THE RETENTION CONSEQUENCES OF CAPS ON EXECUTIVE COMPENSATION DURING FINANCIAL CRISES

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Abstract: We estimate a structural model of CEO compensation and turnover during financial crises and public bailouts, using it to analyze one of the main provisions of the American Recovery and Reinvestment Act of 2009 (ARRA), namely a cap on executive compensation imposed on firms accepting bailouts. Using Compustat and ExecuComp data, we estimate the model's pre-policy regime and then simulate the effect of the policy on the design of executive compensation contracts, CEO turnover, the probability a firm accepts a bailout, and the probability of bankruptcy. The analysis characterizes the distortion in compensation contracts that results from the policy, i.e. the piece rate is suboptimal and is either too high or too low depending upon the executive's risk preferences and the variance in the performance measure on which the variable pay is based. While the theoretical model allows base pay and the piece rate to be either substitutes or complements, the data reveals them to be substitutes.

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1. Introduction

Executive compensation in the U.S. has been a hot-button political issue since the early 1990s (Crystal 1991, McCarroll 1992), with most of the debate surrounding two questions: Are CEOs overpaid? Is the link between CEO pay and performance sufficiently strong? As noted in Murphy (1999), criticisms by shareholders, unions, and the general public that CEOs are overpaid and that their pay is not tied closely enough to performance are amplified during recessions, when shareholders are losing money, whereas economic booms breed shareholder complacency. Thus, it is unsurprising that during the current global financial crisis, the most severe since 1929, fierce criticisms of executive compensation and calls for major reforms have advanced to center stage.[1] Within days of entering the White House, President Obama delivered strong televised criticism of CEOs receiving bonuses when their troubled organizations were in receipt of taxpayer-financed bailout funds:

"This is America. We don't disparage wealth. We don't begrudge anybody for achieving success. And we believe that success should be rewarded. But what gets people upset—and rightfully so—are executives being rewarded for failure, especially when those rewards are subsidized by U.S. taxpayers." – President Barack Obama (February 4, 2009)

Motivated by such public criticism, which in turn was fueled by companies' disclosure of more information about their executives' compensation as mandated by the Securities Exchange Commission, the government recently enacted policies to restrict executive compensation contracts for firms accepting public bailout funds. On February 17, 2009, President Obama signed into law the American Recovery and Reinvestment Act of 2009 (ARRA), also known as the Stimulus Package, which significantly expands the executive compensation restrictions already imposed upon recipients of Troubled Asset Relief Program (TARP) funds under the Emergency Economic Stabilization Act of 2008 (EESA). These policies apply to a number of firms and institutions that have significant market positions and influence in their respective industries (e.g. AIG, Fannie Mae and Freddie Mac, and General Motors), so their scope and potential impacts are worthy of close examination.[2]

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[1] As an example of the type of firm behavior that has come under attack, American International Group (AIG) gave executives in its most troubled business unit tens of millions of dollars in new bonuses even though it had suffered a loss of $61.7 billion for the fourth quarter of 2008 (the largest corporate loss in history) and received a taxpayer bailout of more than $170 billion dollars.

[2] Since the Fed provided the first AIG bailout with access to an $85 billion credit line on September 16, 2008, the total amount of bailouts granted reached $639.8 billion and was distributed to a total of 830 recipients as of March 9, 2010. Source: (http://bailout.propublica.org/main/timeline/index). The Treasury Department is authorized to spend a

In the current aftermath of the near collapse of the U.S. financial system, it is important to understand how such policies aimed at restricting executive compensation can be expected to impact executive and firm performance, retention of top talent, the probability that financially distressed firms accept taxpayer-financed bailout assistance, and the probability that such firms survive or close. Our paper addresses these questions, in what we believe is the first structural analysis of executive compensation and turnover in the context of government regulations on the design of incentive contracts. We investigate one of the ARRA's key provisions, namely a cap on executive compensation at $500,000 per year for firms accepting public bailout funds, with important exceptions for variable pay such as restricted stock grants.[3] Such restrictions distort the design of compensation contracts, resulting in inefficient contracts in which base pay is too low (and variable pay either too high or too low) relative to what the optimal linear contract would be for a risk-averse CEO. The rationale for the restrictions on compensation is to prevent generous compensation awards in failing firms and to mitigate the problems of moral hazard and adverse selection arising from bailouts, by increasing the costs to firms accepting bailout assistance. Criticisms of the restrictions focus on the problems firms may face attracting and retaining top talent when executive pay is restricted.

We develop a two-period theoretical model to analyze the implications of the ARRA for the structure of compensation contracts, CEO hiring and retention, and the probabilities of accepting bailout funding and declaring bankruptcy. In the first period, a firm offers a compensation contract and hires a risk-averse CEO to maximize expected first-period profit. After the CEO is hired, the CEO's performance is observed by the firm. An unexpected financial crisis then hits, causing the firm to incur a large fixed cost. We consider two regimes: a "pre-policy" or baseline regime and a "post-policy" regime. In the pre-policy regime, after observing the CEO's first-period performance, the firm decides whether to retain the CEO through the second period or to fire the CEO and hire a new one. The firm then offers a new contract to either the incumbent CEO (if the firm wishes to retain the CEO) or to a new one. Finally, second-period

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maximum of $698.8 billion on the TARP. As of March 9, 2010, $514.8 billion has been disbursed and $174 billion has been returned.

[3] On February 4, 2009, President Obama made the following announcements on restricting executive pay (http://blogs.wsj.com/washwire/2009/02/04/obamas-remarks-on-limiting-executive-pay/) "As part of the reforms we are announcing today, top executives at firms receiving extraordinary help from U.S. taxpayers will have their compensation capped at $500,000 – a fraction of the salaries that have been reported recently. And if these executives receive any additional compensation, it will come in the form of stock that can't be paid up until taxpayers are paid back for their assistance."

CEO performance (and company profit) is realized. The firm goes bankrupt at the end of the second period if the sum of first and second-period profits (less the fixed cost incurred as a result of the financial crisis) is negative. Otherwise the firm survives.

The post-policy regime is the same as the pre-policy regime except for the following additional features. After the financial crisis hits, the firm is offered the option of taking a government bailout in the form of a lump sum transfer. If the bailout is accepted, constraints are placed on the second-period executive compensation contracts the firm can offer, whether the second-period CEO is the incumbent CEO or a new one. More precisely, there is a cap on base pay, though variable pay is left unconstrained. Thus, the firm can choose one of four options at the end of the first period (accept a bailout and hire a new CEO, accept a bailout and retain the first-period CEO, reject the bailout and hire a new CEO, reject the bailout and retain the first-period CEO). As in the pre-policy regime, the firm either survives or closes at the end of the second period according to whether the sum of profits over both periods (plus the bailout payment, if it is taken, and minus the fixed cost arising from the financial crisis) is positive or negative.

The key tradeoff featured in our model is the attractiveness to the firm of getting a bailout versus the costs of incurring restrictions on the structure of future compensation contracts. The cap on base pay means that the firm must offer a lower level of base pay than is optimal, creating a distortion. What happens to variable pay in this case (i.e. whether it is higher or lower than it would be in the absence of a cap) depends on the executive's risk preferences and the variance in the performance measure on which the variable pay is based. The firm can always meet the participation constraint so that high-performing executives can be retained, despite the cap. This is consistent with the rules of the ARRA, which state that firms can offer additional compensation (beyond the capped base pay) in the form of variable pay such as restricted stock grants.

In a structural analysis using data from Compustat and ExecuComp, we estimate the parameters of the model's pre-policy regime via the method of simulated moments. We then simulate various pre-policy outcomes, including the probability of CEO turnover, the probability of accepting a bailout, the probability of firm closure, and the structure of second-period compensation contracts. We then simulate the corresponding outcomes in the model's post-policy regime, and compare simulations from the pre-policy and post-policy regimes to identify the effect of the ARRA's provision that caps base pay. A structural approach to the executive hiring and retention problem is advantageous for the usual reasons, i.e. we do not require post-policy data to conduct meaningful policy analysis, the outcomes we measure fully account for the optimizing responses of economic agents, and we can consider counterfactual policies.

Our simulations reveal the following results. First, in the post-policy regime the probability that the CEO leaves drops significantly, and the bulk of this effect comes from firms taking the bailout option. This result is counter to the criticism of the pay regulations that is frequently voiced in the popular press, namely that the regulations will make it difficult for firms to retain top executive talent. Simulated executive retention rates are actually higher in bailed-out firms than in the pre-policy baseline regime. Second, the bankruptcy probability is relatively insensitive to the policy, however it is slightly higher for firms that do not take the bailout than for those that do, given that the CEO stays. Third, second-period total CEO compensation does not change much as a result of the policy, though it is slightly higher than in the pre-policy regime given that it is higher in bailout firms. Despite the cap on executive base pay, firms are able to make up the difference by paying CEOs more variable pay to compensate for reduced based pay. Fourth, the bailout policy distorts the structure of compensation contracts. We find that base pay and variable pay are substitutes. That is, the cap on base pay induces firms to raise the piece rate (i.e. steepen the slope of the contract) to meet the CEO's participation constraint. This distortion is particularly pronounced in the event that the CEO leaves (versus stays) in the second period. The result that base pay and the piece rate are substitutes is driven by the data, given that the theoretical model allows for either substitutes or complements according to parameter values.

Furthermore, we provide counterfactual policy simulations and comparative statics analysis in which we explore the effects of changes in bailout amounts on the probability of CEO turnover, the probability of accepting a bailout, the probability of firm closure, and the structure of second-period compensation contracts. First, our policy simulations reveal that the probability the CEO is retained is increasing in the amount of the bailout, mainly due to the increases in the fraction of employers taking the bailout. The CEO retention rate is significantly higher for the bailout firms than for the "no bailout" firms. It is the combination of these two facts that explains why the retention rate is in general increasing in bailout amounts. Second, higher bailout amounts obviously imply an increased probability of accepting a bailout, thereby changing the composition of the "bailout" and "no bailout" groups. Third, a larger bailout amount reduces the probability of firm bankruptcy. Fourth, due to the CEO's risk aversion and the strict convexity of the effort cost function, a larger government bailout increases total second-period compensation, regardless of whether CEO stays or leaves. Given that the policy constrains only base pay and not variable pay, meeting the risk-averse CEO's participation constraint requires a substantial increase in the slope of the incentive contract to induce a higher-than-optimal effort level. Thus, we find that the average level of second-period CEO base pay is decreasing in the bailout amount, whereas the average slope of the second-period compensation contract is increasing.

2. Policy Background (ARRA): Restrictions on Executive Compensation Contracts

The ARRA incorporates a number of the executive compensation guidelines announced by the U.S. Department of the Treasury on February 4, 2009 (the "Treasury Guidelines") and several contained in the initial U.S. Senate version of the Stimulus Package (see http://www.treas.gov/press/releases/tg15.htm). The initiative divides beneficiaries of government bailout funds into two categories. The first consists of companies needing "exceptional assistance" -- such as Bank of America, Citigroup Inc. and the insurance giant AIG -- that received individually tailored bailout packages. Companies receiving exceptional financial recovery assistance must ensure compliance with the Executive Compensation Provisions that limit senior executives to $500,000 in total annual compensation *other than restricted stock*. The second consists of firms seeking assistance through generally available programs like the government's capital-injection effort under the TARP. Companies participating in generally available capital access programs must ensure compliance with the Executive Compensation Provisions that limit senior executives to $500,000 in total annual compensation plus restricted stock, unless waived with full public disclosure and shareholder vote. Additionally, for both groups, the number of executives subject to the cap on bonuses and incentive compensation is a function of the amount of federal assistance received by the TARP recipient.

The government bailouts have been criticized on a number of grounds. One frequent criticism from compensation experts, bank executives, and the media is that the restrictions on executive pay that accompany bailouts may make it hard for firms that are most in need of help to recruit and retain top talent.[4] However, a key feature of the regulation is that it applies only to some components of compensation (e.g. base pay), exempting variable pay such as restricted

[4] For example, AIG claimed "We cannot attract and retain the best and brightest talent to lead and staff the AIG businesses, which are now being operated principally on behalf of the American taxpayers — if employees believe their compensation is subject to continued and arbitrary adjustment by the U.S. Treasury." And Claudia Allen, chairperson of the corporate governance practice at Neal Gerber & Eisenberg LLP said, "It may be well-intentioned, but I wonder if it will have the practical effect of blocking the filling of vital jobs in troubled companies."

stock. This should be thought of not as a cap on total compensation but rather as a distortion in the design of compensation contracts, leading to inefficient contracts relative to what would be optimal for a risk-averse executive. Thus, the aforementioned criticism of the regulation is not entirely correct. Since the restrictions do not apply to variable pay such as restricted stock grants, a firm facing a cap on base pay can meet its CEO's participation constraint and prevent the executive from separating simply by adjusting the level of variable pay. The problem for the firm is not that it is impossible to meet the participation constraint of a high-quality CEO but rather that the restrictions on the structure of contracts force the firm to meet the constraint in a suboptimal, costly, way. [5] This central feature of the policy is captured by our model.

A second criticism of the regulation is that, by capping pay while allowing exceptions for certain forms of variable pay such as restricted stock, compensation contracts are distorted and inefficient, with base pay that is too low and variable pay that is different from what the optimal contract would be for a risk-averse executive. Our analysis characterizes the nature and implications of this distortion. Other criticisms of the bailout plans and accompanying restrictions on executive pay concern abundant loopholes that offer opportunities for crafty lawyers to undermine any real effects of the policies.[6] There are also concerns that the restrictions on executive pay are too stringent and might dissuade some banks from participating that the government would like to see participate. We can quantify such disincentives given that both the decision to accept a bailout or not and the decision to retain an existing executive or hire a new one are endogenous choices in our model.

3. A Model of Executive Compensation, Hiring, and Retention in Distressed Firms

In this section we develop a theoretical framework for analyzing the effect on executive turnover and bankruptcy probability of regulations that restrict executive compensation. We first model the pre-policy regime which exists before the government offers bailout assistance to firms

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[5] As noted by Bebchuck, "While the new restrictions seem to have been motivated by a desire to limit total pay, it is the pay structure that they tightly regulate." See Bebchuk in *Wall Street Journal*: "Congress gets punitive on executive pay", February 17, 2009, (http://www.law.harvard.edu/news/2009/02/17_bebchuk.html).

[6] See, for example, "Wall Street finds ways around executive pay caps" by Puzzanghera, Parsons and Hamilton, February 5, 2009, (http://www.latimes.com/business/la-fi-endrun-execpay5-2009feb05,0,2040936.story); "Exec pay limits will spark search for loopholes", by Schoen, February 8, 2009, (http://www.msnbc.msn.com/id/29059805/); and "Obama Lays Out Limits on Executive Pay", by Weisman and Lublin, February 17, 2009, (http://online.wsj.com/article/SB123375514020647787.html).

in financial distress. We then model the post-policy regime in which the government offers the distressed firm the option to accept a bailout package in exchange for accepting restrictions (i.e. a cap on base pay) on future executive compensation contracts. Finally, we compare simulated outcomes between both regimes to measure the impact of the policy.

3.1. Pre-Policy (Baseline) Regime

Consider a single firm and two time periods.[7] Let Π_t denote the firm's profit in period t, where the price per unit of output is normalized to 1. Each period the firm is assumed to maximize its expected profit for that period. At the start of period 1, the firm hires a risk-averse executive by drawing from the distribution of θ, representing a stochastic and time-invariant executive ability. Although the executives are heterogeneous in ability, they have common preferences given by a per-period exponential utility function,

$$U(W_t) = -\exp(-\gamma(W_t - C(e_t))), \qquad (1)$$

where $\gamma > 0$, W_t denotes period-t total compensation, e_t denotes the executive's period-t effort choice, and $C(e_t)$ denotes the executive's cost of exerting effort, with $C(e_t) = 0$, $C'(e_t) > 0$, and $C''(e_t) > 0$. Compensation contracts are linear in executive performance, P_t, i.e.

$$W_t = a_t + b_t P_t. \qquad (2)$$

We assume $C(e_t) = 0.5\lambda e_t^2$, where $\lambda > 0$, so the executive's optimal effort choice is $e_t = \frac{b_t}{\lambda}$.

Without knowledge of θ, the firm chooses a first-period executive compensation contract, (a_1,b_1), contingent on the executive's first-period performance, P_1, which the principal observes after the contract is set. That is,

[7] One limitation of the two-period setup is that it does not allow for the fact that, in practice, firms accepting bailout assistance have the option to pay back the bailout loans in the future, lifting the restrictions on executive compensation. While this is a limitation, three factors may mitigate it. First, if firms close, the issue of paying back the loan is irrelevant, so it applies only to the subset of surviving firms. Second, given the immediacy of a financial crisis, firms are likely to have a short time horizon in mind when making decisions to accept or reject bailouts (i.e. there is a significant risk of closure in the immediate future). Third, one objective of our analysis is to better understand the implications of bailout programs like ARRA for compensation contracts, and once the bailout is taken, compensation contracts are affected until the funds are paid back (which can be a long time for some firms, and there is significant uncertainty as to when in the future this will occur).

$$W_1 = a_1 + b_1P_1, \quad (3)$$

where a_1 denotes the executive's base pay (i.e. base salary and other components of compensation that do not vary directly with performance) and b_1 denotes the "piece rate". Let $P_1 = \theta + e_1 + u_1$, where u_1 is a mean-zero stochastic component of the executive's first-period performance. The firm's first-period profit is given by

$$\Pi_1 = P_1 + \varepsilon_1 - W_1, \quad (4)$$

where ε_1 is a mean-zero stochastic component that can be interpreted as a firm-specific shock that is independent of θ and u_1. The firm chooses (a_1,b_1) to maximize $E(\Pi_1)$ subject to a reservation expected utility constraint.

In the middle of period 1, Π_1 and P_1 become publicly observable, and a financial crisis hits, placing the firm in financial distress. We capture the notion of financial crisis in two ways. First, we assume that the firm incurs an unexpected, inescapable loss of ξ, where ξ is a positive scalar capturing the notion of the firm's poor financial position as of the middle of period 1. Second, we introduce optimization errors in the firm's hiring and retention decisions, capturing the idea that in an unprecedented and major financial crisis the firm is more likely to make mistakes in decisions about its leadership and knowing what strategic direction should be taken. We elaborate on this feature of the model and its implications at the end of this section. After observing Π_1 and P_1, the firm decides whether to retain the executive through period 2. If the executive is not retained, the firm hires a new executive, taking a new draw, denoted θ', from the distribution of θ. The firm offers second-period compensation contracts at the end of period 1, which are chosen to maximize expected second-period profit subject to the reservation expected utility constraint. For simplicity we assume $U_1 = U_2$, so the executive's reservation expected utility is the same in both periods.

The firm's second-period profits, Π_2, are realized at the end of period 2 and depend on the choice the firm made at the end of period 1 (i.e. "executive stays" or "executive leaves"). Throughout the discussion, these choices are denoted "S" and "L", respectively, in subscripts. The firm closes at the end of the second period if $\Pi_1 - \xi + \Pi_2 < 0$. Second-period profits are $\Pi_2 = P_2 + \varepsilon_2 - W_2$, where P_2 denotes executive performance in the second period, and ε_2 is a mean-zero stochastic shock. Note that P_2 and W_2 in the preceding expressions vary according to the firm's choice at the end of the first period. More precisely, letting u_2 denote the mean-zero stochastic shock to the executive's second-period performance, and letting δ be a non-negative parameter capturing the degree of firm-specific human capital possessed by a second-period executive who remains with the firm, we have

$$P_2 = (1 + \delta)(P_1 + u_2 + \frac{b_S}{\lambda} - \frac{b_1}{\lambda}) \tag{5}$$

and $W_2 = a_S + b_S P_2$ for choice "S", whereas $P_2 = \theta' + u_2 + \frac{b_L}{\lambda}$ and $W_2 = a_L + b_L P_2$ for choice "L".

The aforementioned optimization errors, τ_S and τ_L, are independent of each other and of all other random variables, and they are additive in the second-period expected profit function. That is, τ_L is added to $E(\Pi_L)$ and τ_S is added to $E(\Pi_S|P_1)$, where Π_S (Π_L) denotes period-2 profit given that the executive stays (leaves) in the second period.

We assume that $(\theta, \theta', u_1, u_2, \varepsilon_1, \varepsilon_2, \tau_S, \tau_L)'$ is distributed multivariate normal with mean vector $(\mu, \mu, 0, 0, 0, 0, 0, 0)'$ and diagonal covariance matrix $\sum$, where $\sum_{11} = \sum_{22} = \sigma_\theta^2$, $\sum_{33} = \sum_{44} = \sigma_u^2$, $\sum_{55} = \sum_{66} = \sigma_\varepsilon^2$, and $\sum_{77} = \sum_{88} = \sigma_\tau^2$. The distribution of $(\theta, \theta', u_1, u_2, \varepsilon_1, \varepsilon_2, \tau_S, \tau_L)'$ is publicly observable, and ε_1 and ε_2 are interpreted as firm-specific shocks that are independent of executive ability.[8] As noted earlier, the random variables τ_S and τ_L represent information or optimization errors, capturing uncertainty in organizational decision-making during an unprecedented financial crisis. The greater is σ_τ^2, the more likely the firm is to make optimization errors, either retaining an executive who should have been fired or firing one who should have been retained. The timing of the model is summarized as follows:

<u>Period 1 Timing:</u>

Firm offers linear compensation contract (a_1,b_1) to a new, risk-averse executive.
Firm observes executive performance, P_1, and firm profit, Π_1.
Firm incurs a loss of ξ, placing it in financial distress.
Firm decides whether to retain the first-period executive in the next period.
Firm offers second-period compensation contract to second-period executive.

[8] It is possible to relax the independence assumptions by allowing positive correlations between u_1 and u_2 and between ε_1 and ε_2.

Period 2 Timing:

If the first-period executive stays, then Π_2 is realized and the firm survives or closes.

If the first-period executive leaves, a new executive is hired, Π_2 is realized, and the firm survives or closes.

Optimal Executive Compensation Contracts

The firm's first-period compensation contract for a new executive, (a_1,b_1), has the standard form (e.g. Holmstrom and Milgrom 1991), with $b_1 = \frac{1}{1+\gamma\lambda(\sigma_\theta^2+\sigma_u^2)}$. If the firm chooses "L" at the end of period 1, it achieves this by offering the incumbent executive any contract that provides expected utility strictly less than U_2. This induces the incumbent executive to quit, and the firm hires a new executive with a new contract. When we refer to the "second-period compensation contract" in these instances, we mean the contract offered to the new executive, not the departing executive. To hire a new executive for period 2, the firm must offer a period-2 contract yielding expected utility of at least U_1 (the expected utility of a new executive), whereas to retain its period-1 executive, the firm must offer a period-2 compensation contract yielding expected utility of at least U_2 (the expected utility of the incumbent executive in period 2).

Let $E(\Pi_S|P_1)^*$ and $E(\pi_L)^*$ denote expected period-2 profits (evaluated at the optimal contracts (a_1,b_1), (a_S,b_S), and (a_L,b_L)), given the firm's choice of either "S" or "L", defined as follows:

$$E(\Pi_S|P_1)^* = (1 - b_S)(1 + \delta)(P_1 + \frac{b_S}{\lambda} - \frac{b_1}{\lambda}) - a_S + \tau_S \quad (6)$$

$$E(\Pi_L)^* = (1 - b_L)(\mu + \frac{b_L}{\lambda}) - a_L + \tau_L \quad (7)$$

The firm makes the choice that yields the highest of $E(\Pi_S|P_1)^*$ and $E(\Pi_L)^*$, subject to the reservation expected utility constraint. We now describe the firm's second-period compensation contracts for cases "S" and "L".

In the S case, the firm chooses (a_S,b_S) to maximize

$$E(\Pi_S|P_1) = (1 - b_S)(1 + \delta)(P_1 + \frac{b_S}{\lambda} - \frac{b_1}{\lambda}) - a_S \quad (8)$$

subject to $E[-\exp(-\gamma(W_2 - C(e_2)))|P_1] \geq U_2$ and $E(\Pi_S|P_1) \geq 0$,

resulting in the following generalization (incorporating firm-specific human capital) of the standard expression for the optimal piece rate:

$$b_S = \frac{(1+\delta)}{1+\gamma\lambda(1+\delta)^2\sigma_u^2}.\text{[9]} \quad (9)$$

The second constraint, $E(\Pi_S|P_1) \geq 0$, is satisfied if U_2 is sufficiently small, i.e.

$$U_2 \leq -\exp\{\gamma[0.5\lambda e_2^2 + 0.5\gamma(1+\delta)^2 b_S^2 \sigma_u^2 - (1+\delta)(P_1 + \frac{b_S}{\lambda} - \frac{b_1}{\lambda})]\}. \quad (10)$$

In the L case, the firm chooses (a_L, b_L) to maximize

$$E(\Pi_L) = (1 - b_L)(\mu + \frac{b_L}{\lambda}) - a_L \quad (11)$$

subject to $E[-\exp(-\gamma(W_2 - C(e_2)))] \geq U_1$ and $E(\Pi_L) \geq 0$,

yielding the standard expression for the optimal piece rate: $b_L = \frac{1}{1+\gamma\lambda(\sigma_\theta^2+\sigma_u^2)}$. The second constraint, $E(\Pi_L) \geq 0$, is satisfied as long as U_1 is sufficiently small, i.e.

$$U_1 \leq -\exp\{\gamma[0.5\lambda e_2^2 + 0.5\gamma b_L^2 (\sigma_\theta^2 + \sigma_u^2) - \mu - \frac{b_L}{\lambda}]\}. \quad (12)$$

Given the expression for second-period contracts, we compute realized profits and whether the firm survives or closes. The following algorithm describes our approach:

1. Assign values to δ, λ, γ, μ, σ_θ^2, σ_u^2, σ_ϵ^2, σ_τ^2, ξ, U_1, and U_2.

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[9] The expression for b_S reduces to the standard result when $\delta = 0$. In the case of risk aversion (i.e. $\gamma > 0$), sufficiently high δ ensures that $db_S/d\delta < 0$. Furthermore, in the limit, as $\delta \to \infty$, $b_S \to 0$. The intuition can be seen by inspection of the expressions for expected profit. Higher amounts of firm-specific human capital imply a higher level of surplus to be shared between the principal and agent. At the cost of an increase in base pay, a_S, the principal can acquire a greater share of the surplus (i.e. by reducing b_S) and the returns to doing so increase as δ (and therefore the size of the surplus) grows. The same analysis applies to the post-policy regime in the event that the incumbent executive stays with the firm in the second period.

2. Compute a_1 and b_1.

3. Generate one draw of (θ, θ', u_1, u_2, ε_1, ε_2, τ_S, τ_L).

4. Compute P_1, W_1, and Π_1.

5. Solve for the second-period compensation contracts, i.e. (a_S, b_S) and (a_L, b_L).

6. Compute $E(\Pi_S|P_1)^*$, and $E(\Pi_L)^*$ using the values of a_S, b_S, a_L, b_L from step 5 and the realizations of stochastic components from step 3. Then compute the firm's optimal choice at the end of the first period, which is the choice corresponding to the largest of $E(\Pi_S|P_1)^*$ and $E(\Pi_L)^*$.

7. If the choice was "S" in step 6, use (θ,u_2,ε_2) from step 3. If the choice was "L" in step 6, use (θ',u_2,ε_2) from step 3. Compute P_2, W_2, and π_2.

8. Repeat steps 3-7 to collect N total realizations.

9. From the N realizations, calculate the estimated probability that choice "S" is made, the estimated probability an executive separates given a bailout (and given no bailout), the average compensation of separating executives, the average compensation of retained executives, etc.

10. Change a parameter value in step 1, and then repeat steps 2-9, to conduct comparative statics exercises.

3.2. Post-Policy Regime

In the post-policy regime, the model is the same as in the pre-policy regime until the financial crisis hits in the middle of period 1. At that time, the government announces a bailout option for distressed firms. The advantage to the firm of accepting a government bailout is that revenue in the second period is increased by B, where B > 0 denotes the amount of the bailout. The disadvantage of accepting the bailout is that it subjects the firm, in the second period, to regulations constraining the design of executive compensation. In particular, the executive's base pay is capped at k (> 0) in the second period. In the post-policy regime, after observing Π_1 and P_1, the firm decides whether to accept a bailout and whether to retain the executive through period 2. We denote these choices by "BS", "BL", "NS", and "NL" throughout, where "S" and "L" denote that the executive "stays" and "leaves", and "B" and "N" denote "bailout" and "no bailout." The expressions for second-period profits are as before, with the addition of B if the firm chooses either "BL" or "BS".[10] In summary, the timing for period 1 in the post-policy regime is as follows (timing for period 2 is the same as in the pre-policy regime).

<u>Period 1 Timing</u>

Firm offers linear compensation contract (a_1, b_1) to a new, risk-averse executive.

Firm observes executive performance, P_1, and firm profit, Π_1.

Firm incurs a loss of ξ, placing it in financial distress.

Government offers the option of a bailout, B, combined with future restrictions on executive pay (capping base pay at k).

Firm decides whether to take bailout and whether to retain the executive.

Firm makes second-period compensation offer to second-period executive.

Second-period contracts for the cases of NS and NL are the same as those for cases S and L, respectively, in the baseline regime. In the BS case, assuming first that the regulation does not bind (i.e. the firm wants to offer $a_{BS} < k$), then $b_{BS} = b_{NS}$. Assuming next that the regulation binds (i.e. the firm wants to offer $a_{BS} > k$ but cannot), the firm offers $a_{BS} = k$ and chooses b_{BS} to maximize

$$E(\Pi_{BS}|P_1) = (1 - b_{BS})(1 + \delta)(P_1 + \frac{b_{BS}}{\lambda} - \frac{b_1}{\lambda}) - k + B \tag{13}$$

subject to $E[-\exp(-\gamma(W_2 - C(e_2))) \mid P_1] \geq U_2$.

Rewriting the constraint as an equality yields a quadratic equation with the following roots:[11]

$$b_{BS} = \frac{-(1+\delta)(P_1 - \frac{b_1}{\lambda}) +/- [(1+\delta)^2(P_1 - \frac{b_1}{\lambda})^2 - 2(1+\delta)(\frac{1}{\lambda} - \gamma\sigma_u^2)(\frac{\ln(-U_2)}{\gamma} + k)]^{0.5}}{(1+\delta)(\frac{1}{\lambda} - \gamma\sigma_u^2)}. \tag{14}$$

[10] Furthermore, if either of the choices "BL" or "BS" is made, there are two cases corresponding to whether the regulation binds or not. If it binds, the firm would prefer to choose a_{BL} (or a_{BS}) greater than k, but the policy prohibits this, so $a_{BL} = k$ (or $a_{BS} = k$). If the constraint does not bind, then the firm's optimal choice for a_{BL} (or a_{BS}) is less than k and, therefore, in compliance with the regulation. Thus, when computing second-period optimal contracts in the BL or BS cases, we first compute unconstrained optimal contracts, and if the resulting a_{BL} (or a_{BS}) is greater than k, we impose the constraint $a_{BL} = k$ (or $a_{BS} = k$) and then determine the optimal b_{BL} (or b_{BS}) given that constraint.

[11] If there is a positive and a negative root, the positive root is taken. If both are positive, the one is taken that maximizes $E(\Pi_{BS}|P_1)$. The same approach is taken in the "BL" case to be discussed shortly.

Comparing this contract (for which the regulation binds, i.e. $a_{BS} = k$) to the one for which the regulation does not bind, (i.e. $a_{BS} < k$), the optimal contract is the one that yields the greatest $E(\Pi_{BS}|P_1)$.

In the BL case, assuming the regulation does not bind (i.e. the firm wants to offer $a_{BL} < k$), then the standard result of $b_{BL} = \frac{1}{1+\gamma\lambda(\sigma_\theta^2+\sigma_u^2)}$ obtains. Assuming next that the regulation binds (i.e. the firm wants to offer $a_{BL} > k$ but cannot), the firm offers $a_{BL} = k$ and chooses b_{BL} to maximize

$$\Pi_{BL} = (1 - b_{BL})(\mu + \frac{b_{BL}}{\lambda}) - a_{BL} + B \qquad (15)$$

subject to $E[-\exp(-\gamma(W_2 - C(e_2)))] \geq U_1$.

The constraint, expressed as an equality, yields a quadratic equation with the following roots:

$$b_{BL} = \frac{-\mu +/- [\mu^2 - 2(\frac{1}{\lambda} - \gamma(\sigma_\theta^2 + \sigma_u^2))(\frac{\ln(-U_1)}{\gamma} + k)]^{0.5}}{\frac{1}{\lambda} - \gamma(\sigma_\theta^2 + \sigma_u^2)}. \qquad (16)$$

Comparing this contract (for which the regulation binds, i.e. $a_{BL} = k$) to the one for which the regulation does not bind, (i.e. $a_{BL} < k$), the optimal contract is the one that yields the greatest $E(\Pi_{BL})$.

The expressions for expected second-period profits (evaluated at the optimal contracts), given each of the firm's possible choices at the end of the first period, are defined as follows:

$$E(\Pi_{BS}|P_1)^* = (1 - b_{BS})(1+\delta)(P_1 + \frac{b_{BS}}{\lambda} - \frac{b_1}{\lambda}) + B - a_{BS} + \tau_{BS} \qquad (17)$$

$$E(\Pi_{BL})^* = (1 - b_{BL})(\mu + \frac{b_{BL}}{\lambda}) + B - a_{BL} + \tau_{BL} \qquad (18)$$

$$E(\Pi_{NS}|P_1)^* = (1 - b_{NS})(1+\delta)(P_1 + \frac{b_{NS}}{\lambda} - \frac{b_1}{\lambda}) - a_{NS} + \tau_{NS} \qquad (19)$$

$$E(\Pi_{NL})^* = (1 - b_{NL})(\mu + \frac{b_{NL}}{\lambda}) - a_{NL} + \tau_{NL} \qquad (20)$$

As before, τ_{BS}, τ_{BL}, τ_{NS}, and τ_{NL} denote normally distributed mean-zero optimization errors (with common variance σ_τ^2) distributed independently of each other and of the other random variables in the model. The firm makes the choice that yields the highest of $E(\Pi_{BS}|P_1)^*$, $E(\Pi_{BL})^*$, $E(\Pi_{NS}|P_1)^*$, and $E(\Pi_{NL})^*$, subject to the reservation expected utility constraint.

The following algorithm, modifying the earlier one for the pre-policy regime, describes our approach:

1. Assign values to B, k, λ, δ, γ, μ, σ_θ^2, σ_u^2, σ_ε^2, σ_τ^2, ξ, U_1, and U_2.
2. Compute a_1 and b_1.
3. Generate one draw of $(\theta, \theta', u_1, u_2, \varepsilon_1, \varepsilon_2, \tau_S, \tau_L)$.
4. Compute P_1, W_1, and Π_1.
5. Solve for the second-period compensation contracts (i.e. a_{BS}, b_{BS}, a_{BL}, b_{BL}, a_{NS}, b_{NS}, a_{NL}, b_{NL}).
6. Compute $E(\Pi_{BS}|P_1)^*$, $E(\Pi_{BL})^*$, $E(\Pi_{NS}|P_1)^*$, and $E(\Pi_{NL})^*$ using the optimal contracts from step 5 and the realizations of stochastic components from step 3. Then compute the firm's optimal choice at the end of the first period, which is the choice corresponding to the largest of $E(\Pi_{BS}|P_1)^*$, $E(\Pi_{BL})^*$, $E(\Pi_{NS}|P_1)^*$, and $E(\Pi_{NL})^*$.
7. If the choice was "BS" or "NS" in step 6, use $(\theta,u_2,\varepsilon_2)$ from step 3. If the choice was "BL" or "NL" in step 6, use $(\theta',u_2,\varepsilon_2)$ from step 3. Compute P_2, W_2, and Π_2.
8. Repeat steps 3-7 to collect N total realizations.
9. From the N realizations, calculate the probability of CEO turnover, the probability of accepting a bailout, the probability of firm closure, and the structure of second-period compensation contracts.
10. Change a parameter value in step 1, and then repeat steps 2-9, to conduct comparative statics exercises.

Note that the policy reduces base pay below what the firm would optimally offer. What happens to the optimal contract slope as a consequence depends on parameter values. More precisely, in the BL case, if $-(\frac{1}{\lambda} - \gamma(\sigma_\theta^2 + \sigma_u^2))b_{BL} - \mu < 0$ then reductions in a_{BL} imply increases in b_{BL} (i.e. base pay and variable pay are substitutes), whereas if the inequality is reversed the opposite is true (i.e. base pay and variable pay are complements). Similarly, in the BS case, if $-(\frac{1}{\lambda} - \gamma\sigma_u^2)b_{BS} - (P_1 - \frac{b_1}{\lambda}) < 0$ we have substitutes, and if the inequality is reversed we have complements.[12] In the BL case, if the product $\gamma(\sigma_\theta^2 + \sigma_u^2)$ is sufficiently small, then the case of

[12] Both conditions are found by solving the relevant participation constraint (for the BL case or the BS case) for the contract intercept and then differentiating its right-hand side with respect to the contract slope. Note that in the BS case the condition does not depend on δ.

substitutes occurs, whereas if it is sufficiently large the case of complements occurs. In contrast, in the BS case, the magnitude of $\gamma\sigma_u{}^2$ is insufficient for determining whether the case of substitutes or complements prevails. The reason is that the BS case conditions on first-period performance, so P_1 appears in the resulting inequality. This means that, for example, even if $\gamma\sigma_u^2 = 0$, base pay and variable pay can be complements if $P_1 - \frac{b_1}{\lambda}$ (i.e. the executive's stochastic ability plus the first-period performance shock) is sufficiently negative. In both the BL and BS cases, a higher product of the coefficient of absolute risk aversion and the variance of second-period performance implies a greater likelihood that base pay and variable pay are complements. Intuitively, the risk aversion term in the executive's expected utility becomes quite important when this product is large. Thus, if base pay is reduced (as it is by the ARRA) then to maintain second-period expected utility (i.e. to meet the executive's second-period participation constraint) a reduction in the slope of the contract is needed. In expected utility terms, decreasing the variance of total compensation is more appealing to the executive than raising its mean, hence a drop in the slope accompanies a drop in the base pay. While the theoretical model allows for both complements and substitutes, the data must determine which case is empirically relevant. As we discuss later, the empirically relevant case in our data is substitutes.

Recall that one of the ways we capture the notion of a major financial crisis is by introducing optimization errors in the firm's hiring and retention decisions. One implication of such errors in the post-policy regime is that all four choices (i.e. BL, BS, NL, NS) can potentially be observed, whereas in the absence of these errors, only three of the four outcomes can be observed for any configuration of the model's parameters, given that second-period expected profit in the cases of BL and NL does not vary across the N observations (so either it is higher for BL for all N cases or higher for NL for all N cases). In the pre-policy regime, both firm choices ("S" and "L") are potentially observable even in the absence of optimization errors.

4. Structural Estimation of Parameters for the Pre-Policy Regime

The parameters of the model's pre-policy regime are: δ, λ, γ, μ, σ_θ^2, σ_u^2, σ_ϵ^2, σ_τ^2, ξ, U_1, U_2. We set $\gamma = 3$, following the previous literature suggesting that the Arrow-Pratt coefficient of absolute risk aversion typically ranges from 2 to 4; for example, the manager's coefficient of absolute risk aversion is 4 in Haubrich 1994 and in Coles et al. 2007. We also set $\sigma_\tau = 1$, $\xi = 35$, and $U_1 = U_2$. Let Ω denote $[\delta, \lambda, \mu, \sigma_\theta^2, \sigma_u^2, \sigma_\epsilon^2, U_1]'$, which is the vector of remaining parameters to be estimated. Using data from ExecuComp and Compustat, we use the method of simulated moments (McFadden 1989, Pakes and Pollard 1989) to estimate Ω. That is, letting $m(\Omega)$ denote a φ-dimensional vector of simulated moments based on N stochastic draws, and letting m_o denote a φ-dimensional vector of moments computed from the data, where $\dim(\varphi) \geq 7$, we choose Ω to minimize the distance function $Q(\Omega) = [m(\Omega) - m_o]'M[m(\Omega) - m_o]$.[13] The eight moments we use are Prob(L), $E(W_1)/E(\Pi_1)$, $E(W_2)/E(\Pi_2)$, $E(W_2|S)/E(\Pi_2|S)$, $E(W_2|L)/E(\Pi_2|L)$, $E(b_1P_1)/E(W_1)$, $E(b_2P_2|S)/E(W_2|S)$, and $E(b_2P_2|L)/E(W_2|L)$. To ease the computational burden and because our emphasis in the analysis is on simulating outcomes rather than conducting statistical inference on the underlying structural parameters, we use the identity matrix for M as opposed to the optimal weighting matrix that would yield asymptotic efficiency.

4.1. Data

To estimate the model's pre-policy parameters, we use data on CEO turnover, firm profit, and the characteristics of CEO compensation contracts from Standard and Poor's Compustat and ExecuComp. Compustat contains data on firm characteristics, and ExecuComp contains executive compensation data from S&P 1500 firms (plus companies that were once part of the 1500 plus companies removed from the index that are still trading, and some client requests), collected directly from each company's annual proxy (DEF14A SEC form). Given that we are estimating pre-policy parameters, we start the sample in 1992 (the first year for which ExecupComp data are available) and end in 2007, since the TARP funds under the EESA commenced in 2008. Our final sample with non-missing observations on the key variables contains 13,763 firm-year observations.

In our model, some decisions are made early in period 1 (i.e. before the financial crisis hits) and other decisions are made later (i.e. after the crisis hits). For example, first-period contracts are chosen during a period of normalcy, whereas second-period contracts are chosen during the crisis. To allow for this, we use a subsample of "normal/non-distressed firms" to construct the moments for period-1 variables, whereas we use a subsample of "distressed firms" to construct the moments for period-2 variables. Following studies such as Eisdorfer (2008) that use Altman's (1968) Z-score as a model for predicting bankruptcy, we construct the "distressed"

[13] Note that $m(\Omega)$ is computed following the first 9 steps of the algorithm given in the "pre-policy" subsection of Section 3.

subsample by computing Z-scores for each observation and defining those firms with Z-scores below 1.81 as distressed.[14] The Altman Z-score model is not recommended for use with financial companies, due to the opacity of their balance sheets and their frequent use of off-balance sheet items. For this reason we restrict our analysis sample to non-financial companies, though we note that our model and analysis should still apply to financials, particularly given that (as discussed in Section 2) the restrictions imposed by ARRA are similar for both types of companies.[15] The subsample of "distressed firms" contains 2108 firm-year observations, and the subsample of "non-distressed firms" contains 11,655 firm-year observations.

4.2. Identification

The identification problem is to infer the joint distribution of the stochastic components of the model (except for the optimization errors), the degree of firm-specific human capital (δ), and the executive utility function and reservation utility parameters (λ and U_1) from observed variation across firms and CEOs in profit, CEO turnover, the design of compensation contracts, and whether the firm is in financial distress. The model is overidentified, given that there are more moment conditions (8) than parameters to be estimated (7).

Parameter estimates and standard errors are displayed in Table 1. Table 2 displays the observed moments in column 1 and the simulated moments (from simulation based on N = 100,000 stochastic draws) in column 2, revealing a reasonably good fit. We calibrate the observed moments using the data sample discussed in subsection 4.1. The probability that the CEO leaves (Prob(L)) at the end of both period-1 and period-2 of our model is estimated by the fraction of firm-year observations with CEO turnover to the total number of observations in the distressed firm sample. The compensation-to-profit ratio in period 1, $E(W_1)/E(\Pi_1)$, is defined as the ratio of the average CEO total compensation to the average firm profit (earnings) in the subsample of "normal/non-distressed firms"; similarly, the compensation-to-profit ratio in period 2, $E(W_2)/E(\Pi_2)$, is defined the same ratio in the subsample of "distressed firms". For period 2, the compensation-to-profit ratio when the CEO stays, $E(W_2 \mid S)/E(\Pi_2 \mid S)$, is estimated as the same ratio in the subsample of "normal/non-distressed firms with no CEO turnover"; similarly, the

[14] As a robustness check, we also computed the moments from alternative subsamples using other thresholds of Z-scores and other variables such as negative earnings. We found similar results based on these alternative samples.
[15] In particular, with full public disclosure and a shareholder vote, financials can avoid the cap on restricted stock, and in such cases the restrictions on CEO pay exactly mirror those in non-financial companies. See Section 2 for detailed information on ARRA Executive Compensation Provisions.

compensation-to-profit ratio when the CEO leaves, $E(W_2 \mid L)/E(\Pi_2 \mid L)$, is estimated as the same ratio in the subsample of "normal/non-distressed firms with CEO turnover". To be consistent with the executive compensation restrictions in ARRA (see Section 2), we measure the ratio of variable pay to profit, $E(b_1P_1)/E(W_1)$, using the ratio of the CEO's restricted stocks to profits (earnings). Then, we estimate this ratio for period 1, $E(b_1P_1)/E(W_1)$, period 2 when the CEO stays, $E(b_2P_2 \mid S)/E(W_2 \mid S)$, and period 2 when the CEO leaves, $E(b_2P_2 \mid L)/E(W_2 \mid L)$, using the methods and stratification discussed previously.

Panels A-G of Table 3 illustrate the sources of variation in the data that identify each parameter in the pre-policy regime. In each panel we report comparative statics showing the response of each simulated moment to changes in one parameter holding the other parameters fixed. For example, columns 2, 3, 5, and 6 of Panel A vary δ (the degree of firm-specific human capital) from its estimated value in column 4. The results reveal that when δ is increased, holding the other parameters constant, the probability that the CEO leaves (i.e. the first moment condition) diminishes, as would be expected when firm-specific human capital becomes more important. Thus, observed variation in CEO "stay" versus "leave" outcomes in the data contributes to the identification of δ. Panel B reveals that changing λ (the multiplier in the quadratic effort cost function), holding the other parameters constant, reduces the ratios of variable pay to profit for period 1, $E(b_1P_1)/E(W_1)$, for period 2 given that the CEO stays, $E(b_2P_2 \mid S)/E(W_2 \mid S)$, and for period 2 given that the CEO leaves, $E(b_2P_2 \mid L)/E(W_2 \mid L)$, whereas the other moments are insensitive to changes in λ. Identification of the other estimated parameters can be established via similar arguments.

5. Policy Analysis (ARRA)

In this section, we use the structural parameter estimates from Section 4 to analyze the effect of the cap on base pay for firms accepting bailout assistance. Given the values for δ, λ, γ, μ, σ_θ^2, σ_u^2, σ_ϵ^2, σ_τ^2, ξ, U_1, and U_2 from Section 4, we set values for the two policy parameters (B and k) and simulate various outcomes of interest in the post-policy regime (including the probability the CEO stays in the second period, the probability of accepting a bailout, the probability of firm closure, and the structure of second-period compensation contracts). A comparison of the simulated outcomes to those from the pre-policy regime yields the effect of the policy. We normalize $B = 2$ and set $k = 0.04$. This ratio of $k/B = 0.02$ (the minimum value of this ratio that would occur in practice) can be justified as follows. “Level One” of the rules in the “Treasury Guidelines”[16] dictate that the compensation regulations apply to the single most highly compensated employee in an institution that received $25 million (or less) in financial assistance. The cap on the restricted portion of the CEO’s compensation is $500,000 per year, and if the maximum bailout of $25 million is received, this is $500,000/$25,000,000 = 0.02.

Table 4 displays the post-policy simulation results in column 2 (where we aggregate the two cases “BS” and “NS” into a single “S” case, and the two cases “BL” and “NL” into a single “L” case) to be compared with column 1 which reports the corresponding outcomes for the pre-policy regime. Columns 3 and 4 further decompose the post-policy results from column 2 into the “bailout” cases (Column 3) and the “no bailout” cases (Column 4). The effect of the policy can be inferred by comparing column 1 with either column 2 or with columns 3 and 4. Note that in columns 2, 3, and 4, the empirical frequencies of the firm’s choices are as follows: Prob(BL) = 0.002; Prob(BS) = 0.906; Prob(NL) = 0.016; Prob(NS) = 0.076, so that the probability of accepting the bailout is 0.908. Several points from Table 4 are worth highlighting.

First, in the post-policy regime the probability that the CEO leaves drops significantly, and the bulk of this effect comes from firms taking the bailout option. This result is counter to the criticism of the pay regulations that is frequently voiced in the popular press, namely that the regulations will make it difficult for firms to retain top executive talent. As we noted earlier, this argument is problematic because the regulations do not cap total compensation but rather some components of compensation, leaving other components unrestricted (and therefore able to be adjusted by the firm so as to meet the executive’s participation constraint and prevent a quit). Simulated executive retention rates are actually much higher in bailed-out firms than in the pre-policy baseline regime.

Second, the bankruptcy probability is relatively insensitive to the policy; however it is slightly higher for firms that do not take the bailout than for those that do, given that the CEO stays. Although the bankruptcy probability is higher in the “BL” case, this case should be discounted since it happens so rarely (i.e. as seen in column 3, given that a bailout occurs, the CEO leaves only 0.269% of the time).

Third, second-period total CEO compensation does not change much as a result of the policy, though it is slightly higher than in the pre-policy regime given that it is higher in bailout

[16] See (http://www.treas.gov/press/releases/tg15.htm) and (http://www.martindale.com/members/Article_Body.aspx?id=642324).

firms. Note that this is despite the cap on executive base pay; firms are able to make up the difference by paying CEOs more variable pay to compensate for reduced based pay, as discussed in the next point.

Fourth, as seen in the last four rows of Table 4, the policy distorts the structure of compensation contracts (whether the executive stays or leaves). As noted earlier, there are derivative expressions for the "BS" case and "BL" case that reveal whether base pay and variable pay are complements (i.e. positive derivative) or substitutes (i.e. negative derivative). Given the parameter estimates from Table 1, in the "BL" case, the derivative is constant and negative across the N stochastic draws. In the "BS" case, the derivative varies across the N draws (because it is a function of executive performance, which varies stochastically across the N draws) but its maximum value over the N draws is negative. Thus, base pay and variable pay are substitutes for both the "BL" and "BS" cases. The last four rows of Table 4 confirm this result. Comparing columns 1 and 2, the cap on base pay induces firms to raise the piece rate (i.e. steepen the slope of the contract) to meet the executive's participation constraint. Comparing column 1 to columns 3 and 4 reveals that if no bailout is taken, the optimal contract (because it is unconstrained) replicates the one in the pre-policy regime, whereas if the bailout is taken, the regulation binds and base pay is set at the cap and the piece rate is increased to meet the participation constraint. This distortion is particularly pronounced in the event that the executive leaves (versus stays) in the second period. The fact that base pay and the piece rate are found to be substitutes is a data-driven result of the paper, given that the theoretical model allows for both substitutes and complements depending on parameter values.

Next, we consider counterfactual policy simulations in which we explore the effects of changes in B, holding k constant, on probability of CEO turnover, probability a bailout is taken, probability of firm closure, and the structure of second-period compensation contracts. This comparative statics analysis for B (holding k constant) reflects the considerable heterogeneity that exists in practice across bailout firms in the generosity of the bailout payments they receive.[17] These effects are displayed for all observations in Table 5, for the "bailout" observations (cases BL and BS) in Table 6, and for the "no bailout" observations (cases NL and NS) in Table 7. The rationale for looking at the effects on increases in B on the "no bailout" group (i.e. Table 7) is that

[17] For example, GM took a $2billion bailout on April 22, 2009, AIG took a $30billion bailout on March 2, 2009, and approximately 533 firms took smaller bailouts ranging from $1million to $25million.
Source: (http://bailout.propublica.org/list/index)

when B increases, some employers from the "NS" and "NL" cases transition to the "BS" and "BL" cases, changing the composition (and therefore, potentially, the average behavior) of the "no bailout" group.

Table 5 reveals that the probability the CEO is retained is increasing in B. However, Tables 6 and 7 reveal that the same probability is decreasing in B for the firms that take the bailout and for those that do not. To understand why this happens, first notice that as we move from column 1 to column 5 in Table 5, the fraction of employers taking the bailout increases, because the bailout is becoming more generous. Second, notice that the CEO retention rate is significantly higher for the bailout firms (Table 6), in every column, than for the "no bailout" firms (Table 7). It is the combination of these two facts that explains why the retention rate that combines both groups (Table 5) is increasing in B.

Table 5 reveals that probabilities of firm closure are decreasing in B, as expected. Within the categories of stayers and leavers, however, the closure probabilities are non-monotonic in B. Similarly, both Table 6 (for bailout firms) and Table 7 (for "no bailout" firms) show that the closure probability is non-monotonic in B, both overall and within the categories of stayers and leavers. These results are not surprising, given the small magnitude of B relative to the large estimated variance of the stochastic shocks to per-period profit. Clearly the closure probability must decrease in B, given that the closure probability is $\text{Prob}(\Pi_1 + \Pi_2 + B < 0)$.

Table 5 reveals that total second-period compensation is monotonically increasing in B, both overall and within the categories of stayers and leavers. The intuition arises from the CEO's risk aversion and the strict convexity of the effort cost function. The optimal pre-policy contract is unconstrained and induces the optimal effort choice. Post-policy, when the bailout is taken, the firm is constrained to offer a suboptimally low level of CEO base pay. Given that the policy constrains only base pay and not variable pay, to meet the risk-averse CEO's participation constraint requires a substantial increase in the slope of the incentive contract to induce an effort level higher than the optimum. This distortion in the structure of second-period compensation contracts can be seen in the last four rows of the table. In particular, both for stayers and leavers, the average level of second-period CEO base pay is decreasing in B, whereas the average slope of the second-period compensation contract is increasing in B. Again, the fact that base pay and variable pay move in opposite directions arises because the aforementioned derivative (estimated from the data) is negative, meaning base pay and variable pay are substitutes. If the estimated derivative had been positive, then base pay and variable pay would be complements.

In Table 6, for the bailout firms, the last four rows suggest that the structure of second-period contracts is insensitive to B. In fact, at six significant digits the average slope of the contract (for the stayers) is monotonically increasing in B. In Table 7, for the "no bailout" firms, the last three rows are insensitive to B. The average value of base pay for stayers, while it appears to be increasing in B in Table 7, is actually non-monotonic at six significant digits. The effects that are observed in this table are composition effects, since as the bailout generosity increases from column 1 to column 5, some firms switch from "no bailout" to "bailout."

6. Summary and Conclusion

This paper examines the effects of government regulations on executive compensation that accompany a distressed firm's acceptance of public bailout funds. It is among the first to analyze the implications of the American Recovery and Reinvestment Act of 2009 (ARRA) on: (i) the problems firms may face attracting and retaining top talent when executive pay is restricted; (ii) the probabilities that a firm accepts bailout funds and that a firm closes; (iii) the design of executive compensation contracts, i.e. inefficient contracts can result in which base pay is too low and variable pay is different from what the optimal contract would be for a risk-averse CEO. Ours is also the first structural analysis we are aware of that ties the firm's incentive compensation problem to turnover in the context of government restrictions on executive contracts. The analysis contributes to a broad pre-existing literature in the area of executive compensation, shedding new light on the relationships between executive compensation and turnover, firm performance, and the acceptance or refusal of bailouts during times of financial distress, while also contributing to the literature on compensation policy in distressed firms, an important and under-researched area (Dial and Murphy 1995, Mehran, Nogler, and Schwartz 1998, Bebchuk and Grinstein 2007).

The results of our policy simulations are counter to the criticism of the pay regulations that is frequently voiced in the popular press, namely that the regulations will make it difficult for firms to retain top executive talent. Our results also illustrate the distortion in the structure of executive compensation contracts that result from the ARRA. We also find that base pay and the piece rate are substitutes. Our findings should be of particular interest to policy makers and regulators concerned with future potential changes to ARRA, the long-term sustainability of government bailouts, and how firms can be expected to respond strategically to changing regulations on compensation.

The analysis could be fruitfully extended in a number of directions in future work. Ours is a partial equilibrium analysis focusing on optimal managerial decisions at the firm level in the face of a financial crisis. The overall welfare effect of the ARRA is not captured by our model and would require a general equilibrium analysis. In particular, the government's investment decisions (i.e. optimally choosing how to allocate bailout funds across a pool of distressed firms) were taken as exogenous in our analysis but could be modeled directly in a more general analysis. As noted earlier, extending the model beyond two periods would allow for an analysis of the firm's decision to pay back the public bailout funds (thereby lifting the compensation regulations). Aspects of the ARRA other than the cap on executive base pay could also be investigated (e.g. restrictions on severance pay). The model could also be extended to incorporate competing firms so that the executive's reservation utility would be endogenously determined in each period, though we anticipate that the main qualitative insights of our model should still hold in this case.

We conclude by noting that although we have focused on the ARRA, our approach to the problem is more generally applicable. Our analytical framework and estimation strategy offers a springboard that can be modified and extended to analyze other compensation policies (e.g. regulations on executive and/or broad based stock options) and non-executive workers. For the case of non-executives, the regulations on base pay might arise from, for example, union contracts. Alternatively, a wage floor (as opposed to a cap) may apply, as in the case of a minimum wage, distorting the optimal contract in a different way.

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Table 1. Structural Estimation Results

Results from estimation of pre-policy regime parameters by method of simulated moments (N = 100,000). Minimized function value is Q = 0.00021. Parameters fixed in estimation are $\sigma_\tau = 1$, $\xi = 35$, $U_1 = U_2$, $\gamma = 3$.

	Parameter Estimates	Standard Errors
δ	0.035	0.005
λ	64.141	1014.126
σ_ε	4805.011	333.515
σ_u	1.006	7.962
σ_θ	0.004	0.001
U_1	-0.012	0.003
μ	44.482	2.747

Table 2. Observed and Simulated Moments

Column 1 reports observed moments computed using ExecuComp data as discussed in subsection 4.1. Column 2 reports simulated moments from the pre-policy regime parameter estimates from Table 1.

	Observed Moments (1)	Simulated Moments (2)
Prob(L)	0.186	0.186
$E(W_1)/E(\Pi_1)$	0.028	0.028
$E(W_2)/E(\Pi_2)$	0.055	0.054
$E(W_2 \vert S)/E(\Pi_2 \mid S)$	0.051	0.051
$E(W_2 \vert L)/E(\Pi_2 \mid L)$	0.074	0.074
$E(b_1P_1)/E(W_1)$	0.145	0.153
$E(b_2P_2 \vert S)/E(W_2 \mid S)$	0.151	0.154
$E(b_2P_2 \vert L)/E(W_2 \mid L)$	0.165	0.153

Table 3. Identification of Structural Parameters for Pre-Policy Regime

Each panel pertains to a different structural parameter. In each panel, column 1 reports the actual moments obtained from stratified samples using ExecuComp and Compustat data from 1992-2007, and columns 2-6 report the predicted moments estimated using the method of simulated moments (McFadden 1989, Pakes and Pollard 1989) based on 100,000 stochastic draws. Columns 2-6 display changes in each predicted moment as the parameter (indicated in the first row) is varied, holding other parameters constant. The parameter value is 60% of its estimated value in column 2, 80% in column 3, 100% (original value) in column 4, 120% in column 5, and 140% in column 6.

Panel A: δ

	Actual Moments	**Simulated Moments**				
	(1)	(2)	(3)	**(4)**	(5)	(6)
δ	**---**	0.021	0.028	0.035	0.043	0.050
Prob(L)	0.186	0.294	0.237	0.186	0.142	0.106
$E(W_1)/E(\Pi_1)$	0.028	0.028	0.028	0.028	0.028	0.028
$E(W_2)/E(\Pi_2)$	0.055	0.056	0.055	0.054	0.054	0.053
$E(W_2 \vert S)/E(\Pi_2 \vert S)$	0.051	0.043	0.045	0.051	0.049	0.049
$E(W_2 \vert L)/E(\Pi_2 \vert L)$	0.074	0.201	0.169	0.074	0.146	0.260
$E(b_1P_1)/E(W_1)$	0.145	0.153	0.153	0.153	0.153	0.153
$E(b_2P_2 \vert S)/E(W_2 \vert S)$	0.151	0.154	0.154	0.154	0.154	0.154
$E(b_2P_2 \vert L)/E(W_2 \vert L)$	0.165	0.153	0.153	0.153	0.153	0.153

Panel B: λ

	Actual Moments **(1)**	Simulated Moments (2)	(3)	**(4)**	(5)	(6)
λ	---	38.485	51.313	64.141	76.970	89.798
Prob(L)	0.186	0.186	0.186	0.186	0.186	0.186
$E(W_1)/E(\Pi_1)$	0.028	0.028	0.028	0.028	0.028	0.028
$E(W_2)/E(\Pi_2)$	0.055	0.054	0.054	0.054	0.054	0.054
$E(W_2 \mid S)/E(\Pi_2 \mid S)$	0.051	0.051	0.051	0.051	0.051	0.051
$E(W_2 \mid L)/E(\Pi_2 \mid L)$	0.074	0.074	0.074	0.074	0.074	0.074
$E(b_1P_1)/E(W_1)$	0.145	0.255	0.192	0.153	0.128	0.110
$E(b_2P_2 \mid S)/E(W_2 \mid S)$	0.151	0.256	0.192	0.154	0.129	0.110
$E(b_2P_2 \mid L)/E(W_2 \mid L)$	0.165	0.255	0.191	0.153	0.128	0.110

Panel C: σ_ε

	Actual Moments **(1)**	Simulated Moments (2)	(3)	**(4)**	(5)	(6)
σ_ε	---	2883.006	3844.009	4805.011	5766.013	6727.015
Prob(L)	0.186	0.186	0.186	0.186	0.186	0.186
$E(W_1)/E(\Pi_1)$	0.028	0.030	0.029	0.028	0.027	0.026
$E(W_2)/E(\Pi_2)$	0.055	0.043	0.048	0.054	0.062	0.073
$E(W_2 \mid S)/E(\Pi_2 \mid S)$	0.051	0.042	0.046	0.051	0.058	0.066
$E(W_2 \mid L)/E(\Pi_2 \mid L)$	0.074	0.051	0.060	0.074	0.096	0.137
$E(b_1P_1)/E(W_1)$	0.145	0.153	0.153	0.153	0.153	0.153
$E(b_2P_2 \mid S)/E(W_2 \mid S)$	0.151	0.154	0.154	0.154	0.154	0.154
$E(b_2P_2 \mid L)/E(W_2 \mid L)$	0.165	0.153	0.153	0.153	0.153	0.153

Panel D: σ_u

	Actual Moments **(1)**	Simulated Moments (2)	(3)	**(4)**	(5)	(6)
σ_u	---	0.604	0.805	1.006	1.207	1.409
Prob(L)	0.186	0.154	0.170	0.186	0.203	0.220
$E(W_1)/E(\Pi_1)$	0.028	0.028	0.028	0.028	0.028	0.028
$E(W_2)/E(\Pi_2)$	0.055	0.055	0.054	0.054	0.054	0.054
$E(W_2 \vert S)/E(\Pi_2 \vert S)$	0.051	0.048	0.050	0.051	0.050	0.051
$E(W_2 \vert L)/E(\Pi_2 \vert L)$	0.074	0.249	0.090	0.074	0.078	0.067
$E(b_1P_1)/E(W_1)$	0.145	0.422	0.239	0.153	0.107	0.078
$E(b_2P_2 \vert S)/E(W_2 \vert S)$	0.151	0.423	0.240	0.154	0.107	0.079
$E(b_2P_2 \vert L)/E(W_2 \vert L)$	0.165	0.422	0.239	0.153	0.107	0.078

Panel E: σ_θ

	Actual Moments **(1)**	Simulated Moments (2)	(3)	**(4)**	(5)	(6)
σ_θ	---	0.002	0.003	0.004	0.005	0.006
Prob(L)	0.186	0.186	0.186	0.186	0.186	0.186
$E(W_1)/E(\Pi_1)$	0.028	0.028	0.028	0.028	0.028	0.028
$E(W_2)/E(\Pi_2)$	0.055	0.054	0.054	0.054	0.054	0.054
$E(W_2 \vert S)/E(\Pi_2 \vert S)$	0.051	0.051	0.051	0.051	0.051	0.052
$E(W_2 \vert L)/E(\Pi_2 \vert L)$	0.074	0.076	0.075	0.074	0.072	0.072
$E(b_1P_1)/E(W_1)$	0.145	0.153	0.153	0.153	0.153	0.153
$E(b_2P_2 \vert S)/E(W_2 \vert S)$	0.151	0.154	0.154	0.154	0.154	0.154
$E(b_2P_2 \vert L)/E(W_2 \vert L)$	0.165	0.153	0.153	0.153	0.153	0.153

Panel F: U_1

	Actual Moments	Simulated Moments				
	(1)	(2)	(3)	**(4)**	(5)	(6)
U_1	---	-0.007	-0.009	-0.012	-0.014	-0.016
Prob(L)	0.186	0.160	0.175	0.186	0.195	0.204
$E(W_1)/E(\Pi_1)$	0.028	0.031	0.029	0.028	0.027	0.026
$E(W_2)/E(\Pi_2)$	0.055	0.055	0.055	0.054	0.054	0.054
$E(W_2 \mid S)/E(\Pi_2 \mid S)$	0.051	0.054	0.052	0.051	0.051	0.052
$E(W_2 \mid L)/E(\Pi_2 \mid L)$	0.074	0.062	0.076	0.074	0.073	0.063
$E(b_1P_1)/E(W_1)$	0.145	0.138	0.146	0.153	0.160	0.166
$E(b_2P_2 \mid S)/E(W_2 \mid S)$	0.151	0.154	0.154	0.154	0.154	0.154
$E(b_2P_2 \mid L)/E(W_2 \mid L)$	0.165	0.138	0.146	0.153	0.160	0.166

Panel G: μ

	Actual Moments	Simulated Moments				
	(1)	(2)	(3)	**(4)**	(5)	(6)
μ	---	26.689	35.586	44.482	53.378	62.275
Prob(L)	0.186	0.296	0.238	0.186	0.141	0.105
$E(W_1)/E(\Pi_1)$	0.028	0.042	0.034	0.028	0.024	0.021
$E(W_2)/E(\Pi_2)$	0.055	0.167	0.082	0.054	0.041	0.032
$E(W_2 \mid S)/E(\Pi_2 \mid S)$	0.051	0.084	0.063	0.051	0.037	0.031
$E(W_2 \mid L)/E(\Pi_2 \mid L)$	0.074	-0.122	2.843	0.074	0.093	0.059
$E(b_1P_1)/E(W_1)$	0.145	0.092	0.123	0.153	0.184	0.215
$E(b_2P_2 \mid S)/E(W_2 \mid S)$	0.151	0.093	0.124	0.154	0.185	0.215
$E(b_2P_2 \mid L)/E(W_2 \mid L)$	0.165	0.092	0.123	0.153	0.184	0.215

Table 4. Simulation Outcomes of Pre-Policy vs. Post-Policy Regimes

The two cases "BS" and "NS" in the post policy regime (column 2) are combined into a single "S" case, and the two cases "BL" and "NL" are combined into a single "L" case) to be compared with column 1 which reports the corresponding outcomes for the pre-policy regime. Columns 3 and 4 further decompose the post-policy column 2 into the "bailout" cases (Column 3) and the "no bailout" cases (Column 4). The effect of the policy can be inferred by comparing column 1 with either column 2 or with columns 3 and 4. Prob(S), Prob(L), Prob(closure), Prob(closure|S), and Prob(closure|L) are reported in percentages.

	Pre-Policy (1)	**Post-Policy (2)**	**Bailout (3)**	**No Bailout (4)**
Prob(S)	81.485	98.131	99.731	82.316
Prob(L)	18.515	1.869	0.269	17.684
Prob(closure)	49.842	49.829	49.756	50.550
Prob(closure|S)	49.928	49.833	49.749	50.846
Prob(closure|L)	49.463	49.599	52.459	49.169
$E(W_2)$	1.4808	1.4894	1.4903	1.4808
$E(W_2\|S)$	1.4808	1.4822	1.4823	1.4808
$E(W_2\|L)$	1.4808	1.8696	4.4582	1.4809
$E(a_S)$	1.2525	0.1335	0.0400	1.2532
$E(b_S)$	0.0049	0.0293	0.0313	0.0049
$E(a_L)$	1.2536	1.0952	0.0400	1.2536
$E(b_L)$	0.0051	0.0174	0.0993	0.0051

Table 5. Comparative Statics for B (Bailout Lump Sum) in the Post-Policy Regime

Comparative statics for B, the bailout amount, is computed in the post-policy regime. Simulated outcomes for different values of B are reported in columns 1 to 5. Column (3) represents the benchmark case using the original values of B = 2, k = 0.04. Prob(S), Prob(L), Prob(closure), Prob(closure|S), and Prob(closure|L) are reported in percentages.

	(1)	(2)	**(3)**	(4)	(5)
B	1.2	1.6	2	2.4	2.8
Prob(S)	95.920	97.190	98.131	98.770	99.133
Prob(L)	4.080	2.810	1.869	1.230	0.867
Prob(closure)	49.836	49.835	49.829	49.828	49.826
Prob(closure|S)	49.842	49.839	49.833	49.834	49.831
Prob(closure|L)	49.706	49.715	49.599	49.350	49.250
$E(W_2)$	1.4854	1.4873	1.4894	1.4911	1.4926
$E(W_2\|S)$	1.4820	1.4821	1.4822	1.4823	1.4823
$E(W_2\|L)$	1.5664	1.6651	1.8696	2.2016	2.6692
$E(a_S)$	0.2771	0.1932	0.1335	0.0927	0.0682
$E(b_S)$	0.0261	0.0280	0.0293	0.0302	0.0307
$E(a_L)$	1.2188	1.1784	1.0952	0.9596	0.7693
$E(b_L)$	0.0078	0.0109	0.0174	0.0279	0.0427

Table 6. Comparative Statics for B (Bailout Lump Sum) in the Post-Policy Regime Given that a Bailout is Taken (BS and BL cases)

Comparative statics for B, the bailout amount, is computed in the post-policy regime given that a bailout is taken (including the two cases "BS" and "BL"). Simulated outcomes for different values of B are reported in columns 1 to 5. Column (3) represents the benchmark case using the original values of B = 2, k = 0.04. Prob(S), Prob(L), Prob(closure), Prob(closure|S), and Prob(closure|L) are reported in percentages.

	(1)	(2)	**(3)**	(4)	(5)
B	1.2	1.6	2	2.4	2.8
Prob(S)	99.849	99.796	99.731	99.686	99.644
Prob(L)	0.151	0.205	0.269	0.314	0.356
Prob(closure)	49.798	49.750	49.756	49.814	49.844
Prob(closure|S)	49.791	49.746	49.749	49.805	49.835
Prob(closure|L)	54.701	51.724	52.459	52.685	52.312
$E(W_2)$	1.4868	1.4884	1.4903	1.4917	1.4930
$E(W_2\|S)$	1.4823	1.4824	1.4823	1.4823	1.4824
$E(W_2\|L)$	4.4635	4.4561	4.4582	4.4555	4.4585
$E(a_S)$	0.0400	0.0400	0.0400	0.0400	0.0400
$E(b_S)$	0.0313	0.0313	0.0313	0.0313	0.0313
$E(a_L)$	0.0400	0.0400	0.0400	0.0400	0.0400
$E(b_L)$	0.0993	0.0993	0.0993	0.0993	0.0993

Table 7. Comparative Statics for B (Bailout Lump Sum) in the Post-Policy Regime Given that a Bailout is Not Taken (NS and NL cases)

Comparative statics for B, the bailout amount, is computed in the post-policy regime given that a bailout is taken (including the two cases “NS” and “NL”). Simulated outcomes for different values of B are reported in columns 1 to 5. Column (3) represents the benchmark case using the original values of B = 2, k = 0.04. Prob(S), Prob(L), Prob(closure), Prob(closure|S), and Prob(closure|L) are reported in percentages.

	(1)	(2)	**(3)**	(4)	(5)
B	1.2	1.6	2	2.4	2.8
Prob(S)	82.553	82.322	82.316	82.142	81.564
Prob(L)	17.447	17.678	17.684	17.858	18.436
Prob(closure)	49.965	50.319	50.550	50.086	49.222
Prob(closure|S)	50.051	50.477	50.846	50.478	49.675
Prob(closure|L)	49.558	49.583	49.169	48.283	47.217
$E(W_2)$	1.4808	1.4808	1.4808	1.4809	1.4808
$E(W_2\|S)$	1.4808	1.4808	1.4808	1.4809	1.4808
$E(W_2\|L)$	1.4809	1.4808	1.4809	1.4809	1.4809
$E(a_S)$	1.2531	1.2531	1.2532	1.2532	1.2534
$E(b_S)$	0.0049	0.0049	0.0049	0.0049	0.0049
$E(a_L)$	1.2536	1.2536	1.2536	1.2536	1.2536
$E(b_L)$	0.0051	0.0051	0.0051	0.0051	0.0051