CEO Investment of Deferred Compensation Plans and Firm Performance*

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Abstract

We study how US chief executive officers (CEOs) invest their deferred compensation plans depending on the firm's profitability. By looking at the correlation between the CEO's return on these plans and the firm's stock return, we show that deferred compensation is to a large extent invested in the company equity in good times and divested from it in bad times. The divestment from company equity in bad times arguably reflects CEOs' incentive to "abandon" the firm and to invest in alternative instruments to preserve the value of their deferred compensation plans. This result suggests that the incentive alignment effects of deferred compensation crucially depend on the firm's health status.

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1 Introduction

Top executives of US public firms receive an important fraction of their compensation in the form of retirement benefits. Such benefits are akin to debt-like claims on the firm and are often called "inside debt". As pointed out by Jensen and Meckling (1976) and Edmans and Liu (2011), inside debt can align the incentives of managers and creditors, thus making the former more conservative.[1]

Yet, several studies suggest a more nuanced view of inside debt incentives. Inside debt is composed of pensions (rank-and-file plans and supplemental executive retirement plans) and deferred compensation. Anantharaman, Fang, and Gong (2014) show that the incentive alignment effect of inside debt is driven by supplemental executive retirement plans, i.e., the inside debt component most exposed to default risk. By contrast, rank-and-file plans are protected in bankruptcy, and deferred compensation plans, though often formally at risk in bankruptcy, allow some flexibility in the schedule of withdrawals, which can predate the retirement date (and the maturity date of outstanding debt).[2] Interestingly, deferred compensation plans also allow substantial flexibility in the investment strategy, which has the potential to affect managerial risk-taking incentives.

This last aspect has received little attention. An exception is Jackson and Honigsberg (2014), who show that a substantial fraction of deferred compensation is invested in the company stock. Hence, deferred compensation may provide managers with an equity-like payoff and intensify, rather than diminish, managerial risk-taking incentives. Jackson and Honigsberg (2014) analyze the *average* investment strategy of deferred compensation and do not consider the possibility that this strategy changes over time. By contrast, we focus on the *time-varying* investment strategy of deferred compensation. In particular, we analyze theoretically and empirically the manager's incentives to reallocate his/her

[1] Several studies provide evidence consistent with this view. See, e.g., Sundaram and Yermack (2007) and Cassel, Huang, Sanchez, and Stuart (2012).

[2] See references in Anantharaman, Fang, and Gong (2014).

deferred compensation away from company stock when the firm enters a period of low expected profitability. We then discuss the possible implications of such a reallocation strategy for firm risk.

We start by developing a theoretical framework in which the CEO endogenously decides the allocation of his/her deferred compensation and the level of firm risk. When the firm's expected profitability is low, the CEO reallocates the deferred compensation away from company stock toward assets with higher expected payoffs.

We test this prediction on a large sample of US public firms over the period 2006-2015 by analyzing CEOs' compensation packages. Given that current disclosure rules do not require companies to reveal how CEOs' deferred compensation plans are invested, we measure the exposure of deferred compensation to company stock by means of the correlation between deferred compensation returns and stock returns. As a preliminary step, we substantiate the suggestive evidence of Jackson and Honigsberg (2014) by showing that deferred compensation is indeed significantly linked to company stocks, as witnessed by the positive, large, and statistically significant correlation exhibited by a substantial fraction of CEOs in our sample.

We then focus on the time-varying nature of the correlation between CEO deferred compensation returns and stock returns, which we use as a proxy for the CEO's investment strategy throughout time. We show that such a correlation declines significantly in bad times (i.e., distressed firm-years), in line with CEOs divesting from the firm stock. We confirm this finding using the recent financial crisis as a plausibly exogenous shock to the firm's distress risk. The decline in the correlation is likely to reflect CEOs' desire to "abandon" the firm during bad times.

Moreover, we do not find evidence that CEOs use private information to time the market by means of their deferred compensation investment strategy. However, CEOs appear to be quicker to react to worsened firm conditions through the asset allocation of deferred compensation plans than through trading on traditional stock incentives, possibly because of the more intense scrutiny the latter receive from investors.

Using our theoretical setting, we then discuss the possible implications of CEO investment strategy of deferred compensation for firm risk. By divesting deferred compensation away from firm equity, the CEO can limit losses in case of default. In bad times, the reallocation strategy of deferred compensation works as an insurance that allows the CEO to adopt a sort of gambling for resurrection strategy, increasing the value of equity through higher cash flow volatility without suffering large expected compensation losses. The model thus suggests that deferred compensation may induce the CEO to take on more risk exactly when creditors would need a more prudent behavior, with the effect being stronger if deferred compensation is large.

Early withdrawals are an alternative/complementary way to modifying the investment strategy to limit expected losses on deferred compensation (Jackson and Honigsberg, 2014) and can, as such, lead to increased managerial risk-taking incentives too. We show empirically that in bad times CEOs tend to alter the investment strategy of deferred compensation, rather than withdrawing part of their deferred compensation. This is possibly (i) because of the tax penalty on early withdrawals and (ii) because withdrawals are observable and often criticized by the media, especially when the amount of money involved is substantial, while the investment strategy of deferred compensation is harder to observe. In other words, changing the investment strategy of deferred compensation may be associated with lower monetary and reputational costs, and is therefore more desirable for CEOs than early withdrawals.

It is worth noting that *indirect* equity incentives (i.e., those coming from deferred compensation plans) differ from traditional *direct* equity incentives (i.e., those coming from the part of CEO's wealth directly invested in equity). In the model, the CEO reduces the fraction of deferred compensation invested in company stock in bad times and, as a result, takes more risk. In other words, our theoretical setting predicts a negative relation between firm risk and indirect equity incentives. Differently, the impact of direct equity holdings depends on the interaction of two opposite channels. When the number of directly held shares increases, the CEO has an incentive to take more risk to benefit from the positive effect of risk on the value of equity. At the same time, a surge in firm risk increases the probability of default, thus reducing the value of deferred compensation. Therefore, the relation between direct equity incentives and firm risk hinges on the overall effect of firm risk on the value of total CEO compensation. When deferred compensation is over-invested in company equity, the former channel prevails and direct equity holdings have a positive effect on firm risk. Otherwise, the latter channel prevails and direct equity holdings have a negative effect on firm risk. In the same spirit, Carpenter (2000) and Ross (2004) show that convex compensation schemes may have ambiguous effects on CEO risk-taking incentives. We illustrate that this ambiguity may also be generated by flexibility in the investment strategy of deferred compensation.

2 Literature review

A substantial body of work provides evidence compatible with the risk-reducing role of inside debt suggested by Jensen and Meckling (1976) and Edmans and Liu (2011). Sundaram and Yermack (2007) find a negative relation between the ratio of inside debt to inside equity and default risk. Wei and Yermack (2011) show that, after firms' initial disclosure of top executive retirement plans, bond prices rise while stock prices decrease. Phan (2014) provides consistent evidence looking at firms' mergers and acquisitions (M&A) activity, also documenting that acquiring firms adjust the weight of inside debt relative to equity holdings following M&As to adjust to the new capital structure. Liu, Mauer, and Zhang (2014) illustrate that inside debt helps protect creditors by favoring cash hoarding behavior. Li, Rhee, and Shen (2018) illustrate that firms whose CEOs hold large inside debt holdings tend to issue less convertible debt, which lines up with a risk-mitigating role of inside debt provided that convertibles are used by firms to curb risk-shifting. Srivastav, Armitage, and Hagendorff (2014) focus on the banking sector and document that inside debt limits managerial risk-shifting through a reduction of incentives to divert cash to shareholders. Cassel, Huang, Sanchez, and Stuart (2012) report evidence of a negative relation between executives' inside debt holdings and the volatility of stock returns.

Anantharaman, Fang, and Gong (2014), however, show that inside debt is effective at reducing the cost of private loans only when it is actually exposed to default risk. Colonnello, Curatola, and Hoang (2017) extend this result to public debt and illustrate that low-seniority debt can interact with equity incentives in making CEOs less conservative. Such an unintended increase in managerial risk-taking is concentrated in bad times (Inderst and Pfeil, 2013). Goh and Li (2015) document that CEO pensions are unlikely to qualify as actual inside debt in the UK context, but rather as substitutes for other performance-sensitive compensation items. Jackson and Honigsberg (2014) question the incentive-alignment role of deferred compensation plans by documenting that they are on average heavily invested in firm equity and to a large extent withdrawn by executives after they leave the firm. Cen and Doukas (2017) look at firm risk-taking and the CEO's personal returns on deferred compensation plans, but rather than focusing on their correlation with the firm stock across different states of the world, they examine their unconditional volatility to infer the CEO's risk preferences. We complement this literature by studying how the CEO's exposure to firm risk through deferred compensation changes over time depending on his/her personal portfolio choices. We then discuss how this time-varying exposure of the CEO to the firm can affect his/her risk-taking incentives.

Our paper also speaks to the literature on the hedging behavior of executives on their company equity holdings. Gao (2010) documents that optimal pay-performance sensitivity is decreasing in the hedging costs faced by the CEO. Bettis, Bizjak, and Lemmon (2001) find that managers use derivative instruments such as zero-cost collars and equity swaps to hedge their positions. Anderson and Puleo (2016) show that managers that hedge themselves by pledging their equity awards to borrow funds take on more risk. We illustrate that deferred compensation plans may allow executives more discretion over their exposure to the firm's idiosyncratic risk.

3 Institutional background

Corporate finance theory suggests that deferred compensation is able to reduce managerial risk-taking incentives if it is unsecured in bankruptcy and delivers a fixed payoff in good states (Jensen and Meckling, 1976; Edmans and Liu, 2011). In practice, deferred compensation differs from this theoretical benchmark for two reasons: firstly, its recovery rate in bankruptcy may be higher than that for arm's length debt and, secondly, CEOs enjoy substantial flexibility in the investment strategy of deferred compensation plans. Indeed, the payoff of deferred compensation plans is not fixed, but is linked to the price of the assets in which deferred compensation is invested.

The differences above depend on the type of deferred compensation plan and its features which are summarized below.[3]

3.1 A taxonomy of deferred compensation plans

The first important distinction is between defined benefit (DB) and defined contribution (DC) plans, which together constitute the inside debt. DB plans come in the form of pensions and comprise qualified and non-qualified plans. Qualified DB plans are typically rank-and-file pension schemes regulated by the Employee Retirement Income Security Act

[3] This section is based on Bebchuk and Jackson (2005), Anantharaman, Fang, and Gong (2014), Wei and Yermack (2011), Jackson and Honigsberg (2014), Walker (2017), and on the webpages of the US Department of Labor and the Internal Revenue Service (IRS).

(ERISA), and secured and funded by the Pension Benefit Guaranty Corporation, whereas non-qualified DB plans usually come in the form of supplemental executive retirement plans (SERPs). DB plans promise fixed payments after retirement and are similar to annuities. The payment is a fraction of the final wages and depends on the manager's age and contributions up to retirement. Managers do not have discretion over their investment strategy, making DB plans less prone to the issues analyzed in this paper.[4] Therefore, our analysis focuses on DC plans only.

DC plans can also be divided into qualified and non-qualified plans, depending on whether they are regulated by ERISA. Qualified DC plans are secured in bankruptcy and allow executives to defer part of their current compensation, which is then invested in special investment vehicles (typically a Collective Investment Trust). Participants in these plans have substantial power to decide on the investment strategy of their accounts. Qualified DC plans are tax-beneficial: managers are taxed at the time they receive the amount and not when the amount is set aside, and companies obtain tax deductions for qualified contributions. Because of their tax advantages, the Internal Revenue Code (IRC) limits the amount of money that managers can defer through qualified plans.[5]

Given such a limit, companies also offer non-qualified DC plans to allow their managers to organize the distribution of their future income better and—although not explicitly given a preferential tax treatment—still enjoy a tax advantage under certain conditions. Non-qualified DC plans are essentially a contract between managers and firms and, thus, do not have to comply with ERISA requirements but are regulated by the IRC Section 409A. Assets backing non-qualified DC plans—unlike in the case of qualified ones—must be formally available to general creditors in bankruptcy for these plans to qualify as tax

[4] Anantharaman, Fang, and Gong (2014) show that the risk-mitigating effect of inside debt is driven by SERPs, which most closely satisfy the conditions set forth by Jensen and Meckling (1976) for inside debt to curb risk-taking, namely (i) being unsecured in bankruptcy and (ii) paying a fixed payoff in non-bankruptcy states.

[5] A typical example here are 401(k) plans. Contribution made through these plans are generally limited to $18,000 per year.

deferral vehicles according to IRC Section 409A. In other words, executives' claims on the firm's assets through non-qualified DC plans are formally akin to unsecured debt and thus exposed to forfeiture risk in bankruptcy.

However, non-qualified DC plans' recovery rates in bankruptcy for executives are likely to be substantially higher than that for arm's length debt. Based on anecdotal and survey evidence, Walker (2017) shows that a large fraction of firms (between 50% and 90%) provides 'informal funding' on these plans through (i) a Rabbi trust, and/or (ii) a corporate owned life insurance (COLI). Sometimes COLIs are held within a Rabbi trust. Walker (2017) suggests that informal funding, especially in the form of a Rabbi trust, translates into plan participants' increased protection in bankruptcy.[6]

One should then consider that in the US (i) the recovery rate on unsecured debt is substantial, and (ii) deviations from the absolute priority rule (APR), favoring unsecured over secured creditors, are relatively common. About point (i), Jankowitsch, Nagler, and Subrahmanyam (2014) report a mean recovery rate of 39.09 percent for unsecured bonds based on post-default trading prices. Given that public bondholders tend to exhibit coordination problems, this is arguably a lower bound for the recovery rate on debt claims held by executives such as the ones we study. About point (ii), Capkun and Weiss (2016), using a sample of Chapter 11 bankruptcies, find APR violations favoring unsecured over secured creditors in 16.22 percent of cases. Such APR violations go in the direction of increasing recovery rates on unsecured debt. As a result, the beneficial effect of DC for creditors is not obvious.

[6]Unlike secular trusts, Rabbi trusts do not formally protect plan participants from bankruptcy (Gerakos, 2010). It is important to stress that no comprehensive information on Rabbi trusts is available, therefore we cannot precisely quantify their seniority-enhancing effect on non-qualified DC plans.

3.2 The investment strategy of deferred compensation plans

An important aspect of DC plans is their investment options. The investments options of qualified DC plans, such as 401(k) plans, may include the company's own stock as a possible choice. Firms select the investment options available to the plan's participants, who can then pick one among them, thus choosing the desired asset allocation for their own account within the plan. ERISA identifies the plan's fiduciary as the person (or corporation) responsible for selecting the investment options and managing the deferred compensation plan. Typically, the plan sponsor (the employer adopting the plan) acts as the fiduciary and is therefore responsible for the deferred compensation plan. In addition, the plan sponsor may hire an investment advisor who provides investment recommendations (ERISA section 3(21)), but the plan sponsor maintains control over the investment decisions. Alternatively, the sponsor may delegate to an external institution (i.e., a bank or an insurance company) the management function of the plan (ERISA section 3(38)). These details may be provided in the Investment Policy Statement (IPS). However, the IPS is not required by ERISA, thus, while some companies provide an IPS, some do not.

Nonqualified DC plans allow for more flexibility. Those plans are typically restricted to top executives and designed exclusively for them. Even in this case, the lack of detailed information on the investment strategy is an issue.[7]

The empirical literature has tried to understand whether DC plans are invested in the firm's own stock or not using survey and interviews. The results are inconclusive: Some companies declare that they exclude own stock from the investment menu, some companies allow or even encourage investment in it, but most of the companies are silent

[7] Whereas firms are not obliged to disclose the asset allocation of nonqualified DC plans (Walker, 2017), executives are subject to regular reporting requirements on insider transactions involving firm securities held through these plans. Yet, as we discuss in Section OA.3 of the Online Appendix, these investments may not be clearly identified as such within the overall (indirect) equity holdings of each executive, hence the lack of detailed information.

about this issue. Prominent cases are those of Leggett & Platt Inc., which provides executives with monetary incentives to link their nonqualified DC plans to company stocks, and Aetna Inc., which offers only two investment options, namely company stocks and a fixed income fund. A recent survey suggests that 34% of the responding firms (113) offered the option to invest nonqualified DC plans in company stocks in 2017, increasing from 21% in 2016 (Newport Group, 2014). Many companies in the survey declare they offer investment options very similar to those in their 401(k) plan, which are often invested in company stocks (Mitchell and Utkus, 2002; Meulbroek, 2005; Rauh, 2006; Park, 2017). These pieces of evidence thus suggests that managerial nonqualified DC plans are likely to be invested in company stocks, but it is problematic to assess to which extent.[8]

In a recent study, Jackson and Honigsberg (2014) infer the investment strategy of deferred compensation by looking at the correlation between returns of deferred compensation and stock returns: They find that for a large fraction of listed companies the correlation between returns on deferred compensation plans and stock returns is higher than 80%, suggesting that deferred compensation is substantially invested in the firm's own stock. This correlation is unlikely to happen by chance and is arguably also unlikely to be the result of the advice of an external adviser, who would arguably suggest diversification rather than investing almost exclusively in one stock. Motivated by this evidence, below we study how CEOs change the investment strategy of deferred compensation over time depending on the firm's profitability.

Another important feature of DC plans is the possibility of making early withdrawals. For qualified DC plans, the IRS defines an early withdrawal as the withdrawal of a person younger than 59.5 years of age. In this case, the early withdrawal is subject to an additional 10% tax unless an exemption applies. Discretionary withdrawals from nonqualified DC plans are not possible before the date specified at the time the contract is

[8] We obtained this information on anecdotal and survey evidence from Walker (2017).

signed (which typically coincides with the expected retirement date), except under precise circumstances, such as separation from service or serious health problems.[9] The penalty for non-justified early withdrawals is particularly severe: The total deferred amount is included in the current income and taxed at the underpayment rate plus 1%. In addition, a penalty tax of 20% of the amount included in the current income is applied.

The final value of DC plans also depends on their managing cost. Such a cost depends on the selected trust manager and typically includes advisory fees and operating expenses (i.e., custody, accounting, legal, tax, and record keeping expenses), which may be subtracted from the value of the plan or billed separately. It is interesting to note that those trusts are not subject to the US Securities and Exchange Commission (SEC) registration. For this reason, they bear less reporting expenses than comparable mutual funds with the same investment strategy and, thus, typically charge lower fees.

All in all, although to different degrees, both qualified and nonqualified DC plans (i) allow participants to choose the desired investment strategy of plan assets, and (ii) grant some form of protection against general creditors in bankruptcy. These two features of DC plans amount to departures from the conditions outlined above under which inside debt has a risk-mitigating effect by Jensen and Meckling (1976) and Edmans and Liu (2011). In the next section, we sketch a model that captures such departures, deriving implications for managers' choices about plan investment strategy and firm risk-taking.

Because of the data limitations described below, in the remainder of the paper we restrict our analysis to nonqualified DC plans. For simplicity, we refer to nonqualified DC plans as deferred compensation plans, unless otherwise noted. Yet, our theoretical arguments arguably hold for qualified DC plans as well.

[9] The complete list of exemptions is provided under IRC Section 409A.

4 Allocation of deferred compensation plans in bad times

To derive the main hypothesis on CEO investment of deferred compensation plans conditional on firm performance, we extend the model of Bolton, Mehran, and Shapiro (2015).[10] In their framework, a risk-averse CEO is hired by shareholders and compensated with fixed salary, equity, and a component linked to the spread on the firm's credit default swaps (CDS). The firm has assets in place that can generate three different cash flows: High, intermediate or low. The firm defaults if the realized cash flow is low and the CEO selects firm risk, namely the variance of cash flows. The process of adjusting firm risk is costly and the cost paid decreases the value of equity. We consider two main departures from Bolton, Mehran, and Shapiro (2015): (i) We assume that the CEO is risk-neutral and (ii) replace the CDS component with deferred compensation. Figure 1 displays the timeline of the model.

[Insert Figure 1 about here]

Consistently with empirically observed patterns (Jackson and Honigsberg, 2014), we consider a deferred compensation scheme that allows the CEO to decide how to allocate deferred compensation between own firm equity and alternative investments that deliver a higher payoff in states in which the firm is insolvent. In other words, this contract allows the CEO to modify the expected value of his/her deferred compensation in two ways, that is, the CEO can change both firm risk (and thus the probability of default) and the investment strategy of deferred compensation. We also assume that changing the investment strategy of deferred compensation is costly for the CEO. This reflects the fact that the transaction costs associated to changes in the deferred compensation strategy are detrimental to the fund value.

[10] Details can be found in Appendix Section A.1.

When the firm's profitability decreases, the value of equity is low and this reduces the CEO's expected wealth. But the CEO has the possibility to change the investment strategy of deferred compensation to counteract the effect of equity. Our "main hypothesis" is that, in such circumstances, he/she will reduce the fraction of deferred compensation invested in company equity and increase the fraction invested in other assets. The empirical analysis in the next sections focuses on formally testing this hypothesis.

The model also provides insights into the implications of deferred compensation for CEO risk-taking incentives. As long as the CEO is able to recover a positive fraction of deferred compensation in default, the change in the investment strategy of deferred compensation creates a buffer against bad states. Such a buffer translates into an insurance effect, which induces the CEO to increase the optimal level of firm risk in bad states as compared to a benchmark contract not allowing any discretion in the investment strategy of deferred compensation. The additional risk also increases the value of equity, which, in turn, produces an extra increase in the CEO's wealth especially trough stocks held directly (i.e. not via deferred compensation).

Due to the difficulty of measuring all these inherently unobservable (and endogenous) quantities and interactions, an empirical analysis of the model's implications on risk-taking goes beyond the scope of the paper. Yet, CEO investment of deferred compensation plans is not important per se, but rather for its potential real consequences in terms of risk-taking. Therefore, in Section 7 we return to this issue and provide a more in-depth discussion.

5 Empirical approach and data

In this section, we describe the methodology and the data sources.

5.1 Empirical approach

The initial step is to proxy for the CEO's investment strategy of his/her deferred compensation plans. We then proceed to outline the design of our empirical tests.

Measuring deferred compensation plans' investment strategy. We measure the extent to which deferred compensation is invested in firm equity using the approach suggested by Jackson and Honigsberg (2014) and look at the correlation between returns on deferred compensation and stock returns. We compute stock returns as the total market return on the firm stock over the fiscal year.

The measurement of deferred compensation returns is more challenging. To this end, we use information on each CEO's annual earnings from deferred compensation plans. We employ two different measures of deferred compensation returns. In line with Jackson and Honigsberg (2014), we compute the first measure of return on deferred compensation plans over a given fiscal year as

$$Def.\ comp.\ return = \frac{Earnings}{Balance\ BoY}. \tag{1}$$

Earnings denotes the earnings a CEO receives on his/her plans and includes both dividends/coupons and the marked-to-market capital gains. *Balance BoY*, the aggregate balance of deferred compensation plans held by the CEO at the beginning of the year, is obtained by subtracting earnings and contributions (made by the CEO and the company) from the balance at the end of the year, namely $Balance\ BoY = Balance\ EoY - CEO\ contributions - Company\ contributions - Earnings$.

The second measure is directly adjusted for the withdrawals made by the CEO over the fiscal year. More specifically, we adjust the denominator by adding back the withdrawals over the fiscal year, namely

$$Def.\ comp.\ return\ (alt.) = \frac{Earnings}{Balance\ BoY\ (adj.)}, \tag{2}$$

where *Balance BoY (adj.)* = *Balance BoY* + *Withdrawals*. While this second measure relies on the assumption that withdrawals are made at the end of the fiscal year—similarly to Cen and Doukas (2017)—, the first one relies on the assumption that the withdrawals are made right before the beginning of the fiscal year. To favor the comparability of our results with those of Jackson and Honigsberg (2014), we use the first measure as the baseline.

Empirical design. Our baseline approach, rather than establishing causality, goes in the direction of capturing endogenous patterns in the investment strategy of deferred compensation and firm performance that are consistent with the model (see, e.g., Danis, Rettl, and Whited, 2014). Later, however, we also use a plausibly exogenous shock to distress risk.

We analyze the relation between returns on deferred compensation and stock returns in normal and distressed times by estimating the following specification:

$$\begin{aligned} Def.\ comp.\ return_{j,t} =& \beta_1 \cdot Distress\ zone_{i,t} + \beta_2 \cdot Stock\ return_{i,t} \\ &+ \beta_3 \cdot Distress\ zone_{i,t} \cdot Stock\ return_{i,t} \\ &+ \theta \cdot Control\ variables_{j(i),t} + \upsilon_j + \upsilon_t + \epsilon_{j,t}. \end{aligned} \tag{3}$$

The subscripts j, i, and t indicate the CEO, the firm, and the year, respectively. *Def. comp. return*$_{j,t}$ is the CEO annual return on deferred compensation over the fiscal year. *Stock return*$_{j,t}$ is the annual stock return over the fiscal year.

To capture distress, we use the Z-score threshold proposed by Altman (1968) based on a discriminant analysis of bankrupt firms. In particular, $Distress\ zone_{i,t}$ takes the value of one if a given firm-year's Z-score is above -1.81, and zero otherwise (note that, to favor interpretation, we reverse the Z-score sign relative to the traditional formula, so that our Z-score is increasing in distress risk). It should be stressed that this definition of distress not only captures bankrupt or almost bankrupt firms but also firms that experience a significant deterioration in their performance. This way of defining distress is particularly suitable to study the problem at hand, because it allows us to examine an extended period before potential default in which a CEO may divest his/her deferred compensation from the firm stock.

We first estimate regressions without control variables to limit concerns about "bad controls", namely about selection bias due to the inclusion of control variables that are outcome variables themselves (Angrist and Pischke, 2009). For the same reason, we choose a parsimonious set of control variables. $Control\ variables_{j(i),t}$ include CEO characteristics (age, tenure, and the relative debt-to-equity ratio) and firm size. Age and tenure provide insights into the CEO's distance from retirement, which in turn feeds back on his/her portfolio choices. The relative debt-to-equity ratio, by capturing the CEO's alignment with shareholders vis-a-vis creditors (Jensen and Meckling, 1976), provides a sufficient statistic as to the compensation structure's ability to mitigate debt-equity conflicts. The inclusion of firm size mitigates concerns that large firms award systematically different packages. In Section 6.5, we augment specification (3) with further control variables to account for other motives potentially driving CEOs' personal investment strategy.

Given that our hypothesis relates to the time-varying nature of the investment strategy of deferred compensation plans, we focus on the time-series variation by including CEO fixed effects υ_j. These fixed effects—besides filtering out the effect of CEO turnovers—capture largely time-invariant CEO-specific characteristics, such as skill, risk preferences, or compensation items that are unlikely to change throughout the CEO's term (e.g., ex ante severance pay). Also some of the most widely explored elements of compensation tend to exhibit low within-variation—e.g., salary or even CEO ownership, as shown by (Zhou, 2001)—, so that CEO fixed effects should to a large extent absorb them. To control for changing aggregate economic conditions, we include fiscal year fixed effects υ_t. Standard errors are clustered at the CEO-level.

Jackson and Honigsberg (2014) show that the unconditional correlation between deferred compensation returns and stock returns is typically very high and therefore we expect $\beta_1 > 0$. Our model predicts that in bad times the CEO invests a lower fraction of deferred compensation in company stocks, meaning that we should observe a reduced correlation between deferred compensation returns and stock returns in bad times. Therefore, according to our main hypothesis, we expect $\beta_3 < 0$.

5.2 Data and summary statistics

We consider a sample of US public firms from 2006 through 2015 that have available executive compensation information in the Standard and Poor's ExecuComp database. We start our analysis in 2006, because the SEC enhanced disclosure requirements about executive pensions and deferred compensation were enforced starting in 2006. ExecuComp provides information on nonqualified DC plans in the table "Deferred Compensation". Information on pensions, i.e., qualified and nonqualified DB plans, is reported in the table "Pension Benefits". Qualified DC plans, such as 401(k) plans, are covered by neither of these two tables and thus remain out of our main analysis.[11] Given that only DC plans allow participants to select the investment strategy, our measures of deferred compensation returns are based on nonqualified DC plans alone, which are the focus of

[11] 401(k) plans are covered in ExecuComp only through the impact of contributions to such plans on the annual compensation flow (within the item "All Other Compensation"). However, qualified DC plans are likely to be of limited quantitative importance, because salary deferrals to these plans are typically capped at $18,000 per year (see footnote 22 of Walker, 2017), a small amount for top executives.

the analysis. We then use information on DB plans to compute a comprehensive measure of the CEO's inside debt holdings.

We obtain accounting and stock return data from the the Center for Research in Security Prices/Compustat merged (CCM) database. We require each firm to have traded ordinary shares (CRSP share code 10 or 11). Governance data are from Riskmetrics. We exclude financial institutions, utilities, subsidiaries, and firm-years with negative assets or sales. We also exclude firm-years with missing assets, sales, number of outstanding shares, and stock price at fiscal year-end.

Throughout our analysis, we focus on CEOs. The final sample, being based on Execu-Comp data, includes S&P 1500 firms, which are arguably unlikely to file for bankruptcy. Consistently, our theoretical model describes the behavior of a representative CEO when the company is in good times or when it approaches (but is not yet in) bankruptcy.

Table 1 presents summary statistics for the variables used in our tests. The final sample includes 969 unique firms. Panel A reports summary statistics over the whole sample for which we observe CEO deferred compensation returns. Stock returns are higher and more volatile than deferred compensation returns.[12] The average CEO's deferred compensation outstanding balance (cumulated over his/her time at the firm) amounts to 71% of inside debt holdings (i.e., the sum of deferred compensation and pension plans' balances) and 60% of annual compensation. The importance of deferred compensation relative to inside debt is thus substantial and comparable to the results found by Anantharaman, Fang, and Gong (2014) on a different sample.[13]

The *Distress zone* indicator (equal to one if the Z-score is above -1.81, and zero otherwise) captures deteriorated firm financial health rather than just full-blown default

[12]Note that the baseline and the alternative measure of deferred compensation returns exhibit a high correlation.

[13]Anantharaman, Fang, and Gong (2014) find that, while deferred compensation plans and pensions plans are of comparable size over their sample ($3.8M vs. $3.9M), the risk-reducing effect of inside debt is driven by pension plans.

(to have a Z-score increasing in distress risk, we reverse its sign relative to the traditional definition). This is witnessed by the relatively large fraction of firm-years in the distress zone (17.7%). Among these, the instances in which default has already clearly manifested itself are likely to be a minority. We also define the indicator variable *Gray zone*, which is equal to one for firm-years with a Z-score between -2.99 and -1.81, the region found by Altman (1968) to be susceptible to misclassification of distressed vs. non distressed firms. The fraction of firm-years in the gray zone is 25.4%.

Panel B reports summary statistics distinguishing between distressed and non-distressed firm-years. Whereas average stock returns turn negative in distress, deferred compensation returns are lower but remain positive, in line with CEOs divesting from their own company stock.

[Insert Table 1 about here]

Figure 2 visualizes the empirical cumulative distribution function (CDF) of the Z-score, distinguishing between the financial crisis (2008 and 2009) and the other years in the sample. As one would expect, crisis years are characterized by higher distress risk.

[Insert Figure 2 about here]

All variables are winsorized at the 1% and 99% levels. Only deferred compensation returns are winsorized at the 2.5% and 97.5% levels, as their distribution is more prone to outliers (arguably because of measurement error). We provide detailed definitions of all variables in Appendix Table A.1. All dollar amounts are expressed in 2010 dollars. Table OA.1 of the Online Appendix provides information on the characteristics of the main estimation samples used in the paper.

6 Results

This section presents the results of our empirical analysis.

6.1 Main findings

Figure 3 shows the correlation between stock returns and our two measures of deferred compensation returns. Looking at our baseline measure (left graph), we observe that for a large fraction of CEOs (i.e., 189 out of 779), returns on deferred compensation and stock returns correlate almost perfectly (i.e., the correlation between the two is larger than 0.9). This correlation pattern is even more pronounced for our alternative measure of deferred compensation returns (right panel). This suggests that these CEOs invest nearly all (of the risky component) of their deferred compensation plans in company stock as pointed out by Jackson and Honigsberg (2014).

[Insert Figure 3 about here]

In Table 2, we confirm this prima facie evidence. We regress our two measures of returns on deferred compensation plans on stock returns (columns 1 and 4). Again, we find a positive and significant (at 1% level) relation. This result is robust to the inclusion of selected control variables (columns 2 and 5). One may be concerned that the observed positive relation is driven by firms whose stocks have a high correlation with the market. In other words, our result may be due to CEOs investing their plans in index funds tracking the market (or the industry) rather than in their own company stock. To address this issue, in columns 3 and 6, we distinguish between idiosyncratic stock return and market-adjusted industry stock return (see, e.g., Peters and Wagner, 2014). We find that not only the market-adjusted industry component of stock returns but also the idiosyncratic component enters significantly for our measures of deferred compensation returns. Hence, CEOs appear to be indeed investing deferred compensation plans in their own firm stock.

[Insert Table 2 about here]

We then study CEO investment strategy of deferred compensation over different states of the world. We aim to understand whether the incentives to invest the deferred compensation in company stock change with the firm's financial conditions. Our main hypothesis is that if the CEO is able to decide the investment strategy of deferred compensation, he/she would prefer to mitigate his/her exposure to company stock in bad times. Therefore, we expect to observe a lower correlation between deferred compensation and company stock returns when the firm approaches distress. Figure 4 confirms the model's intuition. We plot the linear relation between deferred compensation returns and stock returns distinguishing between distressed and non-distressed firm-years. In distressed periods, this relation is indeed weaker.

[Insert Figure 4 about here]

In Table 3, we conduct a similar test in a formal regression analysis. Panel A shows that in distressed periods, the correlation between stock returns and deferred compensation returns is significantly lower than in non-distressed periods as indicated by the negative and significant estimated coefficient of *Distress* × *Stock return* (columns 1 and 4). Again, this result is robust to the inclusion of control variables (columns 2 and 5) and to using the idiosyncratic component of stock return (columns 3 and 6).

[Insert Table 3 about here]

Based on the coefficient estimate in column 2 of Panel A (= 0.183), a one standard deviation increase in stock returns (= 41.5%) translates into a 6.9% increase in CEO deferred compensation returns in good times. The coefficient estimate for distressed firm-years ($= 0.183 - 0.073$) shows that the associated change in deferred compensations returns in such circumstances is 4.7%. In other words, the importance of the own firm stock's performance for deferred compensation plans is 31.9% lower in bad than in good states of the world, which illustrates the economic significance of the phenomenon at hand.

In Panel B, we conduct the same tests but including also the lagged distress indicator and its interaction with contemporaneous stock returns among the explanatory variables. For the baseline measure of deferred compensation returns, we find that only the interaction with the lagged distress indicator plays an important role (columns 1 and 2), masking also the role of contemporaneous distress, whose interaction with stocks returns retains a negative and sizable coefficient. This result suggests that CEOs may react sluggishly in their personal investment strategy to changes in the distress status of the firm. Table OA.4 of the Online Appendix consistently shows that CEOs keep a low exposure to own equity even after firm exits the distress zone. When using the alternative measure of deferred compensation returns (which is directly adjusted for withdrawals), the interaction with both the contemporaneous and the lagged distress indicator exhibit a negative and statistically significant coefficient (columns 3 and 4).

6.2 The role of withdrawals

Besides changing the investment strategy of their deferred compensation plans, a CEO may also make a withdrawal to modify personal exposure to firm risk. In Table 4, we analyze the role of CEO withdrawals from deferred compensation balances. In columns 1 and 2, we re-examine the relation between deferred compensation and stock returns including an indicator variable (*Withdrawal*) equal to one in firm-years in which CEO withdrawals from deferred compensation plans are non-zero. Our main results remain unchanged. The decrease in correlation in bad times does not appear to be driven by CEO withdrawals. In other words, the decreased correlation is likely to reflect a change in the CEOs' investment strategy away from company stock.

In columns 3 and 4, we adopt a different perspective and look at how CEO withdrawals correlate with stock returns, also conditioning on financial distress. To this end, we estimate probit regressions of *Withdrawal*, including industry fixed effects. We observe that withdrawals do not vary significantly with stock returns and financial distress, and exhibit a positive and statistically significant relation only with CEO tenure. Hence, CEOs do not seem to reduce their exposure to firm risk by cashing out their deferred compensation during distress. An explanation is that withdrawals in times of distress may be perceived negatively by investors. By contrast, reshuffling the investment strategy of deferred compensation away from company stock may allow CEOs to reduce their exposure to the firm and possibly attract less attention from investors. This result contributes to the discussion originated by Jackson and Honigsberg (2014), who point out that the CEO has two options to reduce losses on deferred compensation in distress: Withdrawal and modification of the investment strategy. Our results suggest that the latter is more likely to be implemented, at least for firms that are distressed but not on the verge of bankruptcy.

[Insert Table 4 about here]

In Table OA.2 of the Online Appendix, using manually collected data on CEO transactions on firm equity from SEC's Form 5 filings, we provide evidence that CEOs indeed tend to reduce their exposure to the firm in distress through indirect equity positions, such as those from deferred compensation plans. In the Online Appendix, we also conduct further tests relating to the definition of distress (Table OA.3) and to changes in distress status (Table OA.4).

6.3 The financial crisis as a shock to distress risk

The results so far show that CEOs reduce their deferred compensation plans' exposure to the firm in bad times. However, it is interesting to examine whether it is indeed increased distress risk driving the reduction in CEOs' exposure to the firm through deferred compensation rather than the other way around.

To this end, we ideally need a shock to firm distress risk that is outside the CEO's and the firm's control. We resort to the recent financial crisis as a plausibly exogenous and unanticipated shock. The collapse of Lehman Brothers and other events in 2008, indeed, triggered a period of turmoil in the financial industry, which then spread to nonfinancial firms, such as the ones in our sample. In the spirit of Dong, Halford, and Qiu (2016), we define as treated those firms whose distress risk—as measured by the Altman's Z-score—increased between 2006 (pre-treatment) and 2008 (post-treatment). The control group comprises firms whose distress risk declined over the same period.

Column 1 of Table 5 reports the results from a triple difference-in-differences specification over the window from 2006 to 2009.[14] In particular, we interact stock returns with the post-event indicator (*Post*) and the treatment indicator (*Treated*). In line with the main hypothesis, the triple interaction term exhibits a negative and statistically significant coefficient. This result is confirmed in column 2, where, to mitigate the potential influence of firms exhibiting extreme (positive or negative) swings in their financial health, we restrict the sample to firms whose absolute change in the Z-score between 2006 and 2008 is within the 90th percentile.

[Insert Table 5 about here]

These findings point to a direct effect of distress risk on CEOs' choice to reduce their exposure to firm risk through deferred compensation. CEOs' reaction to the financial

[14] We limit the analysis to this window to focus on the immediate effect of the financial crisis.

crisis arguably reflects both public information (e.g., available financial statements) and private information (e.g., soft information about the firm's actual exposure to troubled banks), so below we try to disentangle these two channels by looking at the timing of changes in CEOs' personal investment strategy around the onset of distress.

6.4 CEO trading activity around the onset of distress

We analyze CEOs' returns on deferred compensation as opposed to their trading activity on traditional equity incentives, i.e., their portfolio of company stock. We infer the CEO's stock trading behavior by implementing the algorithm of Clementi and Cooley (2009) and Morales (2015), through which we obtain the net trading revenues from selling firm stock and the net number of shares sold. Such trading activity reflects both shares directly traded by the CEO and those obtained through the exercise of stock options.[15]

In the spirit of an event study, we look at the dynamics of CEO deferred compensation returns and stock trading activity vis-a-vis overall firm equity performance around the first insurgence of distress in our sample period. More specifically, we look at firms that at the beginning of our sample are not in in the distress zone and subsequently become distressed. To be included in this analysis, we require that firms have at least one year of information about deferred compensation returns before the onset of distress.

The left graphs of Figure 5 visualize the median CEO deferred compensation return and firm stock return (left axis) against the median CEO net revenue from stock trading

[15] The algorithm is described in detail in Appendix A.2 of Clementi and Cooley (2009) and in Appendix B.1.1 of Morales (2015). Their algorithm extracts the net number of shares sold by the CEO from the law of motion for the number of shares held by him/her. Thus, the key pieces of information are the CEO's total shareholdings at the beginning and at the end of the year, the number of options that vested during the year, and the number of shares the CEO exercises during the year. If the net number of shares sold by the CEO is negative (i.e., the CEO actively purchased shares during the year), the net revenue from stock trading is assumed to be zero. If the net number of shares sold by the CEO is positive, the net revenue from trading is the maximum between (i) zero and (ii) the net number of shares sold times the average stock price over the year minus the cost of exercised options. We follow Clementi and Cooley (2009) and assume that the CEO's net sales of stock are carried out at the average stock price observed during the year.

(right axis), while the right graphs show the same median returns (left axis) against the fraction of CEOs that actively sell shares during the year (right axis) in the three years around the first insurgence of distress. The graphs in Panel A are based on the entire sample of firms described above (127 firms).

The graphs in Panel B restrict the analysis to firms that do not exit the distress zone in the three years after the onset of distress (55 firms).[16] Looking at these firms helps understand CEOs' behavior in those cases in which poor performance persists. The graphs in Panel C are based on firms whose CEO is not replaced over the relevant event window (51 firms). This subsample provides a glimpse into the investment strategies of those CEOs that are supported by shareholders during episodes of distress (e.g., because they are implementing a long-term turnaround strategy or because they are too powerful/entrenched to be removed).

The patterns illustrated in Figure 5 provide suggestive evidence on two aspects.

1. *Private vs. public information.* If CEOs showed some ability to time the overall performance of firm stock, this would point to some degree of reliance on private information in their trading decisions. Given that we only observe deferred compensation returns at annual frequency, we can only provide a coarse analysis of CEOs' timing abilities. Figure 5, in line with Table 3, suggests that CEOs indeed reduce the exposure of their deferred compensation plans to firm stock around the onset of distress (Panel A). The reduction in correlation seems more pronounced for those CEOs that are not replaced over our event window (Panel C). Yet, CEOs still appear to earn low deferred compensation returns on the year of onset of distress. In other words, CEOs do reduce exposure of deferred compensation plans to firm equity as distress emerges, but do not seem able/willing to anticipate it, which points to a limited role of private information

[16] This group includes also those firms that exit our sample in the three years after the onset of distress (as long as this happens before the end of the sample period in 2015): The assumption here is that firms prematurely exiting the sample are especially likely to be under stress (e.g., bankruptcy, exclusion from S&P 1500 indexes, acquisition by a more efficient competitor, etc.).

in their investment strategy.

2. *CEO stock trading activity.* Traditional stock incentives may be more scrutinized by investors than deferred compensation plans, which may make CEOs more reluctant to sell large holdings of such shares at times of distress. The graphs on the left in Figure 5 show some (small) increase in the net revenues from stock sales at the onset of distress and in year -1, followed by a sharp drop in year 1. However, these changes are driven to a large extent by changes in stock prices. Indeed, looking simply at the fraction of CEOs that undertake net sales of shares over a given year (graphs on the right in Figure 5), the pattern—although overall trending down from year -2 until year 1—appears remarkably stable at roughly 75%, thus suggesting that CEOs' selling activity does not change substantially over time. Such a fraction only appears to pick up in year 2 or 3. All in all, this suggests that CEOs' trading on equity incentives is not strongly influenced by private information in line with Armstrong, Core, and Guay (2015), and adjustment to distress may be slower than for deferred compensation plans, possibly because of more intense scrutiny of investors.

[Insert Figure 5 about here]

6.5 Additional control variables

In our baseline results, we keep control variables to a minimum to mitigate concerns about "bad controls" (Angrist and Pischke, 2009). However, there may still be confounding factors at work that are not captured neither by our set of control variables nor by our set of fixed effects.

In Table 6, we directly control for further prominent factors. Whereas in the baseline specification we control for compensation structure by means of *CEO relative D/E ratio*, here in column 1 we also include a set of control variables aimed at better capturing the firm's (and the CEO's) ability to modify his/her exposure to firm risk. For instance, the compensation committee may counter the CEO's decision to reduce firm equity holdings in deferred compensation plans by increasing his/her incentive compensation, through stocks or incentives. We thus control for the CEO's exposure to the firm through effective ownership, which reflects his/her direct equity holdings both from stocks and options. Similarly, we account for the risk-taking implications of CEO option holdings through the vega of his/her portfolio of incentives. At the same time, the CEO him/herself may decide to amplify or mitigate the changes in his/her exposure to firm risk induced by deferred compensation allocation through option exercising behavior. Because of this, we control for the CEO's proceeds from option exercises (relative to total compensation) over the year.

In column 2, we augment the specification with *Acquisitions*, which measures the M&A activity of the firm. As pointed out by Phan (2014), acquiring firms are likely to change the weight of inside debt relative to equity incentives to align it with the new capital structure following M&As. In column 3, we control for other governance mechanisms in place in the firm by including the E-index of Bebchuck, Cohen, and Ferrell (2009). A CEO's ability to modify his/her deferred compensation investment strategy and firm risk-taking is indeed arguably affected by the quality of corporate governance.

We then control for a different set of fixed effects, which should relieve concerns about omitted variables. In column 4, we replace CEO fixed effects with firm fixed effects. Firm fixed effects allow us to explore how sensitive the analysis is to changes in correlation between deferred compensation and stock returns related to CEO turnovers. In column 5, we use calendar (rather than fiscal) year fixed effects. In column 6, to control for seasonal patterns, we control for fiscal year fixed effects and month of fiscal year-end fixed effects.

In each case, the results remain supportive of our main hypothesis. Interestingly, the decline in correlation of deferred compensation returns with stocks returns in distress becomes more pronounced once the effect of CEO turnovers is not filtered out through CEO fixed effects (column 4).

[Insert Table 6 about here]

In sum, these results corroborate the importance of the CEO divestment from firm equity taking place in bad times through deferred compensation plans. Such a divestment is not explained by changes in other compensation or governance mechanisms and thus unlikely to be offset by them. To put it differently, the adjustment in CEO investment strategy of deferred compensation may to a large extent go unnoticed and pose doubts on the risk-taking implications of this form of compensation, which we discuss below.

7 Discussion

The results in Section 6 support the main hypothesis that, when the firm's profitability is low, CEOs "abandon ship" by divesting deferred compensation away from firm equity. While interesting, this finding is especially important for its possible consequences for CEO risk-taking incentives. With the help of our theoretical framework (see the Appendix Section A.1 for details), here we explore such consequences.

The flexibility on the investment strategy of deferred compensation may induce the CEO in our model to take on more or less risk, as compared to a benchmark deferred compensation contract without such a flexibility (henceforth the "non-discretionary contract"), depending on the firm's profitability. When the expected payoff on company stock is sufficiently larger than that of alternative investments, the CEO may decide to overweight company stock in deferred compensation plans, namely to short-sell the alternative assets, and invest the proceeds in the company stock. The CEO realizes a loss on the short selling strategy in case of default which may induce him/her to take less risk ex ante than under the non-discretionary contract to prevent this from happening.

Although interesting from a theoretical point of view, this result is unlikely to happen because it would require the CEO to borrow against his/her deferred compensation to buy additional shares of the company stock. When the firm's profitability is not high enough or short sales are forbidden, the payoff of alternative investments works as an insurance against default, inducing the CEO to take more risk than under the non-discretionary contract. Especially when the firm's profitability is low, the CEO increases the fraction of deferred compensation invested in alternative assets, thus reinforcing this mechanism.

The CEO in the model, besides holding firm equity indirectly through deferred compensation, also holds it directly through traditional equity awards (e.g., restricted stocks and options). His/her allocation of deferred compensation plans between company equity and alternative investments thus affects traditional equity awards' risk-taking incentives and this effect depends again on the company profitability. Recall that firm equity is a call option on asset cash flows and, thus, its value depends positively on cash flow volatility. This implies that, under the non-discretionary contract, the CEO always increases (decreases) risk when the shares of directly held (i.e., not via deferred compensation) equity increases (decreases). In this case, a traditional sale of equity produces the usual result of mitigating the risk-taking incentives of a risk-neutral CEO.[17]

Under the discretionary contract, the value of deferred compensation is no longer constant but depends on its investment strategy which, in turn, is linked to the firm's profitability. On the one hand, higher firm risk increases the value of equity held (both directly and indirectly) by the CEO and, thus, the value of his/her compensation. On the other hand, higher risk means higher probability of default and, thus, reduces the value of deferred compensation. As explained above, when the firm's expected payoff is sufficiently larger than that of alternative investments, the CEO may find it optimal to overweight company stocks in deferred compensation plans. In this case, the value-increasing effect of

[17]This result hinges on the customary limited liability assumption: The creditors bear the cost of default, whereas the CEO enjoys the gains of successful risky investments.

risk on equity dominates, thus giving the CEO an incentive to increase firm risk following an increase in directly held firm equity. When company profitability is not high enough or short sales are forbidden, the effect of risk on the probability of default dominates and the CEO has an incentive to reduce firm risk after an increase in directly held firm equity. Similarly, Carpenter (2000) and Ross (2004) also find that convex compensation schemes do not necessarily increase CEO risk-taking incentives. Our model suggest that the flexibility in the investment strategy of deferred compensation has the potential to also change the risk-taking incentives of traditional equity awards.

The risk-taking implications of indirectly held company stock are less ambiguous. In particular, an increase in the amount of equity held through deferred compensation reduces risk-taking incentives. This is so because direct and indirect equity holdings have a different contractual nature in our model. Direct equity holdings are (exogenously) decided by the shareholders at the time the contract is signed. If the amount of directly awarded company stock changes, the CEO reacts by adjusting firm risk ex ante and his/her optimal choice depends on the overall impact of firm risk on the value of his/her deferred compensation. Differently, the amount of equity held through deferred compensation is (endogenously) decided by the CEO according to the firm's profitability. The CEO finds it optimal to increase his/her indirect investment in company equity in good times, i.e., exactly when he/she seeks to reduce firm risk to maximize the probability of receiving his/her deferred compensation. Thus, our model predicts a negative relation between indirectly held company equity and firm risk.

All in all, the risk-taking implications of flexibility in the investment strategy of deferred compensation plans are potentially important, especially for creditors. However, analyzing the empirical relation between CEO investment strategy of deferred compensation and firm risk is challenging for several reasons. Besides the hard-to-observe nature of deferred compensation investment strategy pointed out above, both firm's profitability and risk are endogenous variables, raising obvious identification concerns. These issues deserve further investigation but exceed the scope of this paper.

8 Conclusion

The recent literature on executive compensation suggests that inside debt induces CEOs to behave more conservatively and, in this way, helps protect creditors from the risk of default. However, to serve this purpose, inside debt has to provide CEOs with debt-like payoffs and expose CEOs and creditors to the same default risk. But what happens if CEOs can invest the inside debt with the goal of protecting their expected compensation against the possibility of default?

We focus on the component of inside debt that allows such a behavior, i.e., deferred compensation plans. The theory and the empirical evidence provided in our paper suggests that the CEO may change strategically his/her deferred compensation asset allocation to increase expected compensation in states in which deferred compensation contracts are supposed to deliver a low payoff, namely in default.

We argue that, as a result, deferred compensation may increase, rather than decrease, risk-taking incentives. Our theory predicts that the CEO incentive to change the investment strategy of deferred compensation is most important in distress and, thus, induces CEOs to increase risk-taking exactly in those periods in which creditors would require a more prudent behavior. We leave the empirical analysis of these risk-taking conjectures for future research.

These results have implications for the ongoing policy debate. It would be inadequate to assume that bonus deferral would unambiguously decrease risk-taking incentives. Moreover, it would be important to have information not only about the investment strategy of the deferred compensation, but also about its development over time.

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Figure 1: Timeline of the model
This figure visualizes the timeline of the model (see Appendix A.1 for details), introducing the distinction between time $t = 0^-$ and $t = 0$ to favor intuition. At $t = 0^-$, a given CEO compensation contract is in place (containing salary, equity incentives, and deferred compensation) and the CEO observes the firm's expected profitability. At $t = 0$, the manager selects (i) the variance of the firm's investment technology and (ii) personal exposure to firm equity through deferred compensation, in such a way to maximize his/her expected wealth. At $t = 1$, the payoff of investment is realized and compensation contract is settled.

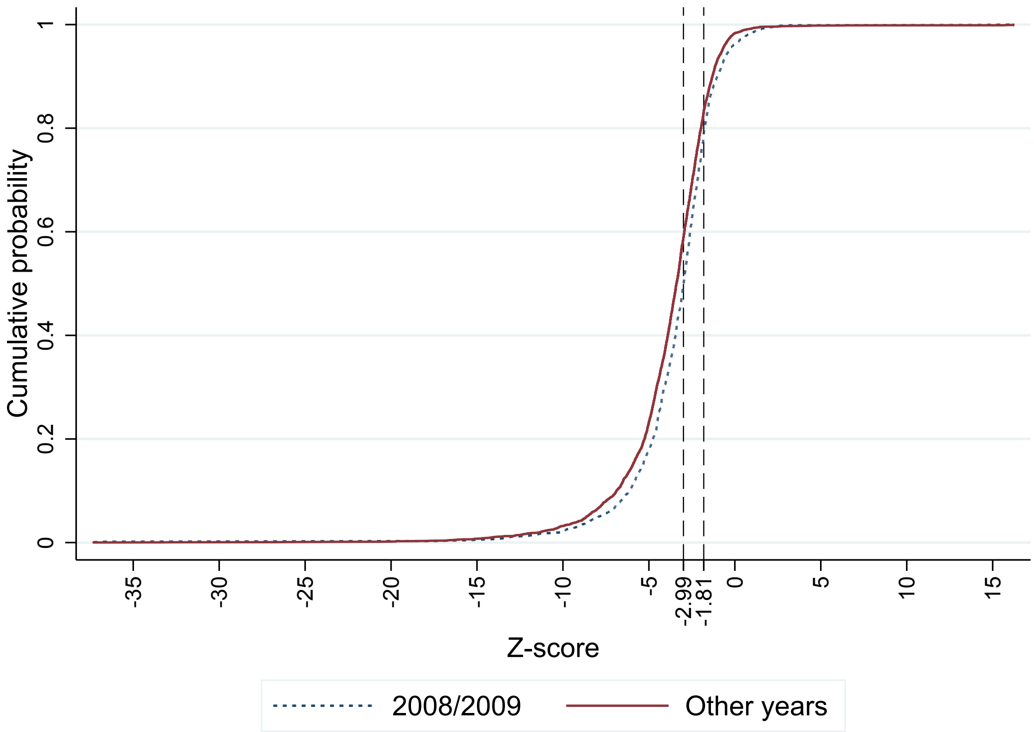


Figure 2: Empirical CDF of the Z-score
This figure shows the empirical CDF of the Z-score in crisis years (2008 and 2009) vs. non-crisis years. The thresholds deliming the "distress zone" (Z-score above -1.81) and the "gray zone" (Z-score between -2.99 and -1.81) are denoted by the two dashed vertical lines. The sample includes those observations for which information on CEO deferred compensation returns is available.

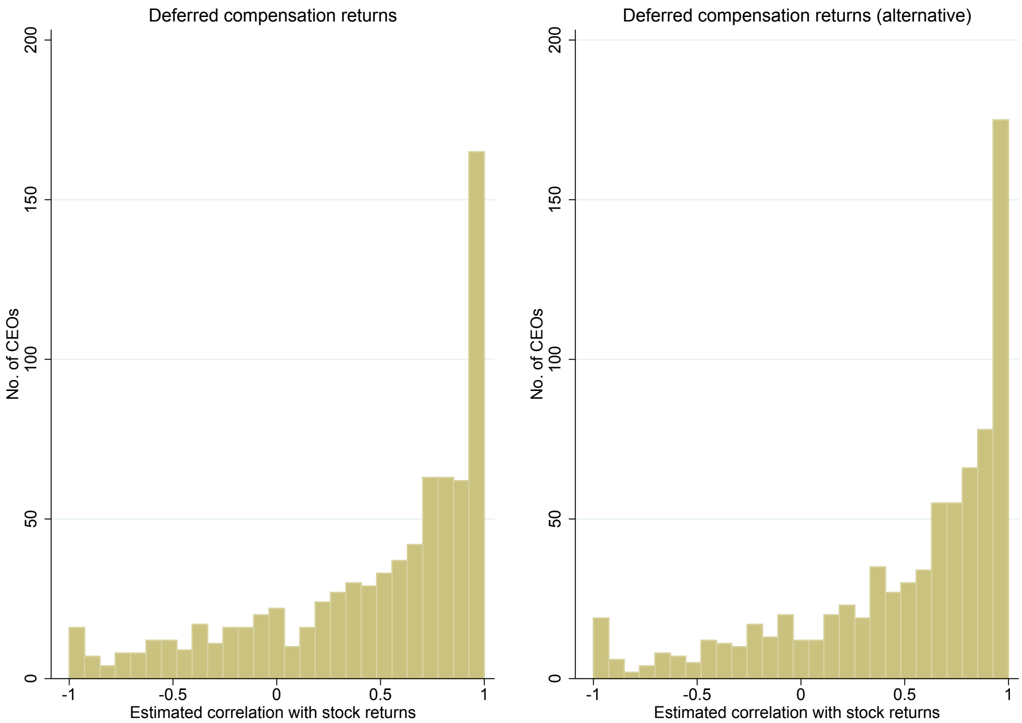


Figure 3: Correlation between stock returns and deferred compensation returns
This figure shows the distribution of correlation between deferred compensation returns and stock returns across CEOs. Correlation is computed for CEOs with at least four observations available. The same correlation is computed for two different measures of deferred compensation returns. Left panel shows the correlation between stock returns and the baseline deferred compensation measure. Right panel shows the correlation between stock returns and an alternative deferred compensation measure.

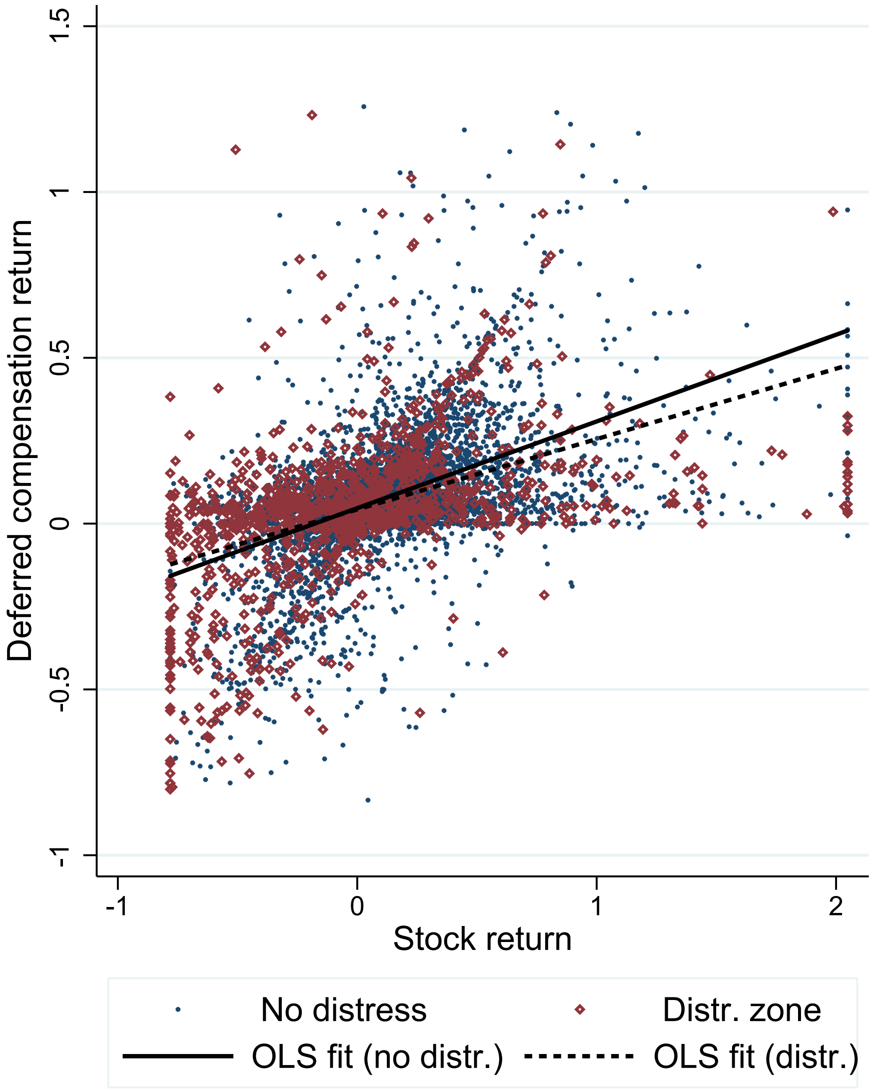
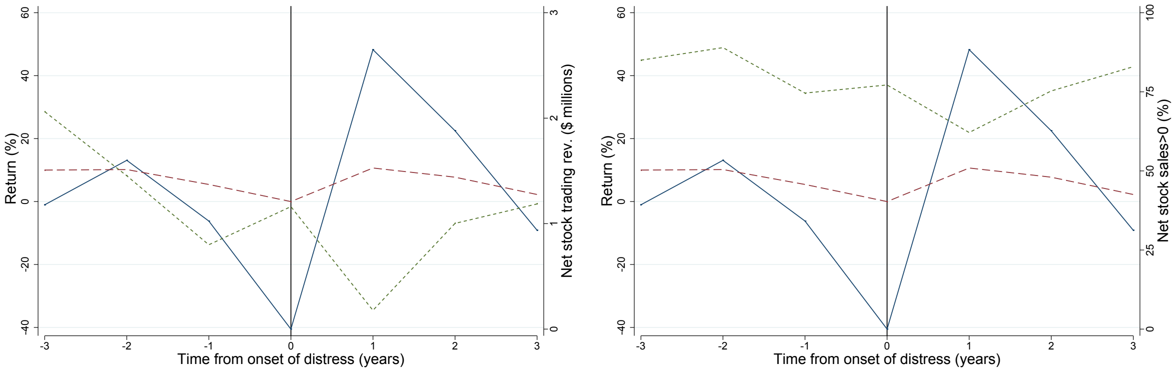
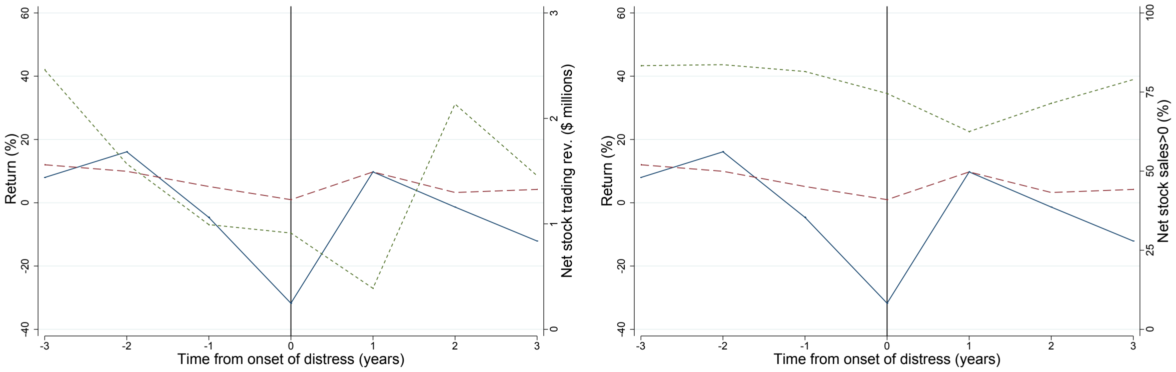


Figure 4: Relation between stock returns and deferred compensation returns
This figure shows CEO deferred compensation returns (baseline measure) and stock returns. The fitted lines are estimated using an OLS regression of deferred compensation returns on stock returns distinguishing firm-years inside and outside the distress zone. Outliers are omitted.

Panel A: All firms that enter the distress zone



Panel B: Firms that do not exit the distress zone



Panel C: Firms that enter the distress zone and do not replace the CEO

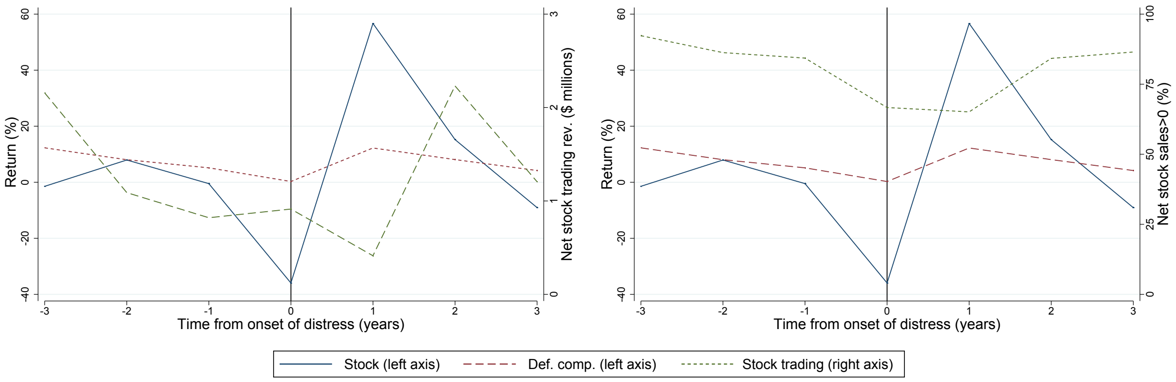


Figure 5: Returns on deferred compensation and stock vs. stock trading activity
This figure plots the median CEO deferred compensation return (baseline measure) and firm stock return against the median CEO net revenue from stock trading (left graphs) and the fraction of CEOs that actively sell shares during the year (right graphs) around the onset of distress. The horizontal axis shows years in event-time. The graphs in Panel A are based on all firms in our sample that enter the distress zone. The graphs in Panel B focus on firms that do not exit the distress zone. The graphs in Panel C focus on firms that do not replace the CEO after they enter the distress zone.

Table 1: Summary statistics

This table reports summary statistics of the variables used in the paper. The sample includes 969 US firms over the period 2006-2015 for which information on CEO deferred compensation returns is available. We obtain executive compensation data from ExecuComp, accounting and stock market data from CCM, and corporate governance data from Riskmetrics. All dollar amounts are in 2010 constant dollars. Panel A reports the summary statistics for the full sample. Panel B reports the summary statistics distinguishing between firm-years in the distress zone (i.e., with a Z-score above -1.81) and the rest of the sample. Refer to Appendix Table A.1 for variable definitions.

Panel A: Full sample

	Mean	St. dev.	Q1	Med.	Q3	Obs.
Returns						
Deferred compensation return	0.082	0.312	0.000	0.065	0.160	6,097
Deferred compensation return (alt.)	0.074	0.204	0.001	0.063	0.152	5,971
Stock return	0.117	0.415	-0.127	0.095	0.312	6,042
Idiosyncratic stock return	-0.001	0.350	-0.187	-0.006	0.182	6,012
Market-adj. industry stock return	0.028	0.171	-0.065	0.007	0.102	6,010
Distress measures						
Z-score	-3.761	2.882	-4.770	-3.291	-2.159	5,947
Distress zone	0.177	0.382	0.000	0.000	0.000	5,947
Gray zone	0.254	0.435	0.000	0.000	1.000	5,947
Z-score (top 25%)	0.119	0.324	0.000	0.000	0.000	5,947
CEO characteristics and compensation						
CEO age	56.280	6.491	52.000	56.000	60.000	6,097
CEO tenure	6.694	6.506	2.000	5.000	9.000	6,097
CEO turnover	0.116	0.321	0.000	0.000	0.000	6,097
CEO effective ownership	0.019	0.037	0.003	0.008	0.017	6,097
CEO vega	155.437	210.198	21.027	76.537	198.945	6,097
CEO exercised options	0.432	1.011	0.000	0.000	0.408	6,090
CEO def. comp. (scaled by inside debt)	0.709	0.370	0.328	1.000	1.000	6,097
CEO def. comp. (scaled by ann. comp.)	0.600	0.867	0.101	0.277	0.671	6,092
CEO relative D/E ratio	3.598	12.580	0.149	0.530	1.687	5,670
Withdrawal	0.112	0.315	0.000	0.000	0.000	6,097
Firm characteristics						
Size	8.093	1.431	7.013	7.970	9.074	6,097
E-index	3.397	1.250	3.000	3.000	4.000	5,603
Cash acquisitions	0.036	0.089	0.000	0.002	0.025	5,657

(Continued)

Table 1: – *Continued*

Panel B: Distressed vs. non-distressed firms						
	Outside distress zone			Inside distress zone		
	Obs.	Mean	St. dev.	Obs.	Mean	St. dev.
Returns						
Deferred compensation return	5,042	0.089	0.309	1,055	0.049	0.327
Deferred compensation return (alt.)	4,942	0.082	0.202	1,029	0.036	0.210
Stock return	5,005	0.144	0.384	1,037	-0.011	0.519
Idiosyncratic stock return	4,975	0.012	0.342	1,037	-0.063	0.376
Market-adj. industry stock return	4,960	0.036	0.164	1,050	-0.007	0.197
Distress measures						
Z-score	4,892	-4.409	2.651	1,055	-0.756	1.805
Distress zone	4,892	0.000	0.000	1,055	1.000	0.000
Gray zone	4,892	0.309	0.462	1,055	0.000	0.000
Z-score (top 25%)	4,892	0.000	0.000	1,055	0.672	0.470
CEO characteristics and compensation						
CEO age	5,042	56.362	6.549	1,055	55.886	6.192
CEO tenure	5,042	6.735	6.535	1,055	6.500	6.366
CEO turnover	5,042	0.118	0.322	1,055	0.110	0.313
CEO effective ownership	5,042	0.020	0.039	1,055	0.014	0.025
CEO vega	5,042	163.389	215.829	1,055	117.433	176.079
CEO exercised options	5,035	0.485	1.065	1,055	0.180	0.639
CEO def. comp. (scaled by inside debt)	5,042	0.712	0.366	1,055	0.694	0.385
CEO def. comp. (scaled by ann. comp.)	5,037	0.634	0.900	1,055	0.437	0.661
CEO relative D/E ratio	4,635	4.100	13.337	1,035	1.353	8.018
Withdrawal	5,042	0.110	0.313	1,055	0.121	0.327
Firm characteristics						
Size	5,042	8.026	1.417	1,055	8.415	1.457
E-index	4,698	3.408	1.250	905	3.339	1.244
Cash acquisitions	4,684	0.034	0.081	973	0.044	0.122

Table 2: Deferred compensation returns and stock returns

This table reports panel regressions of CEO deferred compensation returns on stock returns over the period 2006-2015. The specifications are estimated for two different measures of deferred compensation returns, both based on annual earnings relative to beginning-of-year balance of deferred compensation plans. Columns 1 through 3 (columns 4 through 6) use the baseline deferred compensation return measure (a measure directly adjusted for CEO withdrawals) as the dependent variable. Columns 1 and 4 estimate the baseline specification. Columns 2 and 5 control also for size, CEO age, CEO tenure, and the CEO relative D/E ratio. Columns 3 and 6 distinguish between idiosyncratic stock returns and market-adjusted industry stock returns (based on Fama-French 48 industry groups). All specifications include CEO fixed effects and year fixed effects. The t-statistics are calculated with robust standard errors clustered by CEO. Significance at the 10%, 5%, and 1% levels is indicated by *, **, ***, respectively. Refer to Appendix Table A.1 for variable definitions.

	Def. comp. return			Def. comp. return (alt.)		
	(1)	(2)	(3)	(4)	(5)	(6)
Stock return	0.165***	0.167***		0.152***	0.157***	
	(9.31)	(9.05)		(13.01)	(13.02)	
Idio. stock return			0.127***			0.115***
			(6.57)			(9.22)
Market-adj. ind. stock return			0.188***			0.191***
			(5.47)			(8.10)
Size		0.005	0.005		-0.007	-0.008
		(0.23)	(0.21)		(-0.55)	(-0.62)
CEO age		0.008	0.009		-0.002	-0.000
		(0.50)	(0.56)		(-0.15)	(-0.03)
CEO tenure		-0.003	-0.006		-0.000	-0.004
		(-0.10)	(-0.19)		(-0.02)	(-0.17)
CEO relative D/E ratio		0.001*	0.001*		0.000	0.000
		(1.87)	(1.95)		(1.30)	(1.23)
CEO FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5,679	5,286	5,218	5,564	5,189	5,122
Adjusted R^2	0.21	0.20	0.19	0.34	0.34	0.31

Table 3: Deferred compensation returns, stock returns, and distress

This table reports panel regressions of CEO deferred compensation returns on stock returns conditioning on firms' distress status over the period 2006-2015. Panel A analyzes the unconditional relation between deferred compensation returns and stock returns, interacting stock returns with *Distress zone*, an indicator variable equal to one if a firm-year ehibits a Z-score above -1.81. The specifications are estimated for two different measures of deferred compensation returns, both based on annual earnings relative to beginning-of-year balance of deferred compensation plans. Columns 1 through 3 (columns 4 through 6) use the baseline deferred compensation return measure (a measure directly adjusted for CEO withdrawals) as the dependent variable. Columns 1 and 4 estimate the baseline specification. Columns 2 and 5 control also for size, CEO age, CEO tenure, and the CEO relative D/E ratio. Columns 3 and 6 distinguish between idiosyncratic stock returns and market-adjusted industry stock returns (based on Fama-French 48 industry groups). Panel B estimates the same specifications as in colums 1-2 and 4-5 of Panel A but including also the lagged *Distress zone* indicator and its interaction with contemporaneous stock returns. All specifications include CEO fixed effects and year fixed effects. The *t*-statistics are calculated with robust standard errors clustered by CEO. Significance at the 10%, 5%, and 1% levels is indicated by *, **, ***, respectively. Refer to Appendix Table A.1 for variable definitions.

Panel A: Distressed vs. non-distressed firms

	Def. comp. return			Def. comp. return (alt.)		
	(1)	(2)	(3)	(4)	(5)	(6)
Distress zone × Stock return	-0.086***	-0.073**		-0.086***	-0.086***	
	(-2.84)	(-2.38)		(-4.46)	(-4.46)	
Stock return	0.184***	0.183***		0.179***	0.179***	
	(8.73)	(8.17)		(13.13)	(13.13)	
Distress zone × Idio. stock return			-0.087**			-0.099***
			(-2.49)			(-4.30)
Idio. stock return			0.144***			0.138***
			(6.10)			(9.45)
Distress zone × Market-adj. ind. stock return			-0.160**			-0.169***
			(-2.10)			(-3.54)
Market-adj. ind. stock return			0.225***			0.232***
			(5.57)			(8.73)
Distress zone	0.019	0.016	0.003	-0.002	-0.002	-0.015
	(0.95)	(0.80)	(0.16)	(-0.16)	(-0.16)	(-1.17)
Size		0.006	0.006	-0.005	-0.005	-0.006
		(0.26)	(0.24)	(-0.42)	(-0.42)	(-0.50)
CEO age		0.016	0.017	0.003	0.003	0.004
		(0.88)	(0.93)	(0.27)	(0.27)	(0.37)
CEO tenure		-0.003	-0.006	-0.001	-0.001	-0.005
		(-0.09)	(-0.20)	(-0.05)	(-0.05)	(-0.22)
CEO relative D/E ratio		0.001*	0.001*	0.000	0.000	0.000
		(1.86)	(1.95)	(1.21)	(1.21)	(1.17)
CEO FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5,535	5,145	5,080	5,049	5,049	4,985
Adjusted R^2	0.21	0.20	0.19	0.34	0.34	0.32

Panel B: Distressed vs. non-distressed firms (timing of distress)				
	Def. comp. return		Def. comp. return (alt.)	
	(1)	(2)	(3)	(4)
Distress zone × Stock return	-0.032	-0.021	-0.049**	-0.043**
	(-0.95)	(-0.62)	(-2.28)	(-1.98)
Distress zone	-0.004	-0.002	-0.003	-0.001
	(-0.22)	(-0.09)	(-0.25)	(-0.09)
Distress zone (lagged) × Stock return	-0.080**	-0.080**	-0.059***	-0.060***
	(-2.28)	(-2.22)	(-2.79)	(-2.76)
Distress zone (lagged)	0.051**	0.052**	0.022	0.022
	(2.20)	(2.21)	(1.36)	(1.31)
Stock return	0.199***	0.203***	0.189***	0.193***
	(8.03)	(7.59)	(12.06)	(11.68)
Size		-0.001		-0.010
		(-0.03)		(-0.69)
CEO age		0.003		0.008
		(0.08)		(0.20)
CEO tenure		0.022		0.018
		(0.88)		(0.86)
CEO relative D/E ratio		0.001*		0.000
		(1.81)		(1.15)
CEO FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Observations	4,363	4,064	4,315	4,021
Adjusted R^2	0.26	0.25	0.38	0.37

Table 4: The role of CEO withdrawals from deferred compensation plans
This table analyzes the role of CEO withdrawals from deferred compensation plans over the period 2006-2015. Withdrawals are measured by means of the indicator variable *Withdrawal*, which is equal to one if the CEO withdraws a non-zero amount from his/her deferred compensation balance in a given year. Columns 1 and 2 report linear regressions of CEO deferred compensation returns (baseline measure) on stock returns, including *Withdrawal* as a control variable. Columns 3 and 4 report probit regressions of *Withdrawal* on stock returns. Odd-numbered columns analyze the relation between the dependent variable and stock returns. Even-numbered columns analyze the relation between the dependent variable and stock returns conditional on the firm's financial distress as measured by *Distress zone*, an indicator variable equal to one if a firm-year ehibits a Z-score above -1.81. Columns 1 and 2 include CEO fixed effects. Columns 3 and 4 include industry (Fama-French 48) fixed effects. All specifications include control variables (size, CEO age, CEO tenure, and the CEO relative D/E ratio) and year fixed effects. The t-statistics are calculated with robust standard errors clustered by CEO. Significance at the 10%, 5%, and 1% levels is indicated by *, **, ***, respectively. Refer to Appendix Table A.1 for variable definitions.

	Def. comp. return		Withdrawal	
	(1)	(2)	(3)	(4)
Distress zone × Stock return		-0.073**		-0.147
		(-2.38)		(-1.20)
Distress zone		0.014		0.115
		(0.68)		(1.25)
Stock return	0.167***	0.183***	-0.037	0.058
	(9.05)	(8.16)	(-0.63)	(0.87)
Distress zone × Withdrawal		0.020		
		(0.39)		
Withdrawal	-0.009	-0.017		
	(-0.37)	(-0.67)		
Size	0.005	0.006	0.004	0.004
	(0.22)	(0.26)	(0.11)	(0.10)
CEO age	0.008	0.016	-0.001	-0.002
	(0.50)	(0.88)	(-0.17)	(-0.23)
CEO tenure	-0.004	-0.003	0.012**	0.012**
	(-0.12)	(-0.10)	(2.08)	(2.16)
CEO relative D/E ratio	0.001*	0.001*	0.002	0.003
	(1.88)	(1.88)	(1.07)	(1.32)
CEO FE	Yes	Yes	No	No
Industry FE	No	No	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
Observations	5,286	5,145	5,482	5,352
Adjusted R^2	0.20	0.20		
Pseudo R^2			0.04	0.04

Table 5: The financial crisis as a shock to distress risk
This table reports panel regressions of CEO deferred compensation returns (baseline measure) on stock returns using the financial crisis as a quasi-experiment giving rise to a plausibly exogenous positive shock to firms' distress risk. The sample period is 2006-2009. The treatment indicator variable *Treated* is equal to one if the firm's Z-score increases between 2006 and 2008, and zero otherwise. The indicator variable *Post* is equal to one from 2008 onwards. Column 1 interacts stock returns with *Treated* and *Post*. To reduce the possible influence of firms experiencing extreme (positive or negative) swings in their financial health, column 2 estimates the specification as in column 1 but restricting the sample to those firms whose absolute change in the Z-score between 2006 and 2008 is below the 90th percentile. All specifications include control variables (size, CEO age, CEO tenure, and the CEO relative D/E ratio) and CEO fixed effects. The t-statistics are calculated with robust standard errors clustered by CEO. Significance at the 10%, 5%, and 1% levels is indicated by *, **, ***, respectively. Refer to Appendix Table A.1 for variable definitions.

	Def. comp. return	
	(1)	(2) $\lvert\Delta$Z-score$\rvert$ < P90
Post × Treated × Stock return	-0.393***	-0.377**
	(-2.68)	(-2.56)
Treated × Post	0.084*	0.082*
	(1.79)	(1.74)
Treated × Stock return	0.473***	0.468***
	(3.61)	(3.56)
Post × Stock return	0.305**	0.305**
	(2.27)	(2.28)
Post	-0.437***	-0.434***
	(-7.07)	(-6.98)
Stock return	-0.116	-0.116
	(-0.99)	(-0.98)
Size	-0.001	0.011
	(-0.01)	(0.15)
CEO age	0.101***	0.101***
	(2.99)	(2.95)
CEO tenure	0.052**	0.051**
	(2.18)	(2.12)
CEO relative D/E ratio	0.002	0.002
	(1.57)	(1.37)
CEO FE	Yes	Yes
Time FE	No	No
Sample	2006-2009	2006-2009
Observations	1,656	1,614
Adjusted R^2	0.25	0.24

Table 6: Additional control variables

This table augments the baseline regression specification (i.e., column 2 in Panel B of Table 3) with additional control variables and fixed effects. Column 1 includes the CEO effective ownership, option vega, and option exercises. Column 2 adds a measure of the firm's M&A activity. Column 3 adds the E-index of corporate governance. Column 4 replaces CEO fixed effects with firm fixed effects. Column 5 replaces fiscal year fixed effects with calendar year fixed effects. Column 6 includes month of fiscal year-end fixed effects. All specifications include baseline control variables (size, CEO age, CEO tenure, and the CEO relative D/E ratio). The t-statistics are calculated with robust standard errors clustered by CEO (except in column 4, where standards errors are clustered by firm). Significance at the 10%, 5%, and 1% levels is indicated by *, **, ***, respectively. Refer to Appendix Table A.1 for variable definitions.

	Def. comp. return					
	(1)	(2)	(3)	(4)	(5)	(6)
Distress zone × Stock return	-0.073**	-0.068**	-0.088***	-0.104***	-0.091***	-0.085**
	(-2.38)	(-2.08)	(-2.62)	(-3.15)	(-2.63)	(-2.51)
Distress zone	0.017	0.023	0.017	0.016	0.013	0.021
	(0.87)	(1.14)	(0.84)	(0.93)	(0.60)	(1.01)
Stock return	0.182***	0.183***	0.202***	0.205***	0.243***	0.201***
	(8.12)	(7.83)	(8.30)	(8.61)	(10.25)	(8.26)
Size	0.006	0.019	0.007	0.001	0.012	0.005
	(0.27)	(0.76)	(0.27)	(0.06)	(0.43)	(0.17)
CEO age	0.015	0.017	0.014	0.002	0.025	0.014
	(0.83)	(0.88)	(0.75)	(1.07)	(1.19)	(0.75)
CEO tenure	-0.003	-0.005	-0.007	-0.005***	-0.007	-0.006
	(-0.10)	(-0.16)	(-0.22)	(-3.07)	(-0.23)	(-0.19)
CEO relative D/E ratio	0.001*	0.001*	0.001*	0.000	0.001*	0.001*
	(1.88)	(1.92)	(1.75)	(0.87)	(1.72)	(1.73)
CEO eff. ownership	0.163	0.134	0.139	0.534	0.135	0.143
	(0.42)	(0.34)	(0.34)	(1.37)	(0.34)	(0.35)
CEO vega	0.000	0.000	0.000	0.000	0.000	0.000
	(0.10)	(0.53)	(0.97)	(1.42)	(1.39)	(0.90)
CEO exercised options	0.008	0.008	0.009*	0.010*	0.010*	0.009*
	(1.62)	(1.54)	(1.73)	(1.74)	(1.75)	(1.75)
Acquisitions		-0.110**	-0.093**	-0.075*	-0.101**	-0.098**
		(-2.21)	(-1.97)	(-1.73)	(-2.10)	(-2.06)
E-index			0.009	0.007	0.008	0.009
			(1.22)	(1.07)	(0.96)	(1.17)
CEO FE	Yes	Yes	Yes	No	Yes	Yes
Firm FE	No	No	No	Yes	No	No
Time FE	Yes	Yes	Yes	Yes	No	Yes
Calendar time FE	No	No	No	No	Yes	No
Fiscal month FE	No	No	No	No	No	Yes
Observations	5,141	4,787	4,464	4,673	4,464	4,464
Adjusted R^2	0.20	0.20	0.21	0.19	0.19	0.21

Appendix for

"CEO Investment of Deferred Compensation Plans and Firm Performance"

A.1 Theoretical framework

Our framework builds on the model of Bolton, Mehran, and Shapiro (2015). The firm's CEO can invest an amount I at $t = 0$ and obtain a random payoff $\tilde{x}$ at $t = 1$ that can take three values:

- A high payoff $x + (1 + \mu)\Delta$ with probability q;
- A medium payoff x with probability $(1 - 2q)$;
- A low payoff $x - \delta$ with probability q.

Given that there are three possible states of the world, the probability $q < \frac{1}{2}$ represents tail risk (i.e., the variance of the investment technology) and is the choice variable for the CEO. $\mu \in (0, 1)$ represents the firm's profitability: The higher μ, the higher is the upside potential of the investment. The CEO can change q at the cost $c(q) = \frac{1}{2}aq^2$.

To finance investments, the firm raises external funds at the rate R under the constraint that risk-neutral external creditors obtain a total return $1+R$ at least equal to the risk-free return, which is assumed to be 1 for simplicity. Under the additional assumption that the firm defaults only when the investment payoff is low, the payoff promised to creditors has to satisfy

$$(1 - q)(1 + R) + q(x - \delta) \geq 1. \tag{A.1}$$

R is chosen so that the previous constraint holds with equality, which implies that

$$1 + R = \frac{1 - q(x - \delta)}{(1 - q)}, \tag{A.2}$$

with the additional assumptions $x < 1 + \delta$ and $x > 1 + \frac{1}{2}\delta$. These assumptions, in conjunction with the fact that R is strictly increasing in q, ensure that default only occurs when the payoff is low. The CEO total pay W is given by

$$W = \bar{w} + S_E P_E + S_D D, \tag{A.3}$$

where $\bar{w}$ represents the fixed salary, S_E the share of equity, P_E the price of equity, S_D the loading on deferred compensation, and D the expected value of deferred compensation.[18] The equity component and deferred compensation are paid at $t = 1$, whereas salary is

[18] More precisely, Bolton, Mehran, and Shapiro (2015) assume that the compensation package of the

paid at $t = 0$ and is thus not subject to default risk. The price of equity is given by the present value of cash flows net of operational costs:

$$P_E = q(x + (1 + \mu)\Delta) + (1 - 2q)x - (1 - q)(1 + R) - \frac{1}{2}aq^2. \tag{A.4}$$

Deferred compensation can be interpreted as salary (or other forms of compensation) kept inside the firm for one period, which makes it exposed to the investment project's payoff.

We consider two types of deferred compensation management. The first is a scheme where the CEO receive the total amount of deferred compensation ($\bar{D}$) if the company is solvent, that is with probability $1 - q$, and a fraction $0 < \alpha < 1$ of it if the company is insolvent. Under this scheme, the expected value of deferred compensation is given by $D = (1 - q)\bar{D} + q\alpha\bar{D}$, where $\bar{D}$ is some positive constant decided at the time the contract is signed. We call this contract "non-discretionary".

We also consider a "discretionary" contract that allows the CEO to modify the investment strategy of deferred compensation. Under this contract, the expected payoff of deferred compensation is

$$D = \beta P_E + (1 - \beta)q\alpha\bar{C}, \tag{A.5}$$

where $\bar{C}$ represents the cash flow of the alternative assets. These assets pay off with probability q, i.e., the probability of extreme company cash flows. As a result, such assets may be used by the CEO to increase cash flows in states where cash flows from other assets (equity and deferred compensation) are low.[19] Also in this case, the parameter $0 < \alpha < 1$ explicitly accounts for the fact that only a fraction of the value of alternative investment is received in bankruptcy (see Section 3).[20] The CEO can modify the composition of the deferred compensation by changing β at the cost $c(\beta) = \frac{1}{2}b\beta^2$. We assume that the CEO cannot short-sell his/her own company stock, i.e., we impose $\beta \geq 0$.

In summary, under the non-discretionary contract, the CEO only selects the risk of investment and thus solves the problem

$$\max_q \bar{w} + S_E P_E + S_D D \tag{A.6}$$
$$\text{s.t.} \quad 0 \leq q \leq \frac{1}{2},$$

CEO depends on salary, equity, and the company's credit spread. Thus, the first two components of our compensation package are the same as those in Bolton, Mehran, and Shapiro (2015). Our setting departs from theirs through the third component.

[19]Note that we do not model the optimal compensation structure problem from the point of view of shareholders. We assume that such a contract is in place and analyze, theoretically and empirically, the implications of such a contract for managerial choices and firm risk.

[20]The value of equity is zero in bankruptcy and, thus, there is no reason to scale down the first element on the right hand side of equation (A.5).

where

$$P_E = q(x + (1+\mu)\Delta) + (1-2q)x - (1-q)(1+R) - \frac{1}{2}aq^2, \tag{A.7}$$

$$D = (1-q)\bar{D} + q\alpha\bar{D}. \tag{A.8}$$

Under the discretionary contract, the CEO can also choose the composition of his/her deferred compensation and thus solves

$$\max_{q,\beta} \bar{w} + S_E P_E + S_D D - \frac{1}{2}b\beta^2 \tag{A.9}$$

$$\text{s.t.} \quad 0 \leq q \leq \frac{1}{2}, \quad \beta \geq 0,$$

where

$$P_E = q(x + (1+\mu)\Delta) + (1-2q)x - (1-q)(1+R) - \frac{1}{2}aq^2, \tag{A.10}$$

$$D = \beta P_E + (1-\beta)q\alpha\bar{C}. \tag{A.11}$$

Note that, when defining the discretionary contract, we assume that the cost of changing the composition of the deferred compensation is sustained by the CEO. One could also assume that the cost is borne by shareholders. In this case, the quantity $\frac{1}{2}aq^2$ should be subtracted from the stock price P_E. These two alternatives produce qualitatively identical results. However, if one subtracts the cost $\frac{1}{2}aq^2$ from the stock price P_E, the maximization problem (A.9) becomes non-concave and no closed form solution is available.[21]

The proposition below reports the CEO's optimal choice under the non-discretionary contract.

Proposition 1. *Let*

$$\tilde{q}_1 = \frac{1}{a}\left[(1+\mu)\Delta - \delta - (1-\alpha)\frac{S_D}{S_E}\bar{D}\right]$$

be the unconstrained risk-taking policy under the non-discretionary deferred compensation contract. The optimal constrained policy $\hat{q}_{NDIS}$ is given by

$$\hat{q}_{NDIS} = \begin{cases} 0, & \text{if } \tilde{q}_1 < 0; \\ \tilde{q}_1, & \text{if } 0 < \tilde{q} < \frac{1}{2}; \\ \frac{1}{2}, & \text{if } \tilde{q}_1 \geq \frac{1}{2}. \end{cases} \tag{A.12}$$

Proof. See Section OA.1 of the Online Appendix. □

According to Proposition 1, the CEO takes on more risk when the firm's profitability, as measured by μ, is high. This result hinges on the usual limited liability assumption

[21]More precisely, it is easy to see that in this case the equation for D, which includes the term βP_E, would contain the quantity $-\frac{1}{2}b\beta^3$, which, in turn, would make the objective function non-concave.

that leaves creditors bearing the cost of default and gives the CEO the gains of successful investments. The effect of the firm's profitability is counterbalanced by the deferred compensation: The CEO has the incentive to reduce firm risk to increase the probability to receive the deferred compensation and, as a result, increase his/her expected compensation. Therefore, the higher is the amount of deferred compensation the lower is the amount of risk that the CEO decides to take. This result is valid only if $\alpha < 1$. If $\alpha = 1$, the risk-diminishing effect of deferred compensation vanishes. Finally, note that

$$\frac{\partial q_1}{\partial S_E} = (1-\alpha)\frac{S_D \bar{D}}{S_E^2} > 0,$$

which means that risk-taking incentives increase with equity compensation.

We consider now the discretionary contract.

Proposition 2. *Let β^* be implicitly defined by*

$$\beta^* = \frac{S_D}{b}\left[\pi_F\left(\hat{q}_{DIS}\left(\beta^*\right)\right) - \hat{q}_{DIS}(\beta)\alpha\bar{C} - \frac{1}{2}a\hat{q}_{DIS}(\beta^*)^2\right],$$

where $\pi_F(q) = q\left[(1+\mu)\Delta - \delta\right] + (1-q)x - 1$ represents the firm's expected payoff. $\hat{q}_{DIS}$ is the optimal discretionary risk choice and is given by

$$\hat{q}_{DIS}\left(\beta\right) = \begin{cases} 0, & \text{if } \tilde{q}_2\left(\beta\right) < 0; \\ \tilde{q}_2\left(\beta\right), & \text{if } 0 < \tilde{q}_2\left(\beta\right) < \frac{1}{2}; \\ \frac{1}{2} & \text{if } \tilde{q}_2 \geq \frac{1}{2}; \end{cases} \tag{A.13}$$

where

$$\tilde{q}_2(\beta) = \frac{1}{a}\left[(1+\mu)\Delta - \delta + \frac{S_D(1-\hat{\beta})}{S_E + \hat{\beta}S_D}\alpha\bar{C}\right].$$

is the unconstrained risk-taking policy under the discretionary deferred compensation contract. The associated investment strategy of the deferred compensation plan is

$$\hat{\beta} = \begin{cases} 0, & \text{if } \pi\left(\tilde{q}_2(0)\right) - \tilde{q}_2(0)\bar{C} - \frac{1}{2}aq(0)^2 < 0; \\ \beta^*, & \text{if } \pi\left(\tilde{q}_2(0)\right) - \tilde{q}_2\bar{C} - \frac{1}{2}a\tilde{q}_2^2 \geq 0. \end{cases} \tag{A.14}$$

Finally, for any $\hat{\beta} \in [0,1]$, $\hat{q}_{DIS} \geq \hat{q}_{NDIS}$ and the difference $\hat{q}_{DIS} - \hat{q}_{NDIS}$ decreases with $\hat{\beta}$.

Proof. See Section OA.1 of the Online Appendix.. □

Several implications follow from Proposition 2. First, the possibility to modify the investment strategy of deferred compensation modifies the CEO risk-taking incentives only if $\alpha > 0$, namely as long as a fraction (no matter how small) of deferred compensation is recovered in bankruptcy.

Second, the higher the expected payoff of the firm's investment compared to the payoff of the alternative investment opportunity, the higher is the fraction of deferred compensation the CEO desires to invest in the firm stock. On the contrary, when the alternative investment opportunity is expected to deliver higher payoffs than the firm stock, the CEO has an incentive to short the firm stock. As a result, the short selling constraint binds and the optimal $\hat{\beta}$ is equal to zero.

Third, when, $\hat{\beta} \in [0, 1]$, the discretionary investment policy increases CEO risk-taking incentives[22]. The incremental risk induced by the discretionary policy decreases with the fraction of wealth tied to company stock $\hat{\hat{\beta}}$: The lower the fraction of wealth tied to company stock, the higher the incremental risk induced by the discretionary policy is. This result has to be interpreted in conjunction with the fact that the fraction of wealth tied to the firm stock increases with the expected payoff of the firm's investment. This means that, when the payoff of the investment is expected to be low, the CEO desires to decrease the fraction of deferred compensation tied to company stock and, at the same time, finds it optimal to take on more risk.

Fourth, when the firm's expected payoff is sufficiently larger than the expected payoff of alternative investments, the CEO might find it optimal to overweight company stock, namely to select $\hat{\beta} > 1$, short sell the alternative assets, and invest the proceeds in the company stock. This would mean that the CEO borrows against his/her deferred compensation to buy additional shares of the company stock.[23] In this case, the risk-shifting problem is less severe and creditors are not damaged. In other words, the discretionary contract is akin to an option that allows the CEO to exchange the standard non-discretionary contract with a contract that delivers a positive payoff when the firm is in default. To keep the standard deferred compensation contract, the CEO selects $\beta > 1$. In this case, $A \equiv \frac{S_D(1-\hat{\beta})}{S_E+\hat{\beta}S_D} < 0$, and, therefore, the optimal risk choice of the CEO can be written as

$$\tilde{q}_2(\beta) = \frac{1}{a}\left[(1+\mu)\Delta - \delta - |A|\,\alpha\bar{C}\right],$$

which is in fact similar to the risk choice under the standard non-discretionary contract. In particular, we observe that in this case the deferred cash flows $\bar{C}$ has a negative effect

[22] This assumption is required to make the model realistic. In the absence of this assumption, the CEO may borrow against his/her deferred compensation to invest in the company stock. First, employees cannot take loans out of nonqualified deferred compensation plans, which are widespread among CEOs (see, e.g., https://www.fidelity.com/viewpoints/retirement/nqdc). Second, while in the past it was common practice for firms to extend loans to their executives to buy company stock with the goal of increasing CEO ownership, the Sarbanes-Oxley Act of 2002 forbade this type of loans (Kahle and Shastri, 2004) and our empirical analysis below focuses on the post-2006 period.

[23] Note that we could exclude this case by adding one additional constraint to the maximization problem. We prefer not to do it for two reasons. First, the additional constraint would complicate the exposition of the optimal policy. Second, it is interesting to study the conditions under which the CEO desires to overweight the firm stock.

on the risk choice of the CEO, similarly to the deferred compensation $\bar{D}$ in Proposition 2.

When the firm's expected profitability is low, the CEO exercises the exchange option by choosing $\beta < 1$. In this case, $A \equiv \frac{S_D(1-\hat{\beta})}{S_E+\hat{\beta}S_D} > 0$ and the deferred cash flow $\bar{C}$ has a positive effect on CEO risk incentives, because it allows the CEO to increase the expected payoff of his/her deferred compensation.

Finally, note that

$$\frac{\partial q_2}{\partial S_E} = -\frac{\partial \beta}{\partial S_E}\frac{S_E + \beta S_D}{\left(S_E + \beta S_D\right)^2}\alpha\bar{C} - \frac{S_D\left(1-\beta\right)}{\left(S_E + \beta S_D\right)^2}\alpha\bar{C}, \tag{A.15}$$

where the second term on the right hand side of (A.15) is positive, while the sign of the first term is ambiguous.

A.2 Definition of variables

See Appendix Table A.1.

[Insert Appendix Table A.1 about here]

Table A.1: Definition of variables

Variable	Databases	Definition
Deferred compensation return	ExecuComp	Return on nonqualified deferred compensation plans computed by using information on each CEO's annual earnings. The annual return is computed by dividing the CEO's annual earnings by the beginning-of-year deferred compensation plans' balance. The beginning-of-year balance is obtained from subtracting CEO's and firm's contributions and CEO's annual earnings from the end-of-year balance (Jackson and Honigsberg, 2014).
Deferred compensation return (alt.)	ExecuComp	Same definition as *Deferred compensation return*, but adding back CEO's withdrawals over the fiscal year to the beginning-of-year balance in the denominator.
Stock return	ExecuComp	Total stock return over the fiscal year.
Idiosyncratic return	ExecuComp, Kenneth French's website	Defined as the difference between *Stock return* and the equally weighted industry return (based on Fama-French 48 industry groups).
Market-adjusted industry return	ExecuComp, Kenneth French's website	Defined as the difference between the equally weighted industry return (based on Fama-French 48 industry groups) and the equally weighted market return. Industry returns are from Kenneth French's website.
Z-score	CCM	Altman's Z-score computed as $-3.3 \times \texttt{(pi/at)} - \texttt{(sale/at)} - 1.4 \times \texttt{(re/at)} - 1.2 \times \texttt{((act-lct)/at)} - 0.6 \times \texttt{((prcc\_f} \cdot \texttt{csho)/lt)}$.
Distress zone	CCM	Indicator variable equal to one if *Z-score* exceeds -1.81 in a given firm year.
Gray zone	CCM	Indicator variable equal to one if *Z-score* is between -2.99 and -1.81 in a given firm year.
Z-score (top 25%)	CCM	Indicator variable equal to one if a given firm-year belongs to the top quartile of the Altman's Z-score. The Altman's Z-score quartiles are computed over the CCM universe.
Size	CCM	Firm size defined as the natural logarithm of total assets.
CEO age	ExecuComp	CEO's age. If age information is missing, we use the CEOs' median age.
CEO tenure	ExecuComp	Defined as the number of years the CEO has been in office.
CEO turnover	ExecuComp	Indicator variable equal to one if the CEO is replaced in a given year.
CEO relative D/E ratio	ExecuComp, CCM	Ratio of CEO inside debt holdings to equity incentives divided by the firm's D/E ratio based on information from ExecuComp (see, e.g., Cassel, Huang, Sanchez, and Stuart, 2012).
CEO effective ownership	ExecuComp, CCM	CEO fractional ownership adjusted for the CEO's portfolio of option incentives.
CEO vega	ExecuComp, CCM	Total vega of the CEO's portfolio of option incentives,
CEO exercised options	ExecuComp	Defined as the value of the CEO's option exercises in a given year (scaled by total annual compensation).
Withdrawal	ExecuComp	Indicator variable equal to one if the CEO withdraws a non-zero amount from his/her deferred compensation balance in a given year.
E-index	Riskmetrics	Entrenchment index of corporate governance as defined by Bebchuck, Cohen, and Ferrell (2009).
Acquisitions	CCM	Firm M&A activity as measured by cash acquisitions (scaled by total assets).

Online Appendix for
"CEO Investment of Deferred Compensation Plans and Firm Performance"

OA.1 Proofs

Proof of Proposition 1. Under the non-discretionary contract the CEO solves

$$\max_{q} \bar{w} + S_E P_E + S_D D + \lambda_0 q - \lambda_{\frac{1}{2}} q,$$

where

$$\begin{aligned} P_E &= q(x + (1+\mu)\Delta) + (1-2q)x - (1-q)(1+R) - \frac{1}{2}aq^2 \\ D &= (1-q)\bar{D} + q\alpha\bar{D} \\ 1+R &= \frac{1-q(x-\delta)}{1-q}. \end{aligned}$$

λ_0 is the multiplier attached to the constraint $q \geq 0$ and $\lambda_{\frac{1}{2}}$ is the multiplier attached to the constraint $q \leq \frac{1}{2}$. Replacing P_E, D, and R into the optimization problem, we obtain

$$\max_{q} \bar{w}+S_E\{q\left[x+(1+\mu)\Delta\right]+(1-2q)x-1+q(x-\delta)-\frac{1}{2}aq^2\}+S_D\left[(1-q)\bar{D}+q\alpha\bar{D}\right]+\lambda_0 q-\lambda_{\frac{1}{2}} q.$$

The first order condition (FOC) with respect to q gives

$$S_E\left[(1+\mu)\Delta - \delta - aq\right] - S_D\bar{D}(1-\alpha) + \lambda_0 - \lambda_{\frac{1}{2}} = 0.$$

Let

$$\tilde{q}_1 = \frac{1}{a}\left[(1+\mu)\Delta - \delta - (1-\alpha)\frac{S_D}{S_E}\bar{D}\right]$$

be the unconstrained optimal policy. The optimal constrained policy $\hat{q}_{NDIS}$ follows from an application of the Kuhn-Tucker theorem and is given by

$$\hat{q}_{NDIS} = \begin{cases} 0, & \text{if } \tilde{q}_1 < 0; \\ \tilde{q}_1, & \text{if } 0 < \tilde{q} < \frac{1}{2}; \\ \frac{1}{2}, & \text{if } \tilde{q}_1 \geq \frac{1}{2}. \end{cases} \tag{OA.1}$$

□

Proof of Proposition 2. Under the discretionary contract, the CEO solves

$$\max_{q,\beta} \bar{w} + S_E P_E + S_D D - \frac{1}{2}b\beta^2 + \lambda_0 q - \lambda_{\frac{1}{2}} q + \nu_0\beta, \tag{OA.2}$$

where

$$P_E = q(x + (1+\mu)\Delta) + (1-2q)x - (1-q)(1+R) - \frac{1}{2}aq^2 \tag{OA.3}$$

$$D = \beta P_E + (1-\beta)q\alpha\bar{C} \tag{OA.4}$$

$$1 + R = \frac{1 - q(x-\delta)}{1-q} \tag{OA.5}$$

and ν_0 is the multiplier attached to the constraint $\beta \geq 0$. Replacing P_E, D, and R into the optimization problem, we obtain

$$\max_{q,\beta} \bar{w} + (S_E + \beta S_D)\left\{q\left[x + (1+\mu)\Delta\right] + (1-2q)x - 1 + q(x-\delta) - \frac{1}{2}aq^2\right\} + S_D(1-\beta)q\alpha\bar{C}$$
$$- \frac{1}{2}b\beta^2 + \lambda_0 q - \lambda_{\frac{1}{2}} q + \nu_0\beta;$$

thus

$$\text{FOC}_q: \quad (S_E + \beta S_D)\left[(1+\mu)\Delta - \delta - aq\right] + S_D(1-\beta)\alpha\bar{C} + \lambda_0 - \lambda_{\frac{1}{2}} = 0$$
$$\text{FOC}_\beta: \quad S_D\left[q\left(x + (1+\mu)\Delta - \delta\right) + (1-q)x - 1 - \frac{1}{2}aq^2\right] - S_D q\alpha\bar{C} - b\beta + \nu_0 = 0.$$

The unconstrained risk choice is given by

$$\tilde{q}_2(\beta) = \frac{1}{a}\left[(1+\mu)\Delta - \delta + \frac{S_D(1-\hat{\beta})}{S_E + \hat{\beta}S_D}\alpha\bar{C}\right]$$

and therefore the optimal constrained risk choice is

$$\hat{q}_{DIS} = \begin{cases} 0, & \text{if } \tilde{q}_2 < 0; \\ \tilde{q}_2, & \text{if } 0 < \tilde{q} < \frac{1}{2}; \\ \frac{1}{2}, & \text{if } \tilde{q}_2 \geq \frac{1}{2}. \end{cases} \tag{OA.6}$$

Let now $\pi_F(q)$ be the payoff of the firm's assets expressed as a function of the probability chosen by the CEO

$$\begin{aligned}
\pi_F(q) &= q(x + (1+\mu)\Delta) + (1-2q)x - (1-q)(1+R) \\
&= q(x + (1+\mu)\Delta) + (1-2q)x - (1-q)\frac{1 - q(x-\delta)}{1-q} \\
&= q(x + (1+\mu)\Delta) + (1-2q)x - 1 + q(x-\delta) \\
&= q(x + (1+\mu)\Delta) + (1-q)x - 1 - q\delta \\
&= q(x + (1+\mu)\Delta - \delta) + (1-q)x - 1.
\end{aligned}$$

Using $\pi_F(q)$, we can express the unconstrained investment strategy of the deferred compensation as

$$\tilde{\beta} = \frac{S_D}{b}\left[\tilde{q}_2(\beta)\left(x + (1+\mu)\Delta - \delta\right) + (1 - \tilde{q}_2(\beta))x - 1 - \tilde{q}_2(\beta)\bar{C} - \frac{1}{2}a\tilde{q}_2(\beta)^2\right]$$
$$= \frac{S_D}{b}\left[\pi_F(q) - \tilde{q}_2(\beta)\bar{C} - \frac{1}{2}a\tilde{q}_2(\beta)^2\right]. \tag{OA.7}$$

Note that $\tilde{\beta}$ is only implicitly defined by equation (OA.7). The reason is that the right-hand side of equation (OA.7) depends on $\tilde{\beta}$ through the optimal risk choice $\tilde{q}$. Assume for the moment that a solution to the fixed point problem (OA.7) exists and let this solution be β^*. The Kuhn-Tucker theorem implies that the constrained investment strategy $\hat{\beta}$ is given by

$$\hat{\beta} = \begin{cases} 0, & \text{if } \pi\left(\tilde{q}_2(0)\right) - \tilde{q}_2(0)\bar{C} - \frac{1}{2}a\tilde{q}_2(0)^2 < 0; \\ \beta^*, & \text{if } \pi\left(\tilde{q}_2(0)\right) - \tilde{q}_2\bar{C} - \frac{1}{2}a\tilde{q}_2^2 \geq 0. \end{cases} \tag{OA.8}$$

Concerning the existence and uniqueness of β^*, note that the Brouwer's fixed-point theorem guarantees that there must be at least one $\beta^* \in [0,1]$ such that equation (OA.7) holds. For any optimal $\hat{\beta} \in [0,1]$, we have that

$$\tilde{q}_2 - \tilde{q}_1 = \frac{1}{a}\left[\frac{S_D(1-\hat{\beta})}{S_E + S_D\hat{\beta}}\alpha\bar{C} + (1-\alpha)\frac{S_D}{S_E}\bar{D}\right] > 0. \tag{OA.9}$$

As a result, the difference between $\hat{q}_{DIS}$ and $\hat{q}_{NDIS}$ is given by

$$\hat{q}_{DIS} - \hat{q}_{NDIS} = \begin{cases} 0, & \text{if } \tilde{q}_1 < \tilde{q}_2 < 0; \\ \frac{1}{a}\left[(1+\mu)\Delta - \delta + \frac{S_D(1-\hat{\beta})}{S_E+\hat{\beta}S_D}\alpha\bar{C}\right] = \tilde{q}_2, & \text{if } \tilde{q}_1 < 0 < \tilde{q}_2 < \frac{1}{2}; \\ \frac{1}{a}\left[\frac{S_D(1-\hat{\beta})\alpha\bar{C}}{S_E+S_D\hat{\beta}} + (1-\alpha)\frac{S_D}{S_E}\bar{D}\right] = \tilde{q}_2 - \tilde{q}_1, & \text{if } 0 < \tilde{q}_1 < \tilde{q}_2 < \frac{1}{2}; \\ \frac{1}{2} - \frac{1}{a}\left[(1+\mu)\Delta - \frac{S_D}{S_E}\bar{D}\right] = \frac{1}{2} - \tilde{q}_1, & \text{if } 0 < \tilde{q}_1 < \frac{1}{2} < \tilde{q}_2; \\ 0, & \text{if } 0 < \frac{1}{2} < \tilde{q}_1 < \tilde{q}_2; \end{cases} \tag{OA.10}$$

therefore

$$\frac{\partial(\hat{q}_{DIS} - \hat{q}_{NDIS})}{\partial\hat{\beta}} = \begin{cases} 0, & \text{if } \tilde{q}_1 < \tilde{q}_2 < 0; \\ -\frac{\alpha\bar{C}}{a}\frac{S_DS_E+S_D^2}{\left(S_E+\hat{\beta}S_D\right)^2} < 0, & \text{if } \tilde{q}_1 < 0 < \tilde{q}_2 < \frac{1}{2}; \\ -\frac{\alpha\bar{C}}{a}\frac{S_DS_E+S_D^2}{\left(S_E+\hat{\beta}S_D\right)^2} < 0, & \text{if } 0 < \tilde{q}_1 < \tilde{q}_2 < \frac{1}{2}; \\ 0, & \text{if } 0 < \tilde{q}_1 < \frac{1}{2} < \tilde{q}_2; \\ 0, & \text{if } 0 < \frac{1}{2} < \tilde{q}_1 < \tilde{q}_2. \end{cases} \tag{OA.11}$$

□

OA.2 Sample characteristics

Appendix Table OA.1 provides information on the characteristics (number of observations, number of firms, number of CEOs, mean CEO tenure, median CEO tenure, turnover frequency, and withdrawal frequency) of the main estimation samples used in the paper.

[Insert Table OA.1 about here]

OA.3 Insider transactions reported in Form 5 filings

Here, we seek to provide direct evidence of the CEOs' reshuffling of deferred compensation investment away from firm equity in distress. To this end, we obtain information from CEOs' transactions on firm equity from SEC's Form 5 filings. On these filings, CEOs disclose their insider transactions on a given firm's security (including derivatives) throughout the year.[24] Firm securities held (indirectly) through nonqualified DC plans are no exception to this disclosure rule (see footnote 7).

More specifically, we match each firm's SEC CIK code to its CCM identifier (`gvkey`) by means of the Wharton Research Data Service's SEC Analytics Suite and obtain the online link to Form 5 filings. We then randomly select a sample of 50 firm-years for which we manually retrieve Form 5 information on 223 CEO equity transactions. It is problematic to provide a precise measure of CEO personal return on Form 5 transactions. Because of this, rather than directly validating our deferred compensation return measure against these transactions, we explore the overall direction of CEO transactions when a firm is in the distress zone vis-a-vis other times.

In the naïve analysis of Table OA.2 on "trading imbalance", we compare the number of purchases vs. sales of own equity (or own equity derivatives) carried out by CEOs in the random sample of 50 firm-years. Looking at the trading behavior of CEOs on direct and indirect equity positions, we distinguish between firm-years inside and outside the distress zone. Firm securities held through nonqualified DC (the focus of the main analysis) and qualified DC plans are classified as indirect positions. However, except for the case of qualified DC plans (such as 401(k) plans and employee stock ownership plans) and a few cases of securities held by relatives, no clear information on the nature of indirect ownership is provided in Form 5 filings. Given that our model's implications extend to the case of qualified DC plans, we group together all indirect positions and analyze them jointly.

Outside the distress zone, 25.9% of all (direct and indirect) transactions are sales as opposed to 23.3% in the distress zone. If we distinguish between direct and indirect positions, we see that inside the distress zone 42.8% of indirect transactions are sales as opposed to only 17.3% of direct transactions. Outside the distress zone, 35.8% (19.1%) of direct (indirect) transactions are sales. Although this is evidence based on a small sample, it suggests that in distress CEOs tend to reduce their exposure to firm risk

[24] CEOs timely report each relevant transaction in Form 4 filings. All Form 4 transactions are jointly reported in Form 5 at the end of the year.

through indirect positions, such as those held through deferred compensation plans. This finding corroborates the main result of the paper.

[Insert Table OA.2 about here]

OA.4 Further tests

In this section, we present several additional checks relating to the empirical definition of distress.

Alternative distress definition. We test how sensitive our baseline results in Table 3 are to the definition of distress. In column 1 of Table OA.3, we add to the baseline specification the interaction between the stock return and the indicator variable *Gray zone*, which captures a moderate financial health deterioration. The interaction with *Distress zone* here displays a negative but statistically insignificant at conventional levels (p-value= 0.17) coefficient. Note that by including the interaction with *Gray zone*, we de facto use firms that are neither in the distress zone nor in the gray zone as the reference group, whereas in the baseline analysis the reference group includes also those in the gray zone. To put it differently, CEOs of firms in the distress zone tend to reduce the exposure to own stocks especially if compared to CEOs of firms in the gray zone. One possible explanation is that CEOs in the gray zone, upon the first signs of declining financial health, seek to bolster stock performance by investing in their own firm, as indicated by the positive (albeit insignificant) coefficient estimate for *Gray zone* × *Stock return*, a behavior that reverses if the situation keeps deteriorating and the firm enters the distress zone.

In column 2, we replace the *Distress zone* indicator with *Z-score (top 25%)*, an indicator variable equal to one if a firm-year's Z-score is above the 75th percentile ($= -1.42$, defined over the CCM universe rather than over our final sample). Under this more restrictive definition of distress, the results remain qualitatively unchanged relative to the baseline case.

[Insert Table OA.3 about here]

Changes in distress status. Appendix Table OA.4 further explores how the CEO's deferred compensation strategy changes around distress. In column 1, we look at changes in distress status using *Distress zone (change)*. The correlation between deferred compensation returns and stock returns is statistically indistinguishable from zero (column 1), possibly due to the masking effect of looking together at positive and negative changes in distress status. In column 2, we thus distinguish between instances in which firms enter (*Distress zone (enter)* = 1) and exit (*Distress zone (exit)* = 1) the distress zone. Whereas both events are linked to lower correlation of deferred compensation returns with stock returns, only the interaction with *Distress zone (exit)* is statistically significant. Such a result points to a sluggish and persistent effect of distress on the investment strategy of the CEOs, which is consistent with the findings in Panel B of Table 3. In other words, CEOs do lower their exposure to the firm stock during times of distress, but they may not increase the exposure as soon as the firm exits distress.

[Insert Table OA.4 about here]

Table OA.1: Sample characteristics

This table provides information on the characteristics of several of the samples used throughout the paper: Number of observations, number of firms, number of CEOs, mean CEO tenure, median CEO tenure, turnover frequency, and withdrawal frequency. The samples on each row of the table are defined as follows: [1] corresponds to the sample used in Panel A of Table 1; [2] corresponds to the sample used in column 2 of Panel B of Table 3; [3] corresponds to the sample used in column 1 of Table 5.

Sample	Obs.	No. firms	No. CEOs	CEO tenure (mean)	CEO tenure (median)	Turnover frequency	Withdrawal frequency
[1]	6,097	969	1,516	6.694	5.000	0.116	0.112
[2]	5,471	889	1,371	6.648	5.000	0.110	0.110
[3]	1,656	480	513	6.755	5.000	0.096	0.108

Table OA.2: CEO transactions reported in a random sample of Form 5 filings
This table provides information on the direction (purchases vs. sales) of transactions carried out by CEOs on equity (derivative) securities of the firm. Information on these transaction is from Form 5 filings of a random sample of 50 firm-years. Transactions executed in firm-years in the distress zone (i.e., with a Z-score above -1.81) are compared to those from the rest of the sample. The samples on each row of the table are defined as follows: [1] corresponds to all transactions for which information is available in the random sample of Form 5 filings; [2] corresponds to those transactions on positions held directly by the CEO; [3] corresponds to those transactions on positions held indirectly by the CEO (e.g., through savings plans, trusts, etc.).

	Outside distress zone		Inside distress zone	
	No. purchases	No. sales	No. purchases	No. sales
[1] All positions	143	50	23	7
[2] Direct positions	50	28	19	4
[3] Indirect positions	93	22	4	3

Table OA.3: Alternative distress definitions

This table reports panel regressions of CEO deferred compensation returns (baseline measure) on stock returns conditioning on firms' distress status over the period 2006-2015. Column 1 augments the specification in column 2 of Table 3 with the interaction between stock returns and *Gray zone*, an indicator variable equal to one if a firm-year ehibits a Z-score between -2.99 and -1.81. Column 2 uses the alternative distress indicator *Z-score (top 25%)*, which is equal to one if a firm-year belongs to the top quartile of the Z-score (the quartiles are computed over the CCM universe). All specifications include control variables (size, CEO age, CEO tenure, and the CEO relative D/E ratio) and CEO fixed effects. The t-statistics are calculated with robust standard errors clustered by CEO. Significance at the 10%, 5%, and 1% levels is indicated by *, **, ***, respectively. Refer to Appendix Table A.1 for variable definitions.

	Def. comp. return	
	(1)	(2)
Distress zone × Stock return	-0.050	
	(-1.39)	
Distress zone	-0.008	
	(-0.33)	
Gray zone × Stock return	0.053	
	(1.41)	
Gray zone	-0.033*	
	(-1.88)	
Z-score (top 25%) × Stock return		-0.078**
		(-2.53)
Z-score (top 25%)		-0.004
		(-0.14)
Stock return	0.160***	0.177***
	(5.57)	(8.32)
Size	0.011	0.007
	(0.46)	(0.28)
CEO age	0.016	0.015
	(0.91)	(0.86)
CEO tenure	-0.003	-0.004
	(-0.10)	(-0.13)
CEO relative D/E ratio	0.001*	0.001*
	(1.83)	(1.85)
CEO FE	Yes	Yes
Time FE	Yes	Yes
Observations	5,145	5,145
Adjusted R^2	0.20	0.20

Table OA.4: Deferred compensation returns and stock returns: Change in distress status
This table reports panel regressions of CEO deferred compensation returns (baseline measure) on stock returns augmented with changes in distress status over the period 2006-2015. Column 1 interacts stock returns with *Distress zone (change)*, which is coded as 1 when the firm enters the distress zone (i.e., Z-score above -1.81), as 0 when the distress status does not change, and -1 when the firm exits the distress zone. Column 2 interacts stock returns with *Distress zone (enter)*, an indicator equal to one if a firm enters the distress zone in a given year, and *Distress zone (exit)*, an indicator equal to one if a firm exits the distress zone in a given year. All specifications include control variables (size, CEO age, CEO tenure, and the CEO relative D/E ratio), CEO fixed effects, and year fixed effects. The *t*-statistics are calculated with robust standard errors clustered by CEO. Significance at the 10%, 5%, and 1% levels is indicated by *, **, ***, respectively. Refer to Appendix Table A.1 for variable definitions.

	Def. comp. return	
	(1)	(2)
Distress zone (change) × Stock return	0.025	
	(0.86)	
Distress zone (change)	-0.018	
	(-1.05)	
Distress zone (enter) × Stock return		-0.053
		(-1.02)
Distress zone (enter)		-0.008
		(-0.39)
Distress zone (exit) × Stock return		-0.143***
		(-2.58)
Distress zone (exit)		0.122***
		(2.80)
Stock return	0.169***	0.181***
	(8.19)	(8.18)
Size	-0.004	-0.005
	(-0.15)	(-0.19)
CEO age	-0.001	-0.003
	(-0.03)	(-0.07)
CEO tenure	0.019	0.019
	(0.77)	(0.78)
CEO relative D/E ratio	0.001*	0.001*
	(1.89)	(1.86)
CEO FE	Yes	Yes
Time FE	Yes	Yes
Observations	4,064	4,064
Adjusted R^2	0.24	0.25