CEO Risk Taking Incentives and Bank Failure during the 2007-2010 Financial Crisis

November 2, 2014

Abstract

We show that stronger CEO risk taking incentives prior to the 2007–2010 financial crisis are associated with a higher probability of bank failure during the crisis. To measure risk taking incentives, we propose a simple measure, levered delta, that accounts for the incentives to take on risk generated not only by stock options, but also by the stock of highly levered firms. We find no evidence that risk taking incentives or bank failure are related to the governance failures usually considered in the corporate governance literature. On the contrary, CEOs' incentives are aligned with shareholders' incentives to shift risk to other claim holders. We also find that the use of particular compensation vehicles (such as stock options) explains little of either risk taking incentives or failure.

Keywords: executive compensation, risk taking incentives, bank risk, leverage, risk shifting, bank governance, compensation policies, bank regulation.

We're going to examine the ways in which the means and manner of executive compensation have contributed to a reckless culture and quarter-by-quarter mentality that in turn have wrought havoc in our financial system. Remarks by President Barack Obama on Executive Compensation with Secretary Geithner. September 4, 2009 (Obama, 2009).

Since the inception of the latest financial crisis, many voices have blamed bankers' compensation for creating the incentives to take on excessive risk that led to the crisis. This view of executive compensation has led to the formulation of many proposals to regulate executive pay at financial institutions, the implementation of some of them, and to a heated debate about the need to regulate bankers' pay and the form that such regulation should take.[1]

However, despite the attention devoted to executive pay by regulators, recent research does not provide much support for the hypothesis that CEO compensation in the run-up to the crisis is responsible for the high levels of risk of some financial institutions. Notably, Fahlenbrach and Stulz (2011) report that there is no significant relation between the most commonly used measure of the risk taking incentives generated by executive compensation and bank performance during the crisis.[2] Cheng et al. (2013) also put forth an alternative explanation of the relation between CEO compensation and bank risk, in which banks' exogenously given riskiness determines the (optimal) CEO compensation, and not the other way around, and find results consistent with their proposed explanation. Moreover, Fahlenbrach and Stulz (2011) find that firms whose CEOs had their interests better aligned with those of shareholders, in that the value of their wealth was more sensitive to firm performance, performed worse during the crisis, and Cheng et al. (2013) report that firms whose CEOs were less likely to be entrenched were riskier. Therefore, the authors of both papers conclude that misalignment of the incentives of shareholders and managers of financial institutions is unlikely to have contributed to the financial crisis.

Now, even though banks' different outcomes during the financial crisis may have been just due to luck or the result of different levels of inherent riskiness, financial institutions can alter their riskiness to a larger extent that most non-financial firms. Therefore, if CEOs did have different incentives to take on risk, one would have expected them to act on those incentives. The apparent absence of a relation between risk taking incentives and bank risk is, thus, somewhat puzzling. In this paper, we argue that standard measures of the risk taking incentives generated by executive compensation, such as Guay (1999)'s *option vega* (or the

[1] Section 956 of the 2010 Dodd-Frank Act requires that the banking agencies regulate compensation arrangements at large financial institutions to discourage inappropriate risk taking. In 2011, the different supervisory agencies in charge of bank supervision proposed a rule to regulate pay in covered institutions. Outside of the US, regulatory action has been intense as well. For example, in Europe, the Committee of European Banking Supervisors issued in 2010 a set of *Guidelines on Remuneration Policies and Practices*, the European Union approved directives CRD III (in 2010) and CRD IV (in 2013) to regulate compensation at financial institutions (see Murphy, 2013 for a description and a critical assessment of these reforms), and, in the UK, the Financial Services Authority issued in 2009, and amended in 2010, the so called Remuneration Code. At the multinational level, the Financial Stability Forum issued the *Principles for Sound Compensation Practices* in 2009.

[2] We note, however, that Gande and Kalpathy (2011) report that that same measure computed prior to the crisis is positively associated with the amount of Federal assistance during the crisis.

equity risk sensitivity of Fahlenbrach and Stulz, 2011), do not capture a potentially large component of the incentives to take on risk for bank CEOs, namely the incentive to increase risk generated by stock holdings in highly levered firms (see also Chesney et al., 2012). Moreover, there are other potential sources of risk taking incentives, such as termination payments, which reduce the downside risk for CEOs, or executives' holdings of debt-like claims, such as unsecured pension benefits or deferred compensation, which, by aligning CEOs' incentives with those of debtholders, may reduce risk taking incentives (Jensen and Meckling, 1976; Edmans and Liu, 2011). Therefore, we propose a simple reduced form measure of the incentives to take on risk generated by CEOs' equity holdings in highly levered firms, which we call Levered Delta (LD), and measure other potential sources of incentives. With these measures, we investigate whether CEOs' risk taking incentives are associated with bank risk.

We also propose an ex post measure of bank risk that attempts to remedy the drawbacks of the bank risk measures used in prior studies. Variables such as stock return volatility, systematic risk (beta), or idiosyncratic risk (employed by Cheng et al., 2013 or DeYoung et al., 2013), if measured prior to the crisis, are unlikely to capture the kinds of tail risk that materialized during the financial crisis. Moreover, measures that infer bank risk from the market value of securities (such as the buy-and-hold returns during the crisis employed by Fahlenbrach and Stulz, 2011) capture the part of firm risk that is borne by the holders of those securities, but not the total amount of risk. This distinction may be important for large financial institutions, since bank supervisors may (and do, as manifested during the financial crisis) intervene to prevent the default of systemically relevant institutions. The possibility of bank bailouts, thus, implies that measures of bank risk based on security prices may underestimate bank risk. More importantly, if different banks have different probabilities of being bailed out in the event of likely insolvency, differences in market risk measures may not reflect corresponding differences in the risk of banks' assets. To clarify this point, suppose that bank A would be bailed out for sure in case of distress, whereas bank B would never be bailed out. Bank A could take on greater risk (and, in fact, would have the incentive to do so) than bank B, yet market based measures of the banks' probability of default could show bank B as being riskier. To address these limitations of existing risk measures, we use an encompassing measure of bank failure during the 2007-2010 financial crisis as an ex post measure of risk taking in the run-up to the financial crisis. This is measure is likely to capture the kinds of tail risk not captured by measures such as stock return volatility computed prior to the crisis. Moreover, because of the possibility (realized during the financial crisis) that supervisors may intervene to prevent the default of systemically important financial institutions, our definition of bank failure includes not only bank closures but also acquisitions of distressed banks with the intervention of supervisors. As a case in point, Bear Sterns did not default, yet it was acquired by JPMorgan with the intervention and assistance of the Federal Reserve for $10 per share, when the previous closing price was $30 and when just two weeks earlier the stock had traded at \$85.88. Our measure considers Bear Sterns as a failed financial institution.

We estimate the relation between risk taking incentives measured in year 2006 and bank failure in the period 2007-2010 for a sample of large US financial institutions. We find that, whereas there is no significant relation between bank failure and risk taking incentives measured as option vega (in line with the findings of Fahlenbrach and Stulz, 2011), there is a statistically and economically significant relation between LD and bank failure. Therefore, our results are consistent with the hypothesis that the incentives generated by CEOs' compensation packages had an impact on bank risk. However, we emphasize that we do not have an exogenous source of variation in compensation incentives that would allow us to identify the causal effect of these incentives on risk. Therefore, we cannot claim that causality runs from compensation to risk, and our results could reflect (like those of Cheng et al., 2013) the fact that it is optimal for riskier firms to give their CEOs compensation contracts with larger LD. Although we cannot rule out this possibility, we discuss and test several alternative explanations for our results. Thus, we consider the possibilities that the relation is due to the correlation of our incentive measures with the strength of other unmeasured incentives (such as those stemming from the threat of replacement) or with firm or CEO characteristics potentially correlated with greater risk taking. We test these explanations by using different proxies for the unmeasured incentives or the firm or CEO characteristics that may be correlated with bank risk. Our tests provide, at best, weak support for these explanations and show that the relation between risk taking incentives, as measured by LD, and bank failure survives the inclusion of the different proxy variables. We also find no support for the alternative explanations that our incentive measure is simply measuring risk and not risk taking incentives or that bank failure captures persistently poor performance instead of risk.

The possibility that the incentives created by CEOs' compensation arrangements may have been responsible for excessive levels of risk taking prior to the crisis has led to a variety of proposals for the regulation of bankers' pay. Some proposals aim at improving the quality of banks' governance, under the assumption that the excessive risk taking incentives were the consequence of a misalignment between the interests of shareholders and managers, because of insufficient monitoring by boards or shareholders.[3] To evaluate the merits of this explanation of CEOs' risk taking incentives and of the proposed governance reforms, we investigate whether risk taking incentives or bank risk (as measured by LD and bank failure, respectively) are associated with the quality of corporate governance. If we measure the quality of corporate governance using standard governance measures, which aim to capture managerial entrenchment or the severity of the agency problem between shareholders and managers (such as board size or independence, Gompers et al. (2003)'s *governance index*, or Bebchuk et al. (2009)'s *entrenchment index*), we find no significant relation between these measures

[3]See, e.g., the SEC Chairman's speech at the Transatlantic Corporate Governance Dialogue – 2009 Conference (Schapiro, 2009).

and either bank failure or risk taking incentives, in line with the results of Cheng et al. (2013) and Chesney et al. (2012). Therefore, our results do not lend support to the idea that improving shareholders' ability to monitor and discipline managers would have substantially affected bank risk. In contrast, we propose to use banks' lagged leverage as a measure of shareholders' incentives to shift risk to debtholders and find that it has a very strong and positive correlation with LD. Therefore, using different measures of risk, risk taking incentives, and shareholders' incentives to take on risk, our results are in line with those of Fahlenbrach and Stulz (2011) and Cheng et al. (2013) in that CEOs' risk taking incentives were aligned with those of shareholders.

The alignment of the interests of shareholders and managers, however, does not guarantee that executives choose an efficient level of risk. On the contrary, the shareholders of highly levered firms, such as financial institutions, have an incentive to shift risk to debtholders and other claim holders. Therefore, the alignment of managers' and shareholders' interests may lead to inefficient risk shifting. However, to the extent that shareholders ultimately bear the cost of this excessive risk shifting, one may expect, as proposed by Jensen and Meckling (1976), that they structure executive compensation so as to limit risk shifting. In particular, John and John (1993) propose that more levered firms, whose shareholders have a greater incentive to shift risk to debtholders, may commit to limit risk shifting by reducing the pay-performance sensitivity of their executives' pay, thereby dampening executives' incentives to shift risk to debtholders. John et al. (2010) find evidence consistent with this hypothesis for a sample of US banks. However, in our sample, we do not find that the CEOs of more levered firms have lower pay-performance sensitivity and find little evidence that the compensation policies at more levered firms are different in ways that may reduce the risk taking incentives of their CEOs.

Since several proposals to regulate bank executives' pay involve limitations in pay levels or the use of certain compensation vehicles, such as stock options or termination payments, we investigate whether pay levels or different metrics that capture the use of different compensation vehicles (such as equity, stock options, termination payments, or inside debt) either capture the risk taking incentives measured by LD or are, in other ways, related to bank failure.[4] We find that risk taking incentives are weakly related to the level of total pay, yet we fail to find any significant relation between different measures of compensation structure and either incentives or bank failure. Thus, our findings indicate that limiting particular forms of compensation may not be the most effective way of curbing risk taking incentives.

In the wake of the financial crisis, several articles have analyzed the relation between the compensation

[4]For example, firms receiving TARP funds were not allowed to pay golden parachutes and could not pay bonuses unless they had the form of restricted stock. Although caps on compensation initially proposed by the Treasury in February 2009 were later lifted, stringent limits on the tax deductibility of executive compensation were maintained. A starker example is the European Union's Capital Requirements Directive IV, which, among other things, establishes that the ratio of variable compensation to fixed compensation cannot be, generally, greater than one (and under no circumstances greater than two).

of bank CEOs and risk taking.[5] Fahlenbrach and Stulz (2011) analyze the relation between the stock returns of a sample of large U.S. banks in the period from July 2007 to December 2008 and two measures of incentives computed in 2006: pay-performance sensitivity (*delta*) and option vega (which they label equity risk sensitivity). They find that, whereas there is a negative relation between stock returns during the crisis and delta, there is no significant relation between stock returns and option vega. In the paper most closely related to ours, Chesney et al. (2012) propose a measure of the sensitivity of the value of CEOs' equity holdings to the volatility of the firm's assets (*Asset Volatility Vega* or AVV) derived from a model of equity as a call option on the firm's assets, in which executive stock options are modeled as compound options (that is, as options on options).[6] Chesney et al. (2012) find evidence generally consistent with a positive relation between asset volatility vega in the years prior to the crisis and bank write-downs (which they use as an ex post measure of risk) during the crisis. As a robustness check, we compute AVV for the firms in our sample and find that it is very highly correlated with LD. Moreover, using AVV as a measure of risk taking incentives leads to results very similar to those obtained with LD. DeYoung et al. (2013) analyze the relation between both risk (measured as the standard deviation of returns, the stock's beta, or the stock's idiosyncratic risk) and business policies likely to be related to bank risk (such as noninterest income, commercial loans, or private MBS holdings) and one-year lagged CEO incentives (measured by delta and option vega). In contrast to Fahlenbrach and Stulz (2011), DeYoung et al. (2013) do find a relation between option vega and both bank risk and bank policies for a sample of U.S. commercial banks. However, it is important to note thatDeYoung et al. (2013) measure risk in the period from 1995 to 2006. Cheng et al. (2013) propose a simple principal-agent model in which bank risk is exogenously given (and not influenced by the CEO). Their model yields the result that inherent firm riskiness may bear little relation to CEOs' pay-performance sensitivity and, at the same time, be positively related to excess CEO pay. They test empirically the model's predictions by analyzing the relation between lagged measures of risk (such as the volatility of stock returns and the stock's beta), managerial stock ownership, and excess pay in a sample of large U.S. financial institutions. They find that whereas there is no significant relation between risk and managerial ownership, there exists a positive relation between risk and excess pay. Gande and Kalpathy (2011) use a form of government assistance to banks (the extent of U.S. Federal Reserve emergency loans provided to banks) as an ex post measure of bank risk. In their sample, option vega before the crisis is positively associated with the extent of Federal assistance. John et al. (2010) study the relation between the pay-performance sensitivity of bank CEOs, leverage, and several measures of outside monitoring and find that pay-performance sensitivity is positively associated with outside monitoring and negatively associated

[5] There are few earlier studies of these relation, notably Houston and James (1995) and John and Qian (2003).

[6] Anderson and Core (2013) propose alternative measures of risk taking incentives that aim to capture the incentives embedded in options, equity, and debt-like claims held by CEOs, such as pension benefits and deferred compensation.

with bank leverage. Finally, Bebchuk and Spamann (2010) and Bebchuk et al. (2010) analyze case studies of executive compensation at large U.S. financial institutions and propose compensation reforms.[7]

Our article contributes to the rapidly growing literature analyzing executive compensation and risk taking in banks in several ways. First, we propose a simple measure of risk taking incentives that captures the risk taking incentives generated by CEOs' portfolios of both stock and stock options. Second, we use an ex post measure of bank risk, bank failure during the crisis, that aims to capture the full extent of bank risk taking prior to the crisis. Third, we analyze how shareholder incentives to take on risk are related with the level and structure of CEO compensation and risk taking incentives. Finally, we investigate whether risk taking incentives can be attributed to particular compensation practices, such as the use of termination incentives, or compensation structures, an issue that is relevant for the potential regulation of the compensation of bank executives.

1 Sample selection

To select our sample of financial institutions, we first select all firms with 4-digit SIC codes between 6000 and 6300 covered by the compensation database Execucomp and whose CEO is identified in this database in year 2006. Of the 167 firms so selected, we keep all firms with SIC codes 6020 (*Commercial Banks*), 6035 (*Savings Institutions, Federally Chartered*), and 6036 (*Savings Institutions, Not Federally Chartered*)—a total of 114 firms—and we exclude firms with SIC codes 6111 (*Federal Credit Agencies*) and 6282 (*Investment Advice*). To determine the inclusion of the 41 firms in the remaining SIC codes, we search the National Information Center of the Federal Financial Institutions Examination Council (FFIEC) to verify each firm's institution type in year 2006.[8] We keep a firm in the sample if it is identified as any type of regulated institution.[9] We also keep in the sample those firms listed as primary dealers by the New York FED.[10] This process yields a base sample of 130 firms in 2006, from which we drop five firms because there is not enough information about them for the analysis.[11] Therefore, our final sample has 125 firms. However, for some firms there is not enough information to compute all variables of interest, so the final number of firms that we use in the analysis depends on the data requirements of each specification. For transparency, we report our final

[7] Laeven and Levine (2009) and Erkens et al. (2012) also analyze the relation between bank governance and bank risk for international samples of large financial institutions.

[8] These firms have SIC codes: 6099 (*Functions Rel. To Dep. Bkg.*), 6141 (*Personal Credit Institutions*), 6153 (*Short-Term Business Credit*), 6159 (*Misc Business Credit Instn*), 6162 (*Mortgage Bankers & Loan Corr*), 6172 (*Finance Lessors*), 6199 (*Finance Services*), 6200 (*Security & Commodity Brokers*), 6211 (*Security Brokers & Dealers*). We access the National Information Center of the FFIEC at `http://www.ffiec.gov/nicpubweb/nicweb/SearchForm.aspx`.

[9] The classes of regulated institutions are: financial holding company, bank holding company, savings and loans holding company, federal savings bank, national bank, state member bank, FDIC-insured non-member bank, federal savings association.

[10] `http://www.newyorkfed.org/newsevents/news/markets/2006/an060915p.html`

[11] We drop Center Financial Corp., with SIC 6036, because it does not match with *Compustat Fundamentals*. We drop Raymond James Financial Corp., Bankunited Financial Corp., Glacier Bancorp Inc., and Guaranty Financial Group Inc. because there is not enough information to compute our measures of risk taking incentives.

sample in Appendix B.[12] In Section 8, we also check the robustness of our results to different sample selection criteria.

Since we obtain compensation data from Execucomp, our sample is composed of relatively large publicly traded financial institutions. The sample contains all large bank and financial holding companies whose main activity is commercial banking, from banks with national presence (such as Bank of America or Wells Fargo) to regional banks (Fifth Third Bancorp., National City Corp. or Regions Financial Corp.) or banks operating mainly in one or two states (such as Anchor Bancorp Wisconsin Inc. or Tompkins Financial Corp.). The sample also contains the five large investment banks (Bear Sterns, Goldman Sachs, Lehman Brothers, Merrill Lynch, and Morgan Stanley) and several holding companies (such as American Express Co. and Charles Schwab) that have bank subsidiaries and are federally regulated.

We obtain accounting information from Compustat Fundamentals. Panel A in Table 2 displays several summary statistics of the firms in our sample, whereas Panel B displays the same statistics for the universe of firms in Compustat with SIC codes between 6000 and 6050. If one compares the two tables, one can indeed observe that the financial institutions in our sample are significantly larger, irrespectively of whether size is measured by market capitalization or total assets. In our sample, the average market capitalization in year 2006 is $16.1 billion (median $2.1 billion) and the average total asset value is $106.8 billion (median $11.2 billion). The same values in the Compustat universe of banks are $4.4 billion (median $0.2 billion) and $41.4 billion (median $1 billion), respectively. The financial institutions in the sample appear as well to have a lower leverage and higher ROA than the Compustat universe of banks.

2 Risk and bank failure

Our measure of risk taking in the years preceding the crisis is the occurrence of bank failure during the crisis period. Because of the potentially systemic importance of many of the banks in our sample, regulators may be expected to intervene to bail out a bank at risk of insolvency or to encourage sound banks to acquire the financially distressed banks so as to avoid actual default. Identifying bank failure with default would, thus, not pick up the instances of financial distress in which the regulators' intervention averts bank failure. Therefore, even in the midst of a financial crisis, outright default of large financial institutions may be too rare (and it is indeed rare in the 2007-2010 period) to allow for a precise estimation of the coefficients of interest. Moreover, using default as a measure of failure could bias the estimates if different banks have different probabilities of being bailed out. In particular, the CEOs of those banks more likely to be bailed out if they are at risk of insolvency may take on greater risk in the anticipation of a bailout. If regulators

[12] Our sample selection procedure is analogous to the one employed by Fahlenbrach and Stulz (2011), except that we exclude Federal Credit Agencies. Thus, for example, Fannie Mae is not in our sample.

would not allow these banks to default, one would incorrectly attribute a low level of risk taking to banks with a large risk exposure. Therefore, we define bank failure so as to encompass both institutions that default and those that are acquired by other financial institutions with the support or intervention of regulators.

We define as *failed* a financial institution that ceases operations as an individual entity during the financial crisis because of financial distress. To date the crisis, we follow the time-lines provided by the New York Fed (which dates the beginning of the "financial turmoil" in June 2007, when Bear Stearns pledged $3.2 billion to aid one of its hedge funds)[13] and the Saint Louis Fed (which dates the beginning of the financial crisis in February 2007, coinciding with Freddie Mac's announcement that it would no longer buy the riskiest subprime mortgages and mortgage-related securities)[14] and define 2007 to be the first year of the financial crisis.

To determine the firms that cease operations we first identify which firms are delisted in the period 2007-2010 by analyzing the series of monthly returns in the CRSP stock database.[15] This process yields a set of 31 delisted firms. However, firms may delist for reasons other than bankruptcy or financial distress. For example, firms may go private, merge, or be acquired for strategic reasons even if they are sound. To determine whether firms were delisted because of financial distress, we take the following steps:

1. We check the FDIC webpage for information about banks that become inactive during the crisis period.[16] However, the FDIC provides information about active and inactive banks but not holding companies (which are our unit of observation). Therefore, we first identify the main banking subsidiary of each holding company from the organization's structure provided by the FFIEC. The FDIC indicates if a bank is inactive because it was put into receivership, or because it was merged (with or without financial assistance by the regulator). If the FDIC indicates that the firm was closed or there was a merger with financial assistance by the FED or the FDIC we consider the firm failed. We unambiguously identify 9 firms as failed in this step.

2. *Merger discount.* Following the procedure used by Fahlenbrach et al. (2012), we use the SDC Platinum database to identify mergers and check whether firms not classified as failed in the previous steps are acquired with a discount in the crisis period. In particular, we identify three firms acquired with significant discounts (with 1-day, 1-week and 1-month negative premiums of above 30%). We also consider as failed a firm (Mellon) acquired with a one-day small discount of 6% as well as a firm (Countrywide) that is actually acquired with a 1-day positive premium of 40%, but with 1-week and

[13] `http://www.ny.frb.org/research/global_economy/Crisis_Timeline.pdf` (last accessed on October 17, 2013).
[14] `http://timeline.stlouisfed.org/index.cfm?p=timeline` (last accessed on October 17, 2013).
[15] More precisely, we merge the sample with CRSP monthly stock returns and we identify the last available month of returns provided for each PERMCO.
[16] `http://www2.fdic.gov/idasp/main.asp`.

1-month discounts of 18 and 28%, respectively.

3. For those delisted firms that we do not classify as failed in the previous steps, we search the PROQUEST database using the company name and the following words as keywords: *failed, bankrupt, intervened, closed*. The PROQUEST search identifies one firm as failed (Lehman Brothers).

4. We finally perform the same search on the internet (using standard search engines). This broader internet search indicates that one firm is acquired with substantial regulatory pressure (Merrill Lynch), another one with TARP aid given to the acquiring institution (National City Corp), and another one after a large amount of TARP bailout money is given to the target institution (Provident Bankshares).[17]

The procedure identifies 19 firms in the sample as failed. For transparency, we provide the list of failed firms as well as the reason why they are identified as such in Appendix C. Since the last three steps involve some judgment on our part, in Section 8 we consider the robustness of our results to alternative classifications of the borderline cases.

As discussed in the introduction, using bank failure as a measure of risk helps us avoid some of the key limitations of alternative risk measures. However, bank failure is not without problems. First, as an ex post measure of realized risk, bank failure likely contains a significant amount of measurement error: Whether a bank fails is determined not only by ex ante decisions that determine the level of risk, but also by luck. This measurement error will push up the standard error of our estimates. Second, our measure of bank risk captures the exposure to risks that have negative realizations during the financial crisis. It is possible that those banks more likely to fail conditionally on the events that led to the financial crisis were not riskier ex ante. Third, with our definition of failure we capture instances in which a firm's financial condition is so weak that it is forced to disappear as an independent entity (either because of bankruptcy or forced merger). However, we may consider as healthy systemically important financial institutions that managed to survive only thanks to massive public aid (such as Citigroup or Bank of America). Since this misclassification may bias our results, in Section 8 we evaluate the robustness of the results to classifying as failed (or excluding from the sample) some institutions that survived as separate entities only because they receive extremely large amounts of public funding. Finally, as a binary variable, our measure is coarse, since it makes no distinctions within the groups of failed or surviving banks.

[17] In the case of Merrill Lynch, there were sustained rumors that the Federal Reserve had pressured Bank of America to carry out the acquisition and Congressional hearings were held in 2009 to determine, among other things, whether the Government or the Federal Reserve had pressured or threatened Bank of America's management to acquire Merrill Lynch (see, e.g., Story and Becker, 2009). National City Corp was acquired after being one of the few qualified banks that was denied TARP help. On the contrary, the acquirer (PNC) received TARP money a few weeks before the purchase of National City was announced. We interpret this as a passive way of regulators to support the acquisition of National City by PNC Financial. Finally, Provident Bankshares Corp received $151,500,000 from TARP to prop up capital on Nov. 14, 2008. One month later the purchase by M&T was announced.

3 Risk taking incentives measures

CEO compensation will create incentives to take on risk if increasing bank risk increases the CEO's expected utility of his compensation. Since CEOs, both in general and in our sample of CEOs of large US financial institutions, hold large amounts of stock and stock options, their incentives to take on risk will be largely determined by how risk influences the expected utility of their holdings of stock and executive stock options.

Executive stock options are call options on the firm's stock. Because of the convexity of the relation between the value of the underlying stock and the payoff from exercising the option (see Figure **??**), the expected payoff from a call option is increasing in the volatility of the underlying stock. Indeed, a basic result in asset pricing is that the value of a call option is also increasing in the volatility of the underlying. Because of this result, the most common measure of risk taking incentives in the recent literature on executive compensation is the *option vega* of the executive's wealth (Guay, 1999). The option vega approximates the change in a CEO's wealth that would follow from a 0.01 change in the volatility of the returns of the stock of the CEO's firm. If the CEO holds n_i options of option grant i (where different option grants differ in their strike place and maturity), the CEO's option vega ν_O is:

$$\nu_O = \sum_i n_i \frac{dO_i}{d\sigma_S} 0.01, \tag{1}$$

where O is the option's value and σ_S the volatility of the stock's returns. In the executive compensation literature, O is generally computed as the Black-Scholes value of the option, sometimes adjusted by dividends (Black and Scholes, 1973; Merton, 1973). Since Guay (1999)'s contribution, most papers analyzing CEOs' risk taking incentives measure these incentives by means of option vega (e.g., Knopf et al., 2002; Coles et al., 2006; Brockman et al., 2010). Using this measure of risk taking incentives, Fahlenbrach and Stulz (2011) find that there is no statistically significant relation between risk taking incentives and bank risk (measured by banks' buy-and-hold returns during the financial crisis).

However, because of limited liability, the payoff from holding equity of a levered firm is also a convex function of the value of the firm's assets and, thus, equity value also increases with the volatility of stock returns, as we illustrate in Figure **??**. In fact, one can understand equity as granting shareholders the right to buy the firm's assets from debtholders at a strike price equal to the face value of the firm's debt, so equity can be understood as a call option on the firm's assets (Black and Scholes, 1973; Merton, 1973). As a result, the value of equity, as a call option on the firm's assets, is increasing in the volatility of the firm's assets. Moreover, as Figure **??** illustrates, the sensitivity of the stock's payoff to the volatility of the value of the firm's assets will depend on the firm's leverage. For firms whose debt is much smaller than their value (that is, for firms at which equity, as a call option on the firm's assets, is very much in-the-money), changes in volatility will have a small effect on the value of equity. However, in highly levered firms, whose debt is large relative to their value (and for which, equity is close to being at-the-money), changes in volatility can have a large impact on the value of equity. Therefore, the increase in equity value associated with an increase in the volatility of firm value can be expected to be increasing in the firm's leverage. For highly levered firms, such as large US financial institutions, the impact on equity value of changes in the volatility of firm value may be large.[18]

However, even in a highly levered financial institution, an executive's wealth may not respond much to changes in the volatility of firm value if the executive holds few shares or stock options or if the latter are very much out of the money, so that their value changes little with changes in the stock price. Therefore, to measure the executive's incentives to take on risk, one has to consider both the increase in equity value associated with an increase in firm volatility and the sensitivity of the executive's wealth to changes in the value of the firm's equity. In the executive compensation literature, the sensitivity of a CEO's wealth to changes in the firm's stock price is labeled Delta and is generally defined as the approximate change in CEO wealth associated with a 1% change in the stock price (see, e.g., Brockman et al., 2010)):

$$\Delta = \Delta_S + \Delta_O = \left[n_S \left(\frac{S}{100} \right) \right] + \left[\sum_i n_i \frac{\partial O^i}{\partial S} \left(\frac{S}{100} \right) \right], \tag{2}$$

where Δ_S and Δ_O denote the Delta from stocks and options, respectively, n_S denotes the number of shares of the firm's stock held by the CEO, S the stock price, and i, n^i, and O^i are the identifier of the option grant, the number of options of grant i, and the value of the options of grant i, respectively. A CEO's Delta, thus, depends on the CEO's holdings of the firm stock and stock options, as well as on the sensitivity of the stock option holdings to changes in the price of equity.

To incorporate both the impact of leverage and Delta on risk taking incentives, we define *leveraged-delta* (LD) simply as the product of Delta and firm leverage:

$$LD = \Delta \times leverage. \tag{3}$$

Since we do not observe the firm's market value, we measure leverage (following Fahlenbrach et al., 2012) as the quasi-market value of leverage, computed as the ratio of the quasi-market value of the firm (measured as the book value of assets minus book value of equity plus market value of equity) divided by the market

[18]We note that, to account for the option-like nature of equity, Guay (1999) proposes a method to estimate the derivative of equity value with respect to the volatility of stock returns ($\frac{dS}{d\sigma_S}$) and finds that this derivative is generally very small for a sample of US CEOs in 1993, consistently with a generally small leverage in his sample.

value of equity.[19]

Both option vega and LD are approximations to the change in the CEO's wealth that would be associated with a change in firm risk. However, there may be a substantial wedge between these measures and the corresponding change in the CEO's expected utility. What these measures estimate is the change in the market value of a CEO' stock and option portfolio associated with a change in firm risk. If executive stock options (or restricted stock) were tradeable, the change in the market value of the options that is approximated by the incentive measures would also correspond to the change in the executive's expected utility (measured as the change in the executive's certainty equivalent of the stock and option portfolio). However, executive stock options are not tradeable and there are very stringent limitations to the executive's ability to hedge the risk of the option (ability that is key in determining the market value of the options). As argued by Lambert et al. (1991) or Ingersoll (2006), among others, these limitations may create a significant wedge between market values computed using standard models and subjective values for the executive. For example, suppose that a risk averse executive must hold an option until maturity and cannot trade other assets to hedge the option's risk. The expected payoff of the option, and, thus, the executive's expected wealth, will increase with the volatility of the underlying stock. However, the risk averse executive will also bear a cost (risk premium) for the increased volatility of the stock, since the latter will increase the risk of the executive's stock and option portfolio (Guay, 1999). Moreover, this increase in the CEO's risk premium will tend to be higher the larger the exposure of the CEO's wealth to changes in the firm's stock, i.e. the larger the CEO's delta. Because the increase in the executive's risk premium caused by an increase in stock volatility will tend to be larger the greater the exposure of the CEO's wealth to the firm's stock price, several articles (Guay, 1999; Knopf et al., 2002; Coles et al., 2006; Brockman et al., 2010) propose using delta as a measure of the sensitivity of the risk premium to changes in stock volatility.[20] Taking into account delta when measuring incentives is especially important in our case, since for low leverage levels, increases in delta (and, thus, in LD) will have a small impact on risk shifting incentives, whereas, at the same time, they will increase the CEO's exposure to the firm's risky stock. Therefore, we use delta, in combination with LD, as a measure of the disincentives to increase risk stemming from executives' nondiversifiable exposure to their firms' equity risk.

[19]The quasi-market value of assets is a common approximation to the market value of assets

[20]Knopf et al. (2002) find that, consistently with the hypothesis that a higher delta provides incentives to managers to reduce risk, firms whose CEOs have higher deltas (controlling for option vega) tend to hedge more by means of financial derivatives. Brockman et al. (2010) also argue that a higher delta will be associated with weaker risk taking incentives and find that firms whose CEOs have higher deltas (controlling for option vega) use less short-maturity debt (whose purpose is to limit risk shifting). The evidence in Coles et al. (2006) is less clear cut. Thus, even though a higher delta is associated with less risky policies, it is associated with greater stock return volatility. Coles et al. (2006) also discuss an alternative channel whereby delta may be related with firm risk: If there were a positive correlation between project risk and net present value, a higher delta, by increasing CEOs' incentives to invest in positive NPV projects, could lead managers to implement riskier projects. This channel would also help explain Fahlenbrach and Stulz's results of a positive relation between delta and firm risk in their sample.

Panel A in Table 3 provides descriptive statistics of the incentive measures computed in year 2006.[21] The incentive measures display substantial dispersion, with standard deviations at least twice as large as the mean and with the 90th percentile being ten times as large as the median and about a hundred times larger than the 10th percentile. The distribution of the incentive measures also exhibits right skewness, with a lower bound at zero, some very high values, and with means substantially higher than the median.[22]

Panel B in Table 3 displays the pairwise correlations between the LD, delta, and option vega. Importantly, although LD is positively correlated with option vega, the correlation is relatively low. Therefore, LD and vega measure different things in our sample. This wedge suggests that risk taking incentives generated by equity holdings seems to be important in our sample of large US financial institutions. Delta has a positive correlation with both option vega and LD, and the strong correlation between delta and LD indicates that the variation in LD does not simply reflect variation in leverage.

4 Risk taking incentives and failure

4.1 Empirical strategy

We seek to estimate the relation between risk taking incentives and bank failure during the financial crisis. To estimate this relation, we measure CEO risk taking incentives in year 2006. This choice of measurement period is determined by several requirements. We require the period to be sufficiently close to the crisis to be able to potentially attribute to the compensation incentives in the measurement period an impact over the probability of failure during the crisis. Since we date the beginning of the crisis in 2007, choosing a year such as 2000 would not satisfy this requirement. We also require that the incentive measurement period not be a crisis year for two reasons. First, to the extent that bank failure was motivated to a large extent by actions taken by banks in the years prior to the crisis, the measurement of incentives would take place after the actions they were supposed to incentivize. Second, we would like to avoid capturing reverse causality to the extent possible: Measuring incentives during the crisis would capture the reaction of CEOs' compensation packages to negative realizations of uncertainty during the crisis. Finally, the choice of 2006 as the measurement period also maximizes the availability and quality of the compensation data, because a new set of compensation disclosure requirements became effective in this year. Thus, before year 2006, the

[21] We note that we compute the incentive measures differently for seven firms because of data availability or management changes. In three firms (First Niagara, Goldman Sachs, and UnionBanCal Corporation), the CEO retires in 2006. Since retirement years are highly atypical, for these firms we compute the incentive measures in year 2005. Starting December 15, 2006, SEC disclosure rules require firms to report disaggregated information of option grants awarded to CEOs. This disaggregated information allows us to compute the risk incentive measures directly as described in the Appendix. However, a few firms in our sample had an earlier fiscal year end, so that they did not have to comply with the new disclosure requirement until the next fiscal year (2007). For such firms (Bear Stearns, Goldman Sachs, Lehman Brothers, Morgan Stanley, and Washington Federal Savings) we use the one year approximation technique described in Core and Guay (2002).

[22] Because of this skewness, in Section 8 we also report results obtained using the natural logarithm of the incentive measures.

information on pension benefits and termination payments is very limited, and the information regarding executive stock options improves in 2006. Moreover, other studies have used 2006 as their measurement period (notably, Fahlenbrach and Stulz, 2011), which makes it easier to compare our results with theirs.

Although we have a panel with firm and compensation data, by construction we have only a single cross section of the dependent variable (failure). Therefore, our empirical specifications are cross section regressions with failure during the crisis as the dependent variable and incentives measured in 2006 as the explanatory variable of interest. We note that the use of bank failure during the financial crisis as the dependent variable rules out the use of fixed effect estimation to control for time-invariant unobserved heterogeneity among financial institutions.

Since we would like to capture the potential effect of risk taking incentives on the likelihood of failure, we cannot include as controls in our regressions measures of risk taking that could be the result of those incentives. To make this point clear, suppose that the credit risk of a bank's loan portfolio were the only variable determining bank risk. In this case, even if compensation fully determined CEOs' incentives to take risk (through the choice of riskiness of the loan portfolio), we would observe no effect of compensation on bank risk if we controlled for the credit risk of the loan portfolio in our regressions. In Section 5 we, nonetheless investigate the effect of including proxies for bank risk in the estimating equations. The small size of our sample significantly limits the power of the tests and further constrains our choice of control variables in the estimating equations. Thus, we include independent variables only if there are a priori reasons to expect them to be related to both risk taking incentives and the probability of bank failure. In Section 5 we discuss our choice of regressors in the multivariate specifications. Here we emphasize that the goal of our analysis is not to accurately predict bank failure but to estimate the relation between pre-crisis incentives and bank failure during the crisis.

Our main specification throughout the paper is the linear probability model:

$$f_i = \alpha + \beta w_{i,2006} + \delta \Delta_{i,2006} + \mathbf{x}_{i,2006}\gamma + \varepsilon_i, \quad (4)$$

where f_i is a dummy variable equal to one if the firm fails in the period from 2007 to 2010, w is a measure of risk taking incentives (option vega or LD), Δ is the CEO's delta, and $\mathbf{x}_{i,2006}$ is a vector of controls, which may include lagged controls. Linear probability models have the advantage of easy interpretability, yet are necessarily misspecified because they do not restrict probabilities to lie between zero and one. The small size of our sample, however, makes estimation of nonlinear models (such as probit or logit models) highly imprecise.[23] Therefore, we focus on the results from linear probability models, although in Section 8 we

[23]The small sample size also recommends against alternative specifications such as duration models.

also evaluate the robustness of our results to both non-linear transformations of the incentive measures and non-linear specifications of the estimating equation.

It is important to note that, as discussed above, the risk taking incentive measures are likely to be quite noisy approximations to the true risk taking incentives implied by CEOs' holdings of stock and options. Therefore, even if the measurement error is unrelated to the underlying incentives, the coefficients on the risk taking incentive measures will tend to be biased towards zero because of the attenuation bias due to measurement error.

4.2 Univariate results

As a first step to measuring the relation between risk taking incentives and bank failure, we compare the means and medians of the incentive measures in the subsamples of failed and surviving financial institutions. The results, which we display in Panel C of Table 3, show that failed and surviving banks differ greatly in their risk taking incentives as measured by LD. Thus, the mean leveraged delta among failed banks is almost 4 times larger than among surviving banks and the difference is statistically significant at the 1% level. At the same time, although failed banks exhibit a higher option vega, the difference in mean option vega between failed and surviving banks is smaller and not statistically significant at the 10% significance level. We obtain similar results when we compare the medians of the two subsamples. Therefore, the comparison of the subsamples of failed and surviving banks shows that the measure of risk taking incentives matters: Whereas failed banks have substantially higher risk taking incentives as measured by LD, the difference is small and not statistically significant if measured by option vega.

In Table 4 we report estimated coefficients of the simple linear probability model (4) without controls. The univariate results show that a one standard deviation change in LD is associated with about a 0.10 (ten percentage points) increase in the probability of failure and the estimated coefficient is statistically significant at the 1% level.[24] Increasing leveraged delta from its median to the 90th percentile would increase the probability of failure by 0.09. Therefore, increases in risk taking incentives, when measured by LD, are associated with a statistically and economically significant change in the probability of failure.

If we measure incentives by means of option vega, however, the estimated coefficient is smaller (a one standard deviation change in option vega is associated with a 0.03 increase in the probability of failure) and not statistically significant at conventional significance levels. Therefore, with a different risk measure and a somewhat different sample, our results replicate those of Fahlenbrach and Stulz (2011), who find no statistically significant relation between option vega and bank risk taking. Fahlenbrach and Stulz (2011) do find a positive and statistically significant coefficient for delta. We also estimate a positive coefficient for

[24]Unless otherwise noted, all standard errors are robust.

delta in a univariate specification, although in our sample it is not statistically significant at conventional significance levels. In the light of our results, a plausible interpretation of their positive coefficient for delta is that it is due to the positive correlation between delta and the risk taking incentives not captured by option vega. In fact, if we include option vega and delta simultaneously in the regression, the coefficients barely change with respect to those of the univariate specifications and remain not significantly different from zero. When we estimate the baseline linear probability model (4) with LD and delta as regressors, the coefficient for delta is negative and the coefficient for LD increases substantially, and both estimates are significantly different from zero at the one percent level. Although the negative coefficient for delta implies that increasing delta would reduce the probability of failure for low enough levels of leverage, the leverage of the firms in the sample is sufficiently high to guarantee that the predicted marginal effect of delta ($-0.24 + 0.173 \times leverage$) is positive for all firms.

The results in Table 4 are consistent with the existence of a causal effect of CEO compensation on bank risk. However, we do not have a source of exogenous variation in CEO compensation to identify such causal effect. Therefore, there are, obviously, alternative explanations for the results. In particular, risk taking incentives may be correlated with bank or CEO characteristics that either make banks inherently more risky or provide CEOs alternative incentives to take on risk. In the next section, we propose and evaluate the plausibility of several possible explanations of the univariate results.

5 Alternative explanations

5.1 Other sources of incentives

The positive relation between LD and the probability of failure could be due to the correlation between LD and other, more relevant, determinants of CEOs' risk taking choices. First, the implicit incentives created by the threat of termination could be more powerful in determining CEOs' risk choices than concerns about the sensitivity of current wealth to firm risk. These implicit incentives will arise if banks pay CEOs more than their reservation value and bank risk affects the probability of termination (as in standard efficiency wage models). Whether the threat of termination provides incentives to increase or decrease risk will hinge on the determinants of CEO replacement. If CEOs are replaced only when firm performance is dismal, then the threat of termination may, in general, provide incentives to reduce risk, since CEOs will seek to lower the probability of negative tail risk (see, e.g., Eckbo and Thorburn, 2003). On the other hand, if continuation as CEO requires being at the top of the distribution of performance, then the threat of termination may provide incentives for taking on risk, since moderately poor performance would have similar implications as extremely poor performance, whereas the CEO would benefit from very strong performance. In the former case, our results could be explained by the presence of weaker termination incentives in firms with higher LD; in the latter case, by a positive correlation between LD and termination incentives. In either case, if termination incentives dominated those provided by CEOs' equity portfolios, controlling for termination incentives would significantly reduce the estimated coefficient for LD. Unfortunately, measuring the sign of the effect of termination incentives on risk taking and the strength of these incentives at each firm in our sample is beyond the scope of this paper. However, termination incentives are, other things equal, likely to be stronger for CEOs with a higher total pay (to the extent that at least part of the pay premium reflects quasirents and not merely compensation for unobserved general skills, which would also increase their reservation value), and for younger CEOs, since the number of periods in which these CEOs may earn rents if they are not replaced is higher. Therefore, including total pay and CEO age in the estimating equation is likely to capture in part the effect of termination incentives.

Golden parachutes (which are termination payments associated with a change in control of the firm, such as a takeover or a merger) or more general severance pay may also affect a CEO's termination incentives. Thus, other things equal, a CEO with generous termination payments will suffer less if replaced, which would increase his or her risk taking incentives by reducing the CEO's downside risk. Therefore, if termination payments were positively related to LD, they could explain our univariate results. Termination payments could also be set in place in firms at which there is an inherently higher risk of CEO replacement or a higher sensitivity of replacement decisions to firm performance. If either of these two factors is associated both with firms' inherent riskiness and with LD, this association could help explain our univariate results.

Second, CEOs may have incentives to take or hedge risks to affect the perception that investors have of their ability, since this perception is likely to have a significant impact on their career prospects (DeMarzo and Duffie, 1995; Breeden and Viswanathan, 1998). Again, the sign of the relation between the strength of these career concerns and CEOs incentives to take on risk is not clear a priori. However, irrespectively of the sign of the relation, age may be correlated with the strength of career concerns, with the career concerns of older CEOs likely to be weaker because more information about their abilities has already accumulated and because there are fewer years left in which they may benefit from a higher perceived ability. Therefore, age may act as an, admittedly, noisy of the strength of career concerns.

Finally, our risk taking incentives variables measure the incentives to take risk stemming from CEOs' equity portfolios. However, as recently emphasized by Sundaram and Yermack (2007), Edmans and Liu (2011), and Anderson and Core (2013), defined benefit pension plans and deferred compensation are similar to debt. Such debt-like assets make the CEO akin to a debtholder and, thus, provide incentives to take on (or limit) risk similar to those of debtholders. Again, our univariate results could be due to the fact that equity incentives are negatively correlated with debt-like incentives and the latter are the ones that truly motivate bank CEOs. Since pension benefits are usually benchmarked with total pay and typically increase with the tenure at the firm, we control for these incentives by including total pay and CEO tenure in the regressions.

5.2 Matching, risk, and compensation

Our univariate results could also be explained by the fact that high LD contracts (even if they are not truly associated with stronger incentives to take on risk or if the associated incentives are weak) are the least costly contracts to compensate the CEOs of inherently riskier firms or those CEOs who are more likely to engage in risky practices.

In standard principal-agent models, the performance sensitivity of pay should be, other things equal, negatively correlated with firm riskiness, since the cost of linking pay to performance (in terms of a higher risk premium that has to be paid to the CEO) is higher for firms with more volatile performance.[25] However, if riskier firms were matched with more risk tolerant CEOs, in equilibrium riskier firms could offer contracts with stronger incentives (Ackerberg and Botticini, 2002). Cheng et al. (2013) also consider the possibility that firms that are inherently riskier (which would make a low sensitivity of pay to performance optimal) are also firms in which the marginal return of CEO effort is higher (which would make a high pay-performance sensitivity optimal). If the relation between riskiness and the marginal productivity of CEO effort is positive and strong enough, the CEOs of riskier firms will not have significantly lower deltas and could even have higher deltas (and, as a result, higher values of LD in highly levered firms).

Larger banks could be inherently risky (because of, say, their complexity) or more likely to engage in certain risky practices (because, for example, the existence of a too-big-to-fail implicit guarantee).[26] At the same time, a well known regularity in executive compensation is that CEO pay is increasing in firm size. To the extent that a larger total pay also implies a larger equity pay (because, for example, fixed pay is limited by legal or reputational constraints), firm size could be, somewhat mechanically, positively correlated with LD. Including size in our regressions could control for the impact of size on both riskiness and LD. As we discuss in Section 4.1, however, we do not want to include controls that may be themselves measures of bank riskiness. Since risky expansion policies in the years prior to the crisis may have influenced bank size as of

[25] See Prendergast (2002) for a discussion of the standard models and the empirical evidence relative to the relation between risk and incentives.

[26] Size could have the opposite effect of reducing the probability of failure if larger banks had more skilled managers, if there were economies of scale in risk management, or if, despite the potentially perverse incentives they create, the net effect of too-big-to-fail guarantees on the probability of failure were negative. However, given the positive correlation between incentive measures and size, if the correlation between size and failure probability had a negative sign, then it would not explain our univariate results.

Table 1: Alternative Explanations. Each row corresponds to a possible explanation for the results in Table 4. Each cell displays the expected sign of the relation between the variable corresponding to the cell's column and failure, according to the explanation corresponding to the cell's row. A proposed explanation may explain the results in Table 4 if the sign of the relation between a variable related to that explanation and LD is the same as the sign reported in the corresponding cell. We display an expected sign in boldface if the sample correlation between the corresponding variable and LD has the same sign as the difference in the average value of the variable between the subsamples of failed and surviving banks and this sign is equal to the expected sign in the table.

	CEO pay	Age	Term. payments	Inside debt	Size	Wealth	Leverage	Pre-crisis returns
Termination incentives	+/−	+/−	+					
Career concerns		+/−						
Debt-like incentives	−			−				
Size	+				+			
CEO risk aversion		−				+		
LD measures risk							+	
Poor management								−

2006 (Fahlenbrach et al., 2012), we measure firm size with in year 2003.[27]

Finally, there may be CEO characteristics that determine CEOs' risk choices or risk tolerance, and different compensation contracts may attract CEOs of different characteristics or be optimal given different risk-relevant CEO characteristics. For example, it is plausible that firms with more risk tolerant CEOs will have stronger incentives and higher risk as a result of CEO choices (see, e.g., Dittmann and Maug, 2007). We do not have a measure for CEOs' risk aversion. However, we can control for variables that are likely to be correlated with it. First, CEO age may be negatively correlated with CEOs' risk aversion, CEOs' estimates of the risk of different policies (for example, older CEOs may have lived through previous crises, like the savings and loans crisis, in positions of responsibility),[28] or CEO overconfidence. Similarly, if CEOs' risk aversion decreases with their wealth, a measure of CEOs' wealth may also allow us to partly control for differences in risk aversion. Therefore, we also control for CEO wealth (other than the wealth in the form of their own firm's equity) in our regressions.

[27]We note, however, that measuring size in 2006 does not affect our results.
[28]See Malmendier and Nagel (2011) or Koudijs and Voth (2014).

5.3 Risk taking incentives or risk?

By construction, LD is increasing in firm leverage (as long as Delta is positive) and will be positively correlated with firm leverage unless the correlation between Delta and leverage is negative and sufficiently strong. At the same time, leverage may be interpreted as a measure of firm risk. Therefore, an alternative explanation of our results is that LD does not measure risk taking incentives but, instead, firm risk itself. In such a case, our results would just imply that the value of some nonlinear increasing function of firm risk is associated with a higher probability of failure.

To the extent that a higher risk of failure increases risk shifting incentives, distinguishing the effect of an exogenous increase in firm risk from the effect of the increase in risk generated by the stronger risk shifting incentives is not straightforward. However, as a crude way to evaluate the possibility that LD simply measures bank leverage, one can control for leverage in the regressions. If the relation between incentives and failure is due to the fact that the former are simply a proxy for leverage, then controlling for leverage should make the coefficients for incentives vanish. Since the relation between leverage and the probability of failure may be nonlinear, we also include leverage squared in the regressions. However, as we discuss in Section 4.1, if CEOs have the ability to determine leverage and leverage is an important determinant of risk, controlling for leverage could make the estimated coefficient of incentives vanish, even if risk taking incentives fully determined leverage and, thus, risk. The substantial correlation between leverage and incentives together with our small sample size may also render the estimates less precise.

5.4 Risk vs. poor management

Another possible interpretation of our results is that failure is not measuring risk taking but, rather, poor management. Under this interpretation of bank failure, the univariate results could be due to the fact that firms with worse prospects or less able managers may have provided their CEOs stronger incentives for effort prior to the crisis. If these incentives were not strong enough or did not last long enough to improve banks' prospects, banks with stronger incentives prior to the crisis (which could plausibly translate into higher LD) may have had a higher probability of failure. Alternatively, LD may be negatively correlated with CEOs' incentives to exert effort or make sound decisions (although a priori it is not clear why this should be so). To account for this possibility we also consider the relation between firm performance prior to the crisis (measured by either ROA or stock returns) and both LD and failure.

Table 1 summarizes the expected sign of the relation between different variables and the probability of failure, according to the different explanations discussed in this section. For a proposed explanation to potentially explain the results in Table 4, the sign of the relation between LD and the variables that have to do with that explanation should be the same as the predicted sign of the relation between those variables and failure. As a way of evaluating the plausibility of the different explanations, in Table 1 we display in boldface the expected signs that are equal to both the sign of the difference in the corresponding variable between the subsamples of failed and surviving firms and to the sign of the sample correlation between that variable and LD. In the online appendix, we report the correlations among the different variables and between them and LD, as well as the results of tests of the difference in means and medians between the subsamples of failed and surviving firms.

5.5 Results

In Panels A and B of Table 6, we report the results of estimating our linear probability model including the different control variables discussed in the previous subsection. The first noteworthy result is that the coefficients for LD and Delta remain highly statistically significant and with the same signs as in the specification without controls. Moreover, including controls other than termination payments does not affect the magnitude of the estimated coefficients for LD and Delta, which are unchanged relative to the specification without controls. The magnitude of the coefficients increases (in absolute value) if severance pay or golden parachutes are included as controls. However, the change is not due to the inclusion of these controls, but to the fact that there are a few firms for which information on termination payments is not available.[29] It turns out that the companies with no information on termination payments include four of the five large investment banks (which have very large values of LD and delta). In section 8 we analyze the influence of these observations.

The second implication of the results in Table 6 is that, with the exception of leverage, none of the proposed controls has an estimated coefficient different from zero at conventional significance levels. Moreover, with the exception of the coefficient of total pay (which implies that a one standard deviation change in total pay is associated with a 0.05 increase in the probability of failure), the estimated coefficients are also small . We highlight that the estimated coefficients for both the average ROA and the average stock returns in the period from 2004 to 2006 are positive. The sign and statistical significance of these coefficients (as well as the difference in the corresponding variables between surviving and failed banks) do not support the hypothesis that a high LD is associated with persistent underperformance or that this persistent underperformance can explain bank failure during the crisis.

Although the coefficients of both leverage and leverage squared are positive and statistically significant, including these variables in the regression barely affects the estimated coefficients for LD and delta. The

[29]In unreported results, we run the specification in column (2) of Panel A (with only size as a control) for the subsample of firms with information on severance pay, and we obtain a coefficient identical to the ones reported in columns (6)-(9) of Panel A.

results show that the relation between the probability of failure and LD is not simply due to the positive linear correlation between these variables and leverage. Thus, either the relation between leverage and the probability of failure is nonlinear in a way that is captured by LD, or the interaction between leverage and CEO compensation has a positive relation with risk beyond the direct impact of leverage on risk.

6 Bank governance

The quality of a bank's governance may determine the level and structure of CEO compensation. At the same time, governance quality may also influence the CEO's risk choices through other channels. In particular, governance failures are commonly cited as a main cause of the 2007-2010 financial crisis and a proposed alternative to limit bank risk is to improve the quality of the governance of financial firms. In this section, we investigate the impact of bank governance on risk taking and incentives.

According to managerial power theories of CEO pay, the CEOs of poorly governed banks are likely to be paid more. To the extent that higher pay is not accompanied by a change in compensation structure (in particular, with a reduction in the fraction of total pay that takes the form of equity), the CEOs of poorly governed firms will have larger equity holdings of their own firms and, thus, other things equal, stronger risk-taking incentives. Moreover, according to some managerial power theories of CEO pay, poorly governed firms may structure CEO compensation so as to camouflage the level of that compensation (Bebchuk and Fried (2004)). In particular, poorly governed firms may make greater use of equity compensation, especially of stock option compensation, because these forms of compensation can be justified as providing incentives to the manager and because the cost to the firm of these compensation vehicles may have been easier to conceal or undervalue. Therefore, LD (which increase with the size of equity holdings and with the use of stock options) may be higher for the CEOs of poorly governed firms. At the same time, the CEOs of poorly governed banks may make riskier choices for reasons unrelated to the risk taking incentives captured by LD. For example, entrenched CEOs may be less likely to be replaced if the bank performs poorly. Therefore, these CEOs may not suffer much from downside risk and benefit as much as other CEOs from upside risk, which would make risky strategies more attractive for more entrenched CEOs. Worse governed firms may also have poorer risk management systems, which may allow for the excessive accumulation of risk.[30]

To investigate the impact of bank governance on the probability of bank failure, we consider several standard measures of the quality of corporate governance: board independence (measured as the percentage

[30]We note that poor governance may also decrease firm risk. For example, less entrenched managers may need to achieve stelar performance to keep their job (which would increase risk incentives), whereas more powerful managers may be able to remain at their post with mediocre performance. To the extent that entrenched managers earn greater rents, they may also be less inclined to follow policies that increase the probability of default, since default (or regulator intervention to replace the management team) would imply the loss of those rents. In any case, what matters for the argument is that governance may be associated with firm risk through channels other than the incentives measured by LD.

of directors who are independent); board size (since larger boards have been often described as less effective); the Governance Index (GI) of Gompers et al. (2003); and the Entrenchment Index (EI) of Bebchuk et al. (2009). The GIM governance index and the EI attempt to measure the degree of managerial entrenchment, with higher values of these variables denoting greater managerial entrenchment. We compute board independence and board size using information from RiskMetrics, BoardEx, and proxy statements. We obtain the GI index from Andrew Metrick's webpage,[31] and the EI index from Lucian Bebchuk's webpage.[32]

Table 7 displays summary statistics of the governance variables. The boards of the banks in the sample are relatively large (which is consistent with the size and complexity of the banks in the sample) and there is not a large heterogeneity in board independence. Otherwise, the levels and variation in the governance indices are similar to those reported in previous articles (Gompers et al. (2003), Bebchuk et al. (2009)).

We first check whether including standard governance measures in our regressions affects the size or sign of the coefficients of the incentive measures. As we report in Table 8, the estimated coefficient for LD and its standard error are largely unchanged with respect to the benchmark specification with only firm size as control. Moreover, none of the coefficients associated with the governance variables is statistically significant at conventional levels. The magnitude of the estimated coefficients is also relatively small, with one standard deviation changes in the variables associated with changes in the probability of failure between 0.007 and and 0.035 for all variables and specifications. The results, thus, suggest that, controlling for compensation incentives, bank governance quality is not associated with banks' probability of failure

Despite the above results, governance quality could still be responsible for firms' risk choices if it determined the risk taking incentives embedded in CEO pay. To evaluate this possibility, we regress our measures of incentives on different governance variables. The results, reported in Table 8, show that only board size has a statistically significant relation with LD. The coefficient is negative, which indicates that larger boards, often perceived as less effective, are associated with weaker risk taking incentives.[33] Whereas the coefficients for the GIM index and the Entrenchment index also suggest that worse governance (in the sense of greater management entrenchment) is associated with weaker incentives, the coefficient for board independence suggests that greater board independence (often interpreted as a sign of better governance) is associated with weaker incentives. However, these coefficients are estimated very imprecisely, so our sample does not provide evidence that managerial entrenchment or board independence are related to risk taking incentives.

In summary, standard measures of the quality of corporate governance do little to explain bank risk, and only board size has a statistically significant relation with CEOs' risk taking incentives, with an estimated

[31] `http://faculty.som.yale.edu/andrewmetrick/data.html`.

[32] `http://www.law.harvard.edu/faculty/bebchuk/data.shtml`.

[33] Yermack (1996) and Eisenberg et al. (1998) find performance to be decreasing in board size. However, Coles et al. (2008) show that performance is positively associated with board size for complex firms. However, these results should be interpreted with caution because of potentially large unresolved endogeneity problems.

coefficient that suggests that risk incentives are stronger in smaller boards. Our results are, thus, broadly in line with the ones by Cheng et al. (2013) and Chesney et al. (2012), who find no discernible relation between governance variables and bank risk or incentives. Since CEO risk taking incentives in 2006 may be the result of past governance quality instead of the governance quality in 2006, in unreported results we also run the regressions reported in Table 8 with the governance variables measured in 2003 and find similar results, with only board size having a discernible impact on LD.[34]

7 Shareholder incentives, compensation policies, and risk taking

In the previous section, we investigate whether there is a relation between the severity of the agency problem between shareholders and management (which the governance variables are supposed to measure) and risk taking incentives. However, managers' incentives to take on risk may be determined not by the divergence between managers' and shareholders' interests but, instead, by the incentives that shareholders themselves have to encourage risk taking. Because of a combination of limited liability, very high leverage, and implicit government guarantees, bank shareholders may have an incentive to increase the risk of bank assets at the expense of depositors and debtholders. As we discuss in Section 3, equity can be interpreted as a call option on the firm's assets, and the increase in value of this call option associated with an increase in asset risk is increasing in leverage. Therefore, a possible measure of shareholders' incentives to shift risk to other claim holders is the bank's leverage. Because leverage in 2006 may reflect to a larger extent the results of prior risk choices than shareholder incentives at the time of setting CEO compensation, we use leverage in 2003 as a measure of shareholders' incentives to take on risk (although we note that measuring leverage in 2006 does not alter the results) and estimate the relation between this measure and LD.

Of course, by definition, the partial derivative of LD with respect to leverage is non-negative and equal to Delta. So, to the extent that there is some persistence in leverage, one would expect that, keeping Delta constant, LD (measured in 2006) would increase with 2003 leverage. However, we are not interested in the relation between leverage and LD keeping Delta constant. If shareholders of more levered firms managed their CEO's compensation to achieve a lower delta, the relation between LD and leverage could be flat or even negative.[35] Indeed, there are theoretical arguments that suggest that the relation between LD and leverage may be relatively flat. If debt markets accurately reflected bank risk, excessive risk would be borne by shareholders through higher interest rates of the firm's debt (Jensen and Meckling, 1976). Therefore, it may be in the interest of those firms whose shareholders have stronger incentives to shift risk to debtholders

[34] In unreported results, we also find that there is no significant relation between any of the governance variables and failure in specifications that omit the incentive variables LD and Delta.

[35] Let L denote leverage and assume that L measures shareholders' risk shifting incentives. Then, $LD(L) = \Delta(L)L$ and $LD'(L) = \Delta'(L)L + \Delta(L)$. Therefore, if $\Delta'(L) < 0$, it can be the case that $L > L'$ and $LD(L) \leq LD(L')$.

to design the compensation of their managers so as to limit their incentives to take risk. It follows from this argument that the CEOs of more levered banks will have lower pay-performance sensitivity (John and John, 1993). This lower performance sensitivity (lower Delta) can be achieved by granting the manager fewer shares or stock options or by managing the portfolio of CEO stock options to achieve a lower delta. Therefore, if shareholders bore the costs of higher default risk, then one would not expect a strong and positive correlation between leverage and LD. However, because of deposit insurance, implicit government guarantees, or lack of sophistication by depositors, the interest rates on banks' debt and deposits may not reflect bank riskiness. In such case, those banks whose shareholders have greater incentives to take on risk may also provide stronger risk taking incentives to their CEOs.

In Table 9, we report the results of estimating regressions of LD and Delta (measured in 2006) on leverage and firm size (both measured in 2003). As the table shows, LD is increasing in leverage. Therefore, CEOs' risk taking incentives in year 2006 are increasing in shareholder's risk shifting incentives in 2003 (as measured by 2003's leverage). At the same time, the relation between Delta and leverage is positive, although the estimated coefficient is not statistically significant at conventional significance levels. To further explore the relation between lagged leverage and Delta, we also regress each of Delta's two components, the Delta from stock (Δ_S) and the Delta from options (Δ_O)—as defined in equation (2) and measured in 2006—on bank size and leverage, measured in 2003. Again, the relation between lagged leverage and either component of Delta is not statistically significant and small in magnitude. Therefore, it does not appear as if more levered banks adjust the sensitivity to performance of their CEOs' wealth. This result is in contrast to the results reported by John et al. (2010), who estimate a negative relation between pay-performance sensitivity and leverage for a sample of bank holding companies in the period from 1993 to 2007. However, John et al. (2010) employ a different definition of pay-performance sensitivity. Thus, whereas Delta measures the relation between the dollar value of the CEO's portfolio of equity and stock options and percentage stock returns, John et al. (2010), define pay-performance sensitivity as the relation between the dollar value of CEO total compensation (which includes both total pay, as defined in this paper, and the changes in the value of the CEO's equity and option holdings) and the dollar return to shareholders. To check whether the difference between their results and ours is due to the different definition of pay performance sensitivity, we define $\Delta_\$$ as the change in the dollar value of the CEO's portfolio of stocks and options associated with a change in \$1,000 in the firm's market capitalization. If we let N denote the number of shares of stock (so that market capitalization is $N \times S$, where S denotes stock price) and assume this number to be constant, then a change in the stock price of $\frac{1{,}000}{N}$ would lead to a change of \$1,000 in market capitalization. Therefore, we define:

$$\Delta_{\$} = \frac{dW}{dS}\frac{1,000}{N}.$$

However, as column () in Table 9 shows, this measure also has a positive, yet not statistically significant relation with leverage. Therefore, the difference between John et al. (2010)'s results and ours may stem either from their more inclusive definition of CEO wealth or, simply, because they analyze a different sample (their sample consists of about 70 bank holding companies per year) and in a different sample period. In fact, whereas they report a mostly negative relation for the years 1993-2002, the relation is mostly positive for the years 2003-2006.

We further investigate whether more levered banks pay their CEOs differently by analyzing the relation between leverage in 2003 and subsequent pay level and structure. We measure the compensation level by means of total pay, which encompasses salary, cash bonuses, the value of stock awards, restricted stock awards, and option awards, as well as other compensation components, such as contributions to pension plans or disclosed perks. To describe the structure of CEOs' compensation packages, we define three ratios that seek to capture the relative use of different types of pay. We define a firm's *equity ratio* in year t as the total dollar value of stock and stock option grants in year t over total compensation in year t. Thus, equity pay reflects the relative importance of equity as a compensation vehicle (the part of compensation that is not equity consists mainly of cash—salary and performance-related cash compensation—and pension contributions). We also define the *option ratio* as the total value of option grants in year t over the total value of equity grants (options and stock) in year t. For firms in which the denominator is zero we define the option ratio to be zero. The option ratio captures the relative importance of options versus stock in CEOs' equity compensation. Finally, we define the inside debt ratio as the ratio of the CEO's holdings of debt-like claims (as defined in Section 5) over the CEO's equity holdings.[36] Since pay levels and the compensation ratios may vary year to year, we focus on four-year time averages (2003-2006) of the different pay variables, except for the inside debt ratio, which is measured in 2006, because of data availability (although we note that measuring the compensation variables in 2006 does not alter the results).

Both total pay and the compensation ratios are easy to compute from firms' proxy statements or standard compensation databases. Therefore, it is worth investigating whether these measures capture the variation in risk taking incentives (as measured by LD) and whether, beyond their relation with LD, they are associated with greater risk taking. In Panel B of Table 11, we display the results of regressions with LD as dependent variable and firms size and the equity and option ratios as explanatory variables. A higher total pay is

[36] As opposed to the other two ratios (which are ratios of flow variables), the inside debt ratio is a ratio of stock variables.

associated with a higher LD. The coefficient for the equity ratio (controlling for total pay) is negative, whereas the coefficient for the option ratio is negative but not statistically significant. Similarly, a higher inside debt ratio (controlling for total pay) is negatively related to LD. . In Panel A of Table 11 we report the results of estimating a linear probability model with failure as dependent variable and the pay level and structure measures as explanatory variables. Total pay is associated with a higher probability of failure, with a positive coefficient that is both large and highly statistically significant. However, the coefficients of the equity and option ratios are negative and not statistically significant at conventional significance levels (or marginally, as in the case of the equity ratio when all compensation measures are included simultaneously). Tables 10 and 11 thus show that whereas pay levels are associated with bank risk, the relation between compensation structure and risk is weak at best. Moreover, if anything, a greater weight of equity or of stock options is associated with a lower probability of failure.

The results in this section, together with the results concerning termination payments discussed in Section 5, suggest that risk taking incentives at a point in time are stronger for CEOs with higher pay, but are not strongly associated with any particular compensation vehicle or compensation structure. Moreover, we only find some evidence of a positive relation between pay level and risk. Therefore, our results suggest that limiting the use of certain compensation vehicles may not be a fruitful way of controlling bank CEOs' incentives.

8 Robustness checks

8.1 Alternative measure of risk taking incentives

We propose LD as a simple measure of the risk taking incentives implicit in CEOs' holdings of equity and stock options. Chesney et al. (2012) propose an alternative measure of CEO risk taking incentives that also incorporates the risk taking incentives implied by CEOs' stock holdings (for an alternative measure, see Anderson and Core, 2013). Chesney et al. (2012) propose a stylized structural model of equity as a call option on the firm's assets (as in Black and Scholes (1973) and Merton (1973)) and derive the value of stock and stock options and their derivatives with respect to firm volatility in closed form. In the baseline case in which the CEO holds n_O identical options, their measure of risk taking incentives (Asset Volatility Vega or AVV) is defined as:

$$AVV = n_O \frac{dO}{d\sigma_v} 0.01 + n_S \frac{dS}{d\sigma_v} 0.01, \qquad (5)$$

where O is the value of the option and S is the stock price (as a call on firm value), and the derivatives are taken with respect to the volatility of firm value, σ_v.

To check the robustness of our results to the use of an alternative measure of risk taking incentives that also takes into account the risk taking incentives of equity, we compute AVV for all firms in the sample in year 2006, following Chesney et al. (2012). (We briefly describe the methodology in Appendix A, but refer to the article by Chesney et al. (2012) for the details.)

In Panel A of Table 12, we report the correlation of AVV with LD, Delta, and OV. Two results are especially noteworthy. The first one is the very strong correlation between LD and AVV. Despite their very different definitions, in our sample, most of the action in AVV is captured by our simple measure LD. At the same time, AVV has a low correlation with option vega, similar to the one between LD and option vega. Therefore AVV and LD, on the one hand, and vega, on the other hand, are measuring different things.

In Panel B of Table 12, we replicate the main multivariate specifications reported in Table 6, with AVV replacing LD as the measure of risk taking incentives. The results are very similar both in terms of magnitude (for example, a one standard deviation—10.38—increase in AVV would increase the probability of failure by 0.11) and statistical significance. Therefore, either measured by means of LD or AVV, CEOs' risk taking incentives are associated with a higher probability of failure during the crisis.

The structural model employed by Chesney et al. (2012) to measure AVV suggests as well an alternative measure of shareholders' incentives to take on risk. This measure, which we label Shareholder Risk Shifting Incentives ($SRSI$), is simply the return on the firm's stock associated with a 0.01 increase in the standard deviation of asset returns:

$$SRSI = \frac{1}{S}\frac{dS}{d\sigma_v}0.01. \tag{6}$$

8.2 Alternative risk measures

For the reasons discussed in Section 2, we argue for using bank failure during the crisis—an ex post measure—as the measure of risk taking prior to the crisis. Since our measure is different from those used in prior research, in this section we study the relation between bank failure during the crisis and alternative risk measures and the robustness of our results to the use of these alternative measures.

We consider as alternative risk measures, the volatility of stock returns and the market beta of the firm's stock (as in Cheng et al., 2013, and the buy-and-hold returns of the firm's stock in the period (as in Fahlenbrach and Stulz, 2011). [37]

[37] We estimate volatility as ... We choose the period XXX to evaluate buy-and-hold returns to ensure comparability with the results by Fahlenbrach and Stulz (2011).XXX

We first check whether higher levels of volatility or beta computed prior to the crisis are associated with the incidence of bank failure. As Table 14 shows, there is no significant difference in volatility or beta prior to the crisis between banks that would fail during the crisis and those that would survive. In unreported regressions, we also estimate univariate linear probability and probit models of the probability of failure with these risk measures (computed prior to the crisis) as the explanatory variable and find that they contribute very little to explaining failure during the crisis. We also consider the possibility that changes in these variables in the run-up to the crisis may be associated with failure. As we report in Table 14, changes in the risk measures prior to the crisis explain very little of the variation in bank failure. Therefore, our results indicate that ex ante measures of volatility or beta capture little of the exposure to the kind of bank risk that realized during the crisis and that led to the failure of a significant fraction of the financial institutions in our sample.

However, when measured during the crisis period, all risk measures are strongly associated with bank failure. Banks that eventually fail have significantly lower buy-and-hold returns in the period from July 1st, 2007 to December 31st, 2008. Not surprisingly, given the strong correlation between buy-and-hold returns, volatility, and beta, the latter two measures are also strongly correlated with failure. This strong correlation between failure and the alternative risk measures is reassuring in that if bank failure were orthogonal to these risk measures, one would be justified in questioning the ability of failure to capture bank risk. At the same time, failure is not identical with any of the alternative risk measures, so we check whether the relation between incentives and risk is robust to the use of alternative ex post measures of risk. As we show in Table 14, the signs and statistical significance of the coefficients are the same for all risk measures. Therefore, the difference between our results and those of prior studies (such as those by Fahlenbrach and Stulz, 2011, who use buy-and-hold returns, or Cheng et al., 2013, who use volatility and beta) is due to the different measure of risk taking incentives and not to the measure of bank risk.

8.3 Sample selection

The diversity of activities carried out by large financial institutions makes it difficult to determine unambiguous sample selection criteria. For this reason and for the sake of comparability, we also conduct our analysis for the sample of financial institutions used by Fahlenbrach and Stulz (2011). Fahlenbrach and Stulz (2011)'s sample contains only 98 firms and is not a proper subset of our sample. For example, Fahlenbrach and Stulz (2011) include—and we do not—federal credit agencies, such as Fannie Mae. As Column 1 in Table 15 shows, the results are largely unchanged if we use this alternative sample of financial institutions. The only difference is that, whereas in our sample the coefficient for delta is not statistically significant, it becomes statistically significant for the Fahlenbrach and Stulz (2011)'s sample, in line with their results.

8.4 Failed institutions

Some of the steps of the procedure that we use to identify firms as failed require the use of some judgement and soft information. In particular, as we discuss in Section 2, we consider as failed two firms (Mellon Financial and Countrywide Financial) that were acquired during the crisis but that cannot be said to clearly meet our merger discount requirements. We also consider as failed three firms (Merrill Lynch, National City Corp and Provident Bankshares) on the basis of information obtained from the media. Column 2 in Table 15 shows that results are largely unchanged if we consider that none of these five firms fail during the crisis. In unreported results, we also consider each of the two groups separately, and the results are identical.

8.5 Investment banks

Our sample contains three primary dealers (Bear Sterns, Goldman Sachs and Merrill Lynch) that supervisors do not identify as a regulated institution, but that we include because of their systemic importance. Moreover, our sample also contains the two other large investment banks, Lehman Brothers and Morgan Stanley, which the National Information Center of the FFIEC identifies as regulated institutions. To investigate whether our results are driven by the inclusion of the five large investment banks, we estimate the baseline regressions excluding them from the sample. As column 4 in Table 15 shows, the coefficients for the incentive variables remain highly statistically significant and increase in magnitude, because, as we explain below, some of the investment banks have very large values of the incentive variables. In unreported results, we observe that the results are similar if we exclude only the investment banks not identified as regulated institutions. Including a dummy for the investment banks (rather than excluding them from the sample) does not change the results relative to our baseline specification.

8.6 Too big to fail institutions

We identify as failed those firms that either close or are acquired with the intervention of regulators. However, some financial institutions may be too large for regulators to either allow them to fall or be able to find a suitable acquirer. These financial institutions may thus not be part of our list of failed institutions, even if they took on large risks ex ante and experienced strongly negative outcomes as a result of those risks. This possibility may bias our estimates towards zero if the risk taking incentives of too-big-to-fail (or be acquired) institutions are strong and these firms took on large risks. On the other hand, it may lead us to overestimate the relation between risk taking incentives and bank risk if, for example, large banks take on large risks yet opt for compensation arrangements with low values of LD.

We take two approaches to evaluate the potential biases generated by too-big-to-fail institutions. First, following Fahlenbrach et al. (2012), we consider Citigroup and Bank of America as failed, given the massive amount of aid they received from the government. As column 3 of Table 15 shows, considering these banks as failed does not alter our results. Second, we identify the banks in the sample that could be considered both too-big-to-fail and "too-big-to-be-acquired," banks, which we label TBTBA. There is obviously no official list of TBTBA firms, so we consider the robustness of our results to different definitions. Our first definitions take as TBTBA those firms larger than the largest failed institution in our sample (with size measured either as market capitalization or total assets in 2006).[38] The other two definitions use the Financial Stability Board's lists of systemically important financial institutions (created in 2011) and global systemically important banks (created in 2012). Our first definition defines as TBTBA all the U.S. institutions on the 2011 list. The 2012 list divides the systemically important financial institutions into five buckets, according to their level of systemic importance, with bucket five (one) containing the institutions with the greatest (smallest) systemic importance. Our second definition defines as TBTBA only those firms on the 2011 list that are in buckets two to five (the ones with the greatest systemic importance) of the 2012 list.[39] To evaluate the potential biases introduced by TBTBA institutions, we include a dummy variable for these firms in our regressions and run the regressions excluding the TBTBA firms from the sample. For the sake of brevity, we only report in columns 5-6 of Table 15 the results obtained when we exclude TBTBA banks, defined in terms of market capitalization or according to the 2011 list of systemically important institutions, from the sample. The results, which are essentially identical for the other definitions or when we include dummies instead of excluding banks from the sample, show that our results are not biased by the presence of TBTBA institutions.

8.7 Extreme values and specification

A possible concern about our results, especially given the small size of our sample, is that they may be influenced by the presence of firms with extreme values of the incentive measures. In fact, some firms, such as Bear Sterns, have very large values of LD. The presence of firms with very large values of the incentive measure in the group of failed banks may lead to a positive estimated coefficient even if there is no positive

[38] If size is measured by total assets, the largest failed institution is Merrill Lynch and the TBTBA institutions are Morgan Stanley, JPMorgan Chase, Bank of America and Citigroup. If size is measured by market capitalization in 2006, the largest failed institution is Wachovia and the TBTBA institutions are Wells Fargo, JPMorgan Chase, Bank of America and Citigroup.

[39] The 2011 and 2012 lists contain the same eight U.S. financial institutions: Bank of America, Bank of New York Mellon, Citigroup, Goldman Sachs, JPMorgan Chase, Morgan Stanley, State Street, and Wells Fargo. Buckets two to five contain all these banks except for State Street and Wells Fargo. Further restricting the list to buckets three to five would leave only Citigroup and and JPMorgan Chase as TBTBA. The list can be accessed at the Financial Stability Board's website: `https://www.financialstabilityboard.org/list/fsb_pa/tid_174/index.htm`.

relationship between the incentive measure and failure. However, since the dependent variable lies between zero and one, the presence of banks with very large values of the incentive measures among the banks with a value of one for the dependent variable may have the opposite effect of biasing the estimated coefficient towards zero. To check the robustness of our results to the presence of firms with very high values of the incentive measures, we winsorize them at the 2% level and re-estimate the baseline univariate regression. As column 1 of Panel B in Table 15 shows, the estimated coefficient remains statistically significant and is of similar magnitude. .

A related concern is that our linear specification (given by expression 4) is necessarily misspecified, since the dependent variable is bounded between zero and one. Although this misspecification may not be severe in some cases, it may create substantial bias if, as it is the case with LD, the explanatory variable of interest has a skewed distribution. . Therefore, we also consider the robustness of our results to different specifications that are nonlinear in LD. The first specification is a simple log linear model, in which we replace LD and delta by the natural logarithm of one plus the corresponding variable (we add one because of the presence of firms with zero or close to zero values of the incentive measures). This specification allows for a concave relation between the incentive measures and the probability of failure and, at the same time, can be estimated by OLS. The estimated coefficients, which we report in Column 2 of Panel B in Table 15, are highly statistically significant . In columns 3 and 4 of Panel B in Table 15 we also report estimated marginal effects (evaluated at the sample means of the explanatory variables) of probit and logit models.

9 Conclusion

In this paper, we analyze the relation between the risk taking incentives created by executive compensation and bank risk and study both the potential determinants of those incentives and whether they are associated with the use of certain compensation vehicles (such as stock options or termination incentives).

To measure bank risk taking in the period prior to the 2007-2010 financial crisis we identify those banks that failed during the crisis. Because of the potential for government intervention to facilitate the acquisition of distressed banks by sounder financial institutions, we propose a definition of bank failure that identifies as failed not only those financial institutions that went bankrupt or were forced into receivership but also those that were acquired by others with the assistance or intervention of supervisors or the government. This ex post measure of bank risk aims to, on the one hand, sidestep the limitations of standard ex ante risk measures (which may not have been that informative about the actual risks taken by banks in the run-up to the crisis) and, on the other hand, measure the full risk borne by banks and not only the part borne by bank shareholders.

Since financial institutions are highly levered, we propose a reduced form measure of the risk taking incentives generated by CEO compensation, Levered Delta (LD), which incorporates the incentives generated by the option-like nature of equity in levered institutions. We define LD as the product of leverage and the sensitivity of the CEO's wealth to changes in the firm's stock price (Delta).

For our sample of large U.S. financial institutions, we show that the risk taking incentives implied by LD are associated with higher probability of failure during the financial crisis. We propose and investigate different potential explanations for these results and interpret our results as supporting two alternative explanations for the positive relationship between our measures of risk taking incentives and bank failure. The first explanation is that these incentives did have an impact on banks' risk choices prior to the crisis. The second explanation is that inherently riskier banks found it optimal to compensate their CEOs in ways that lead to high values of our incentive measures, even if either CEOs did not have the ability to determine bank risk or their choices were motivated by other incentives or constraints. However, to our knowledge, there is no theory of the optimal compensation of bank executives that would yield this prediction.

We show that standard measures of governance quality, such as the Governance Index, the Entrenchment Index, board size, or board independence, do not help explain bank failure or the level of risk taking incentives. In stark contrast, CEOs' risk taking incentives are strongly correlated with shareholders' incentives to shift risk to debtholders, as measured by lagged leveraged. These results suggest that either compensation incentives are designed to align CEOs' incentives with those of shareholders or, at least, that compensation policies are not set so as to counteract the risk taking incentives embedded in banks' equity. In fact, in contrast to the theoretical predictions of John and John (1993) that more levered firms would structure CEO compensation so as to limit CEOs' incentives to take on risk, we find the CEOs' pay-performance sensitivity to be largely unrelated to bank leverage (which implies stronger risk taking incentives for the CEOs of more levered banks) and little evidence that more levered banks structured their CEOs' compensation so as to reduce risk taking incentives. We interpret our results as implying that, as opposed to the shareholders in John and John (1993)'s model, bank shareholders may not internalize (through higher interest rates or limited debt funding) the costs that risk shifting impose to debtholders.

Unexpectedly, we find no relationship between the weight of options in CEO compensation or the fraction of CEO pay in the form of stock or options and either bank failure or CEO risk taking incentives. We find also that there is at most a weak relation between termination payments (severance pay or golden parachutes) and bank failure. Therefore, we find that there is no particular compensation vehicle responsible for bank CEOs' incentives to take on risk.

Our results have several implications for bank supervision and regulation. First, our results are consistent with compensation being a significant source of risk taking incentives for bank executives and, therefore, suggest that some form of incentive regulation could modulate those incentives. However, we cannot make any strong policy recommendation because because of the lack of an exogenous source of variation in incentives does not allow us to identify the causal effect of compensation incentives on bank risk. Regarding the potential form that incentive regulation may take, our results suggest that it may be unwise to regulate bank CEOs' risk taking incentives by means of limits to particular forms of compensation. Defining and monitoring actual measures of risk taking incentives may be a more useful form of incentive supervision. Similarly, we find no support for the proposition that improving bank governance by, say, limiting managerial entrenchment or increasing board independence, would have a significant effect on risk taking incentives or bank risk. However, our results are silent regarding some governance failures specific to banks, which have also received attention from regulators, such as the financial background of directors, the quality of the risk management systems, or the relevance in the organization of the executives in charge of risk management. We should emphasize as well that even if we provide evidence that is consistent with an important role for compensation incentives in determining bank risk taking prior to the financial crisis, our results alone do not prove that those incentives or bank risk itself were excessive.

The limitations of our analysis point at several promising avenues for future research. On the theory side, our results suggest that it may be useful to derive the optimal compensation contract for bank CEOs under different assumptions of the roles played by bank executives, boards of directors, and shareholder in determining and monitoring compensation decisions and risk choices. The implications of these models could then be taken to the data to shed light on the actual mechanism that links compensation and bank risk. The very different results obtained with option vega and levered delta also suggest that more attention should be paid to deriving better measures of risk taking incentives. On the empirical side, finding credible sources of exogenous variation in incentives remains the main challenge to be addressed to be able to confidently propose policy recommendations regarding the compensation of bank executives.

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Table 2: Firm characteristics: summary statistics. SD denotes standard deviation and p10, p50, and p90 the percentiles 10, 50, and 90, respectively. *Market Cap.* is the firm's market capitalization computed as total common equity multiplied by the price of the stock at the close of the calendar year. *Total Assets* is the book value of the total assets of the firm. Market Cap. and Total Assets are measured in billions of dollars. *Leverage* is the quasi-market value of leverage, computed as book value of assets minus book value of equity plus market value of equity, divided by the market value of equity. *ROA* is the ratio of operating income before depreciation over total assets at the end of the previous year. All variables are measured in 2006. *Panel A* displays summary statistics for our sample. *Panel B* displays summary statistics for the entire population of firms available in Compustat for year 2006 with SIC codes between 6000 and 6050. The number of firms in the sample is 125.

Panel A. Firms in the sample

	Mean	SD	p10	p50	p90
Market_Cap	15.73	39.57	0.62	2.04	31.49
Total_Assets	103.85	284.27	2.85	11.52	199.95
Leverage	6.36	2.85	3.93	5.64	9.33
ROA	0.03	0.01	0.02	0.03	0.05

Panel B. Compustat population (SIC codes 6000–6050)

	Count	Mean	SD	p10	p50	p90
Market Cap.	747	4.40	18.92	0.04	0.17	4.50
Total Assets	778	41.37	203.17	0.28	1.01	20.86
Leverage	746	7.28	3.19	4.31	6.52	10.97
ROA	759	0.02	0.03	0.01	0.02	0.04

Table 3: Incentive measures in year 2006: summary statistics. *LD* is the product of *Leverage* and *Delta*, where *Leverage* is the quasi-market value of leverage, as defined in Table 2, and *Delta* is the change in the value of the CEO's portfolio of stock and options (measured in $ million) associated with a 1% change in the price of the stock of the firm. OV is the change in the value of the CEO's option portfolio (measured in $ million) associated with a change of 0.01 in the standard deviation of the price of the stock. All variables are measured in 2006. *Panel A* contains summary statistics. *Panel B* contains correlation coefficients. *Panel C* contains the means and medians of the incentive variables for the subsamples of failed and surviving institutions. Asterisks in the mean and median columns of the group of failed institutions represent statistically significant differences according to the t-test of means and the rank-sum test for differences in medians, respectively. *, ** and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively. The number of firms in the sample is 125.

Panel A. Incentive measures

	Mean	**SD**	**p10**	**p50**	**p90**
LD	8.89	22.29	0.23	2.02	22.09
OV	0.32	0.55	0.00	0.08	0.90
Delta	1.34	4.24	0.04	0.37	2.97

Panel B. Pairwise correlations between incentive measures

	LD	OV	Delta
LD	1		
OV	0.2575	1	
Delta	0.7175	0.2329	1

Panel C. Differences in means and medians between failed and surviving banks

	Surviving		Failed	
	Mean	Median	Mean	Median
LD	6.34	1.72	23.06***	9.36*
OV	0.30	0.07	0.46	0.15
Delta	1.23	0.30	2.00	1.03*
N	106		19	

Table 4: Risk taking incentives and bank failure: univariate regressions. The table presents estimated coefficients of different specifications of a linear probability model with *Failed* as the dependent variable. *Failed* is a dummy variable equal to 1 if the firm fails in in the period from 2007 to 2010. *LD* is the product of *Leverage* and *Delta*, where *Leverage* is the quasi-market value of leverage as defined in Table 2, and *Delta* is the change in the value of the CEO's equity portfolio (measured in $ million) associated with a 1% change in the price of the stock of the firm. *OV* is the change in the value of the CEO's portfolio of options (measured in $ million) associated with a change of 0.01 in the standard deviation of the stock price. *LD, OV*, and *Delta* are measured in year 2006. *, ** and *** represent significance levels at 10%, 5%, and 1%, respectively. The number of observations is 125. Robust standard errors in parentheses.

	(1)	(2)	(3)	(4)	(5)
LD	0.004***			0.007***	
	(0.002)			(0.002)	
OV		0.065			0.059
		(0.067)			(0.069)
Delta			0.006	−0.023***	0.004
			(0.009)	(0.005)	(0.008)
N	125	127	125	125	125
R^2	0.073	0.011	0.004	0.107	0.012

Table 5: Alternative explanations: summary statistics of relevant variables in year 2006. *Total pay* is the total compensation received by the CEO. It comprises salary, bonus, other annual payments, restricted stock grants, long term incentive plan (LTIP) payouts, other compensation, and the value of option grants. *CEO age* denotes the CEO's age in years. *G. Parachute* and *Severance Pay* are the contingent payments upon termination with and without a change in control, respectively, as in year 2006's proxy statements. *Non-firm wealth* is the non-firm wealth of the CEO, as defined by Dittmann and Maug (2007). *Inside debt* is the sum of the total pension and defered balance of the CEO at the end of 2006. *Firm size (2003)* is the log of total assets. *Return avg.* is the average annual stock return in the period 2002-2006. *Leverage* is the quasi-market value of leverage computed as book value of assets minus book value of equity plus market value of equity, divided by market value of equity. *ROA* is the ratio of operating income before depreciation over total assets at the end of the previous year. All compensation variables are measured in millions of dollars. All variables are measured in 2006.

	Count	**Mean**	**SD**	**p10**	**p50**	**p90**
Total Pay	125	6.89	10.37	0.66	2.20	20.37
CEO Age	128	57.51	6.66	49.00	58.00	65.00
InsideDebt	118	8.69	15.50	0.00	3.40	26.96
Severance Pay	119	6.27	13.23	0.00	0.63	18.40
G. Parachute	119	12.31	19.74	0.00	4.88	39.22
Firm Size (03)	128	9.45	1.68	7.65	9.14	12.07
Non-Firm Wealth	125	29.45	98.49	0.45	5.17	64.72
Leverage	128	6.36	2.85	3.93	5.64	9.33
ROA	129	0.03	0.01	0.02	0.03	0.05
Return avg.	121	0.11	0.10	0.02	0.10	0.23

Table 6: Risk taking incentives and bank failure: multivariate results. The table presents estimated coefficients of different specifications of a linear probability model with *Failed* as the dependent variable. *Failed* is a dummy variable equal to 1 if the firm fails in in the period from 2007 to 2010. *LD* is the product of *Leverage* and *Delta*, where *Leverage* is the quasi-market value of leverage as defined in Table 2, and *Delta* is the change in the value of the CEO's equity portfolio (measured in $ million) associated with a 1% change in the price of the firm's stock. *Leverage sqrd.* is leverage squared. All other variables are as defined in Table 5. All variables are measured in year 2006.

Panel A. Firm characteristics, CEO characteristics, and other incentives

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
LD	0.007***	0.005***	0.007***	0.032***	0.007***	0.033***	0.033***	0.032***
	(0.002)	(0.002)	(0.002)	(0.008)	(0.002)	(0.008)	(0.008)	(0.008)
Delta	−0.022***	−0.019***	−0.022***	−0.093***	−0.021***	−0.096***	−0.094***	−0.094***
	(0.005)	(0.005)	(0.005)	(0.023)	(0.006)	(0.022)	(0.022)	(0.022)
Firm_Size_03	0.011		0.011	−0.019	0.017	−0.025	−0.024	−0.025
	(0.021)		(0.021)	(0.026)	(0.023)	(0.022)	(0.024)	(0.023)
Total_Pay		0.006						
		(0.005)						
CEO_Age			−0.004					−0.003
			(0.005)					(0.005)
Inside_Debt				−0.001				
				(0.002)				
Non_Firm_Wealth					−0.000			
					(0.000)			
Severance_Pay						0.001		0.001
						(0.003)		(0.003)
G_Parachute							0.000	
							(0.002)	
N	125	123	125	117	123	118	118	118
R^2	0.109	0.124	0.115	0.164	0.113	0.166	0.165	0.168

Panel B. Risk and pre-crisis performance

	(1)	(2)	(3)
LD	0.006***	0.007***	0.007***
	(0.002)	(0.002)	(0.002)
Delta	−0.012**	−0.022***	−0.022***
	(0.006)	(0.004)	(0.005)
Firm_Size_03	−0.004	0.005	0.015
	(0.022)	(0.021)	(0.023)
Leverage	0.113**		
	(0.049)		
Leverage_sqrd.	−0.005**		
	(0.002)		
ROA_avg		4.625	
		(3.742)	
Return avg.			0.152
			(0.314)
N	125	125	121
R^2	0.174	0.128	0.112

Table 7: Governance variables in year 2006: summary statistics. *G-index* is the *Governance Index* defined by Gompers et al (2003). *E-index* is the entrenchment index as defined by Bebchuck et al. (2009). *Board size* is the number of members of the board of directors. *Independence* is the number of independent directors divided by board size. All variables are measured in year 2006.

	Count	Mean	S.d.	p10	median	p90
GIM	106	9.98	2.79	7.00	10.00	13.00
Eindex	106	2.93	1.32	1.00	3.00	4.00
Independence	124	0.72	0.13	0.55	0.75	0.87
Board_Size	124	12.50	3.11	9.00	12.00	17.00

Table 8: Governance, risk taking incentives, and bank failure. *Panel A* displays estimated coefficients of different specifications of a linear probability model with *Failed* as the dependent variable. *Failed* is a dummy variable equal to 1 if the firm fails in in the period from 2007 to 2010. *LD* is the product of *Leverage* and *Delta*, where *Leverage* is the quasi-market value of leverage as defined in Table 2, and *Delta* is the change in the value of the CEO's equity portfolio (measured in $ million) associated with a 1% change in the price of the stock of the firm. *G-index* is the *Governance Index* defined by Gompers et al (2003). *E-index* is the entrenchment index as defined by Bebchuck et al. (2009). *Board size* is the number of members of the board of directors. *Independence* is the number of independent directors divided by board size. All variables are measured in year 2006, except *Firm size (2003)*, which is the natural logarithm of total assets as of year 2003. *Panel B* displays estimated coefficients of different specifications of a linear probability model with *LD* as the dependent variable. *, ** and *** represent significance levels at 10%, 5%, and 1%, respectively. Robust standard errors in parentheses.

Panel A. Governance, risk taking incentives, and bank failure

	(1)	(2)	(3)	(4)	(5)
LD	0.007***	0.007***	0.007***	0.007***	0.007***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Delta	−0.023***	−0.022***	−0.023***	−0.022***	−0.024***
	(0.005)	(0.005)	(0.006)	(0.004)	(0.006)
Firm_Size_03	0.015	0.012	0.017	0.023	0.019
	(0.025)	(0.027)	(0.021)	(0.021)	(0.025)
GIM	0.010				0.011
	(0.011)				(0.011)
Eindex		−0.013			
		(0.026)			
Independence			0.065		0.141
			(0.264)		(0.321)
Board_Size				−0.011	−0.009
				(0.011)	(0.012)
N	105	105	121	121	104
R^2	0.126	0.122	0.121	0.129	0.133

Panel B. Governance and risk taking incentives

	(1)	(2)	(3)	(4)	(5)	(6)
Firm_Size_03	6.406***	5.737***	5.797***	6.394***	7.139***	4.475***
	(1.781)	(1.358)	(1.487)	(1.662)	(1.853)	(1.325)
GIM	−0.286				−0.366	0.298
	(0.470)				(0.586)	(0.414)
Eindex		−3.119				
		(2.495)				
Independence			−24.236		−34.496	−10.357
			(34.426)		(41.261)	(14.978)
Board_Size				−1.333***	−1.556***	−0.875*
				(0.387)	(0.480)	(0.460)
Leverage_03						4.324**
						(2.006)
N	105	105	121	121	104	103
R^2	0.187	0.213	0.210	0.225	0.254	0.462

Table 9: Shareholder risk taking incentives and CEO risk taking incentives. The table shows results from regressions in which the dependent variable is the variable indicated in the column heading and the explanatory variables are *Firm size (2003)*, which is the natural logarithm of total assets as of year 2003, and *Leverage (2003)*, which is the quasi-market value of leverage as of year 2003. *LD* is the product of *Leverage* and *Delta*, where *Delta* is the change in the value of the CEO's equity portfolio (measured in $ million) associated with a 1% change in the price of the stock of the firm. Δ_S is the delta from stock holdings, and Δ_O the delta from option holdings, as defined in equation (2). $\Delta_\$$ is the change in the value of the CEO's equity portfolio (measured in $ million) associated with a $1,000 change in the firm's market capitalization. All dependent variables are measured in year 2006. *, ** and *** represent significance levels at 10%, 5%, and 1%, respectively. Robust standard errors in parentheses.

	LD	Delta	Delta_S	Delta_O	Delta_Dollar	Failed
Firm_Size_03	3.661***	0.703***	39.460	0.643***	−5.356**	0.014
	(1.037)	(0.255)	(25.032)	(0.235)	(2.143)	(0.020)
Leverage_03	4.329**	0.021	5.438	0.012	0.839	0.045***
	(2.015)	(0.221)	(21.068)	(0.203)	(1.102)	(0.011)
N	124	124	123	122	124	127
R^2	0.438	0.080	0.031	0.078	0.032	0.128

Table 10: Compensation policies: summary statistics. *Total pay* is the total compensation received by the CEO. It comprises salary, bonus, other annual payments, restricted stock grants, long term incentive plan (LTIP) payouts, other compensation, and the value of option grants. *Equity ratio* is the fraction of a CEO's annual total pay that is granted in the form of equity pay (options and stock). *Option ratio* is the value of all stock option grants awarded in a year divided by total equity pay (options and stock) in that same year. *Inside debt ratio* is the ratio of total Inside Debt (the sum of pension and defer balance of the CEO) divided by total equity holdings (stock and option). Inside debt is measured in year 2006. For all other variables, we compute the average of the variable in the period 2003-2006. To compute the average of a variable, we require that there be at least three years of data for that variable in the period 2003–2006. SD denotes standard deviation and p10, p50, and p90 the percentiles 10, 50, and 90, respectively.

Panel A. Incidence of stock and stock option compensation

	Total	**Stock Pay**	**Option Pay**
Number of firms	88	88	80

Panel B. Summary statistics

	Count	Mean	S.d.	p10	median	p90	% with 0
Total_Pay_avg	88	6.69	9.02	0.95	2.78	22.32	0
Equity_ratio_avg	88	0.39	0.22	0.11	0.42	0.66	3
Option_ratio_avg	88	0.52	0.28	0.11	0.51	0.96	6
Inside_Debt_ratio	116	0.29	0.39	0.00	0.16	0.68	12

Table 11: Compensation policies, risk taking incentives, and failure. *Panel A* contains the results of multivariate regressions where the dependent variable is *LD* in year 2006. *LD* is the product of *Leverage* and *Delta*, where *Leverage* is the quasi-market value of leverage as defined in Table 2, and *Delta* is the change in the value of the CEO's equity portfolio (measured in $ million) associated with a 1% change in the price of the firm's stock. *Panel B* contains estimated coefficients of a linear probability model with *Failed* as dependent variable. *Equity ratio (avg)* and *Option ratio (avg)* are the averages for each firm over the period 2003–2006 of *Equity ratio* and *Option ratio*, respectively. To compute the average of each of these two variables, we require that there be at least three years of data for that variable in the period 2003–2006. *Inside debt ratio* is *Inside debt ratio* is the ratio of total Inside Debt (the sum of pension and defer balance of the CEO) divided by total equity holdings (stock and option) and is measured in 2006. *Firm size (2003)* is the natural logarithm of total assets as of year 2003. *, **, and *** represent significance levels at 10%, 5%, and 1%, respectively. Robust standard errors in parentheses.

Panel A: Compensation policies and failure

	(1)	(2)	(3)	(4)	(5)
Firm_Size_03	−3.210	5.727*	6.036***	−2.940	
	(2.782)	(2.925)	(1.988)	(2.130)	
Total_Pay_avg	2.189**			2.199**	1.859**
	(0.958)			(1.005)	(0.795)
Equity_ratio_avg		3.995		−3.881	−10.586
		(14.555)		(14.086)	(17.377)
Option_ratio_avg			−4.796	−2.030	−1.084
			(7.909)	(6.307)	(6.103)
N	86	86	86	86	86
R^2	0.488	0.202	0.204	0.490	0.475

Panel B. Compensation policies and leverage.

	(1) Total_Pay_avg	(2) Equity_ratio_avg	(3) Option_ratio_avg	(4) Inside_Debt_ratio	(5) G_Parachute	(6) Severance_Pay
Firm_Size_03	3.848***	0.091***	0.004	−0.241	5.667***	3.042**
	(0.397)	(0.012)	(0.020)	(0.236)	(1.633)	(1.198)
Leverage_03	0.692***	−0.012**	−0.018**	0.111	−0.757	−0.120
	(0.223)	(0.005)	(0.007)	(0.119)	(1.351)	(1.101)
N	88	88	88	115	118	118
R^2	0.670	0.430	0.033	0.006	0.202	0.134

Panel C: Compensation policies and risk taking incentives

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Firm_Size_03	−0.031	0.092**	0.046*	0.026	0.025	0.026	0.015	
	(0.035)	(0.039)	(0.027)	(0.022)	(0.024)	(0.024)	(0.045)	
Total_Pay_avg	0.019***						0.019**	0.021***
	(0.007)						(0.008)	(0.007)
Equity_ratio_avg		−0.525**					−0.545**	−0.512**
		(0.250)					(0.265)	(0.234)
Option_ratio_avg			−0.195				−0.107	−0.113
			(0.163)				(0.167)	(0.169)
Inside_Debt_ratio				−0.002**			−0.004**	−0.004**
				(0.001)			(0.002)	(0.002)
G_Parachute					0.000		−0.002	−0.002
					(0.002)		(0.002)	(0.002)
Severance_Pay						0.000		
						(0.003)		
N	88	88	88	116	119	119	80	80
R^2	0.113	0.097	0.063	0.015	0.016	0.016	0.139	0.137

Table 12: Risk taking incentives and bank failure: alternative measure of risk taking incentives. The table replicates Table 6 with *AVV* (Asset Volatility Vega) as the measure of risk taking incentives. *AVV* is the change in the value of the CEOs portfolio of stocks and options associated with a 0.01 change in the standard deviation of the value of the assets of the rm. The table presents estimated coefficients of different specifications of a linear probability model with *Failed* as the dependent variable. Failed is a dummy variable equal to 1 if the firm fails in in the period from 2007 to 2010. *Delta* is the change in the value of the CEO's equity portfolio (measured in $ million) associated with a 1% change in the price of the stock of the firm. *Leverage sqrd.* is leverage squared. All other variables are as defined in Table 5. All variables are measured in year 2006.

Panel A. Correlation table

	AVV	LD	Delta	OV
AVV	1			
LD	0.8472	1		
Delta	0.2499	0.7175	1	
OV	0.1604	0.2575	0.2329	1

Panel B. Multivariate results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
AVV	0.010***	0.008***	0.011***	0.061***	0.010***	0.061***	0.061***	0.060***
	(0.003)	(0.003)	(0.003)	(0.020)	(0.003)	(0.020)	(0.020)	(0.020)
Delta	−0.003	−0.004*	−0.001	−0.004	−0.001	−0.005	−0.003	−0.005
	(0.002)	(0.002)	(0.002)	(0.003)	(0.005)	(0.006)	(0.003)	(0.005)
Firm_Size_03	0.016		0.016	−0.014	0.022	−0.016	−0.014	−0.016
	(0.021)		(0.021)	(0.026)	(0.022)	(0.022)	(0.024)	(0.022)
Total_Pay		0.006						
		(0.005)						
CEO_Age			−0.004					−0.002
			(0.005)					(0.005)
Inside_Debt				0.000				
				(0.002)				
Non_Firm_Wealth					−0.000			
					(0.000)			
Severance_Pay						0.001		0.001
						(0.003)		(0.003)
G_Parachute							−0.000	
							(0.002)	
N	125	123	125	117	123	118	118	118
R^2	0.104	0.123	0.110	0.161	0.107	0.163	0.162	0.164

Table 13: Shareholder risk taking incentives and CEO risk taking incentives: alternative measure of shareholder risk shifting incentives. The table replicates Table 9 with *SRSI* replacing leverage as the measure of shareholders' risk shifting incentives. *SRSI* is the return on the firm's stock associated with a 0.01 increase in the standard deviation of asset returns. The table shows results from regressions in which the dependent variable is the variable indicated in the column heading and the explanatory variables are *Firm size (2003)*, which is the natural logarithm of total assets as of year 2003, and *Leverage (2003)*, which is the quasi-market value of leverage as of year 2003. *LD* is the product of *Leverage* and *Delta*, where *Delta* is the change in the value of the CEO's equity portfolio (measured in \$ million) associated with a 1% change in the price of the stock of the firm. Δ_S is the delta from stock holdings, and Δ_O the delta from option holdings, as defined in equation (2). $\Delta_\$$ is the change in the value of the CEO's equity portfolio (measured in \$ million) associated with a \$1,000 change in the firm's market capitalization. All dependent variables are measured in year 2006. *, ** and *** represent significance levels at 10%, 5%, and 1%, respectively. Robust standard errors in parentheses.

	(1)	(2)	(3)	(4)	(5)	(6)
Firm_Size_03	3.657***	0.689***	37.841*	0.631***	−5.018**	0.009
	(1.090)	(0.232)	(22.544)	(0.215)	(2.202)	(0.023)
SRSI_03	523.575**	10.526	1255.001	8.810	163.856	5.757***
	(206.977)	(18.545)	(1768.387)	(16.967)	(111.037)	(1.392)
N	101	101	100	99	101	104
R^2	0.485	0.076	0.032	0.073	0.036	0.178

Table 14: Alternative measures of bank risk. *Volatility (2003-2006)* and *Volatility (2007-2008)* are the standard deviation of daily returns for firms with at least 60 days of trading, *Beta (2003-2006)* and *Beta (2007-2008)* are the firm's market beta using for the market return the CRSP value-weighted index return including dividend. *BHR (2007-2008)* are the buy and hold returns from 08/01/07 to 12/31/08 following Fahlenbrach & Stulz (2010). Diff-volatility (diff-beta) is the difference between the firm volatility (beta) in the period 2005-2006 and the firm volatility (beta) in the period 2003-2004. Panel A contains the means and medians of the ex ante risk measures (*Volatility (2003-2006)* and *Beta (2003-2006)*) for the subsamples of failed and surviving institutions. Panel B contains the means and medians of the ex post risk measures (*Volatility (2007-2008)*, *Beta (2007-2008)*, and *BHR (2007-2008)*) for the subsamples of failed and surviving institutions. Asterisks in the mean and median columns of the group of failed institutions represent statistically significant differences according to the t-test of means and the rank-sum test for differences in medians, respectively. Panel C reports the results of regressions with LD and Delta as explanatory variables and the ex post risk measure indicated in the column title as dependent variable. *, ** and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively. We report robust standard errors in Panel C.

Panel A. Ex ante risk measures and bank failure: surviving vs. failed banks.

	Surviving		Failed	
	Mean	Median	Mean	Median
Volatility (2003-2006)	0.46	0.44	0.47	0.47
Beta (2003-2006)	1.04	1.00	1.09	1.05
diff - volatility	−0.02	−0.02	−0.01	−0.01
diff - beta	0.24	0.20	0.29	0.25
N	102		19	

Panel A. Ex post risk measures and bank failure: surviving vs. failed banks.

	Surviving		Failed	
	Mean	Median	Mean	Median
Volatility (2007-2008)	0.86	0.83	1.60***	1.62***
Beta (2007 - 2008)	1.26	1.26	2.08***	1.88***
BHR	−0.20	−0.21	−0.88***	−0.91***
N	101		19	

Table 15: Robustness checks. *Panel A* contains estimation results for linear probability models with *Failed* as the dependent variable. For each model, we report the value of the coefficients, the standard error of the coefficient estimates (s.e.), the sample size, and the R^2. In column (i) we construct the sample as in Fahlenbrach and Stulz (2011). Column (ii) contains results using an alternative definition of *Failed* that considers Merrill Lynch, National City, Provident, Mellon Financial and Countrywide as *not* failed. In column (iii) we use a definition of *Failed* that considers all the firms mentioned in column (ii) as failed, as well as Citigroup and Bank of America. Column (iv) excludes investment banks from the sample. Column (v) excludes firms that are too-big-to-be-acquired (TBTBA) in terms of market capitalization. Column (vi) excludes excludes firms that are too-big-to-be-acquired according to the FSB's 2011 list of systemically important banks. *Panel B* contains univariate regressions where the dependent variable is *Failed*. In column (1) the independent variables are *LD* and *Delta* winsorized at the 2% level. In column (2) the independent variables are the natural logarithm of 1 plus *LD* and the natural logarithm of 1 plus *Delta*. Column (3) reports probit marginal effects, and column (4) reports logit marginal effects (evaluated at the sample means in both cases). *, ** and *** represent significance levels at 10%, 5%, and 1%, respectively. Robust standard errors in parentheses.

Panel A: Sample selection, failure definition, and too-big-to-be-acquired banks

	i	ii	iii	iv	v	vi
AVV	0.01***	0.01***	0.01***	0.05**	0.01***	0.01***
s.e.	(0.00)	(0.00)	(0.00)	(0.02)	(0.00)	(0.00)
N	93	125	125	116	120	117
R^2	0.108	0.105	0.089	0.120	0.104	0.119
Delta	0.08***	0.01	0.01	0.05	0.01	0.01
s.e.	(0.03)	(0.01)	(0.01)	(0.04)	(0.01)	(0.01)
N	97	125	125	116	120	117
R^2	0.093	0.005	0.005	0.026	0.005	0.006
OV	0.08	0.05	0.08	0.06	0.08	0.13
s.e.	(0.08)	(0.06)	(0.07)	(0.07)	(0.08)	(0.09)
N	93	125	125	116	120	117
R^2	0.014	0.007	0.015	0.008	0.012	0.028
AVV	0.00	0.01***	0.01***	0.07***	0.01***	0.01***
s.e.	(0.00)	(0.00)	(0.00)	(0.03)	(0.00)	(0.00)
Delta	0.07	-0.00	-0.00	-0.05	-0.00	-0.00
s.e.	(0.05)	(0.00)	(0.00)	(0.04)	(0.00)	(0.00)
N	93	125	125	116	120	117
R^2	0.131	0.105	0.089	0.133	0.104	0.119

Panel B: alternative specifications and extreme values

	LPM		Probit		Logit	
	(1)	(2)	(3)	(4)	(5)	(6)
WAV	0.03**					
	(0.01)					
WDelta	−0.00					
	(0.02)					
ln_AVV		0.20***				
		(0.05)				
ln_Delta		−0.06				
		(0.04)				
AVV			0.02*	0.02*	0.02	0.02
			(0.01)	(0.01)	(0.01)	(0.01)
Delta				−0.01		−0.01
				(0.01)		(0.01)
N	125	125	125	125	125	125
R^2	0.127	0.167				
pseudo R^2			0.110	0.112	0.107	0.108

Appendices

A Risk Incentive Measures

Delta Delta is defined in equation (2), which we reproduce here:

$$\Delta = \Delta_S + \Delta_O = \left[n_S\left(\frac{S}{100}\right)\right] + \left[\sum_i n_i \frac{\partial O^i}{\partial S}\left(\frac{S}{100}\right)\right], \quad (2)$$

where Δ_S and Δ_O denote the Delta from stocks and options, respectively, n_S denotes the number of shares of the firm's stock held by the CEO, S the stock price, and i, n^i, and O^i are the identifier of the option grant, the number of options of grant i, and the value of the options of grant i, respectively.

Due to availability of disaggrgated information about maturity and expiration dates of each option grant to the CEO, the method used for Delta and related variables in year 2006 is slightly different to the method employed for the same variables for years previos to 2006. For years previous to 2006 we need to use the "one year approximation" techinique described in Core and Guay (2002) . For years where the disaggregated grants information is available we follow a similar procedure as in **?**. For details in the methodology and variables used, please see Coles et al. (2013).

In general, based on the Black-Scholes (1973) formula for valuing European call options, modified to account for dividend payouts by Merton(1973), the value of an option is:

$$Option - value = [Se^{-dt}N(Z) - Ke^{-rT}N(Z - \sigma T^{(1/2)}] \quad (7)$$

where

$$Z = \frac{[ln(\frac{S}{K}) + T(r - d + \frac{\sigma^2}{2})]}{(\sigma\sqrt{T})} \quad (8)$$

N: cumulative probability function for the normal distribution.

S: price of the underlying stock.

K: exercise price of the option.

σ: expected stock-return volatility over the life of the option.

r: natural logarithm of risk-free interest rate.

T: time to maturity of the option in years.

d: natural logarithm of expected dividend yield over the life of the option.

Then,

Δ_i: sensitivity of an option grant with respect to a 1% change in stock price

$$\Delta = e^{-dT}N(Z) * (S/100) \quad (9)$$

ν_i(vega): sensitivity of an option grant with respect to a 1% change in stock volatility

$$\nu = e^{-dT} N'(Z) S \sqrt{T} \tag{10}$$

Finally, total Δ and ν for the **portfolio** will be

$$\Delta = \frac{S}{100}(\Delta_{NG} Q_{NG} + \Delta_{PUU} Q_{PUU} + \Delta_{PUE} Q_{PUE} + Q_{Stock} \tag{11}$$

$$\nu = \frac{1}{100}(\nu_{NG} Q_{NG} + \nu_{PUU} Q_{PUU} + \nu_{PUE} Q_{PUE}) \tag{12}$$

Where Q is the size of the grant, NG means New Grant, PUU is previously grants unexercised unexerciseble and PUE means previously granted unexercised exerciseble.

Finally, note that in the calculation of the portfolio's ν, stock or restricted stock holding's ν is not included. This exclusion is very common in the literature (see Brockman et al (2010), Coles et al. (2006), Hanlon et al. (2004), Knopf et al. (2002), and Rajgopal and Shevlin (2002)). This is based on Guay's (1999) findings suggesting that the CEOs combined stock and option portfolio vega can estimated using only the option portfolio vega and excluding stock holdings since the stock portfolio vega is relatively small. Accoridng to Guay (1999), the median CEO option portfolio vega ($20,915) is 10,457 times larger than the median CEO stock portfolio vega ($2).

Asset Volatility Vega (AVV) We follow the procedure described by Chesney et al. (2012) to compute the Asset Volatility Vega from stocks (AVV_S) and from options (AVV_O). Here we provide only the formulas that we use to compute the different variables and the data used to perform the computations. We refer to the article by Chesney et al. (2012), especially the appendix, for the description of the model, and the derivation and details of the calculations.

We compute the Asset Volatility Vega from stocks (AVV_S) and from options (AVV_O) separately. The avv_S for a single share of stock is defined as:

$$avv_S \quad = \quad \frac{\partial BS(V, D, r, T, \sigma_v)}{\partial \sigma_v} \times 0.01, \tag{13}$$

where $BS(V, D, r, T, \sigma_v)$ is the Black-Scholes value of equity as a call option on the firm's value (see Chesney et al. (2012) for the detailed assumptions made to obtain this value) and σ_v is the volatility of asset value (all other variables are described below). It follows from the Black-Scholes formulation that:

$$avv_S \quad = \quad \varphi(d_1(V, D, r, T, \sigma_v)) V \sqrt{T}(1/100), \tag{14}$$

where

$$d_1 = \frac{ln(V/D) + (r + \sigma_v^2/2)T}{\sigma_v \sqrt{T}}. \tag{15}$$

To compute AVV_S, we multiply the avv_S (defined for a single share of stock) by the number of shares held by the CEO.

Following Chesney et al. (2012), we define avv_O for a given stock grant as:

$$avv_O \quad = \quad \frac{\partial CC}{\partial \sigma_v} \times 0.01, \tag{16}$$

where CC is the value of the stock option as a call on a call (compound option). Chesney et al. (2012) show that the value of this derivative is:

$$
\begin{aligned}
\frac{\partial CC}{\partial \sigma_v} &= V\Bigg[\varphi(h+\sigma_v\sqrt{\tau_1})N_1\left(\frac{k+\sigma_v\sqrt{\tau_2}-\frac{\tau_1}{\tau_2}(h+\sigma_v\sqrt{\tau_1})}{\sqrt{1-\frac{\tau_1}{\tau_2}}}\right)\sqrt{\tau_1} \\
&+ \varphi(k+\sigma_v\sqrt{\tau_2})N_1\left(\frac{h+\sigma_v\sqrt{\tau_1}-\frac{\tau_1}{\tau_2}(k+\sigma_v\sqrt{\tau_2})}{\sqrt{1-\frac{\tau_1}{\tau_2}}}\right)\frac{d(k+\sigma_v\sqrt{\tau_2})}{d\sigma_v}\Bigg] \\
&- De^{-r\tau_2}\varphi(k)N_1\left(\frac{h-\sqrt{\frac{\tau_1}{\tau_2}}k}{\sqrt{1-\frac{\tau_1}{\tau_2}}}\right)\frac{dk}{d\sigma_v}, \qquad (17)
\end{aligned}
$$

where:

$$
\begin{aligned}
k &= \frac{ln(V/D)+(r-\frac{1}{2}\sigma_v^2)\tau_2}{\sigma_v\sqrt{\tau_2}}, \qquad (18)\\
h &= \frac{ln(V/\bar{V})+(r-\frac{1}{2}\sigma_v^2)\tau_1}{\sigma_v\sqrt{\tau_1}}, \qquad (19)\\
\frac{dk}{d\sigma_v} &= -\frac{k}{\sigma_v}-\sqrt{\tau_2} \\
\frac{d(k+\sigma_v\sqrt{\tau_2})}{d\sigma_v} &= -\frac{k}{\sigma_v}. \qquad (20)
\end{aligned}
$$

See below for the definition of all variables.

To compute AVV_O, we first compute for each option contract held by the CEO the avv_O for a single stock option and multiply it by the number of options held by the CEO. We then sum the AVV_O's of the different option grants.

Asset Volatility Vega (AVV) is defined as:

$$AVV = AVV_S + AVV_O. \qquad (21)$$

B Sample Selection

The following table lists the financial institutions included in the sample. For those firms not in SIC codes 6020 (Commercial Banks), 6035 (Savings Institutions, Federally Chartered), or 6036 (Savings Institutions, Not Federally Chartered), Column *FFIEC Inst. Type* reports the institution type in year 2006, according to the firm's history at the FFIEC's National Information Center. The institution types present in the sample are FHC (Financial Holding Company), FSB (Federal Savings Bank), and S&LHC (Savings and Loans Holding Company). The *Primary Dealer* column displays "PD" if the firm is listed as a primary dealer in 2006 according to the NY FED.

Number	Company Name	SIC	SIC - Description	FFIEC Inst. Type	Primary Dealer
1	AMERICAN EXPRESS CO	6199	FINANCE SERVICES	S&LHC	
2	AMERIPRISE FINANCIAL INC	6211	SECURITY BROKERS & DEALERS	S&LHC	
3	ANCHOR BANCORP WISCONSIN INC	6035	SAVINGS INSTN,FED CHARTERED		
4	ASSOCIATED BANCCORP	6020	COMMERCIAL BANKS		
5	ASTORIA FINANCIAL CORP	6035	SAVINGS INSTN,FED CHARTERED		
6	BANCORPSOUTH INC	6020	COMMERCIAL BANKS		
7	BANK MUTUAL CORP	6035	SAVINGS INSTN,FED CHARTERED		
8	BANK OF AMERICA CORP	6020	COMMERCIAL BANKS		
9	BANK OF HAWAII CORP	6020	COMMERCIAL BANKS		
10	BANK OF NEW YORK MELLON CORP	6020	COMMERCIAL BANKS		
11	BANK OF THE OZARKS INC	6020	COMMERCIAL BANKS		
12	BANKUNITED FINANCIAL CORP	6035	SAVINGS INSTN,FED CHARTERED		
13	BB&T CORP	6020	COMMERCIAL BANKS		
14	BBCN BANCORP INC	6020	COMMERCIAL BANKS		
15	BBX CAPITAL CORP	6035	SAVINGS INSTN,FED CHARTERED		
16	BEAR STEARNS COMPANIES INC	6211	SECURITY BROKERS & DEALERS		1
17	BOSTON PRIVATE FINL HOLDINGS	6020	COMMERCIAL BANKS		
18	BROOKLINE BANCORP INC	6035	SAVINGS INSTN,FED CHARTERED		
19	CAPITAL ONE FINANCIAL CORP	6141	PERSONAL CREDIT INSTITUTIONS	FHC	
20	CASCADE BANCORP	6020	COMMERCIAL BANKS		
21	CATHAY GENERAL BANCORP	6020	COMMERCIAL BANKS		
22	CENTRAL PACIFIC FINANCIAL CP	6020	COMMERCIAL BANKS		
23	CHITTENDEN CORP	6020	COMMERCIAL BANKS		
24	CITIGROUP INC	6199	FINANCE SERVICES	FHC	1
25	CITY HOLDING CO	6020	COMMERCIAL BANKS		
26	CITY NATIONAL CORP	6020	COMMERCIAL BANKS		
27	COLONIAL BANCGROUP	6020	COMMERCIAL BANKS		
28	COLUMBIA BANKING SYSTEM INC	6020	COMMERCIAL BANKS		
29	COMERICA INC	6020	COMMERCIAL BANKS		
30	COMMERCE BANCORP INC/NJ	6020	COMMERCIAL BANKS		
31	COMMERCE BANCSHARES INC	6020	COMMERCIAL BANKS		
32	COMMUNITY BANK SYSTEM INC	6020	COMMERCIAL BANKS		
33	COMPASS BANCSHARES INC	6020	COMMERCIAL BANKS		
34	CORUS BANKSHARES INC	6020	COMMERCIAL BANKS		
35	COUNTRYWIDE FINANCIAL CORP	6162	MORTGAGE BANKERS & LOAN CORR	FHC	1
36	CULLEN/FROST BANKERS INC	6020	COMMERCIAL BANKS		
37	DIME COMMUNITY BANCSHARES	6035	SAVINGS INSTN,FED CHARTERED		
38	DOWNEY FINANCIAL CORP	6035	SAVINGS INSTN,FED CHARTERED		
39	E TRADE FINANCIAL CORP	6211	SECURITY BROKERS & DEALERS	S&LHC	
40	EAST WEST BANCORP INC	6020	COMMERCIAL BANKS		
41	FIFTH THIRD BANCORP	6020	COMMERCIAL BANKS		
42	FIRST BANCORP P R	6020	COMMERCIAL BANKS		
43	FIRST COMMONWLTH FINL CP/PA	6020	COMMERCIAL BANKS		
44	FIRST FINL BANCORP INC/OH	6020	COMMERCIAL BANKS		
45	FIRST FINL BANKSHARES INC	6020	COMMERCIAL BANKS		
46	FIRST HORIZON NATIONAL CORP	6020	COMMERCIAL BANKS		
47	FIRST INDIANA CORP	6020	COMMERCIAL BANKS		
48	FIRST MIDWEST BANCORP INC	6020	COMMERCIAL BANKS		
49	FIRST NIAGARA FINANCIAL GRP	6036	SAVINGS INSTN, NOT FED CHART		
50	FIRST REPUBLIC BANK	6020	COMMERCIAL BANKS		
51	FIRSTFED FINANCIAL CORP/CA	6035	SAVINGS INSTN,FED CHARTERED		
52	FIRSTMERIT CORP	6020	COMMERCIAL BANKS		
53	FLAGSTAR BANCORP INC	6035	SAVINGS INSTN,FED CHARTERED		
54	FRANKLIN BANK CORP	6036	SAVINGS INSTN, NOT FED CHART		
55	FRONTIER FINANCIAL CORP/WA	6020	COMMERCIAL BANKS		
56	FULTON FINANCIAL CORP	6020	COMMERCIAL BANKS		
57	GLACIER BANCORP INC	6020	COMMERCIAL BANKS		
58	GOLDMAN SACHS GROUP INC	6211	SECURITY BROKERS & DEALERS		1
59	GREATER BAY BANCORP	6020	COMMERCIAL BANKS		
60	GUARANTY FINANCIAL GROUP INC	6020	COMMERCIAL BANKS		
61	HANMI FINANCIAL CORP	6020	COMMERCIAL BANKS		
62	HUDSON CITY BANCORP INC	6035	SAVINGS INSTN,FED CHARTERED		
63	HUNTINGTON BANCSHARES	6020	COMMERCIAL BANKS		
64	INDEPENDENT BANK CORP/MI	6020	COMMERCIAL BANKS		

65	INDYMAC BANCORP INC	6162	MORTGAGE BANKERS & LOAN CORR	FSB	
66	INVESTORS FINANCIAL SVCS CP	6020	COMMERCIAL BANKS		
67	IRWIN FINANCIAL CORP	6020	COMMERCIAL BANKS		
68	JPMORGAN CHASE & CO	6020	COMMERCIAL BANKS		1
69	KEYCORP	6020	COMMERCIAL BANKS		
70	LEHMAN BROTHERS HOLDINGS INC	6211	SECURITY BROKERS & DEALERS	S&LHC	1
71	M & T BANK CORP	6020	COMMERCIAL BANKS		
72	MAF BANCORP INC	6035	SAVINGS INSTN,FED CHARTERED		
73	MARSHALL & ILSLEY CORP	6020	COMMERCIAL BANKS		
74	MELLON FINANCIAL CORP	6020	COMMERCIAL BANKS		
75	MERCANTILE BANKSHARES CORP	6020	COMMERCIAL BANKS		
76	MERRILL LYNCH & CO INC	6211	SECURITY BROKERS & DEALERS		1
77	MORGAN STANLEY	6211	SECURITY BROKERS & DEALERS	S&LHC	1
78	N B T BANCORP INC	6020	COMMERCIAL BANKS		
79	NATIONAL CITY CORP	6020	COMMERCIAL BANKS		
80	NATIONAL PENN BANCSHARES INC	6020	COMMERCIAL BANKS		
81	NEW YORK CMNTY BANCORP INC	6036	SAVINGS INSTN, NOT FED CHART		
82	NORTHERN TRUST CORP	6020	COMMERCIAL BANKS		
83	OLD NATIONAL BANCORP	6020	COMMERCIAL BANKS		
84	PACWEST BANCORP	6020	COMMERCIAL BANKS		
85	PEOPLE'S UNITED FINL INC	6036	SAVINGS INSTN, NOT FED CHART		
86	PINNACLE FINL PARTNERS INC	6020	COMMERCIAL BANKS		
87	PNC FINANCIAL SVCS GROUP INC	6020	COMMERCIAL BANKS		
88	POPULAR INC	6020	COMMERCIAL BANKS		
89	PRIVATEBANCORP INC	6020	COMMERCIAL BANKS		
90	PROSPERITY BANCSHARES INC	6020	COMMERCIAL BANKS		
91	PROVIDENT BANKSHARES CORP	6020	COMMERCIAL BANKS		
92	RAYMOND JAMES FINANCIAL CORP	6211	SECURITY BROKERS & DEALERS	S&LHC	
93	REGIONS FINANCIAL CORP	6020	COMMERCIAL BANKS		
94	S & T BANCORP INC	6020	COMMERCIAL BANKS		
95	SANTANDER HOLDINGS USA INC	6035	SAVINGS INSTN,FED CHARTERED		
96	SCHWAB (CHARLES) CORP	6211	SECURITY BROKERS & DEALERS	FHC	
97	SIMMONS FIRST NATL CP CL A	6020	COMMERCIAL BANKS		
98	SOUTH FINANCIAL GROUP INC	6020	COMMERCIAL BANKS		
99	STATE STREET CORP	6020	COMMERCIAL BANKS		
100	STERLING BANCORP/NY	6020	COMMERCIAL BANKS		
101	STERLING BANCSHARES INC/TX	6020	COMMERCIAL BANKS		
102	STERLING FINANCIAL CORP/WA	6036	SAVINGS INSTN, NOT FED CHART		
103	SUNTRUST BANKS INC	6020	COMMERCIAL BANKS		
104	SUSQUEHANNA BANCSHARES INC	6020	COMMERCIAL BANKS		
105	SVB FINANCIAL GROUP	6020	COMMERCIAL BANKS		
106	SWS GROUP INC	6211	SECURITY BROKERS & DEALERS	S&LHC	
107	SYNOVUS FINANCIAL CORP	6020	COMMERCIAL BANKS		
108	TCF FINANCIAL CORP	6020	COMMERCIAL BANKS		
109	TD BANKNORTH INC	6020	COMMERCIAL BANKS		
110	TOMPKINS FINANCIAL CORP	6020	COMMERCIAL BANKS		
111	TRUSTCO BANK CORP/NY	6035	SAVINGS INSTN,FED CHARTERED		
112	U S BANCORP	6020	COMMERCIAL BANKS		
113	UCBH HOLDINGS INC	6020	COMMERCIAL BANKS		
114	UMB FINANCIAL CORP	6020	COMMERCIAL BANKS		
115	UMPQUA HOLDINGS CORP	6020	COMMERCIAL BANKS		
116	UNIONBANCAL CORP	6020	COMMERCIAL BANKS		
117	UNITED BANKSHARES INC/WV	6020	COMMERCIAL BANKS		
118	UNITED COMMUNITY BANKS INC	6020	COMMERCIAL BANKS		
119	WACHOVIA CORP	6020	COMMERCIAL BANKS		
120	WASHINGTON FEDERAL INC	6035	SAVINGS INSTN,FED CHARTERED		
121	WASHINGTON MUTUAL INC	6035	SAVINGS INSTN,FED CHARTERED		
122	WEBSTER FINANCIAL CORP	6020	COMMERCIAL BANKS		
123	WELLS FARGO & CO	6020	COMMERCIAL BANKS		
124	WESTAMERICA BANCORPORATION	6020	COMMERCIAL BANKS		
125	WHITNEY HOLDING CORP	6020	COMMERCIAL BANKS		
126	WILMINGTON TRUST CORP	6020	COMMERCIAL BANKS		
127	WILSHIRE BANCORP INC	6020	COMMERCIAL BANKS		
128	WINTRUST FINANCIAL CORP	6020	COMMERCIAL BANKS		
129	ZIONS BANCORPORATION	6020	COMMERCIAL BANKS		

C Failed firms

The following table lists the institutions that we identify as failed. Columns *Year* and *Month* represent the last year and month, respectively, for which there is information for the corresponding firm in CRSP.

Company Name	Year	Month	STEP 1	STEP 2	STEP 3	STEP 4	Failed
BEAR STEARNS COMPANIES INC	2008	5		1			1
COLONIAL BANCGROUP	2009	7	1				1
CORUS BANKSHARES INC	2009	8	1				1
COUNTRYWIDE FINANCIAL CORP	2008	6		1			1
DOWNEY FINANCIAL CORP	2008	10	1				1
FIRSTFED FINANCIAL CORP	2009	2	1				1
FRANKLIN BANKCORP	2008	10	1				1
FRONTIER FINANCIAL CORP/WA	2010	4	1				1
INDYMAC BANCORP INC	2008	6	1				1
IRWIN FINANCIAL CORP	2009	8	1				1
LEHMAN BROTHERS HOLDINGS INC	2008	8			1		1
MELLON FINANCIAL CORP	2007	6		1			1
MERRILL LYNCH & CO INC	2008	12				1	1
NATIONAL CITY CORP	2008	12				1	1
PROVIDENT BANKSHARES CORP	2009	4				1	1
SOUTH FINANCIAL GROUP INC	2010	9		1			1
UCBH HOLDINGS INC	2009	10	1				1
WACHOVIA CORP	2008	12		1			1
WASHINGTON MUTUAL INC	2008	8	1				1