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, using it to analyze the effects of a cap on executive compensation in distressed firms accepting public bailouts. Given estimates of the model's parameters, we simulate the effect of the policy on executive turnover, the design of compensation contracts, the probability a bailout is accepted, and the bankruptcy probability. We characterize the resulting distortion in compensation contracts, i.e. the contract slope is either too high or too low depending upon the executive's risk preferences and the variance in the performance measure on which variable pay is based.

Keywords: Executive Compensation, Retention, Corporate Bailouts, Financially Distressed Firms

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Executive compensation has been a politically charged issue in the U.S. since the early 1990s (Crystal 1991, McCarroll 1992), with most of the debate surrounding two questions: Are CEOs overpaid?[1] 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 recent global financial crisis, the most severe since 1929, fierce criticisms of executive compensation and calls for major reforms advanced to center stage. Within days of his inauguration, President Obama delivered strong televised criticism of CEOs receiving bonuses when their troubled organizations were in receipt of taxpayer-financed bailout funds: [2]

"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)

In response to these criticisms – which were fueled by companies' disclosures of more information about their executives' compensation, as mandated by the Securities Exchange Commission – the government enacted a policy to restrict executive compensation contracts for firms accepting public bailout funds. The rationale for the policy was 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. The relevant legislation, signed into law by President Obama on February 17, 2009, is the American Recovery and Reinvestment Act of 2009 (ARRA).[3] We focus on the provision of the ARRA that caps executive compensation at $500,000 per year for firms accepting public bailout funds, with important exceptions for variable pay in the form of restricted stock grants.[4] The cap distorts the

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[1] See Frydman (2008) for a review of theoretical explanations for the rapid increase in CEO pay that has occurred during the last three decades.

[2] As an example of the type of firm behavior that has come under attack, American International Group (AIG) paid contractually obligated executive bonuses and other payments reportedly totaling $450 million, even though the company had reported 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.

[3] This is also known as the Stimulus Package. It significantly expanded the executive compensation restrictions already imposed upon recipients of Troubled Asset Relief Program (TARP) funds under the Emergency Economic Stabilization Act of 2008 (EESA).

[4] 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

design of compensation contracts, resulting in inefficient contracts in which base pay is too low (and the contract slope either too high or too low) relative to what the optimal linear contract would be for a risk-averse CEO. Critics argue that the cap impedes firms' efforts to attract and retain top talent, and this criticism is a key motivation for our analysis.

We investigate how the cap can be expected to impact CEO retention, the structure of compensation contracts, the probability that financially distressed firms accept bailout assistance, and the probability that such firms survive or close. The cap is worth studying given that it applies 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).[5] To our knowledge, this is the first structural analysis of the relationship between executive compensation and turnover in the context of government regulations on the design of incentive contracts.[6] A structural approach is advantageous for the usual reasons, i.e. we do not require post-policy data to conduct meaningful policy analysis, the outcomes we measure account for the optimizing responses of economic agents, and we can consider counterfactual policies.[7]

We develop a two-period theoretical model of CEO hiring and retention. In the first period, a firm offers a compensation contract and hires a risk-averse CEO to maximize expected 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 fixed cost. We consider a "baseline world" and a "policy world". No policy exists in the baseline world, so when the financial crisis occurs the firm does not have an option to take a bailout and therefore is not subject to constraints on executive pay. In the policy world, when the financial crisis occurs the firm has an option to accept public bailout assistance with accompanying restrictions on executive pay.

In the baseline world, after observing first-period profit and the CEO's first-period performance, and following the onset of the crisis, the firm decides whether to retain the CEO

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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."

[5] 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).

[6] Taylor (2011) estimates a structural model of CEO compensation and turnover but does not consider public bailouts or the effect on turnover of restrictions on CEO pay.

[7] The structural approach is consistent with a trend towards increasing use of such methods in the finance literature. Coles *et al*. (2007) demonstrate the importance of the structural approach by showing how a quantitative model of the firm can isolate important aspects of organizational structure, quantify the economic significance of incentive mechanisms, and mitigate the endogeneity problems that commonly plague empirical corporate finance.

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

The policy world is the same as the baseline world 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 baseline world, the firm either survives or closes at the end of the second period according to whether the sum of profits over both periods (including the bailout payment, if it is taken) minus the fixed cost arising from the financial crisis is positive or negative.

The key tradeoff in our model is the attractiveness to the firm of getting a bailout versus the costs of incurring restrictions on the structure of future pay contracts. The cap on base pay means that the firm must offer a lower level of base pay than is optimal, creating a distortion in the contract. Whether the resulting contract slope is higher or lower than it would be in the absence of a cap depends on the executive's risk preferences and on the variance of 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 provisions of the ARRA, which state that firms can offer additional compensation beyond the capped base pay in the form of restricted stock grants.

We use data from Compustat and ExecuComp to estimate the parameters of the baseline world via the method of simulated moments, using the parameter estimates to simulate the probability of CEO turnover, the probability of firm closure, and the structure of second-period compensation contracts. Then, using calibrated values for the two policy parameters (the bailout amount and the cap on base pay), we simulate the corresponding outcomes in the policy world.

We then compare the simulated outcomes from the policy world to those from the baseline world to identify the effect of the policy.

Our simulations reveal the following results. First, the probability that the CEO leaves after the financial crisis hits drops significantly, and the bulk of this effect occurs in the case in which the bailout is taken. 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 the bailout case than in the baseline world. Second, the bankruptcy probability is relatively insensitive to the policy; however it is slightly higher when the firm does not take the bailout than when it does, 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 baseline world given that it is higher in the case of a bailout. Despite the cap on executive base pay, the firm is 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 the contract slope are *substitutes*, meaning the cap on base pay induces firms to 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 in the second period. The result that base pay and the contract slope are substitutes is driven by the data, given that the theoretical model allows for either substitutes or complements according to parameter values.

Finally, we conduct counterfactual comparative statics simulations in which we explore the effects of changes in the generosity of bailouts 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 an increase in the likelihood that the firm takes the bailout; the CEO retention rate is significantly higher in the "bailout" case than in the "no bailout" case. It is the combination of these two facts that explains why the retention rate is in general increasing in bailout amounts. Second, as expected, higher bailout amounts 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 bailout increases total second-period compensation – regardless of whether the

CEO stays or leaves – by increasing the variance of compensation. Given that the policy constrains only base pay and not variable pay, meeting the risk-averse CEO's participation constraint requires an 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.

I. Related Literature

Our analysis relates to several areas in the executive compensation literature surveyed in Murphy (1999), including the design and structure of compensation (Dittmann and Maug 2007, Dittman, Maug, and Spalt 2010); the theory and empirical estimation of CEO turnover (Taylor 2011); and the link between executive compensation and the market for CEOs (Murphy and Zábojník 2006). Our analysis also relates to a literature on compensation policy in distressed firms (Gilson and Vetsuypens, 1993; Dial and Murphy 1995; Mehran, Nogler, and Schwartz 1998; Bebchuk and Grinstein 2007). There is also an emerging literature on compensation restrictions to which our paper contributes (e.g. Llense 2010; Garner and Kim 2010; Bolton, Mehran, and Shapiro 2010; Thanassoulis 2010; Cadman, Carter, and Lynch 2010; and Dittman, Maug, and Zhang 2011).

The paper most closely related to ours is the recent study by Dittmann, Maug, and Zhang (2011), which examines proposals to restrict CEO compensation by calibrating contracting models of executive compensation that describe how firms would react to different types of regulations, including proposals to restrict realized compensation, to restrict the value of compensation, and to restrict components of pay. Our study differs from the Dittmann *et al*. analysis in several key respects. First, that analysis does not consider CEO turnover, which is the primary focus of our paper. The question of how turnover is affected by executive pay restrictions is important given that, as mentioned earlier, one of the main criticisms of these restrictions is that they thwart the attraction and retention of high-performing CEOs. Second, given that the focus of that study is on policies in multiple countries rather than on the U.S. alone, it does not consider the firm's decision whether to accept or reject a public bailout, whereas this is an endogenous choice of the firm in our analysis. A related point is that the CEOs in their analysis are assumed to be exogenously struck by regulations on pay of various forms, whereas in our model it is the firm's endogenous choice (whether or not to accept a public bailout that comes with accompanying restrictions on executive pay) that determines whether it is subject to compensation restrictions. Thus, two of the firm's decisions (whether to accept or reject a bailout and whether to retain the CEO or not) that are central to our paper are not modeled in the Dittmann *et al*. analysis. Third, that analysis is based on a calibration approach, i.e. all of the parameters in their model were assigned values for each firm in the sample rather than estimated from data in a structural analysis. We see the differences between the two analyses as driven by differences in the research questions addressed. Thus, the papers are complementary and shed light on different aspects of the under-explored research area of executive pay restrictions.

Taylor (2011) is the first to estimate a structural model of CEO turnover, quantifying the potential effects of suboptimal turnover decisions on shareholder value. He estimates the model's parameters via the method of simulated moments using data on firm profitability and CEO turnover (both voluntary and involuntary) in large U.S. firms from 1971 to 2006. The estimated parameters include the real cost of CEO turnover to shareholders, the variation in ability across new CEOs, the volatility and persistence of profitability, the precision of boards' additional information about CEO ability, and the effective personal turnover cost. Our study differs from Taylor's analysis in several key respects. First, our study focuses on the implications for turnover of government restrictions on executive pay, whereas Taylor's analysis considers executive turnover in the absence of such restrictions. Thus, Taylor's main goal is to understand the effect of involuntary CEO turnover on shareholder value during periods of normalcy, whereas our main goal is to consider the effects of pay regulations imposed during times a financial crisis. Second, in our model both turnover and executive pay contracts are endogenous firm choices, allowing us to consider their joint determination, whereas in Taylor's model the firm makes turnover decisions treating executive pay as exogenous. Third, in our model the firm maximizes expected profit per period as we discuss in the next section, whereas Taylor estimates a fully dynamic model.

Our study also relates to Eisfeldt and Rampini (2008), which proposes a model of CEOs' incentives for revealing private information to explain cyclical variation in CEO turnover and compensation. They calibrate their model to match the procyclical variations in managerial compensation and CEO turnover. The turnover rate is calibrated in their model, whereas it is an endogenous outcome in our model. Furthermore, our simulations focus on predicting CEO turnover during a period of financial crisis rather than over the entire business cycle as in Eisfeldt and Rampini (2008).

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

The ARRA reflects 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). Our focus is on companies needing "exceptional assistance" that received individually tailored bailout packages.[8] 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*.[9] The number of executives subject to the cap is a function of the amount of federal assistance received by the TARP recipient.

The restrictions on executive pay that accompany 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 may make it hard for firms that are most in need of help to recruit and retain top talent.[10] However, a key feature of the regulation is that it exempts variable pay in the form of restricted 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 restricted stock grants, a firm facing a cap on base pay can meet its CEO's participation

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

[9] A second type of bailout recipient consists of financial institutions participating in generally available capital access programs (like the government's capital-injection effort under the TARP). Such companies 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. Because for this group the cap is on *total* compensation (i.e. without an exemption for restricted stock grants) the theoretical prediction on CEO turnover would be an unambiguous decrease in retention rates. Our focus is on the more interesting case in which the compensation contracts do not cap restricted stock grants, since in this case the theoretical effect on CEO retention is less straightforward.

[10] 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."

constraint and prevent the executive from separating by adjusting the unrestricted component of compensation. 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.[11] This feature of the policy is captured by our model.

A second criticism of the regulation is that, by capping pay while allowing exceptions for restricted stock grants, compensation contracts are distorted and inefficient, with base pay that is too low and a contract slope that is different from what would be optimal for a risk-averse executive. Our analysis characterizes the nature and implications of this distortion. 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.

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

In this section we develop a theoretical framework for analyzing the effects on executive turnover and the bankruptcy probability of regulations that restrict executive compensation. We first model the baseline world in which no bailouts or regulations on CEO pay exist. We then model the policy world in which the government offers the distressed firm the option to accept a bailout in exchange for accepting restrictions (i.e. a cap on base pay) on future executive compensation contracts. Finally, we compare simulated outcomes between the policy world and the baseline world to measure the impact of the policy.

A. Baseline World

Consider a single firm and two time periods, with an unanticipated financial crisis hitting in the middle of the first period.[12] Normalize the price per unit of output to 1, and let Π_t denote the

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[11] 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 the *Wall Street Journal*: "Congress gets punitive on executive pay", February 17, 2009, (http://www.law.harvard.edu/news/2009/02/17_bebchuk.html).

[12] The two-period setup does not allow for the fact that firms accepting bailout assistance have the option to pay back the bailout loans in the future, lifting the restrictions on executive compensation. Three factors may mitigate this limitation of the model. 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

firm's profit in period t. To simplify the analysis in order to enrich it in other dimensions (e.g. endogenous firm choices of compensation contracts, CEO turnover, and, in the policy world, whether to accept or reject public bailout funds and the accompanying restrictions on pay contracts) we assume that the firm maximizes per-period expected profit. The model is therefore not fully dynamic given that when making first-period choices the firm does not account for the effect of its decisions on second-period profit; the two periods represent different regimes – pre and post crisis. Given this approach, the probability of a future financial crisis is not taken into account in the pre-crisis decisions of the firm and workers. The financial crisis is modeled as a non-stochastic, unexpected fixed cost incurred by the firm in the middle of the first period.[13]

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. Let U_t denote the executive's period-t reservation expected utility. Although the executives are heterogeneous in ability, they have common preferences given by a per-period exponential utility function,

$$U(W_t) = -\exp(-\gamma(W_t - C(e_t))), \tag{1}$$

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 $C(0) = 0$, $C'(e_t) \geq 0$, and $C''(e_t) > 0$. Compensation contracts are linear in executive performance, P_t, i.e.

$$W_t = a_t + b_t P_t. \tag{2}$$

For simplicity, 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,

$$W_1 = a_1 + b_1 P_1, \tag{3}$$

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 it is uncertain when in the future this will occur).

[13] A fully-dynamic model would involve decisions that account for implications for future profit and also for the probability a financial crisis might occur. However, when considering crises of a catastrophic magnitude that occur at most once or twice per century, it may be reasonable to suppose that firms make myopic pre-crisis decisions without accounting for the possibility of such a crisis. To the extent that the crisis (and the resulting government response and bailout programs) was unanticipated it can be thought of as initiating a new regime.

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 contract slope.[14] Let $P_1 = \theta + e_1 + u_1$, where u_1 is a mean-zero stochastic component of the executive's first-period performance.[15] 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 incentive compatibility and participation constraints.

In the middle of period 1, P_1 and Π_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 financial loss of ξ, where $\xi > 0$. 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. After observing P_1 and Π_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 incentive compatibility and participation constraints.

At the end of period 1, the firm decides whether the executive "stays" or "leaves", and throughout the discussion these choices are indicated by subscripts "S" and "L". The expressions P_2 and W_2 vary according to these choices. 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

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

[14] Variable pay in this model represents restricted stock grants, which are the only component of executive compensation that is not capped by ARRA.
[15] These shocks represent factors that affect a CEO's performance in a persistent manner but that are beyond his or her control. For example, the executive might acquire a highly-productive (or unproductive) assistant.

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".[16] 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. $\Pi_2 = P_2 + \varepsilon_2 - W_2$, where ε_2 is a mean-zero stochastic shock. The firm closes at the end of the second period if $\Pi_1 + \Pi_2 - \xi < 0$.

While the performance shocks (u_1 and u_2) are independent across periods, the presence of P_1 on the right-hand side of (5) implies persistence of first-period shocks, capturing the idea that the stochastic part of performance reflects a blend of persistent and idiosyncratic components. However, note that b_1/λ is subtracted in (5) to cancel its appearance in P_1 (which also appears in (5)). Thus, persistence in performance is modeled via stochastic shocks rather than via effort choices.[17] Note also that the recursive structure of performance, with P_1 being observed by the firm and appearing on the right-hand side of P_2, eliminates the need for Bayesian updating about θ when making second-period compensation and retention decisions, because θ is embedded in the observed P_1. Thus, the retention decision requires only a comparison of the observed P_1 with $E(\theta')$ as opposed to a comparison of $E(\theta|P_1)$ with $E(\theta')$ as would be the case if the expression for second-period performance in the retention case were $P_2 = (1 + \delta)(\theta + u_2 + \frac{b_S}{\lambda} - \frac{b_1}{\lambda})$ rather than, as in our model, $P_2 = (1 + \delta)(P_1 + u_2 + \frac{b_S}{\lambda} - \frac{b_1}{\lambda})$.

Let τ_S and τ_L denote the aforementioned information or optimization errors. They are mean-zero random variables with common variance σ_τ^2, distributed independently 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. Higher values of σ_τ^2 imply that the firm is more likely to make optimization errors, either retaining an executive who should have been fired or firing one who should have been retained. The firm observes neither $(\tau_{L,}\tau_S)$ nor σ_τ^2, and thus does not anticipate making optimization errors and does not account for the possibility of errors when making its decisions. The optimization errors capture the realistic idea that mistakes in organizational decision-making are more likely during an unprecedented, major financial crisis. From a modeling standpoint these errors are not essential in the baseline world and could be

[16] The presence of firm-specific human capital, δ, ensures that the CEO retention rate implied by the model is sufficiently high to match what is observed in the data.
[17] As noted earlier, an example of such a persistent shock would be the acquisition of a high-quality (or low-quality) staff member or assistant.

eliminated without changing anything fundamental, whereas in the policy world they play a more significant role, as we explain in the next subsection.

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. The timing of the model is summarized as follows:

Period 1 Timing:

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.

Financial crisis occurs, and 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.

Period 2 Timing:

If the first-period executive stays, then P_2 and Π_2 are realized and the firm survives or closes.

If the first-period executive leaves, a new executive is hired, P_2 and Π_2 are 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. Holmström 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 cases, 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). We assume $U_1 = U_2$ for simplicity.

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 $E(\Pi_L)^*$. 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 standard expression for the optimal piece rate, generalized to incorporate firm-specific human capital:

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

[18]

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.

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

[18] 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 (8). 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. A similar argument applies in the policy world in the event that the incumbent executive stays with the firm in the second period.

Given the expression for second-period contracts, we compute realized profits and whether the firm survives or closes. The following algorithm describes our approach, which provides the basis for the estimation routine described in the next section:

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.

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 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 $E(\Pi_S|P_1)^*$ 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 repeat steps 2-9, to conduct comparative statics analysis.

B. Policy World

The model in the policy world is the same as in the baseline world until the financial crisis hits. At that time, the government unexpectedly announces a bailout option. The advantage to the firm of accepting a bailout is that revenue in the second period is increased by B, where $B > 0$ denotes the amount of the bailout.[19] 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 policy world, 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"

[19] The bailouts provided during the financial crisis were mainly aimed at preventing bankruptcy or closure of the firm; as such, the bailout payment in our model provides an immediate cash/capital inflow to profits to ensure that the firm can repay its financial obligations, thereby lowering the risk of closure/bankruptcy.

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".[20] The timing for period 2 is the same as in the baseline world, and the timing for period 1 in the policy world is 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.

Financial crisis occurs, and 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 world. In the BS case, assuming first that the regulation does not bind, then $b_{BS} = b_{NS}$. Assuming next that the regulation binds, the firm offers $a_{BS} = k$ and chooses b_{BS} to maximize

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

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:[21]

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

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

[20] 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.

[21] 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.

In the BL case, assuming the regulation does not bind, 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, the firm offers $a_{BL} = k$ and chooses b_{BL} to maximize

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

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:

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

Comparing this contract to the one for which the regulation does not bind, 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:

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

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

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

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

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 $E(\Pi_{NL})^*$.

From a modeling standpoint, there is a practical reason for incorporating optimization errors in the policy world. An implication of these errors in the policy world 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 contrast, in the baseline world both firm choices ("S" and "L") are potentially observable even in the absence of optimization errors. This rationale for incorporating optimization errors into the model is reminiscent of the virtually universal practice of incorporating measurement error in hours worked in labor supply models involving the econometrics of piecewise linear budget constraints (e.g. MaCurdy, Green, and Paarsch 1990, Blundell and MaCurdy 1999). In that literature, progressive taxes create piece-wise linear, convex budget constraints, with kinks occurring at particular hours of work that correspond to switches in the worker's marginal tax rate. The theoretical model predicts that workers' choices of hours cluster at these kink points. Empirically, however, it is not unusual (even in datasets of thousands of worker hours choices) for few or even no observed hours choices to occur exactly at these kink points. In MaCurdy, Green, and Paarsch (1990), only a single observed hours choice occurred at a kink point. The authors note that in the absence of assumed measurement error in hours worked, such evidence would be the basis for immediate rejection of the theoretical model. Researchers in this literature resolve the issue by assuming measurement error in hours worked, thereby reconciling the theoretical model with the data. Similarly, incorporating optimization errors in our model allows all four firm choices to potentially be observed, just as they are in the data.

The following algorithm, similar to the one for the baseline world, describes our approach:

1. Assign values to B, k, λ, δ, γ, μ, σ^2_θ, σ^2_u, σ^2_ϵ, σ^2_τ, ξ, U_1, and U_2.
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_{BS}, b_{BS}), (a_{BL}, b_{BL}), (a_{NS}, b_{NS}), and (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 (θ,u_2,ε_2) from step 3. If the choice was "BL" or "NL" 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 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 analysis.

Note that the policy reduces base pay below what the firm would optimally offer. What happens to the contract slope depends on parameter values. More precisely, in the BL case, if $\gamma(\sigma_\theta^2 + \sigma_u^2)b_{BL} < \frac{1}{\lambda}b_{BL} + \mu$ then reductions in a_{BL} imply increases in b_{BL} (i.e. base pay and the contract slope are substitutes), whereas if the inequality is reversed the opposite is true (i.e. base pay and the contract slope are complements). Similarly, in the BS case, if $\gamma\sigma_u^2 b_{BS} < \frac{1}{\lambda}[b_{BS} - b_1] + P_1$ we have substitutes, and if the inequality is reversed we have complements.[22] In the BL case, if the product $\gamma(\sigma_\theta^2 + \sigma_u^2)$ is sufficiently small, then the case of 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 the piece rate 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. Whereas 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.

[22] 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.

IV. Structural Estimation of Parameters in the Baseline World

The parameters in the baseline world 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, Lemmon, and Meschke (2007). We also assume $\sigma_\tau = 1$, $\xi = 35$, 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 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. 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 $Q(\Omega) = [m(\Omega) - m_o]'M[m(\Omega) - m_o]$.[23] 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.

A. 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 (containing data on firm characteristics) and ExecuComp, which 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, plus 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, 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 pre-crisis variables, whereas we use a

[23] Note that $m(\Omega)$ is computed following the first 9 steps of the algorithm given at the end of subsection III.A.

subsample of “distressed firms” to construct the moments for post-crisis variables. Following studies such as Eisdorfer (2008) that use Altman’s (1968) Z-score as a model for predicting bankruptcy, we construct the “distressed” subsample by computing Z-scores for each observation and defining those firms with Z-scores below 1.81 as distressed.[24] 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 should also be applicable to financials, particularly given that the restrictions imposed by ARRA are similar for both types of companies.[25] The subsample of “distressed firms” contains 2108 firm-year observations, and the subsample of “non-distressed firms” contains 11,655 firm-year observations.

B. 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 utility function and reservation utility parameters λ and U_1 (= U_2) from observed variation across firms and CEOs in profit, CEO turnover, the design of compensation contracts, and whether the firm is in financial distress. We use 8 moment conditions to estimate 7 parameters.

Parameter estimates and standard errors are displayed in Table I. Table II displays the observed moments in column 1 and the simulated moments (based on N = 100,000 stochastic draws) in column 2, revealing a good fit. We calibrate the observed moments using the data sample discussed in subsection IV.A. 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 ratio of average compensation to average profit 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

[24] 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.
[25] In particular, based on the two categories of public bailout funds, either of the following two groups can avoid the cap on restricted stock: (i) financial institutions receiving "exceptional assistance" or (ii) those participating in generally available capital access programs with full public disclosure and a shareholder vote. In such cases the restrictions on CEO pay exactly mirror those in non-financial companies. See Section II for further information on the ARRA Executive Compensation Provisions.

"normal/non-distressed firms";[26]similarly, the ratio of average compensation to average profit in period 2, $E(W_2)/E(\Pi_2)$, is defined using 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 "distressed firms with no CEO turnover"; similarly, the 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 "distressed firms with CEO turnover". To be consistent with the executive compensation restrictions in the ARRA (see Section II), 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).[27] 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.

-- Insert Tables I and II here --

Panels A-G of Table III illustrate the sources of observed 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, consider δ. Columns 2, 3, 5, and 6 of Panel A vary δ from its estimated value in column 4. When δ is increased holding the other parameters constant, Prob(L) 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 average variable pay to average 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.

-- Insert Table III here --

[26] The total compensation variable is obtained from ExecuComp and is comprised of the following components: salary, bonus, non-equity incentive plan compensation, grant-date fair value of option awards, grant-date fair value of stock awards, deferred compensation earnings reported as compensation, and other compensation.

[27] Under the ARRA provision (see Section II), restricted stock is the only component of compensation exempted from the cap on compensation. As such, shifts in variable pay in our model will mainly be restricted stock (and not options and other compensation types). Consistent with our model, restricted stocks are based on firm performance whereas stock options are based on the stock price.

V. Policy Analysis (ARRA)

In this section, we use the parameter estimates from Section IV 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 IV, we set values for the two policy parameters (B and k) and simulate various outcomes of interest in the policy world, 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 from the policy world to those from the baseline world yields the predicted 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"[28] 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.[29]

Table IV displays the simulation results for the policy world 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-crisis baseline world. Columns 3 and 4 further decompose the results from the policy world in 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 IV are worth highlighting.

-- Insert Table IV here --

First, the probability that the CEO leaves drops significantly as a result of the policy, and the bulk of this effect arises from the case in which the firm takes a bailout. This result is counter to the criticism of the pay regulations that is frequently voiced in the popular press, namely that

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

[29] Some companies, e.g. AIG, received far more bailout assistance than $25million, though these funds were received *before* implementation of the policy restricting executive pay.

the regulations will make it difficult for firms to retain top executive talent. As we noted earlier, this argument is problematic because the cap exempts a component of compensation that can be adjusted by the firm so as to meet the executive's participation constraint and prevent a quit. Simulated executive retention rates are actually higher when the firm takes a bailout than in the baseline world.

Second, the bankruptcy probability is relatively insensitive to the policy; however it is slightly higher when the firm does not take the bailout than when the firm does, given that the CEO stays.[30] A higher first-period performance increases the likelihood that the bailout is taken and that the CEO is retained. If the firm has a lower chance of second-period closure anyway (even absent the bailout) it finds the bailout more appealing. To understand why this happens, recall that a high first-period performance increases the likelihood of a high second-period performance due to persistence in the performance shocks. The increased likelihood of a high second-period performance is more valuable in the case of a bailed-out firm with a retained CEO because of the firm-specific human capital parameter, δ, which enters multiplicatively, raising the marginal return to second-period CEO performance.

There is another mechanism, also relating to firm-specific human capital, that explains why when the firm takes a bailout it tends to retain the CEO. This mechanism concerns incentives. Recall that our empirical results imply that base pay and the contract slope are substitutes, so that the second-period contract slope is higher when the bailout is taken than when it is not. The steeper slope induces incremental CEO effort, and the marginal effect of this effort on performance is particularly valuable in the presence of multiplicative firm-specific human capital. In other words, the distortion in the structure of compensation that the policy creates (i.e. requiring the firm to offer a higher slope than desirable) is not as costly to the firm in the presence of firm-specific human capital, given that the marginal return to the firm of CEO effort is higher in the presence of firm-specific human capital than in its absence.

Third, second-period total CEO compensation does not change much as a result of the policy, though it is slightly higher than in the baseline world given that it is higher when the bailout is accepted. Note that this is despite the cap on executive base pay; the firm is able to make up the difference by paying CEOs more variable pay to compensate for reduced based pay, as discussed in the next point. An increase in second-period total compensation is expected, since

[30] 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).

accepting a bailout and its attached restrictions on CEO pay has the following two implications, both of which predict higher total compensation: 1) a higher contract slope in the case of a bailout increases incentives, resulting in higher levels of CEO effort, and thereby performance and compensation, 2) the fact that CEOs are risk-averse and that the variance of total compensation is higher when the contract is constrained than when it is not requires that total compensation in bailout firms include a risk premium.

Fourth, as seen in the last four rows of Table IV, the policy distorts the structure of compensation contracts, whether the executive stays or leaves. As noted in footnote 22 and the surrounding discussion, there are derivative inequalities for the “BS” case and “BL” case that reveal whether base pay and the contract slope are complements (i.e. positive derivative) or substitutes (i.e. negative derivative). Given the parameter estimates from Table I, 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 the contract slope are substitutes for both the “BL” and “BS” cases. The last four rows of Table IV confirm this result. Comparing columns 1 and 2, the cap on base pay induces firms to raise 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 baseline world, whereas if the bailout is taken, the regulation binds, base pay is set at the cap, and the slope 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 slope 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.

The Effect of Changing the Generosity of the Bailout

Next, we consider counterfactual policy simulations in which we explore the effects of changes in B, holding k constant, on the probability of CEO turnover, the probability a bailout is taken, the 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 bailed-out firms in the generosity of the bailout payments they receive. These effects are displayed for all observations in Table V, for the "bailout" observations (cases BL and BS) in Table VI, and for the "no bailout" observations (cases NL and NS) in Table VII. The rationale for looking at the effects of increases in B on the "no bailout" group (i.e. Table VII) is that 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.

-- Insert Tables V, VI, and VII here --

Although Table V reveals that the probability the CEO is retained is increasing in B, Tables VI and VII reveal that the same probability is decreasing in B when the firm takes the bailout and when it does not. To understand why this happens, first notice that as we move from column 1 to column 5 in Table V, the likelihood that the employer takes 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 VI), in every column, than for the "no bailout" firms (Table VII). It is the combination of these two facts that explains why the retention rate that combines both groups (Table V) is increasing in B. The reason why Prob(S) is a decreasing function of B in Tables VI and VII can be explained as follows. First, as noted earlier, a higher first-period performance increases the likelihood of a bailout. Second, as B increases in columns 6 and 7, the firm is naturally more likely to take the bailout; in the context of simulations this means that some "marginal firms" that would have chosen to reject the bailout when B was low switch to accepting the bailout when B is higher. This lowers the average first-period performance both in the case of the bailout being accepted (i.e. Table VI) and in the case of it being rejected (i.e. Table VII) which in turn implies an increased probability of separation in both cases, given that lower first-period performance implies a greater likelihood of lower second-period performance, due to persistence in CEO performance.

Table V 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 VI (for bailout firms) and Table VII (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. The closure probability is

Prob($\Pi_1 + \Pi_2 - \xi < 0$), and it must decrease in B, *ceteris paribus*, given that the expression for Π_2 includes the term "+ B".

Table V reveals that total second-period compensation is monotonically increasing in *B*, both overall and within the categories of stayers and leavers. The intuition is as follows. As the bailout becomes more generous (holding *k* fixed) the firm becomes more likely to accept it. This results in a constrained contract, with a steeper slope, that has two implications, both of which predict higher total compensation. First, the steeper slope strengthens the CEO's incentives, implying higher effort levels and therefore higher performance and total pay. Second, the steeper slope increases the variance of total compensation which, due to the CEO's risk aversion, necessitates that total compensation reflect a larger risk premium.

The optimal contract in the baseline world is unconstrained and induces the optimal effort and risk sharing. In the policy world, when the bailout is taken, the firm is constrained to offer a suboptimally low level of CEO base pay. Given that the policy constrains base pay but exempts some variable pay, to meet the risk-averse CEO's participation constraint requires an increase in the slope of the incentive contract to induce an effort level higher than the optimum, leading to a high amount of variable pay. 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 the slope move in opposite directions arises because the aforementioned derivative (estimated from the data) is negative, meaning base pay and the slope are substitutes. If the estimated derivative had been positive, then base pay and the slope would have been complements.

In Table VI, for the bailout case, 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 VII, for the "no bailout" case, 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 VII, 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."

VI. 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 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 relates to a broad pre-existing literature in the area of executive compensation, 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 contract slope 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. Our partial equilibrium analysis focused 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.[31]

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 offer 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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[31] An alternative would be to simply assume that the CEO's reservation utility is lower after the financial crisis than before, capturing the notion that competing employers are also subject to the financial crisis which influences the compensation they can offer the executive. As a result, the inefficiency caused by the upper bound on base pay may not be as high as it is in the current model, because a lower wage would suffice to retain the executive.

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Table I. Structural Estimation Results

Results from estimation of parameters in the baseline world by method of simulated moments (n = 100,000 stochastic draws). 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 II. Observed and Simulated Moments

Column 1 reports observed moments computed using ExecuComp data as discussed in subsection IV.A. Column 2 reports simulated moments (n = 100,000 stochastic draws) from the parameter estimates of the baseline world from Table I.

	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
$E(W_2 \| S)/E(\Pi_2 \| S)$	0.051	0.051
$E(W_2 \| L)/E(\Pi_2 \| L)$	0.074	0.074
$E(b_1P_1)/E(W_1)$	0.145	0.153
$E(b_2P_2 \| S)/E(W_2 \| S)$	0.151	0.154
$E(b_2P_2 \| L)/E(W_2 \| L)$	0.165	0.153

Table III. Identification of Structural Parameters for Baseline World

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 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
$E(W_2 \mid S)/E(\Pi_2 \mid S)$	0.051	0.043	0.045	0.051	0.049	0.049
$E(W_2 \mid L)/E(\Pi_2 \mid L)$	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
$E(b_2P_2 \mid S)/E(W_2 \mid S)$	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 B: λ

	Actual Moments	**Simulated Moments**				
	(1)	(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	Simulated Moments				
	(1)	(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	Simulated Moments				
	(1)	(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
$E(W_2 \mid S)/E(\Pi_2 \mid S)$	0.051	0.048	0.050	0.051	0.050	0.051
$E(W_2 \mid L)/E(\Pi_2 \mid L)$	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
$E(b_2P_2 \mid S)/E(W_2 \mid S)$	0.151	0.423	0.240	0.154	0.107	0.079
$E(b_2P_2 \mid L)/E(W_2 \mid L)$	0.165	0.422	0.239	0.153	0.107	0.078

Panel E: σ_θ

	Actual Moments	Simulated Moments				
	(1)	(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
$E(W_2 \mid S)/E(\Pi_2 \mid S)$	0.051	0.051	0.051	0.051	0.051	0.052
$E(W_2 \mid L)/E(\Pi_2 \mid L)$	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
$E(b_2P_2 \mid S)/E(W_2 \mid S)$	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 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
$E(W_2\|S)/E(\Pi_2 \mid S)$	0.051	0.054	0.052	0.051	0.051	0.052
$E(W_2\|L)/E(\Pi_2 \mid L)$	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
$E(b_2P_2\|S)/E(W_2\|S)$	0.151	0.154	0.154	0.154	0.154	0.154
$E(b_2P_2\|L)/E(W_2\|L)$	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
$E(W_2\|S)/E(\Pi_2 \mid S)$	0.051	0.084	0.063	0.051	0.037	0.031
$E(W_2\|L)/E(\Pi_2 \mid L)$	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
$E(b_2P_2\|S)/E(W_2\|S)$	0.151	0.093	0.124	0.154	0.185	0.215
$E(b_2P_2\|L)/E(W_2\|L)$	0.165	0.092	0.123	0.153	0.184	0.215

Table IV. Simulation Outcomes of Baseline World Versus Policy World

In column 2, the two cases “BS” and “NS” in the policy world 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 pre-policy outcomes for the baseline world. Columns 3 and 4 further decompose the policy world in 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.

	Baseline World	**Policy World**		
	Pre-Policy (1)	**Post-Policy (2)**	**Post-Policy (Bailout) (3)**	**Post-Policy (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 V. Comparative Statics for B (Bailout Lump Sum) in the Policy World

Comparative statics for B, the bailout amount, are computed in the policy world. 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 VI. Comparative Statics for B (Bailout Lump Sum) in the Policy World Given that a Bailout is Taken (BS and BL cases)

Comparative statics for B, the bailout amount, is computed in the policy world 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 VII. Comparative Statics for B (Bailout Lump Sum) in the Policy World Given that a Bailout is Not Taken (NS and NL cases)

Comparative statics for B, the bailout amount, are computed in the policy world 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