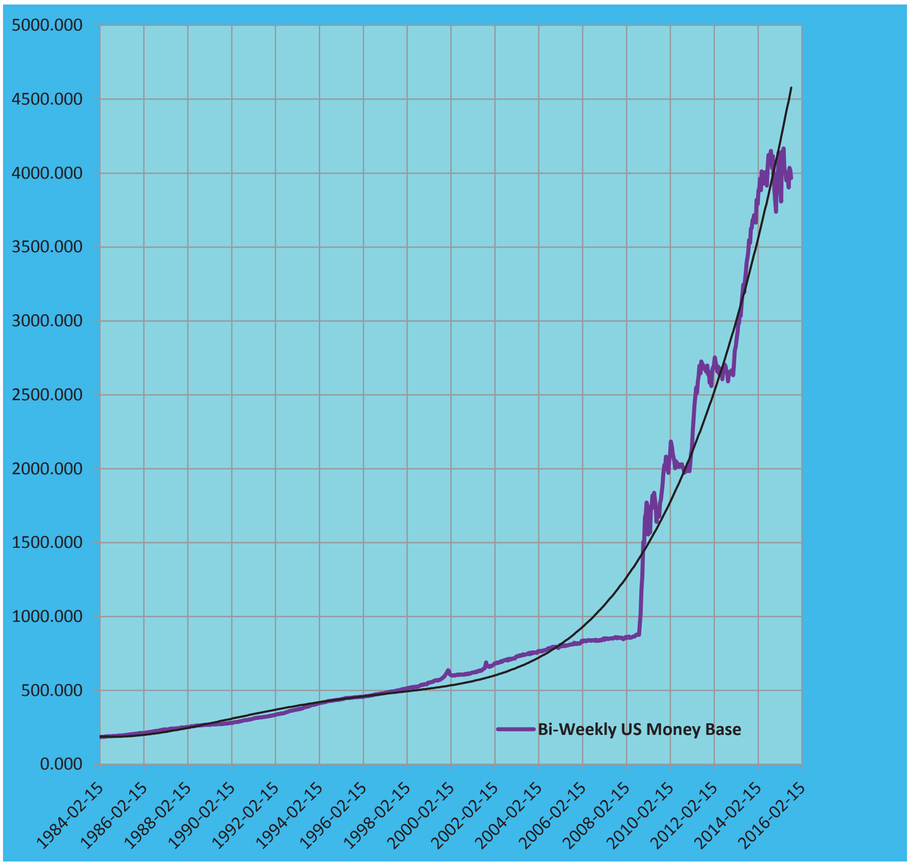
Figure 7: FDIC Insured Commercial Banks Leverage 1934-2010 Using Adrain-Shin Formula



Undeniably, in the context of our model, regulators of financial institutions sent deregulation signals which increased leverage and by extension the value of their career options.[26] In particular, the observed increased use of leverage is consistent with our model's prediction that the price of financial products in regulator induced strategy space G in Lemma 2.4, and consumer welfare tradeoffs in Proposition 2.3, were relatively high.

[26]See Appelbaum and Nakashima (2008) ("But critics said that the [Office of Thrifts Supervision] agency had neglected its obligation to police the thrift industry and instead became more of a consultant").

Figure 8: US Biweekly Money Base:
1984:02:15-2015:08:19



To wit, regulators used mechanism design to induce a strategy space G in which high interest rates (the consumer price) accompanied increased leverage (firm profit)–as predicted by Proposition 2.3–while at the same time permitting the high rates to be tax deducted. This was tantamount to an option in which the financial industry (the firm) benefited from upside risk, while taxpayers (the consumer) held the downside risk by and through a perceptible decrease in tax revenue.[27] In effect, the interest deduction was a functional transfer from

[27]In private communique with one of the authors, Dr. Philip Obazee characterized this phenomenon thusly:

> I have thought of what [is] described * * * as "puts" on government/central banking authority[.] [A]nd the "effervescent premiums" on those puts invariably spurred economic growth, and the monetization of the illiquid assets (via the subprime channel) that ensued acted as cap on inflation. Unfortunately, this process works with the help of "arbitrageurs" who depend on continuous supply of liquidity to function, and an unexpected shock (Lehman Brothers, for example) to this supply channel tends to results (sic) in arbitrage cascades, liquidity spirals and liquidity black holes.

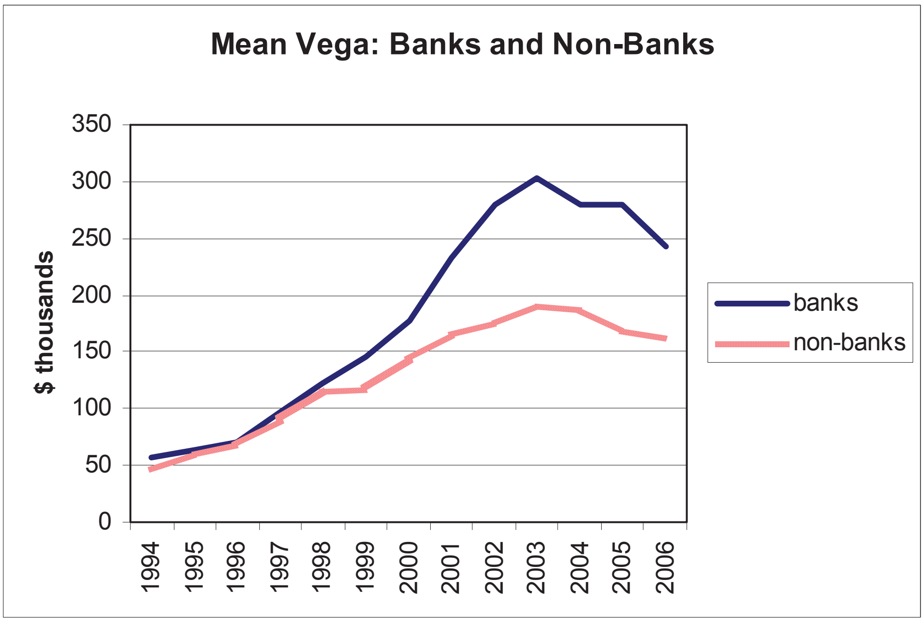
Those observations are borne out by Figure 5 and Figure 8.

the tax department to the financial industry.

3.2 Bank CEO vega and leverage as predictors of financial crisis

Figure 9: FDIC Insured Commercial Bank CEO
Vega: 1994-2006

This figure reports the dollar value (in thousands of 2006 dollars) of vega (the dollar change in the CEO's wealth for a 0.01 change in standard deviation of returns) for CEOs in banks (881 observations) versus industrial firms (19,447 observations) from 1994 to 2006.



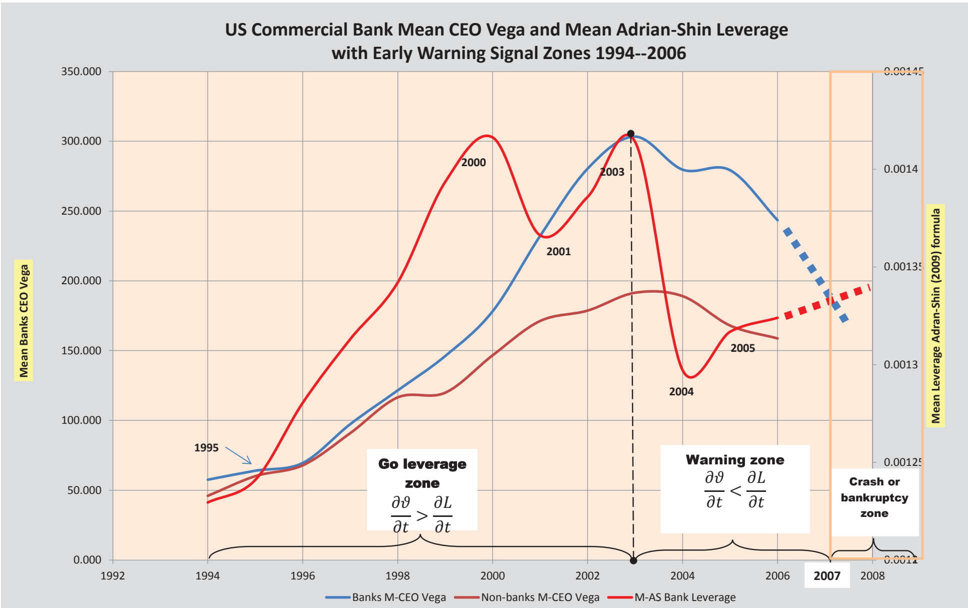
Source: DeYoung, Peng and Yan (2010), "Executive Compensation and Business Policy Choices at U.S. Commercial Banks," Federal Reserve Bank of Kansas City

From a behavioural economics perspective, the financial industry was engaged in risk seeking over low quality loan portfolios (Barberis and Huang, 2008; Kumar, 2009). In particular,

> In 1994, for example, interest rates increased and the volume of originations in the prime market dropped. Mortgage brokers and mortgage companies responded by looking to the subprime market to maintain volume. The growth through the mid-1990s was funded by issuing mortgage-backed securities (MBS, which are sometimes also referred to as private label or as asset-backed securities [ABS]).

(Chomsisengphet and Pennington-Cross, 2006, pg. 38). However, the increased trend in

Figure 10: Critical time points in Banks'
leverage-vega space



Source: Charles-Cadogan (2015)

leverage began long before the sub-prime loans saga[28] which is often blamed for the Great Recession of 2008. Figure 9 is taken from (DeYoung et al., 2013, Fig. 2 CEO Vega) it plainly shows that the vega for commercial bank CEOs continued to increase until around 2003 after which it began to fall. Also, the mean vega for commercial bank CEOs is concordant with and higher than that for non-financial firms–as it should be–by virtue of the leveraged nature of banking. So our theory is well defined. By comparison, average leverage for commercial banks depicted in Figure 5 continued to increase. Assuming appropriately scaled axes, Proposition 2.7 was in play here. Even though the plot for CEO vega is cut off in 2006, its not difficult to see that the warning signs described in Proposition 2.7 were in place soon after 2003. And that the critical crash point (L_c, ϑ_c) from Proposition 2.7 was imminent circa 2007-2008.[29] Those scenarios are depicted in Figure 10 which is an empirical analog of Figure 3.

[28](Kindleberger, 2000, pp. 111-115) reports that historically stock market bubbles lead real estate prices.

[29]Because Figure 9 was lifted from DeYoung et al. (2013) it could not be superimposed on Figure 5 to find the critical point. Additionally, Proposition 2.7 was motivated by those curves.

A study by Coffinet et al. (2013) applied survival analysis techniques to bank exchange traded option contracts which also provide support for Proposition 2.7. To be sure, asset securitization of sub-prime loans added fuel to the leverage fire but the data plainly show that they were not the cause of leverage. As it were, by 2008, the prediction of (2.26) and Proposition 2.6 came to pass. A bad shock to the economy, which was exposed to greater value of risk than it would have in the absence of regulatory capture,[30] sent the financial industry into a tailspin from which it is still reeling.[31]

4 Conclusion

We introduce a model of regulator career option to quit and join firm management in a world with labor market mobility, and regulatory capture. The model predicts, and thus explains, several empirical regularities of the revolving door phenomenon between the public and private sector. Moreover, it plainly shows that when a regulator's career option depends on firm leverage, firm value at risk is greater in bad states of nature. This result has implications for the banking industry where extant regulatory [micro-management] requirements all but mandate regulatory capture by requiring regulators to work with management to obtain low CAMELS scores. In which case, according to our theory, bank supervisors involvement in risk micro-management, together with their reputation concerns, and resultant regulatory capture, actually increases bank leverage and value-at-risk in bad states. Even so, the theory presented in this paper is applicable in any environment where regulators can exercise career option to quit and join regulated firms.

We note that financial institutions and banks are attracted to the possibility that they might minimize capital requirements if they attract a regulator. And the regulator is attracted by the career option strike price (K on page 12). The net result is really a labor

[30]See (Laffont and Tirole, 1991, pp. 1090-1091) for a taxonomy of incentives for regulatory capture.

[31]See Nocera (2011) extensive interview with outgoing FDIC chair Shelia Bair for further institutional response and background information. See also, Dymski (2012) for a review of proposals, and financial institutions responses, to mitigate the "too big to fail" hypothesis which some analysts believe lies at the heart of the Great Recession of 2008.

market process for regulators that is not now called that. One result is that this supports a system that is more beneficial to institutions which can independently participate in that market. In other words, there is a market for "ex-regulators" with strike price K as a market price at any time. We characterize this phenomenon in the context of our model thusly:

1. With a tradition of profitable revolving door behavior, we can expect that contingent on the regulatory agency, there will be some minimum strike price - given both the regulator's compensation in her current employment, and the "market" established price obtained by the last regulator who left.

2. There will only be a limited number of current banks that alone can afford to meet the strike price. These would also be the institutions best positioned to fully exploit the IRR advantage from the regulator's labor

3. A process of industry concentration of existing banks will evolve. In that context, we should then expect any of the following to be very prominent:

   (a) Some "too big to fail" institutions may emerge and disproportionately attractive alternative employers for current regulators. These may be banks which are branded currently as reflecting national "systemic risk" and for regulatory purposes, these may be the focus of an institution like the Board of Governors of the Federal Reserve Board.

   (b) Other institutions, not quite "too big to fail" might share specialized IRR projects and together meet the regulators' strike price e.g. major regional banks may seek to be branded as such, and work closely with the regional Federal Reserve Bank

   (c) Lesser institutions may seek other aggregating strategies[32] in an effort to meet the regulators' strike price:

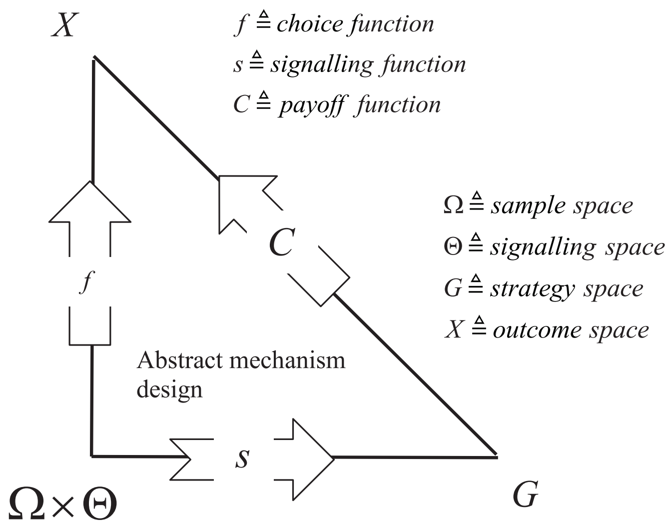
[32] Berger and Bouwman (2009) introduced a bank liquidity measure which found that the relationship between capital and liquidity creation is positive for large banks and negative for small banks. However, in a subsequent paper, Berger and Bouwman (2013), after removing large banks perceived as too big to fail from the data, they found more encouraging results for small banks.

    i. Organizations of Community banks e.g. the Independent Community Bankers of America.
    ii. Women owned banks
    iii. Minority owned banks

4. The revolving door may be seen in banking as either corrupting or self-reinforcing of educating institutions about the regulatory process - its costs and benefits!

Even though we make no policy recommendations, one must be careful about regulatory overreaction to negative news coverage about revolving doors. For firms, whether banking or otherwise, are part of the economy and too much regulation can have the effect of stifling economic growth. Nonetheless, this paper suggests whether in cash, in kind, or deferred compensation regulator compensation should be tied to market outcomes of the firms they regulate. Also, it suggests that monitoring vega for managerial compensation, and average liquidity are necessary elements in mitigating market crashes or firm bankruptcy. The eternal quest is to strike an equitable balance between regulation and financial institutions leverage as engines of economic growth. Further research along the lines presented in this paper include but is not limited to optimal quitting time for regulators, contract design to preclude regulatory capture, and human capital beta pricing for regulators.

Figure 11: Regulator's abstract mechanism design



APPENDIX

A Abstract mechanism design for embedding regulator signals

The main advantage of formulating the problem in the context of an abstract mechanism design is it allows us to plug in select variables in the reduced form so that we can examine a taxonomy of regulator signals. In the sequel we define incentive compatibility and participation constraints for our regulator. And we characterize the revelation principle which induces a regulator [and firm] to report its type truthfully. Suffice it to say that in the sequel, the regulator designs an implicit game or indirect mechanism–consistent with maximizing her welfare function–in which she frames the strategies or choices available to a firm. In order for the firm's participation constraint to be binding, the price of its product must be at least equal to its marginal cost. This is consistent with the revelation principle in (Baron and Myerson, 1982, pg. 913). In which case, the firm's incentive compatibility constraint rests on its ability to maximize profits in that milieu[33]. By contrast, the regulator reports her type truthfully in order to maximize her career option. The interested reader is referred to Baliga and Sjöström (2008) for a brief or Börgers (2008) for a more detailed exposition on mechanism design theory, and (Dal Bó, 2006, pg. 208, Appendix) for details on application and implementation in the context of a revolving door model.

Definition A.1 (Mechanism)**.** A mechanism $\mathcal{M} = (G, C)$ defines a set of feasible strategic actions G available to an agent in outcome space X with outcome rule $C : G \to X$. □

[33]We thank Sam Myers Jr. for clarification on this point.

That said, let Θ be a type space for regulators, and Ω be a sample space or states of nature, $\mathcal{F}$ be the σ-field of Borel measurable subsets of Ω, and P a probability measure on Ω. Let X be an outcome space, and f be a stochastic choice function such that $f : \Omega \times \Theta \to X$ is a direct mechanism. Based on her type, the regulator sends a state dependent signal s into some strategic space G, i.e. $s : \Omega \times \Theta \to G$. For instance, the space G may comprise the signal $s(\omega, \theta)$ obtained from the regulator's welfare maximization; a menu of profits Π for the firm, and the strategic form g. So that

$$G = \{s(\omega, \theta), \Pi, g\} \tag{A.1}$$

However, that signal $s(\omega, \theta)$ is subject to the vagaries of the state of nature. Nonetheless, it might be favorable regulation or deregulation. On the basis of interactions in G, i.e. the firms response, the regulator maps a payoff function C into X, i.e $C : G \to X$. These mappings are depicted in Figure 11 on page 32.

Definition A.2 ((PC): Regulator's participation constraint)**.**
Let K be the compensation package of the regulator, assumed fixed over the epoch of career mobility, and $V(\omega, \Pi)$ be the value of the firm as a function of profits. The regulator will participate in exercise of a state contingent career [call] option when

$$C(s(\omega, \theta)) = (\alpha V(\omega, \Pi) - K)^+$$

for some equity stake $0 < \alpha < 1$ □

Definition A.3 ((IC): Regulator's incentive compatibility constraint)**.**
Let θ be the regulator's true type and $\hat{\theta}$ be any other reported type. Let $(\Omega, \mathcal{F}, P)$ be a probability space for states of nature. Then for some event $A \in \mathcal{F}$ we have

$$\int_A C(s(\omega, \theta))dP(\omega) \geq \int_A C(\hat{\theta}, \omega))dP(\omega)$$

That is, the regulator has incentive to reveal her true type because the expected value of her career option is greater than the expected value if she does not. □

Figure 11 on page 32 depicts an indirect mechanism, i.e. "topological lifting" of the stochastic choice function f. That is, for some $\omega \in \Omega$ we have a composite function $C \circ s$ that is functionally equivalent to f. This gives rise to the following

Definition A.4 (Revelation principle)**.**
Given any feasible career option mechanism $C : G \to X$, there exist a feasible direct mechanism $f : \Omega \times \Theta \to X$ such that for $A \in \mathcal{F}$ we have

$$f(\omega, \theta) \cong (C \circ s)(\omega, \theta) \tag{A.2}$$

$$\int_A f(\omega, \theta)dP(\omega) = \int_A (C \circ s)(\omega, \theta)dP(\omega) \tag{A.3}$$

□

With full information the regulator's [options] contract can be described by the direct mechanism f. There is no signalling or need for the regulator to implement a set of rules for the firm. Because everyone knows that regardless of the state of nature Ω, the regulator will quit and join the regulated firm for a payoff in X. However, that scenario may be associated with a "P-negligible event, i.e. small probability of occurrence for probability measure P on Ω, in the Borel subsets $\mathcal{F}$ of Ω. However, with asymmetric information we need to design an option contract in G-space so that its value is $C(s(\omega, \theta)), \ \ \omega \in \Omega, \ \theta \in \Theta$. The elements of that state dependent contract must include firm value and other "observable" regulatory signaling variables. For instance, abstract signals can represent the regulators effect on taxes, sales, and other corporate liabilities such as introduction of legislation that forces on [or off] balance sheet items that affect reported earnings. In the case of banking, CAMELS[34] scores are probably the best example of a regulator signal. For a low CAMELS score assigned to a highly leveraged bank signals regulator approval of the bank's risk management processes.

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[34] The acronym stands for: **C**apital adequacy, **A**sset quality, **M**anagement, **E**arnings, **L**iquidity, **S**ensitivity to market risk. Details on computation of each component are described in UNIFORM FINANCIAL INSTITUTIONS RATING SYSTEM (UFIRS) (eff. 1996) available at http://www.fdic.gov/regulations/laws/rules/5000-900.html. Scores are based on a ranking of 1 = best to 5 = worst.

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