Did Executive Compensation Encourage Extreme Risk-taking in Financial Institutions?

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Abstract

The effect of executive compensation on extreme risk is frequently cited as a leading candidate for the financial crisis. The evidence for or against is scarce. This paper assembles panel data on 117 financial firms from 1995 through 2008, using the financial crisis as a type of 'stress test' experiment to determine the relation of equity-based incentives on the probability of default. After estimating default probabilities using a Heston-Nandi specification, we apply a dynamic panel model to estimate statistically the effect of compensation on default risk. The results indicate uniformly that equity-based pay (i.e. restricted stock and options) increases the probability of default, while non-equity pay (i.e. cash bonuses) decreases it.

The causes of the financial crisis are as numerous as suspects in an Agatha Christie mystery. One suspect commonly named is the compensation policies that incentivized top executives of United States financial institutions to take extreme risks precipitating the near collapse of the financial system. The regulatory implications of this claim have been significant. The U.S. federal government introduced compensation guidelines for executive compensation and appointed Kenneth Feinberg as "Special Master of Compensation" to ensure that companies receiving TARP funding acted in accordance with government compensation guidelines. This appointment was part of a call for reforms in the financial service industry not just for TARP recipients but for all industry participants. The compensation guidelines set out by the US Treasury Secretary, Timothy Geithner, sought to "align the interest of shareholders and reinforce the stability of the financial system." (Treasury Dept, 7/10/2009) Federal Reserve Chairman Ben Bernanke described the Fed's efforts to develop rules that will "Ask or tell banks to structure their compensation, not just at the top but down much further, in a way that is consistent with safety and soundness – which means that payments, bonuses and so on should be tied to performance and should not induce excessive risk" (WSJ, 5/13/2009).

The academic evidence that speaks to this claim of extreme risk is surprisingly sparse. The treatment of compensation and risk has conventionally assumed that effort by the agent increases in risk, though inefficiently since the principal is assumed to be risk-neutral, while the agent is risk averse and yet bears risk. While relevant to our study, this approach is misleading in the context of extreme events such as a financial crisis. In place of assuming that performance increases by imposing risk on the agent, we ask if compensation policies may amplify default probabilities and lead to extreme risk taking.

This question is different from that addressed by an important line of financial research on the positive relation of risk, incentive pay, and corporate performance. Considerable academic evidence suggests that equity-based compensation aligns the decisions of management more closely with the value maximizing objectives of shareholders and encourages risk-taking decisions. (See, for example, Tufano (1996) and Rajgopal and Shevlin (2002), among others.) Accepting this relationship leads logically to the consideration that at some point the assumption of more risk poses the prospect of default, an absorbing state. Examining default risk is hence distinct from the conventional "going concern" notions of risk measured as volatility of stock prices or earnings that are typically viewed as promoting entrepreneurship and leading to value creation by incentivized managers. The focus of this study on the structure of executive compensation and default risk, as opposed to risk as volatility, is a substantial difference from, and contribution to the literature.

We measure risk as the likelihood that the institution will default, a definition that captures the regulatory concern that high-powered incentives with moral hazard increases distress probabilities. Following Merton (1974), we treat the firm's equity as a call option on the assets struck at the value of the debt. From this model adjusted to allow for time-varying volatility per Heston and Nandi (2000), we derive the default risk implied by the firm's security prices given the observable accounting and market variables. Default risk is, then, an estimate derived from the state value of the underlying assets and the boundary condition given by the book value of the liabilities. It is thus distinct from 'riskiness' qua volatility and permits a direct proxy for the variable of interest, namely 'extreme risk,' as we focus on the upper tail of the distribution of a firms default probability.

In this paper, we examine the relationship between incentive compensation and the default risk in financial institutions domiciled in the United States. The financial institutions in our study include depository institutions (banks), non-depository credit institutions (credit and mortgage companies), and security broker, dealers and exchanges (investment bankers). We include all of these groups as they all were involved in some level of activity related to the financial crisis of 2007 in which they sustained heavy losses.

We focus on two critical components of executive compensation, the proportion of compensation from equity-based incentives and the proportion of compensation from non-equity based sources. Prior research hypothesizes that equity-based compensation, is likely to induce risk-taking behavior, which is commonly seen as desirable seeking of higher returns. Cash incentives based on metrics of firm performance are less risky than equity-based compensation, as these are derived from historically delivered results and not forward looking market values (Barclay et al 2005). Our analysis consequently focuses on these two types of pay: equity-based and non-equity-based compensation; these two components, as we will show, make up the bulk of annual executive pay. Further proposed compensation regulations are likely, as a first order effect, to change the relative proportion these two components.

Given the long-standing regulatory focus on banks, we begin by describing important trends in the banking industry for which there is unusually good historical data due to regulatory requirements. We present the trend line regarding the percentage of bank holdings in real estate and credit card debt, as well as the proportion of incentivized pay over time. The subsequent sections define our measure of default risk and its relation to executive compensation. For our sub-sample of our firms, the default probability estimates are strongly correlated with the spread on credit default swaps which are market-traded instruments priced in reference to default risk. As credit default swaps do not exist for all firms, and in particular for the majority of firms in our sample, we use our measure of default risk for subsequent analysis. Noting that there is persistence in default risk from year to year, we treat the obvious potential endogeneity of default risk and compensation in the context of a dynamic panel analysis, relying on Arellano-Bond and Blundell-Bond specifications. The results indicate consistently that the default risk measure is positively determined by the equity-based incentive compensation and negatively determined by the non-equity-based incentives, after controlling for firms size, growth, and accounting based ratios commonly used to measure performance and risk.

The contribution of this study is its analysis of the relation between executive compensation and default risk, the central concern of regulators who described their goals in terms of "Safety "and "Stability". The remainder of this paper is organized as follows. Section 2 motivates our research question and provides background. Section 3 presents our research design. Section 4 presents our sample and its descriptive statistics. Section 5 presents our results and finding. Section 6 concludes.

II) Motivation, Research Question and Background

2.1 Motivation and Research Question

A long-standing debate in the regulation of financial institutions concerns the relationship of executive incentives and the riskiness of the firm. The standard finding, in non financial firms is that equity-based incentives induce more risky investments and decisions. Ex ante, it is not obvious that the results of prior work are likely to hold in a study of financial institutions. Financial institutions differ from traditional non-financial firms in at least three important ways. [1] The first is that the nature of financial services is to transform liabilities (e.g. deposits) into assets (e.g loans) constrained by reserve requirement; thus high leverage is integral to the business of a bank. The second reason stems from the first, namely that high leverage creates a default risk and a vulnerability to contagious bank runs or credit calls, leading to regulatory guarantees, such as deposit insurance, to render banks more credible to depositors during periods of financial crisis (Diamond and Dybvig, 1983).

The third reason follows from the second and has been strongly emphasized by Bebchuck and Spamann (2009). The mechanism justifying the claim that executive compensation incentives lead to 'extreme risk' is the moral hazard arising not only from the standard compensation contract for managers, but also from the implicit government guarantee to 'bail out' financial institutions should they be near default. The public provision of guarantees to secure deposits generates the moral hazard of increasing risk because the upside benefits accrue to top executives and shareholders while the downside costs are borne by the government. Treating FDIC insurance as giving a put to shareholders at the value of the deposits, Merton (1977) estimated the cost of the insurance to the public guarantor; bank shareholders receive symmetrically a subsidy of the same magnitude. O'Hara and Shaw (1990) found that the public announcement by the Comptroller of the Currency in 1984 that the 11 largest banks were 'too big to fail' increased their valuation by 1.3% on average and decreased those below the suspected cutoff. For the recent crisis, Zingales and Veronesei (forthcoming) estimate that the bailed-out financial institutions gained by at least $84 billion, whereas the government and taxpayer expended at least $25 billion.

[1] For brevity we present illustrative examples using banks; analogous examples of the interaction of leverage, risk and implicit or explicit government guarantees hold in other financial institutions such as in investment banks.

This separation between private and social value is fundamental to any situation in which managerial actions can result in mean-preserving increases in variance, where the upside is captured privately but the downside losses are insured publicly. Crawford, Ezzel, and Miles (1995) found that pay-for-performance sensitivity of CEO pay increased more at less well-capitalized institutions, suggesting a moral hazard problem induced by FDIC deposit insurance that transfers risk to the taxpayer. John and Qian (2003) show that bank CEOs have lower pay-for-performance sensitivity than other CEOs, inferring that moral hazars necessitate a commitment device of less sensitive performance compensation to re-assure debt-holders. In all, this literature views increases in the incentives for executives to take on risk as putting bank executives and shareholders in conflict with those who bear the costs of the provision of depositor insurance and debt.

The claim that incentives can be 'extreme' from a perspective of debt holders and society due to moral hazard is contrary to bank studies that approach executive compensation and risk-taking from an efficient contract lens. In an early study, Barro and Barro (1990) found evidence that bank executive compensation responds to performance and that CEO departure is predicted by poor performance as well. Houston and James (1995) found that equity-based incentives increased the value of banks' charters (the market to book ratio) during the 1980s. Hubbard and Palia (1995), Cunat and Guadalupe (2007), and Chen et al. (2006) studied deregulation in banking for various recent periods, showing that pay for performance lead to greater risk taking. It is notable that the above studies focused on periods largely unmarked by major banking crises.

A financial crisis provides willy-nilly a real time stress test on the asset and liability composition of a bank's balance sheet.[2] The studies that directly examined compensation and risk in banks and financial institutions in recent years, inclusive of the crisis, have not found a negative relationship between compensation and performance. Mehran and

[2] In 2008, some of the most important American financial institutions went bankrupt, were partly or fully nationalized, converted into banks, or were sold in distress: Bear Stearns, AIG, Lehman Brothers, Fannie Mae, Freddie Mac, Wachovia, Washington Mutual, Merrill Lynch, Goldman Sachs, Morgan Stanley, Citibank, Countrywide, IndyBank, etc.; starting in fall 2008, some 56 financial institutions, most of them in dire straits, received emergency lending from the US Government through its TARP (Troubled-Asset Relief Program).

Rosenberg (2007) demonstrate that stock options compensation increase the holding of riskier assets, but lowers borrowing and raises capital ratios making the net on default risk unclear. Pathan (2009) analyzes data on 212 banking holding companies for the period of 1997 to 2004 (which includes the economic downturn of 2001), finding that banks with 'strong' boards increase risk taking; however, independent directors dampened this relationship, presumably because of broader concerns for other stakeholders such as bondholders. In an important study, Fahlenbach and Stulz (2009) pursue an analysis of the crisis of 2008, similar to our own, find no evidence that banks lead by CEOs whose incentives were closely aligned to shareholders via invested wealth performed better; they found some evidence that they performed worse. They found no relationship between performance and stock option incentives. Cheng, Hong, and Scheinkman's (2009) study is also similar to ours, and shows that residual pay (once controlling for other predictors) is correlated with various risk measures. They found no effect of governance variables on risk taking.

Our approach, developed below, differs from the above by focusing directly on extreme risk taking as measured by a probability of default, and uses the financial crisis as a type of stress test on the contribution of compensation policies to extreme risk taking. By estimating the probability of default from stock market prices and balance sheet data, we focus on catastrophic risk most relevant to the type of non-convexities that would arise as a cost to abusing moral hazard. As we will show, this cost is harder to detect in the absence of a financial crisis. In this sense, the crisis is a real-time stress test leading to results that indicate the dangers of high-powered incentives for risk-taking.

2.2 Trends in the composition of the banking industry

In what ways would high powered incentives lead to risk taking by financial firms? Clearly, a minimal expectation is that higher risk should be reflected in the composition of the balance sheets of financial institutions. At the center of the financial crisis was the failure or increased risk of failure in the performance of real estate related assets. In this section we show this and other related trends in commercial banks to understand the magnitude of growth in the economic activities that precipitated the financial crisis.

The financial crisis starting in 2007 has lead to renewed interest in this trade-off. Figure 1a shows that the banks in our sample saw a decrease in total market capitalization of over 60% from the beginning of 2007 to the end of 2008, leading to considerable industrial restructuring. However, even prior to the current crisis, the banking industry has undergone significant consolidation. The number of smaller banks, those with total assets of less than forty billion dollars, decreased from over 9000 in 1984 (entities reporting to the FDIC) to nearly 1000 in the year 2008. While the number of entities has been decreasing the sum of total assets on the balance sheets of all banks reporting to the FDIC has risen steadily from 1984 to 2008, from about 4 to 14 trillion dollars.

These competitive pressures may well explain the increased risk in the asset composition of banks during the years prior to the crisis. Figure 1b shows the sum of all real estate and of credit card related assets on the balance sheets of all banks reporting to the FDIC. Real Estate related assets include holding of all loans related to real estate (Mortgages) and all holdings of derivatives of real estate loans (mortgage backed securities). Correspondingly credit card related assets include holding of all credit card loans and assets derived by securitizing credit card loans. The holdings of both of these types of assets were increasing since 1984, especially between 2000 and 2005. In all, the rapid consolidation of banking assets and banks during the past decade is correlated with increasing percentages of risky assets.

2.3 Executive compensation patterns in financial services

To investigate whether executive compensation led to extreme risk, it is useful to note that annual compensation is composed of several components.

Base Salary: The current mode base salary in CEO compensation in larger corporations and banks is $1,000,000 as that is the maximum that can be granted as a tax deductible expense under current US corporate tax regulations. For additional pay to be tax deductible is must be Performance based and paid in cash or equity. [3]

[3] Section 162m, of the federal tax code states that all compensation exceeding $1,000,000 is tax deductible only if it is a performance based reward in accordance with a compensation plan approved by a proxy vote.

Non-Equity (Cash) Based Incentive Compensation: Is compensation from the annual bonus and the company's Long Term Incentive Plan (LTIP). Non-Equity based incentive compensation is typically derived from an agreement that specifies the payment of a bonus conditional on the achievement of accounting revenue or earnings based targets.

Disclosure of the specific details of the arrangement is currently not required by any regulatory mandate and. Surveys show that Non-Equity based incentive compensation (Murphy 1998) varies across firms in the type and number of measures used, thresholds (minimum level of performance required to earn any bonus), target (level of performance expected), and cap (level of performance above which the bonus payment does not increase) (Murphy 2000). There is also variation in the use of subjectivity; some firms determine cash based incentives solely by formula and other allow subjective judgment in addition to prescribed formulas in the determination of bonuses (Gibbs, et al 2004).

Non-Equity incentives are typically awarded annually based on single year objectives. Non-Equity incentives may also be awarded using a long term incentive plan (LTIP), that spans multiple years, has targets specified over multiple periods, and offers increasing bonus payouts for the achievement of consecutive targets (Larcker 1983). Barclay, Gode and Kothari (2005) argue that using accounting based information to provide cash compensation focuses on measures more directly linked to actions taken by managers. In contrast, stock prices also react to factors other than the firm's performance and manager's actions, such as interest rates and other macro economic trends.

Equity-based incentives Compensation: This component is compensation given to an executive in the form of stock options or restricted stock. Stock options, typically in the form of American Calls, are struck at the money on the date of issue. Restricted stock is shares in the company's equity given to executive and valued at prices as of the date of issue. Stock options typically have a vesting period during which the executive is not permitted to exercise the options; further, the executive must still be employed at the end of the vesting period in order to exercise vested options. Restricted stock also carries a vesting period during which the executive cannot sell the stock. Typical vesting periods range from three to five years. Restricted stock also typically carries "performance conditions" that specify performance thresholds that need to be achieved for vesting. Since

June of 2005 when SFAS 123r (requiring expensing of stock and option awards) went into effect companies have de-emphasized stock options and shifted toward restricted stock. (Balsam et al. 2007).

Equity-based compensation has commonly been viewed as useful in aligning shareholder and manager interests, but as past work (e.g. Rajgopal and Shevlin, 2002) has shown, equity compensation is likely to induce risk taking. Equity compensation induces risk taking by adding convexity to manager's payoffs explicitly when stock options are used, and implicitly through performance conditions when restricted stock are used. Core, Guay and Larcker (2003) observe that high powered equity incentives will have declining marginal utility in wealth. Since many top executives are very wealthy, the implication is that equity incentives must be substantial, a point to which we return later.

Other Compensation: includes pension contributions, healthcare benefits, other post retirement benefits, and perquisites. Total executive compensation is the sum of salary, non-equity compensation, equity-based incentive compensation and other compensation.

In figure 2, we show the proportion of executive compensation that has historically been paid using salary, cash-based incentives, equity-based incentives and other compensation. In this figure we present the proportion of compensation from each of these four sources as a percent of total compensation over time beginning in 1995 and ending in 2008. Both panels in the figure show the proportion of equity-based compensation reached its peak in 1999, at the height of the dot com boom. In subsequent years firms reduced the amount of compensation from equity sources until recent years, when the proportion increased again form 2005 up through 2008. In addition, other compensation is typically less than or equal to 5% of total compensation in the large majority of the years in all of the panels shown. Unlike earlier studies for the 1980s on the lower use of pay for performance in financial service companies (see Houston and James, 1995), financial and non-financial firms had very similar profiles in our sample. Notably, there appears to be a slight pro-cyclical rise in the importance of equity-based compensation prior to the 2001 and 2008 downturns.

III) Research Design

3.1 The measurement of Risk

In the literature on executive compensation and its relation to risk taking, the conventional measures of risk rely upon the volatility of accounting or stock market data. For our purposes, the problem with these measurements is that volatility, while related, is not identical to default risk, and hence provides only an indirect test. .Conceptually default is the state in which the value of the assets is less than liabilities. Default then is an absorbing barrier to the stochastic process governing the asset value dynamics. Such a probability is not observable, since neither the time series of asset values, nor their volatility are given but must be estimated.

Merton (1974) proposed a solution to backing out the asset price dynamics by adapting the Black and Scholes (1972) and Merton (1973) option pricing models for the valuation of corporate securities, such as debt, for which there are often no market prices. The fundamental insight of the Merton model was to derive from the Black and Scholes equation that the value of risky debt plus the equity of the firm must dynamically equal the value of the firm's assets. The risky debt is valued as a risk-free bond minus the value of an implicit put option, since the holders of the debt can always claim the residual value of the bankrupt firm. The equity of the firm is equivalent to a European call option, with the same strike price set equal to the default barrier.

The calculation of the default probability using the Merton model confronts two major problems. The first is that the Merton model relies upon a constant volatility of asset values, when clearly volatility is state dependent. The second challenge is data, since only the liability book value and the equity market values are known; the asset values remain unknown. Merton provided a solution to the simultaneous inference of the value of firm assets and their volatility from the equity prices, assuming however constant volatility.

Subsequent papers proposed models for time-varying volatility, e.g. Engle (1982), and Duan (1994, 1995). By assuming that asset returns follow a GARCH process, Heston and Nandi's (2000) model is especially attractive, for it is analytically convenient and also produces an option pricing formula that approximates the Black and Scholes model. The Heston and Nandi model assume an underlying spot asset price S_t that has a log return at time t defined as $r_t = \log(S_t/S_{t-\Delta})$ w here Δ is the time interval. The log returns and the return volatility follow the joint dynamics:

$$\log(S_t) = \log(S_{t-\Delta}) + r + \lambda h_t + \sqrt{h_t\, z_t} \qquad (1a)$$

$$h_t = \omega + \sum_{i=1}^{p} \beta_i h_{t-i\Delta} + \sum_{i=1}^{q} \alpha_i \left(z_{t-i\Delta} - \gamma_i \sqrt{h_{t-i\Delta}}\right)^2, \qquad (1b)$$

In these equations, r is the risk-free rate, h_t is the conditional variance at time t, z_t is the standard normal disturbance; the remaining parameters (λ, ω, β,α,γ) are those to be estimated. The coefficient λ to h_t is the market price of risk and shifts the average return according to the level of risk; ω is the constant volatility; β and α govern the mean reversion; and γ is a diffusion parameter.

To value the contingent claims on S_t, the risk-neutral distribution of the spot price is calibrated to comply with the Black-Scholes option pricing that generates a distribution of disturbances z_t as a standard normal under risk-neutral probabilities. The formula for the derived call option price under the Heston and Nandi assumptions is Equity(t)=Asset price(t)*P_1- Debt(t)*e^{-rT}*P_2, where P_1 and P_2 are the following two integrals:

$$\mathbb{P}_1 = \frac{1}{2} + \frac{e^{-r(T-t)}}{\pi S_t} \int_0^\infty R\left[\frac{K^{-i\phi} f^*(i\phi+1)}{i\phi}\right] d\phi$$

$$\mathbb{P}_2 = \frac{1}{2} + \frac{1}{\pi} \int_0^\infty R\left[\frac{K^{-i\phi} f^*(i\phi)}{i\phi}\right] d\phi$$

1-P_2 gives the distance to default probabilities, P_2 being the survival distribution. Given symmetry, the left side integrates to ½ and only the right side must be evaluated.

It is easier to solve for the characteristic functions by calculating the coefficients of the Fourier series of the probability density function (see Fang and Oosterlee, 2008 and Epps, 2009: 337-9). Since this method did not converge for all GARCH parameter values, we relied on the method described in Rouah and Vainberg (2007) that combines the two integrals and then solves for the default probabilities.

The calculation of the option pricing depends upon the estimation of the GARCH (1,1) model and the unknown parameters used in equations 1a and 1b above. These estimates permit the retrieval of the time series of the asset values and their return volatility, given the observed time series of equity and the book values of liabilities. In other words, the asset values are iteratively backed out of the equation Equity = E((Asset-Debt)$^+$). We use the Merton model to initiate the pricing for the first 30 days, and then apply the GARCH model for the subsequent estimation, using all past asset prices.

The nature of our data presents particular challenges, since the equity prices for the firm are taken daily but the liabilities are reported only quarterly. Book values for liabilities provide the appropriate benchmark in measuring default in terms of a firm's inability to fulfill contractual obligations. Correspondingly the literature implementing Merton model has used, as we do, the book value of liabilities in its estimation of default probabilities (Hillegiest et al. 2004, Vassolu and Xing 2004, Bharat and Shumway 2008, Campbell, Hilscher and Szilagyi 2008). Unfortunately, the quarterly reporting of liabilities leads to unrealistic default estimations. We used an exponential interpolation of liabilities, whereby at each time k, the interpolated liabilities were calculated as

$$estimate(k) = \delta \sum_{i=0}^{i=k} (1 - \delta)^{k-i} \, observation\,(i)$$

where δ is a parameter set to smoothen the estimated liabilities from the real observations.

These risk-neutral probabilities differ from the physical probabilities. Since we do not observe the asset composition of the financial institutions from the Compustat, FDIC, or Federal Reserve data, a fine grained calculation of these physical probabilities is difficult. However, the physical probabilities can be obtained by a relatively simple calculation (Arora et al. 2005). Using the correlation of stock prices and market returns, we calculated the physical probabilities for each of the financial institutions in our sample for each year in our data. The correlation between the two probability series is very high. Since the coefficient of variance for the physical probabilities was also very low, there is a similar factor of proportionality across the financial institutions. We thus retained our risk-neutral probabilities as the measure of default risk.

To illustrate the results of the above estimations, we compare the estimates for Wells Fargo, Goldman Sachs, and JP Morgan; see Figure 3 below. All three institutions survived the crisis and thus are roughly comparable. Goldman Sachs started as a public investment bank before converting to a commercial bank, JP Morgan has been lionized for its more diligent risk management, and Wells Fargo succeeded in acquiring Wachovia Bank, which faced serious default prospects. There is a correlation between the CDS spreads and default probabilities, with the implied default especially high for Goldman Sachs –one of the few major investment banks to survive. Note the correspondence between the book leverage and default estimates in the three cases.

A disadvantage of this measure is the possibility that share prices may deviate significantly from firms' fundamental values, so that volatility may reflect not only changes in fundamentals but also the influence of bubbles and speculative traders. To validate further the default probabilities, we also correlated them with the spreads on the credit default swaps for the 51 financial institutions and banks for which Bloomberg provided data –some of these institutions are not in our database used for the statistical estimations. The CDS spreads were selected for securities of 5 year maturities listed on the Bloomberg terminal. A spread is the price of the insurance in basis points for a security traded that day with a 5 year horizon. Our risk estimates are calculated on a one-year horizon, since we found that default probabilities were clustering too high for the year 2008 for longer horizons. We transformed the spreads into probabilities.[4]

In all, the correlations between the CDS risk neutral probabilities and our probability default estimates were very close; on average, the quarterly correlation between the spreads is .845. We plot in the first panel to Figure 4 the daily data we have for CDS and our risk estimates; the values on the axis are meaningful for the CDS spreads only for purposes of comparison. The CDS probabilities are always higher as we chose a

[4] To get the risk-neutral CDS probabilities, we solved for equations 15 and 16 in Bharath and Shumway (2004). recovery rates net out to make minor differences and we set them to zero. We also removed spikes due to missing interest rate data; during a crisis, the term structure inverts, thus causing the CDS and Risk lines to cross. Malone, Rodriguez, and ter Horst (2009) calculated the CDS spreads and default probabilities for a sample of banks, finding that the GARCH model out-predicted the Duan and Merton models for out-of-sample CDS spreads.

five year horizon for the CDS securities. Overall, the year to year movements approximate each other. However, the correlations for the daily data are only .45 since the one-year probability default data are more volatile than the five year CDS probabilities. The other three panels in Figure 4 show the daily data for two of the banks in Figure 3; we substitute CIT Group (which failed) for Goldman Sachs. Again we generally see co-movement, but not always. It is notable that JP Morgan had higher CDS spreads and default probabilities at the start of the series during a period of acquisition.

The central variable of interest in our study, consistent with our focus on extreme risk, is the maximum default probability obtained by the daily measure of default probability in the fiscal year (called Maxprob), which measures the stress of a bank.[5] Figure 5a presents a scatter plot of maximum probability of default in a given period; the first order autocorrelation coefficient is approximately 0.63 and the second order autocorrelation coefficient is 0.33. This high level of autocorrelation poses a problem of weak instruments, which we address below. Figure 5b shows the same plot for 'trough to trough'; the correlation is much less obvious here, suggesting that banks do not in general have *cultures of risk* that would show up in the same ones troubled at every economic downturn. Still, we found three banks in the upper right corner –indicating persistent high risk strategies; they are Flagstar Bancorp, E*Trade and Fremont General. Flagstar was taken over by private equity in 2009 (70% equity acquired for $350 million); Freemont General filed for chapter 11 bankruptcy in 2008; E*Trade sold a good deal of its subprime exposure in fall 2007 in response to falling equity values and survived the crisis.[6] In Figure 5a we found Lehman Brothers appears three times in the upper right hand corner, more than any other bank.

3.2 Accounting based measurements as risk determinants

[5] We examine robustness by using the 99th and 95th percentile of the measure annually as well as the annual average.

[6] We also correlated the listed 56 TARP recipients and our risk measure, finding a value of .045; since so many of the large banks received TARP assistance and our sample is weighted towards these, there was not a lot of variation to explain. Conversely, since so few of the large banks and institutions defaulted (under FDIC surveillance), there was insufficient data to check the correlation between our risk measure and failure.

The baseline model using accounting to predict default is rooted in Altman (1968) which showed that financial ratios based on accounting numbers can predict financial distress in non-financial firms. One standard approach to implementing such ratio analysis is the classic "Dupont" decomposition of return on equity (ROE) (Bodie et al 2002). The Dupont analysis decomposes ROE into the product of Return on Assets (ROA), and Leverage. ROA is then further decomposed into Margin and Asset Turnover. In our analysis of risk we use Compustat data on the financial intuitions we study to calculate each of these measures and examine their association with our measure of default risk.

We measure Return on Equity as Compustat field NI divided by SEQ (net income, and shareholders equity respectively). We measure Return on Assets as NI divided by AT (where AT is total assets). Margin is measured as NI divided by the sum of NIINT and TNII (revenue from net interest and revenue from non interest sources respectively. Turnover is the sum of NIINT and TNII divided by AT. Leverage is measured as AT divided by SEQ.

3.3 Executive compensation determinants of risk

In our paper we use the ratio of equity based incentive compensation to total compensation and the ratio of cash based incentive compensation to total compensation as our central explanatory variables of interest in examining the association between executive compensation and the underlying risk of the bank. We focus on these variables as they are the variables of interest to regulators who are seeking to change the structure of executive compensation in the aftermath of the financial crisis.

Regulators have proposed measures to increase the proportion of compensation that is paid in equity in an effort to reign in risk taking. These proposals include the provisions in the federal Emergency Economic Stabilization Act of 2008 which propose to limit all cash compensation, including that which is paid as part of performance based bonuses to $500,000. Any additional incentive compensation would then be paid in stock. In the recent 2009 bonus cycle, many investment banks have voluntarily begun following the proposed legislation by paying bonuses primarily in equity (Goldman Sachs 2009).

We use data on executive compensation from the Execucomp database to form our variables of interest. Execucomp data are only available on an annual basis. We measure total compensation as the Execucomp data fields TDC1. Our measure of base salary is the field SALARY. Our measure of Equity based incentive compensation is the sum of the fields BLK_VALUE_OPTIONS, RSTKGRNT, OPT_AWARD_FV and STOCK_AWARD_FV. Our measure of Cash based incentive compensation is the sum of the fields BONUS, LTIP, and NONEQ_INCENT. Using these measures we calculate the ratio of Equity-based incentives to total compensation and the ratio of Cash based incentive compensation to total compensation as our variable of interest.[7]

The recent shift from options into restricted stock has the potential to reduce the risk taking incentives induced by options. However, current restricted stock contracts typically include performance conditions which also introduce convexity and induce risk taking. Further, the financial accounting literature has viewed cash bonuses based on the achievement of accounting based targets as potentially efficient since they focus on historically-delivered results as measured by accounting numbers (Barclay et al 2005). In this literature, accounting based measures of performance are viewed as less risky since they are a reflection of the historical performance of the firm, while stock prices are forward looking and subject to changes in the market's expectations of the firm's performance as well as other economic variables (interest rates, tax policy changes, etc). As discussed earlier, prior studies excluded financial institutions in their analysis and, for the reasons cited earlier, it is an open empirical question whether the results of prior research are likely to persist in a sample of financial institutions.

3.4 Specification and related econometric issues

The dependent variable is the annual maximum probability of default, calculated as explained in section 3.3.1. We estimate risk daily (excluding weekends and holidays) and take the maximum value in conformity with the concept of a stress test. We examine the prediction of the default variable by accounting based variables of size, performance and risk (as defined in section 3.3.2), and compensation variables (as defined in section 3.3.3).

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[7] All field names in CAPS refer to the actual field names used in the Execucomp annual compensation data base on the WRDS system. As described in the documentation on WRDS the structure of Execucomp changed in 2006 post SFAS 123r, our selection of the variables we aggregate is consistent with and adjusts for the changes in execucomp's data structure.

These values are available to us annually; the Compustat quarterly data are less complete and the Exucomp data are, as noted earlier, only available annually in any event. Thus, the cross-section is per year; year fixed effects are always included in the estimates.

A simple OLS regression of the default probability on the explanatory variables confronts the problems of heteroskedasticity due to clustered errors and endogeneity. Endogeneity error is present, since the unobservable of the quality of management and governance influences compensation policy and default. There are no obvious instruments that are both uncorrelated with the error and correlated with the independent variable. Consider for example governance variables, such as the index constructed by Gompers et al (2003), that might be assumed to determine top executive pay and thus is correlated with an unobservable representing the quality of executive management. However, this instrument may well also be correlated with default probability risk; boards that overly incentivize managers may also choose high levels of risk.

Given an absence of exogenous instruments, an alternative strategy is to rely on statistical instruments in the form of lagged values of the dependent variable. We use Generalized-Method-of Moments (GMM) estimators developed for dynamic panel models by Holtz-Eakin, Newey and Rosen (1988), Arellano and Bond (1991) and Arellano and Bover (1995). We employ the *system* panel estimator developed by Arellano and Bover (1995). Blundell and Bond (1998) show that a system panel estimator that uses both the *difference* panel data and the data from the original *levels* specification results in large improvements in consistency and efficiency, provided that the instruments are valid using the standard Sargan-Hansen tests of over-identifying restrictions.

Since GMM dynamic panel models are sensitive to surprisingly small changes in specification, we estimate several different specifications, starting with OLS pooled regressions and then fixed and random effects panel analysis. Blundell and Bond (1998) show that these latter two models set the lower and upper bounds to the coefficients on the lagged variables. The conventional panel analysis is troubled by problems of persistence and autoregressive error, which violate the assumption of the independence of the error and lagged variable. Since dependent variable y_{it} is a function of the error, then $y_{i,t-1}$ is also a function of the same error by the definition of autocorrelation. From this ensues violations of the orthogonality conditions for OLS, fixed effects, and random effects specifications.

Since the problems of persistence and weak instruments as well as the moment conditions are discussed thoroughly elsewhere, we turn directly to the diagnostic tests to verify the specification. [8] The consistency of the GMM estimator depends on the validity of the assumption that the error terms do not exhibit serial correlation and on the validity of the instruments. To address these issues we use two specification tests suggested by Arellano and Bond (1991), Arellano and Bover (1995), and Blundell and Bond (1998). The first is a Sargan/Hansen test of over-identifying restrictions, which tests the overall validity of the instruments by analyzing the sample analog of the moment conditions used in the estimation process. The second test concerns whether the differenced error term is second-order serially correlated. Our data shows second-order correlation, which disappears when a second-order lag of the dependent variable is added to the model. We consequently lag the instruments by two periods.[9]

The estimation of the appropriate statistical tests for the coefficients is derived from the moment conditions. As discussed in Arellano and Bond (1998), the one-step system estimator assumes homoskedastic errors, while the two-step estimator uses the first-step errors to construct heteroskedasticity-consistent standard errors (e.g., White, 1982). The first step treats the error terms as independent and homoskedastic across cross-sectional units and over time. In the next step, the residuals obtained in the first step are used to construct a consistent estimate of the variance-covariance matrix, thus independence and homoskedasticity assumptions can be dropped. The two-step estimator is thus asymptotically more efficient relative to the first step estimator.

It is useful to note that one-step and two-step estimators entertain offsetting statistical weaknesses. Arellano and Bond (1991) show that the asymptotic standard

[8] Roodman (2006, 2008) and Baltagi (2005) provide excellent discussion of these issues and of dynamic panel GMM estimation in general.

[9] GMM dynamic panel analysis confronts the problem of weak instruments, which encourages the use of long lags. Our results are also sensitive to the choice of lags; we followed the policy, explained later, of choosing a number of instruments that lead to reasonable statistics for overidentification. See Roodman (2008).

errors for the two-step estimators are biased downwards. The one-step estimator is asymptotically inefficient relative to the two-step estimator. The coefficient estimates of the two-step estimator are asymptotically more efficient, whereas the asymptotic inference from the one-step standard errors tend to be more reliable. As a consequence, we report the first- and second-stage results.[10]

IV) Sample selection and descriptive statistics

We identify a sample of industry SIC codes 6000 to 6299, with accounting data available in the Compustat bank file, Crsp stock return file and Exucomp compensation files from the years 1995 to 2008. The beginning of our sample is restricted to 1995 as that is the beginning year of coverage in Exucomp. Overall we identify 123 unique firms with 1524 firm year of data on total assets available. Of the 123 distinct firms in our sample 74 distinct firms have observations in all the years in the panel, 14 firms appear in the panel beginning after 1995, and 28 firms leave the sample before 2008. There are 3 firms that are missing data in the middle of their time series in the panel. In total, due to missing data, 6 firms are dropped and 117 firms enter our statistical analysis.

Table 1 presents descriptive statistics of the central variables in our analysis. The first row provides descriptive statistics for the variable Maxprob, the maximum value that our probability of default variable obtained for a given firm in a given year. The variable has a mean of 0.1202 and has a minimum value of zero and max value of 1. The next two sets of rows show the descriptive statistics of the first and second lag of Maxprob. The means for both of these lags are lower than that for the un-lagged variable showing the increased likely default in the final year of our sample, i.e. the peak of the financial crisis. The next two sets of rows present the descriptive statistics for the proportions of equity and non-equity based incentive compensation, as a percentage of total compensation for the CEOs of banks in our sample. The means show that on average the equity based incentive component is larger and displays more variation within the sample than does the non-equity based incentive component. These default probability and compensation

[10] The Stata program Xtabond2 uses the Windmeijer (2005) correction for the standard errors.

variables will be the dependent and primary independent variables of interest in our subsequent regression analysis.

The remaining sets of rows provide the descriptive statistics for total assets, growth in total assets and the components of ROE in a standard DuPont decomposition. The data show that, on average, the institutions grow by a bit more than 13.19% per year in assets on the balance sheet, and that the average asset value in the sample is roughly 104 billion dollars. Firms are leveraged, on average at 12.26 dollars of assets for every dollar of shareholders' equity ratio. The asset turnover variable indicates that, on average, revenue from net interest and non interest sources are on average almost 12.49% of annual asset value. Margins, the ratio of net income to total revenue, show financial institutions to be, on average, profitable at a rate of nearly 19.9%. These variables will be used as controls in our subsequent regression analysis.

Table 2 shows pair-wise correlations among the central variables of interest. The first column shows the auto correlation of the Maxprob variable. Further the maximum probability of default is positively associated with the proportion of compensation paid using equity, and inversely associated with the proportion of compensation paid in cash, which is based typically on accounting measures of performance. Larger firms are positively associated with risk; firm growth also is positively associated with risk. Firms with higher margins and higher asset turnover are negatively associated with risk and leverage is positively associated with risk.

V) Results and findings

Table 3 reports the main results of estimation of model (1) across various estimators using the baseline sample 1995–2000. The primary variable of interest is called Equity Pay, which is the *proportion* of total compensation paid out in options and restricted stock. All estimations include the dependent variable lagged once and twice, since the AR tests for the GMM specifications indicate second order correlation that needs to be purged. Following Blundell and Bond (1998), Bond (2002), and Roodman (2006), we start with a naïve OLS regression and Within Groups to get the bounds on the lagged variable coefficients. The naïve OLS regression results in an estimate for the lagged dependent variable that is positively correlated with the error; the Within Group regression suffers a negative bias. This provides useful bounds for the GMM estimated coefficients on the lagged dependent variable. Also included, in every specification, is our Altman baseline model which uses income statement and balance sheet based ratios as default predictors. We thus control for the effects of the components of return on equity (leverage, asset turnover and margins), as well as size and change in size.

Columns 1 and 2 show the results of Within Groups and Pooled OLS estimations that provide, respectively, the lower and upper bound for the coefficient to Maxprob (Maximum Default Probability). The coefficient to Equity-Pay in the Within Group estimation is weakly significant. The Breusch-Pagan statistic has a Chi-sq (1) of 0.27, with a p-value of 0.60, thus the variance is homoskedastic.[11]

The GMM estimations transform the regressors by differencing them in order to make them exogenous to the fixed effects. Columns 3and 4 provide respectively the one- and two-step Difference GMM estimators. Equity-Pay is correctly signed and significant at .01. The results are essentially confirmed by the System GMM estimators given in columns 5 and 6. The coefficients on the lagged dependent variables are within the bounds established by the OLS and Within Group regressions. The results for the System GMM specifications are largely the same. The coefficients on the two-year lagged dependent variable are within the bounds set by the Pooled OLS and Within Group estimations, suggesting mildly a better specification than the Difference GMM.

Since the test for first-order serial correlation always rejects the null of no first-order serial correlation, we do not report this test. The AR(2) null is always accepted, thus verifying the inclusion of two lags and the specification; a two-period lag succeeded in purging the second-order autocorrelation. The (Sargan-) Hansen statistic indicates that the null hypothesis that the instruments as a group are exogenous can be safely rejected.

Of the accounting based control variables included, none display a relationship that is consistent in all specifications. When significant, the level of assets is negatively

[11] Though the basic results that equity pay increases significantly risk are the same to the fixed effects model, the random effect model is rejected by a GMM generalization of the Hausman test. The Sargan-Hansen statistic is Chi-sq(19), with a test statistic of 184.47 and a P-value of 0.00.

associated with risk, potentially indicating some benefit of diversification coming from size. Growth in assets is when significant positively associated with risk indicating incremental risk taking through new investments. Margins, when significant, are inversely related to risk, indicating that more profitable financial institutions are less likely to fail. Similarly asset turnover is also, when significant, inversely related to risk indicating that intuitions that utilize their assets more effectively are less likely to fail. When including other control variables, leverage is not significantly associated with risk in our specifications.

In all, Table 3 shows consistently strong support that Equity Pay increases the probability of default using the maximum value for the subsequent year. The Altman baseline controlled for balance sheet and income statement based differences, thus the effect of compensation pay is net of these items. The GMM uses the exogenous Altman variables plus year effects as instrumental variables for the lagged dependent variable. Diagnostics:

The dynamic panel analysis using GMM has proven in practice to be sensitive to specification error (see, for example, Bobba and Coviello, 2007). In Table 4, we present several diagnostics tests. Since the compensation variables are percentages, they sum to 100% and are collinear. In columns 1, we replace Equity Pay by Non-Equity Pay. The coefficient is significant and negatively signed: higher proportion of bonus cash pay reduces the probability of default. Column 2 shows the results for estimating jointly Equity Pay and Non-Equity Pay. The coefficients are signed as before, and the results for Equity Pay are significant at .05. The diminishment of significance is expected given the correlations, and yet the results for the effect of Equity Pay remain robust.

The next column tests the functional specification. Column treats equity pay as endogenous and is instrumented by the Altman baseline plus year effects. By and large, the estimated coefficients remain the same as does their statistical significance. The Hansen statistic goes to p=1. This all-too-good result is a product of too many instruments; note that the number of instruments exceeds the number of cross-sectional observations which commonly plagues the utility of the Hansen statistic (Roodman, 2008).

Column 5 explores a specification using a dummy variable if there was a new CEO in the previous year. A new CEO is likely to have less wealth and to have more years of future income on the job, thus to be more sensitive to performance pay; Wulf (2004), for example, found age and tenure effects in her study on mergers among equals. However, we find no significant effect for the New CEO variable.

The most insightful of the diagnostic runs is given in column 6 of Table 4, which uses the same specification reported in column 6, Table 3, but excluding the year 2008 crisis observations. The compensation effects are no longer significant. This result is expected, since the plot of the probability of default variable in the earlier figures for Goldman Sachs, JP Morgan, and Wells Fargo show that variability is driven by business cycles and the financial crisis in particular. This result is a useful indication that the effect of compensation policies, as for other policies, becomes more apparent during a natural stress test.

Table 5 presents the last set of diagnostic tests excluding the observations on the brokerage firms. Brokerage firms are regulated by the SEC (unless part of bank holding companies), whereas banks are regulated largely by the Federal Reserve Board. Investment banks, when public, are under SEC supervision, but in 2008, all public investment banks that survived had become commercial banks under the Fed regulatory supervision. Many of the brokerage firms also carry out proprietary trading on a leveraged basis. Whereas the probability default estimates for many of the brokerage firms were extremely high in 2008, their elimination from the data set did not change the primary conclusions from the previous estimations.

Further Robustness Tests:

We also checked the robustness of the results for the effect of outliers. We winsorized the risk measure to the 99^{th} percentile and rejected that outliers were responsible for the results. We also winsorized the data also to the 95^{th} percentile and found that the central results retained their signs and significance, even if attenuated.

A puzzle posed by the crisis is that so many executives lost wealth during the crisis, and thus they should have cared about total risk. Executives earn not only income, but also accumulate wealth. Often, this wealth is invested in the company through unvested stocks and options or through the holding of vested but unexercised options and retained stock. It would not be surprising if invested wealth influences risk-taking behavior independent of compensation. Wealthy CEOs heavily invested in their company of employment may become risk averse; younger CEOs with less wealth may prefer risk. Though we did not find earlier any 'new CEO' effect, it is possible that direct observations on wealth may reveal independent effects.

Data on the proportion of an executive's total wealth that is invested in their own company's stock is typically not publicly available. ExecuComp, which is used in this study and other similar databases, provides data on unvested options previously granted, and unexercised holdings of vested options, however they do not give data on stock holdings based on exercised vested options or holdings acquired in the open market outside of executive compensation. Core and Guay (2002) showed that by using this easy to acquire though partial information it is possible to develop estimates of stock option portfolio values that are highly correlated with difficult-to-get and private full information. They show that ExecuComp data can be used to proxy highly accurate estimates of executive wealth held in stock options written on the share price of the company.

Using then the ExecuComp data, we estimated the Black Scholes value of the stock option portfolio of top executives to get the Core and Guay option value of CEO wealth in the corporation. We estimated the dynamic panel model first by replacing the CEO pay variable; the option wealth variable was insignificant and negatively signed. We also included the option wealth value into the model, keeping the CEO pay variable, and again found the variable coefficient to be insignificant and negative. We found similar results in tests that included the vega of the CEO's stock option portfolio. The wealth effect dampens risk, but is far from statistical significance. A wealth effect is not then evident in our estimates for the determinants of extreme risk. This finding suggests that managerial behavior may be more complex than the standard principal-agency model, a point which we discuss next.

Discussion

The above results indicate quite strongly that financial institutions lead by executives whose remuneration was heavily weighted in equity (stock and options) were more likely to be marked by extreme risk taking, especially during the 2008 crisis. These results pose the larger question of why did such incentives, which are labeled as pay-for-performance, fail. We review three explanations: underestimation of the implications of high income and wealth on the required compensation incentives, faults in the optimal contract due to regulatory moral hazard, and over-confidence.

The explanation for the underestimation of the implications of high levels of pay rests on the difficulty of incentivizing already rich managers. The standard model for moral hazard qua hidden action is to characterize the manager's utility by a constant absolute risk aversion, i.e. $U(x) = 1 - e^{-ax}$. As is well known, such a model means that $1000 of extra pay is equivalent for the executive earning a $100,000 and for the executive earning $10 million. In the context of an executive compensation, constant relative risk aversion utility, e.g. $U(x) = \log x$, is more satisfactory insofar that executives might care more about proportional increases in income than absolute. However, a relative risk aversion specification has very important and non-trivial effects on the level of pay and the required incentives. Imposing utility functions that are separable in effort and income is also not innocuous in the context of large compensation packages. CARA utility functions are useful for finding closed-form solutions and simple linear descriptions of pay incentives (Bolton and Dewatripont (2005). The cost to these models is an under-appreciation of the massive incentives required to motivate already highly paid and wealthy CEOs.

The implication of these results is that many models of incentives and risk do not scale well to executive compensation. If compensation operates through the goal of incentivizing managers, then the large incentive packages of CEOs of financial institutions conform to the belief that top managers experience declines in marginal utility in income, requiring ever greater incentives as income increases. This possibility is consistent with evidence that compensation grows in firm size (Gabaix and Landier, 2008), not only due to competence to manage complexity but also to the marginal decline in utility.

Of course, top managers have exercised their options and reduce their exposure to the performance of their company. Bebchuk and Spamann (2009) calculate that the top management at Bear Stearns and Lehman cashed out $1.3 billion and $1 billion between the years 2000 and 2008.

Still, even if executives cash out, the evidence points to a surprisingly high level of wealth invested by top management in their companies. The study by Fahlenbrack and Stulz (2009) lists the top five best paid executives in financial services in 2006; these include the CEOs of Lehman Brothers, Bear Stearns, Merrill Lynch, Morgan Stanley, and Countrywide Finance. Only 1 one of these companies survived the crisis as an independent operation. The top 20 CEOs had equity stakes valued at more than $100 million; the mean (median) value of the CEO's equity stake was $88.1 million ($36.3 million). Still, the average equity held by top management was about 1.6% of total shares. This low percentage indicates the challenges of executive compensation of bank managers who are already wealthy.

The question still remains why executives should have taken imprudent risk if they had so much wealth invested in the firm. The mechanics of a bubble require that people hold beliefs about asset values in excess of fundamentals. Bolton, Scheinkman, and Xiong (2006) propose a model in which the interests of managers and current shareholders as aligned with future naïve shareholders as the losing party. This type of moral hazard parallels the alignment of shareholders and managers interests in the presence of government guarantees, with taxpayers and debt holders as the losing parties.

By this argument, the incentive structure in these institutions failed to account for the massive moral hazards arising out of implicit government guarantees. Since these guarantees shifted risk from managers and shareholders to taxpayers, Bebchuk and Spamann (2009) argue that extreme risk taking was a rational consequence. If this conclusion is correct, there are ways to improve on the standard principal-agent contract.

One way to design this contract would be to pay compensation not only in equity but also in debt, so that top managers will be responsive to the total risk of the firm, thus attenuating the moral hazard due to the non-linearity in payouts. Sundaram and Yermack (2007) found that executives do hold substantial debt in the form of promised future pension payments, though apparently this was not dissuasive in financial institutions. Clawbacks, i.e. deferring and putting at risk awarded compensation for a number of years, also have this feature.

However, what if managers are not very good at timing the market and are motivated by the same 'animal spirits' that affect equity prices? Pay is often set relative to industry 'benchmarks', thus encouraging inter-firm comparisons that can be particularly damaging during bubbles (DiPrete, T., G. Eirich, and M. Pittinsky, 2010). Given that the financial crisis wiped out managerial wealth, an alternative class of explanations might look at behavioral motivations, such as the overconfidence that infects CEOs, as well as the top executive team and boards Malmendier and Tate (2005). The findings by Bertrand and Mullainathan (2001) that CEOs are rewarded for luck imply as incentives ignore the overall business cycle and thereby include a pro-cyclical bias insofar that equity-based pay should proportionally grow. This bias is visible in Figure 4 given earlier. Whereas 'smart' CEOs may understand the optimal timing to exit or to change to less risky strategies, the evidence from the crisis does not inspire the belief that market timing was widely exercised. By a process of elimination of other explanations, overconfidence appears to be an essential element in the explanation for extreme risk.

VII) Conclusion

The study of compensation incentives poses the question of whether equity-based compensation contributes to causing the financial crisis? The results indicate the answer is yes. The empirical results follow from the logic of the compensation contract. If incentives are designed to promote risk-taking, then these incentives must be big for top managers to overcome wealth effects and the marginal declining value of income. Indeed, the top compensation incentives were big and they worked: financial firms took big risks. The upshot is that the tuning of the parameters to encourage performance during buoyant markets can lead to too much risk-taking, individually and collectively.

Still, this logic begs the eventual question of whether incentives lead managers to exploit intentionally the moral hazard of limited liability as well as of government deposit and bailout guarantees? Or did the frenzy of making large sums of money during a long upward swing render them over-confident, confusing their ability with random luck? Did boards fail to monitor and manage risk, since they were already co-opted by management or they too were over-confident (Bebchuk and Fried, 2004)? As in most historical narratives, the motives are no doubt plural, but no matter which ones were operative, equity-based incentives for highly levered institutions with government guarantees should be very strongly examined for their role in the formation of financial crises.

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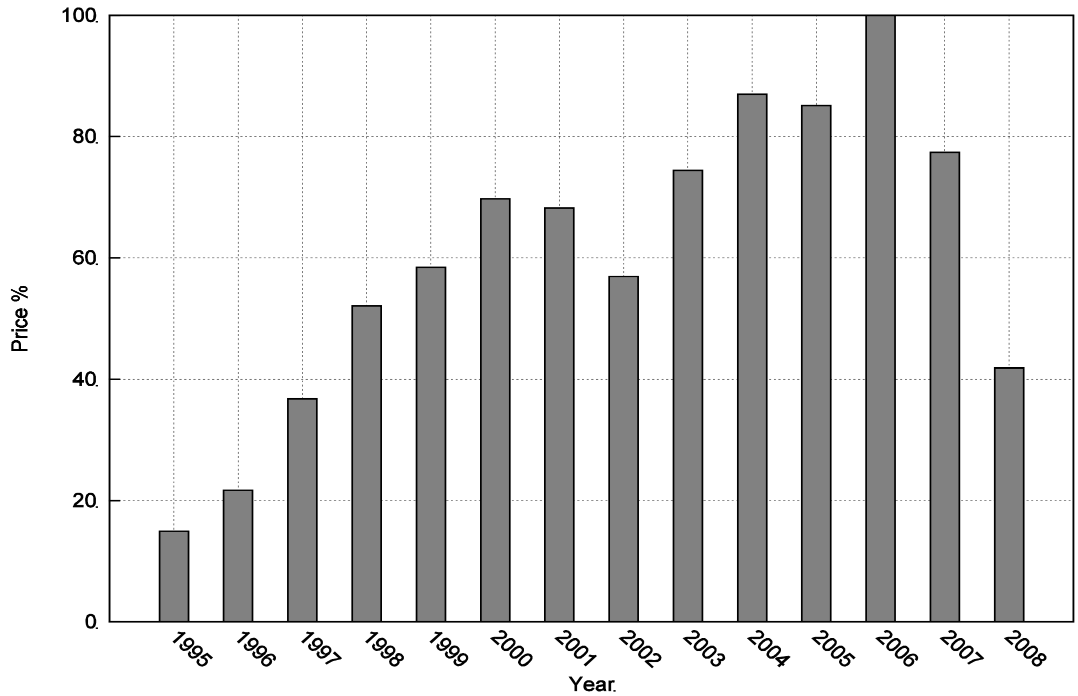
Figure 1: Bank Market Capitalization and Growth in Risky Assets

A. Constant Sample Market Capitalization as a Percentage of 2006 Market Cap.



B. Growth in Real Estate and Credit Card Loans

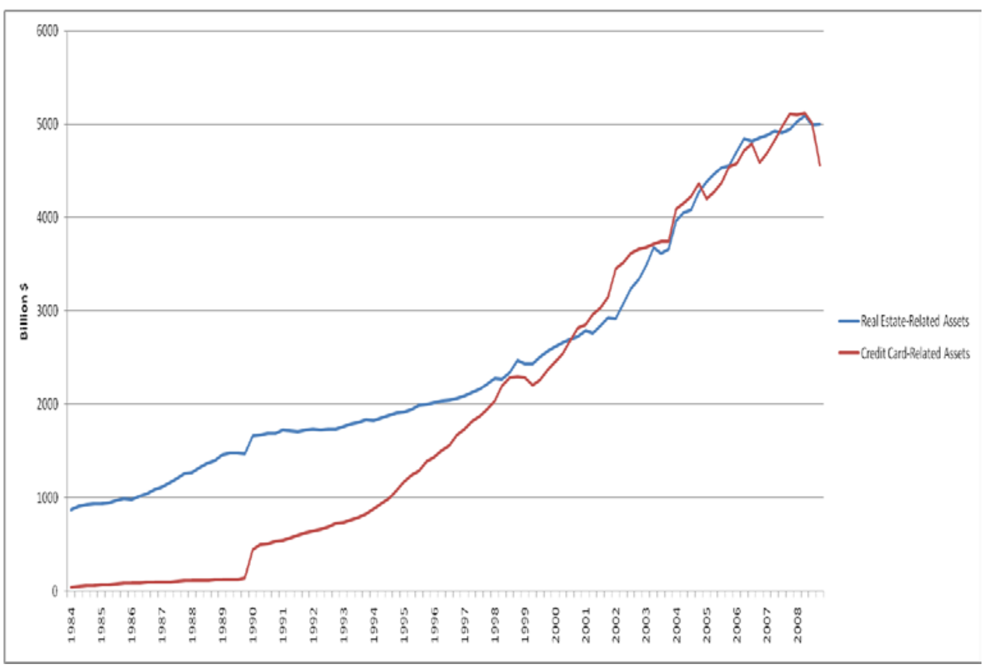
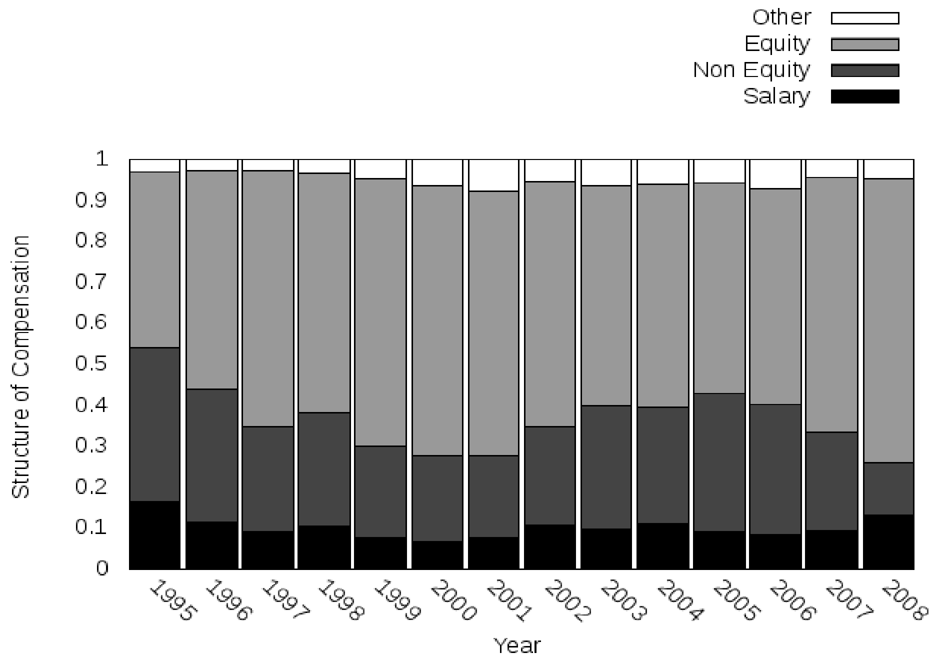


Figure 2: CEO Compensation, 1995 -2008

Panel A: Composition of CEO Compensation for Financial Service Firms



Panel B: Compensation for Named Executives Financial Service Firms

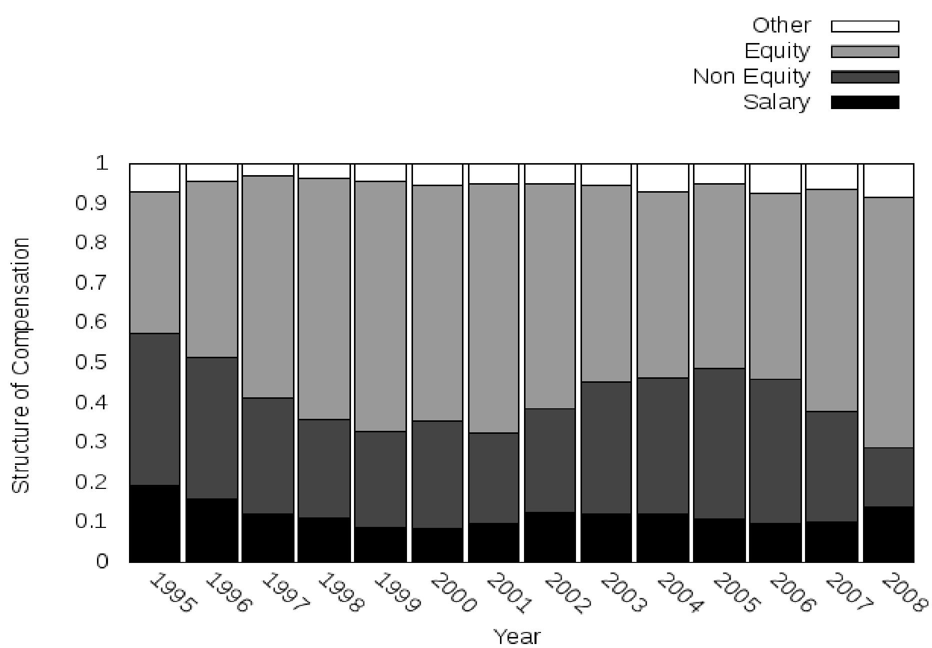


Figure 3: Comparison of Default probabilities and Leverage (Market Value of Equity/Smoothed Book Value of Debt)

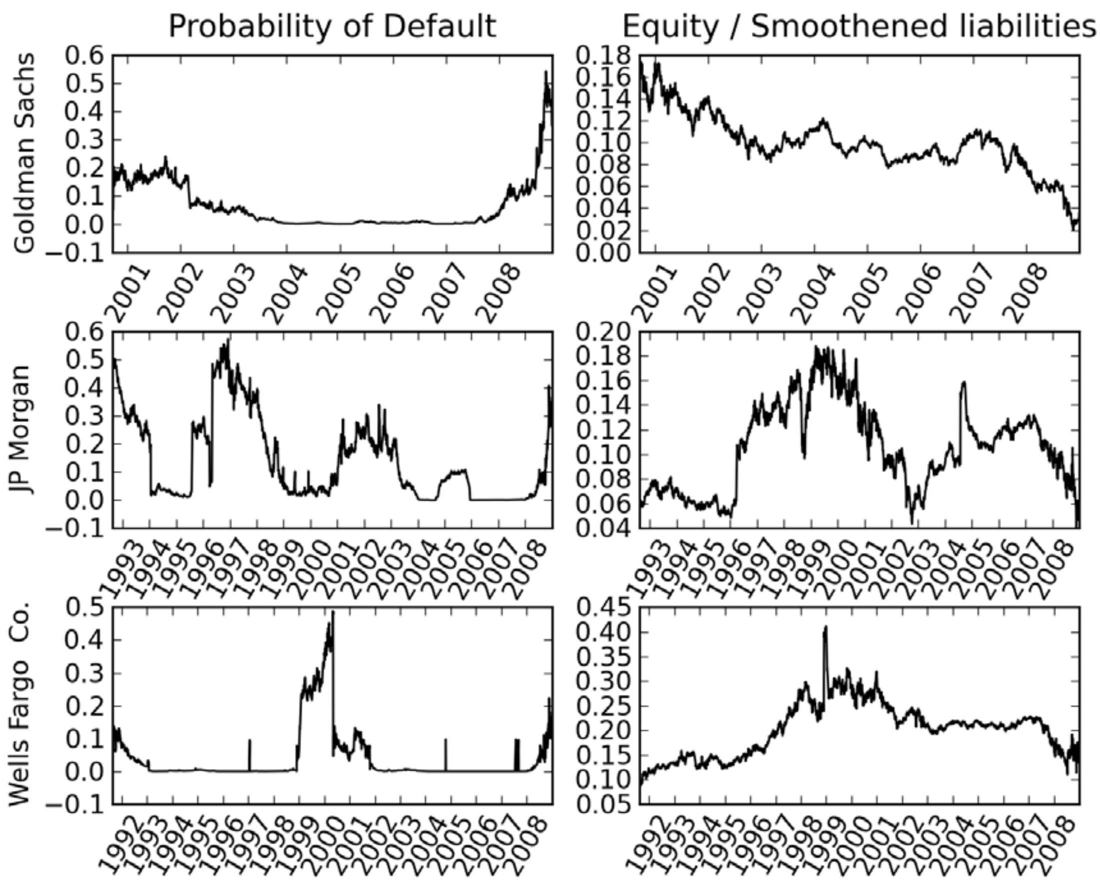


Figure 4: Comparison of CDS Spread and Maximum Default Probability (MaxProb) for Average, CIT Group, Wells Fargo and JP Morgan.

(Red: CDS; Blue: Default Probability)

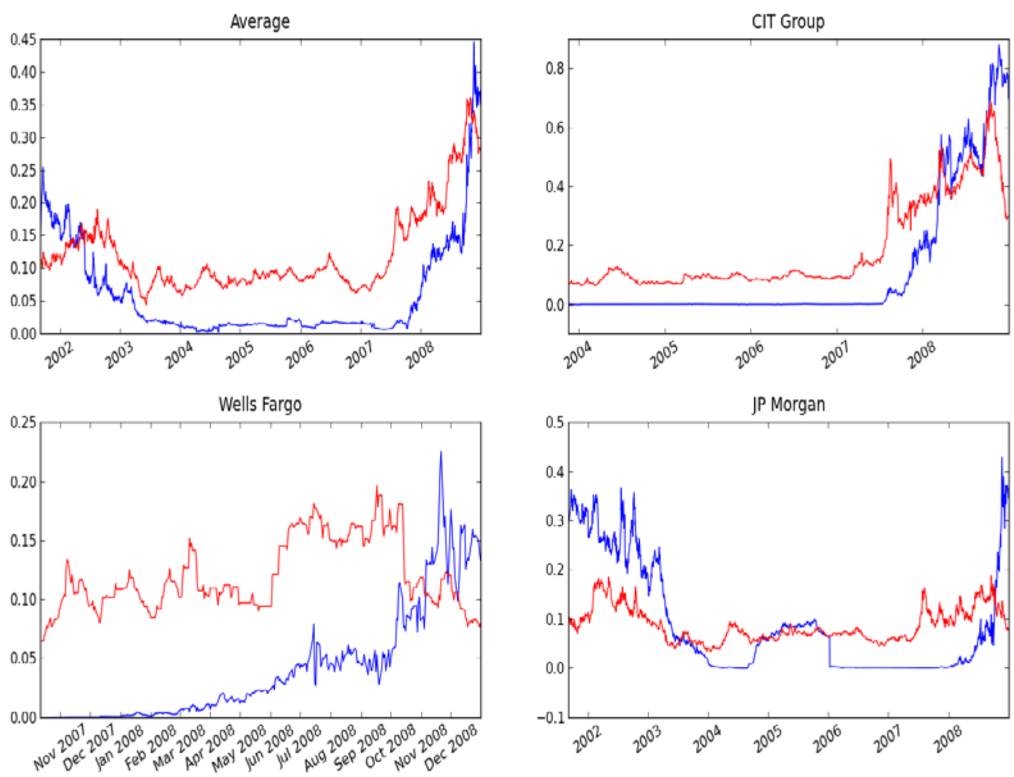
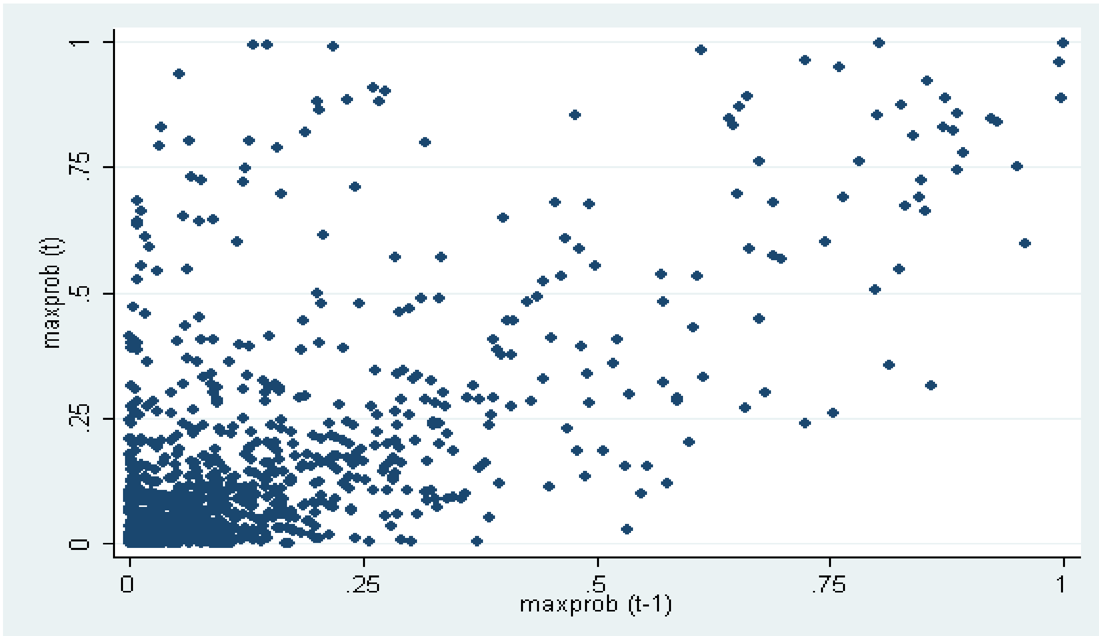


Figure 5: Persistence of annual maximum default probability

A: First-order correlation



B. Trough to Trough (2000 and 2008)

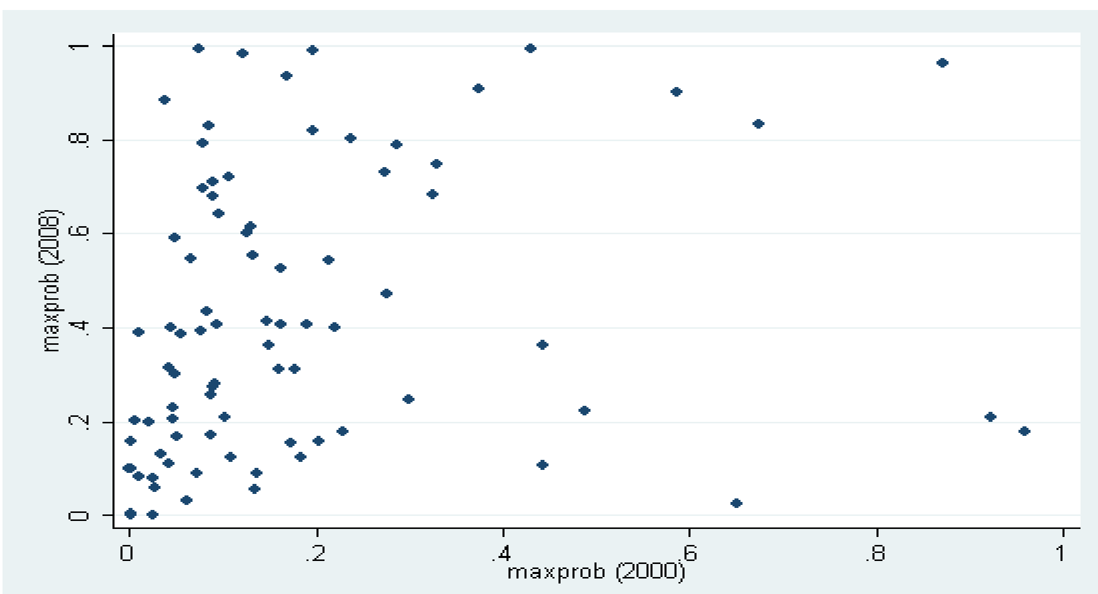


Table I: Descriptive Statistics

	mean	sd	min	max
Maxprob	0.1260	0.2014	0.0000	0.9962
L.Maxprob	0.1023	0.1687	0.0000	0.9962
L2.Maxporb	0.1102	0.1782	0.0000	0.9983
L.Equity Pay	0.4066	0.2730	0.0000	1.0000
L.Non Eq Pay	0.2892	0.2121	0.0000	0.9731
L.Assets	10.1103	23.8032	0.0141	218.7631
L.Asset Growth	1.3099	4.2448	-18.6766	39.0281
L.Margin	0.2192	0.1316	-0.7545	0.9550
L.Turnover	0.1262	0.2314	0.0147	1.7976
L.Leverage	12.3667	6.8199	1.1348	59.1615
N	1039			

Notes:

Maxprob, is the maximum daily default probability for a given firm in a given year, L.Maxprob is the Maxprob of the firm in the prior year, L2.Maxprob is the Maxprob of the firm form 2 years prior. L.Equity Pay is the proportion of total compensation derived from equity based incentive sources for the prior year. L.Non Eq Pay is the proportion of total compensation derived from non-equity incentive sources such as annual bonuses and long term incentive plans. L.Assets is prior year end total assets, in billions. L.Asset Gro. is prior year growth in assets, in billiions, L.Margin is prior year profit margin, L.Turnover is prior year asset turnover and L.Leverage is the prior year ratio of total assets to total shareholders equity.

Table II: Correlations

	Maxprob	L.Maxprob	L2.Maxprob	L.Equity Pay	L.Non Eq Pay	L.Assets	L.Asset_Gro	L.Margin	L.Turnover	L.Leverage
Maxprob	1.0000									
L.Maxprob	0.6354	1.0000								
L2.Maxprob	0.3381	0.7894	1.0000							
L.Equity Pay	0.1439	0.1195	0.1042	1.0000						
L.Non Eq Pay	-0.1768	-0.1512	-0.1022	-0.5480	1.0000					
L.Assets	0.1109	0.0014	-0.0064	0.2076	0.0516	1.0000				
L.Asset_Gro	0.1095	-0.0066	-0.0120	0.1565	0.0498	0.7543	1.0000			
L.Margin	-0.3165	-0.2122	-0.0967	-0.1106	0.0307	-0.1854	-0.1397	1.0000		
L.Turnover	-0.1158	-0.1140	-0.1248	-0.1812	0.3082	-0.1088	-0.0789	-0.1488	1.0000	
L.Leverage	0.1780	0.1672	0.1431	0.1371	-0.0486	0.3753	0.2735	-0.1994	-0.4096	1.0000

Note. All variables are as described in Table 1.

Table III: Principal Results of Equity Compensation on Default Risk (Dependent Variable Maxprob)

	(1)	(2)	(3)	(4)	(5)	(6)
	Pooled OLS	**Within**	**Diff-1 GMM**	**Diff-2 GMM**	**Sys-1 GMM**	**Sys-2 GMM**
L.Maxprob	0.995***	0.873***	0.852***	0.817***	0.867***	0.827***
	(0.043)	(0.045)	(0.104)	(0.103)	(0.107)	(0.104)
L2.Maxprob	-0.307***	-0.363***	-0.208***	-0.176**	-0.191**	-0.161**
	(0.035)	(0.043)	(0.075)	(0.073)	(0.079)	(0.080)
L.Equity Pay	0.034**	0.029*	0.317***	0.275***	0.186**	0.163**
	(0.014)	(0.017)	(0.116)	(0.101)	(0.074)	(0.067)
L.Assets	-0.000	0.000	0.002	0.002*	-0.001*	-0.000
	(0.000)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)
L.Asset Growth	0.003*	0.003*	0.003**	0.003**	0.004***	0.004***
	(0.002)	(0.002)	(0.001)	(0.002)	(0.001)	(0.001)
L.Margin	-0.157***	-0.164***	-0.012	-0.043	-0.094**	-0.086
	(0.042)	(0.060)	(0.070)	(0.096)	(0.047)	(0.053)
L.Turnover	-0.048***	-0.072	-0.072	-0.215	-0.009	-0.008
	(0.015)	(0.053)	(0.127)	(0.217)	(0.025)	(0.032)
L.Leverage	0.000	-0.001	0.003	0.002	0.001	0.001
	(0.001)	(0.002)	(0.003)	(0.004)	(0.001)	(0.001)
Constant	0.060***	0.376***			0.282***	0.292***
	(0.020)	(0.037)			(0.037)	(0.040)
Number of Obs	1039	1039	916	916	1039	1039
AR(2)			0.637	0.607	0.716	0.635
Hansen P			0.302	0.302	0.169	0.169
Instruments			82	82	94	94
N Included Banks		117	112	112	117	117

Notes: The dependent variable is Max Default Probability (Maxprob), which is the maximum value of the estimated default probability during a year from a Heston-Nandi model. Diff-1 and Diff-2 are the one (two) difference GMM estimators. Sys-1 (-2) GMM are the one (two) step system GMM estimators. L. is a lag operator for one year; L.2 indicates a 2 year lag. Equity Pay is the proportion of CEO compensation awarded in deferred stock and stock options. The independent variables are as described in table 1. Robust standard errors are used for the T-tests reported in "()". The one step estimates are Huber-White standard errors; the two-step estimates are heteroskedastic covariance-variance with Windmeijer corrected errors. A * indicates significance at 10%; ** at 5%, and *** at 1%. The AR(2) give p-values for second-order auto-correlated disturbances for the first difference estimates; the AR(1) estimates are not given as the first difference disturbances are auto-correlated. The Hansen statistic tests for the exogeneity of the instruments. A unit increase in our asset variable reflects a 10 billion dollar increase in assets reported.

Table IV: Additional Specifications, Non-equity incentives, Incentives of Senior Mgmt Team, New CEO

	(1) Non-Equity System	(2) Both Comp System	(3) GMM Equity	(4) New CEO	(5) Drop 2008
L.Maxprob	0.767***	0.806***	0.919***	0.839***	0.822***
	(0.11)	(0.12)	(0.09)	(0.10)	(0.11)
L2.Maxprob	-0.137*	-0.169*	-0.226***	-0.156**	-0.143*
	(0.08)	(0.09)	(0.06)	(0.07)	(0.08)
L.Non Eq Pay	-0.310**	-0.253*			
	(0.13)	(0.13)			
L.Equity Pay		0.12	0.102**	0.205**	0.044
		(0.08)	(0.04)	(0.08)	(0.09)
L.Assets	0.000	0.000	0.000	0.000	-0.001***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
L.Asset Growth	0.004***	0.004***	0.003**	0.003*	0.005***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
L.Margin	-0.094	-0.082	-0.143***	-0.139**	-0.100*
	(0.07)	(0.07)	(0.05)	(0.06)	(0.05)
L.Turnover	0.057	0.077	-0.046*	-0.003	-0.018
	(0.06)	(0.07)	(0.03)	(0.03)	(0.03)
L.Leverage	0.002*	0.002*	0	0.001	0.001
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
L.New CEO				-0.058	
				(0.05)	
Constant	0.402***	0.338***	0.329***	0.282***	0.071
	(0.03)	(0.04)	(0.03)	(0.05)	(0.05)
Number of Obs	1039	1039	1039	1039	952
AR(2)	0.31	0.438	0.882	0.398	0.871
Hansen P	0.222	0.373	0.999	0.233	0.096
Instruments	94	94	171	94	81
N Included Banks	117	117	117	117	114

Notes: This table includes also Non-Equity Pay and New CEO as variables. All other variables and specifications are the same as in Table 4. Only system GMM and step-two standard error specifications are estimated. The IV system adds Equity Pay to the instrumental variables; GMM Equity treats Equity Pay as also endogenous and is instrumented by the exogenous and pre-determined variables. The last column drops all observations for 2008.

Table V: Additional Specifications Without Brokerage Firms

	(1)	(2)	(3)	(4)
	Diff-2 GMM	Sys-2 GMM	Diff-2 GMM	Sys-2 GMM
L.Maxprob	0.860***	0.795***	0.841***	0.845***
	(0.070)	(0.112)	(0.115)	(0.105)
L2.Maxprob	-0.238***	-0.157**	-0.188**	-0.164**
	(0.049)	(0.079)	(0.079)	(0.080)
L.Non Eq Pay	-0.384***	-0.355**		
	(0.112)	(0.138)		
L.Equity Pay			0.294***	0.157***
			(0.086)	(0.058)
L.Asset Growth	0.004**	0.004***	0.003*	0.004***
	(0.002)	(0.001)	(0.002)	(0.001)
L.Margin	0.033	-0.097	-0.075	-0.119**
	(0.109)	(0.059)	(0.086)	(0.051)
L.Turnover	-0.000	0.066	-0.123	-0.009
	(0.118)	(0.054)	(0.204)	(0.036)
L.Leverage	0.004	0.002**	0.003	0.001
	(0.003)	(0.001)	(0.003)	(0.001)
Constant		0.413***		0.311***
		(0.038)		(0.038)
Number of Obs	848	964	848	964
AR(2)	0.786	0.355	0.502	0.453
Hansen P	0.301	0.272	0.311	0.223
Instruments	93	94	82	94
N Included Banks	105	110	105	110

Notes: The specifications above are as defined in previous tables but brokerage firms have been excluded from the analysis.