Pension Risk Taking and Stock Price Crash Risk

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Abstract

Using a large sample of U.S firms for the period 1990-2013, we provide strong and robust evidence that pension risk taking is positively associated with future stock price crash risk. We also find that the effects of pension risk-taking on future crash risk is significantly greater in firms with low funding ratio and high default risks. Overall, we present strong evidence that risk taking in DB pension asset management can be a new additional predictor of future crash risk. Our study makes important contributions in helping stakeholders and shareholders appropriately evaluate firms with DB pension plan, and also has important implications for policymakers who need to protect workers' retirement benefits and shareholder wealth.

Key words: Stock price crash risk; Defined benefit plans; Pension risk-taking

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I. Introduction

The purpose of this study is to examine whether risk taking in Defined Benefit (DB) assets allocation can be predictor in future stock price crash risk. Recently, the crash risk is one of the most interesting topics in the fields of finance and accounting. Individual investors tend to concentrate their investments in a small number of firms, and stock price crashes of firms in their portfolios can be highly detrimental to their personal wealth (Barber and Odean, 2013). Thus, identifying what affects stock price crash risk has the potential to make a significant contribution to protect shareholder wealth. Many previous studies have been focused mainly on the determinants of crash risk, which are known to be financial reporting quality, managerial characteristics, corporate governance, and informal institutions and so on (Habib et al., 2018). This study also tries to provide additional evidence on the determinants of crash risk.

Corporate DB pension plans play an important role in business management activities. The impact of pension expense on net income is significant, especially as retirement benefit obligations accounts for a significant component of firms' total liability, the strategy for the accumulation and management of DB pension plan has become an essential issue in corporate management. Many previous literature documents various incentives and factors related to sponsors' pension funding and investment risk. We focus on pension investment risk measured by the proportion of equity investment in DB pension assets and examine whether aggressive investment strategy for pension assets increases future crash risks of sponsoring firms. By doing so, we try to find empirical evidence that the decision on DB pension plan management can become serious and fatal results for companies. At the same time, we attempt to uncover the channel between pension risk taking and stock price crash risk.

The recent market crisis has amplified the financial risks for pension funds. During the first week of October 2008, pension funds lost over $100 billion (Bruno, 2008). If the ratio of risky assets to DB assets is high, the pension funds have lost value more dramatically when the market shocks, and the underfunded is further severe. The greater the level of underfunded, the higher the level of mandatory contributions and the greater the level of cash outflows from the company, the more financially constrained. Companies should make deep cuts in capital expenditure or sell more assets to fund their operations in response to the financial constraints (Campello et al., 2010). This, in turn, increases the corporate bankruptcy risk and the likelihood of a plunge in stock prices.

Chen et al.(2013) show that the increase of bankruptcy risk cause an stronger moral hazard incentive for pension sponsor because the put option value by PBGC has the greatest value. An et al. (2013) also show that financially distressed sponsors take high pension risk when they are on the verge of bankruptcy. The pension benefit guarantee by PBGC provides strong moral hazard incentives for pension funding and investment decision. Sponsors can make low pension contributions and bet on risky investments in their pension assets. Such gambling decision-making deepens the level of underfunded and increases the risk of bankruptcy. This pension risk mismatch (An et al., 2013) amplifies the crash risk in times of crisis. In this background, we try to see whether pension risk taking has a significant impact on future stock price crash risk, and clarify what the channel between the two variables is.

In this study, we measure pension risk taking as a risky investment percentage of pension assets (Bodie et al., 1987; Rauh, 2009). We use three proxies for stock price crash risk. There are the negative conditional skewness of weekly return (Chen et al., 2001), the down-to-up volatility (Chen et al., 2001), and a dummy variable indicating whether firms experience returns that fall more than 3.2 standard deviations below the mean firm-specific weekly returns over the fiscal year (Hutton et al., 2009; Kim et al., 2016). These measurements are based on firm-specific weekly returns that estimate residuals from the market model (Chen et al., 2001). This is because crash risk is reflected by firm-specific factors or characteristics rather than broad market movements.

Using the pension data from the database from Munnell et al. (2015) for the period between 1990 and 2013, we find that firms that invest in their DB plans' assets more aggressively experience future stock price crash more. The results are strong and robust across fixed effect regression and change regression. Moreover, we find evidence that the relationship between pension risk taking and crash risk is significant in the firms with low funding ratios or high default risks.

Our study lies on the extension of the study to determine the determinants of future crash risk. In the meantime, extant research has been conducted on the determinants of crash risk and tax avoidance, corporate social responsibility, anti-takeover provisions, institutional shareholder stability, overconfident managers, and internal controls are known to be related to future stock price crash risk (Kim et al., 2011; Kim et al., 2014; Bhargava et al., 2017; Andreou et al., 2016). No study has revealed that pension risk taking has significant predictive power for future stock price crash risk. This study has a contribution in that it presents additional evidence for the determinants or predictors of crash risk.

This study shows that risk preference in the corporate DB pension plan management has a significant effect on the future share price of the firm. Theories that explain corporate decision-making about pension contribution and management are largely risk shifting (moral hazard) theory (Sharpe, 1976;

Treynor, 1977; Broeders and Chen, 2010) and risk management theory (Black, 1980; Tepper, 1981; Francis and Reiter, 1987; Bodie et al., 1987). This study is based on the theory of risk shifting and provides empirical evidence that management's moral hazard or opportunistic decision-making to maximize PBGC's put option value ultimately affects future crash risk. Our results can provide managers, policy makers and regulators useful information regarding corporate pension systems.

The remainder of this paper proceeds as follows. Section 2 reviews the research background of DB pension plan and develops Hypothesis. Section 3 describes our data and research design. Section 4 presents the main empirical analysis. Section 5 concludes the paper.

II. Background and hypothesis development

2.1 Defined Benefit Plans

Defined Benefit (DB) Plans are set up to offer employee beneficiaries with a fixed steam of cash flows during their retirement. Therefore, the claims on a firm held by beneficiaries are similar to those held by the firm's debtholders. Treynor (1997) argues that a firm with DB plans holds a put option. This is because the assets of the firm and DB plan fall short of the pension fund liabilities, and the firm has the option of giving these assets to the beneficiary of the DB plan as payment. Given the fact that the value of a put option rises with the risk of the underlying assets, managers of sponsoring companies may have incentives to make risky investments with DB plan assets. These incentives are a manifestation of classic risk shifting incentives argued in Jesen and Meckling (1976) and Myers (1977).[1]

The existence of the Pension Benefit Guarantee Corporation (PBGC) exacerbates the incentive of risk shifting. Under the regulatory environment based on the Employee Retirement Income Security Act (ERISA) of 1974, the PBGC takes over the underfunded plans of the sponsoring company going

[1] On the other hand, previous literature documents that mandatory pension contributions under ERISA constrain risk shifting behavior in pension funds. Mayer and Smith (1982) and Smith and Stulz(1985) theoretically argue that required contributions increase the probability of financial distress on firms' non-pension debts and thus incur costs of financial distress. Furthermore, such mandatory requirements may force firms to forgo attractive investment projects, especially for firms that are financially constrained (Mayer & Smith, 1987). Consistent with the risk management story, Rauh (2009) documents that risk management dominates risk shifting by showing that firms with less underfunded pension plans and strong credit ratings invest heavily in risk asset classes, while firms with more underfunded plans and weak credit ratings allocate a large share of plan assets to safe asset classes.

into bankruptcy and then makes up the deficit; managers of the firm would have an incentive to make risky investments with plan assets. Furthermore, the guarantees from the PBGC would weaken the incentives of rank-to-file employees to monitor the management of their plan assets. Despite the strong theoretical background for risk shifting, empirical evidence has been surprisingly weak. In this regard, Anantharaman and Lee (2014) argue that executive compensation structure affects the extent of managerial risk taking incentives in pension plans. They find that risk shifting through allocating risky assets and underfunding is stronger in firms in which managers have high wealth-risk sensitivity and weaker in firms with high wealth-price sensitivity. Using UK pension data, Cocco and Volpin (2007) provide evidence for the risk shifting behavior of levered firms. By showing the evidence that the DB plans of more levered firms with a higher proportion of insider trustees allocate greater proportions of their pension assets in equity, they argue that insider trustees act in the best interests of shareholders of the sponsoring firms rather than the beneficiary.

DB pension plans are required to set pension assets aside in a trust with trustees responsible for the management of them. However, given that these trustees are appointed by management without shareholder assent, they are likely to side with management. (Chaplinsky & Niehaus, 1990; Gordon & Pound, 1990; Chang & Mayers, 1992). Frank (2002) argues that it is sponsoring firms that control over allocating DB plan assets and making up any deficit in DB assets through trust. Furthermore, prior literature documents that mutual funds are more likely to support management by voting against shareholder proposals, regardless of the best interests of the investors, for the purpose of managing and retaining pension assets (Davis & Kim, 2007; Ashraf et al., 2012; Iliev & Lowry, 2015). These findings indicate that managers may have greater incentives to operate pensions for purpose other than the pension beneficiary’s best interests. In the same vein, these managers may also have greater incentive to engage in bad news hoarding activity, resulting in stock price crash risk.

2.2 Hypothesis

We adopt risk shifting theory as a main driver of pension risk-taking. Given that pension risk-taking is explained by managers’ moral hazard in maximizing the put value, and therefore maximizing the level of risky assets in pension plans, these managers would be more likely engage in bad news hoarding activities. In other words, if managerial incentives to allocate risky assets in pension plans is motivated by risk shifting, we would expect that firms taking more risk in pension assets are more likely to experience stock price crash risk. This paper extends prior research by examining the relationship between managerial incentives to risk shifting in pensions, and futures stock price crash risk. Recently, a large body of literature exploring the determinants of managers' bad news hoarding activities and the consequential stock price crash risk have drawn considerable attention. The bulk of the recent empirical studies on the determinants of crash risk have heavily relied on the agency theoretical framework from Jin and Myers (2006). They argue that information asymmetries between management and shareholders can attribute to stock price crash risk. The rationale behind this risk is that asymmetric information can enable managers to withhold bad news for a certain period to pursue their private benefits. (Kothari et al., 2009). Once the accumulated bad news exceeds the limit, it would be revealed to the market, causing a large drop in stock price.

Prior studies document that tax avoidance, corporate social responsibility, anti-takeover provisions, institutional shareholder stability, overconfident managers, and internal controls are associated with future stock price crash risk (Kim et al., 2011; Kim et al., 2014; Bhargava et al., 2017; Andreou et al., 2016; Louca & Petrou, 2016). However, there is no literature examining whether there is any relation between pension risk-taking motivation and corporate crash risk.

Against this backdrop, this paper explores whether managerial incentives to take more risk in DB plans is associated with stock price crash risk. We use the percentage of pension assets allocated to equities in DB plans as a proxy for pension risk taking. By doing so, our research provides a unique setting to see managerial incentives to pension risk-taking, in that managers have considerable discretion in asset allocation of DB plans but the presence of trustees makes monitoring roles of shareholders weaken. Specifically, we posit that moral hazard from asymmetric payoffs on pension assets between managers and employees could drive managers to take more risk in pension management. In this case, managers who have greater pension risk-taking incentives are also likely to take advantage of information asymmetry and thus engage in more bad news hoarding activities. This leads to our first hypothesis:

Hypothesis 1: Pension risk-taking is positively related to stock price crash risk.

If risk shift stories from agency theory can explain a positive relationship between pension risk-taking and stock market crash risk, we would expect stronger effects for firms with underfunded pension plans and with default risk. The rationale behind this is that put options provided by PBGC would provide a higher value for firms facing bankruptcy and a higher probability of large plan termination, which could enhance moral hazard incentives and thus exhibit more pension risk-taking behavior. Consistent with this argument, Friedman (1983) and Amir and Benartzi (1999) find that firms close to distress increase allocations to riskier asset such as equities. Further, An et al. (2013) showed that pension risk-taking incentives dominate risk management incentives for firms on the verge of bankruptcy and firms needing to freeze, terminate, or convert from DB to DC plans. Hence, we propose the following hypotheses:

Hypothesis 2: Firms with highly underfunded pensions will exhibit higher sensitivity to stock price crash risk in response to pension risk-taking

Hypothesis 3: Firms with higher default risk will exhibit higher sensitivity of stock price crash risk in response to pension risk-taking

III. Sample and empirical design

3.1 Sample

To examine the impact of pension risk-taking on stock price crash risk we use the percentage of pension assets allocated to equities in the DB plans for the period between 1990 and 2013. Given that sponsoring companies make their asset allocation decision and bear the investment risk for DB plans, the measure can be considered as a proxy for corporate risk-taking in pension. Under the provisions set by ERISA, firms are required to disclose their pension investment portfolios annually by the end of July if plans have 100 or more participants. Thus, we can directly obtain the electronic pension data from Form 5500 of the Department of Labor (DOL). However, databases on asset allocation from Form 5500 have two drawbacks. First, since a non-trivial number of firms report their pension assets under mutual funds, collective trusts, pooled separated accounts, and master trusts, we cannot determine the full asset allocation under these categories without looking at the hard-copy filings. Furthermore, the latest year for which all the data are available from Form 5500 of DOL is 1999. We therefore obtained the database of asset allocations in pension plans directly from Munnell et al. (2015).

The initial data begins with firms that have at least one DB plan. We used the Compustat Fundamentals Annual database to map GVKEY identifiers into the IRS Employer Identification Number (EIN) of the pension asset allocation database to collect financial information. We also collected CRSP weekly/monthly stock files to estimate stock price crash risk and control variables. Then, we selected only NYSE, Amex, and NASDAQ firms that have at least 26 weeks of weekly stock returns. Firms were also required to have non-positive book values and total assets, as well as fiscal year end prices of more than \$1. Finally, we excluded firms in financial services and utilities industries.

3.2 Research Design

Following the previous literature (Kim et al., 2011; Kim & Zhang, 2016; Kim et al., 2016), we adopted two different metrics for firm-specific crash risk based on Jin and Myers' (2006) market model for each firm-year observation. Specifically, we estimated firm-specific daily returns by running the following expanded market model regression for each firm and year:

$$r_{j,\tau} = \alpha_j + \beta_{1,j} r_{m,\tau-2} + \beta_{2,j} r_{m,\tau-1} + \beta_{3,j} r_{m,\tau} + \beta_{4,j} r_{m,\tau+1} + \beta_{5,j} r_{m,\tau+2} + \varepsilon_{j,\tau} \quad (1)$$

where $r_{j,\tau}$ is the return on firms j in week τ and $r_{m,\tau}$ is the return on the CRSP value-weighted market index in week τ. By including the lead and lag terms for the market index return, we corrected for nonsynchronous trading (Dimson, 1979). We also included the industry index return based on two-digit SIC codes as well as the market index returns in the equation (1), and obtained robust (tabulated) results. We denote $W_{j,\tau} = \ln(1 + \varepsilon_{j,\tau})$ as the firm-specific weekly return for firm j in week τ, measured by natural logarithm of one plus the residual return from Equation (1). The first proxy for the stock price crash risk is the negative conditional firm-specific skewness of weekly return (NCSKEW), calculated by taking the negative of the third moment of firm specific weekly returns for each year divided by the standard deviation of firm-specific weekly returns raised to the third power. More specifically, NCSKEW for each firm is defined as:

$$NCSKEW_{j,\tau} = -\left[n(n-1)^{3/2} \sum W_{j,t}^3\right] / \left[(n-1)(n-2)(\sum W_{j,t}^2)^{3/2}\right] \quad (2)$$

where n is the number of weekly return observations during the fiscal year t and $W_{j,\tau}$ is as previously defined. A higher value for NCSKEW corresponds to a more left-skewed return distribution, implying a higher stock price crash risk. The second proxy for the stock price crash risk is the down-to-up volatility (DUVOL), calculated by the logarithm of the ratio of the standard deviation in the "down" weeks to the standard deviation in the "up" weeks. Down weeks are defined as those weeks when the returns were below the annual mean of firm-specific weekly returns, while up weeks are defined as those weeks when the weekly returns are above the annual mean. In particular, DUVOL is calculated as:

$DUVOL_{j,\tau} = -log\{(n_u - 1)\sum_{down} W_{j,t}^2 / (n_d - 1)\sum_{up} W_{j,t}^2\}$ (3)

A higher value of DUVOL indicates a more left-skewed return distribution, implying a higher stock price crash risk. Given that DUVOL does not include the third moments, it is less likely to be affected by extreme return values (Chen et al., 2001). Following Kim et al. (2016), the third measure of stock price crash risk is an indicate variable, CRASH. This equals one if firms experience firm-specific weekly returns that fall more than 3.2 standard deviations below the mean firm-specific weekly returns over the fiscal year, with 3.2 chosen to generate a frequency of 0.1% in the normal distribution.

Based on prior studies (Kim et al. ,2011; Kim & Zhang, 2016; Kim et al., 2016), we estimate the following regression equation to investigate the relation between corporate pension risk-taking and firm-specific stock price crash risk:

$Crash\ Risk_{j,t} = \alpha_0 + \alpha_1 Pension\ risk\ taking_{j,t-1} + \sum_k \alpha_{k,j}\ Controls^k{}_{j,t-1} + (Year\ dummies) + (industry\ dummies) + \varepsilon_{j,t-1}$ (4)

where $Crash\ Risk_{j,t}$ is measured by either $NCSKEW_{j,t}\ DUVOL_{j,t}$, or $CRASH_{j,t}$ and $Pension\ risk\ taking_{j,t-1}$ is proxied by the proportion of equity invested in pension assets. Our use of the prior year's $Pension\ risk\ taking$ to predict current stock price crash risk in the regression analyses alleviates reverse-causation. We also conducted several tests to make stronger causal inferences in the robustness section later. All regressions include the Fama-French industry and year dummies to control for industry and year-fixed effects. Regression equations are estimated initially using pooled ordinary least square and logistic regressions with standard errors clustered at firm level.

We include industry and time dummies rather than firm-fixed effects in the empirical analysis in the next section. This is because the equity ratio in pension plans varies widely across firms, while it changes slowly over time within a given firm. Zhou (2001) argues that firm fixed effects should not be included in settings with little time series variation in the variables of interest. However, given the fact that cross-section variation in pension risk taking could be explained by unobserved heterogeneity, we conducted fixed effect and change regression in the robustness section later.

In line with prior literature, we controlled for a number of firm characteristics to ensure that the relation between pension risk-taking and crash risk is driven by other factors. We include $NCSKEW_{j,t-1}(DUVOL_{j,t-1})$, to capture potential persistence of the dependent variables. This is because Chen et al. (2001) shows that stocks with negative weekly return skewness in the fiscal year of t-1 are likely to experience the negative weekly return skewness in the fiscal year of t. From the findings that firms with higher past returns are more likely to generate extremely negative returns in the future (Chen et al. ,2001), the average firm-specific weekly return over the fiscal year t-1, $RET_{j,t-1}$, was adopted. We included the variable $SIGMA_{j,t-1}$, standard deviation of firm-specific weekly returns over the prior fiscal year to control for stock return volatility. We adopted the change in turnover ratio, $DTURN_{j,t-1}$, calculated as the average monthly share turnover in the fiscal year of t-1, minus the average monthly share turnover in the fiscal year of t-2. The rationale behind adding this variable was that prior literature (Chen et al., 2001) shows that firms with higher changes in turnover are more likely to experience stock price crash risk. Following prior literature (Chen et al., 2001; Hutton et al., 2009; Kim et al., 2001), we employ discretionary accruals estimated from the modified Jones model (Dechow et al., 1995). The variable, $DACC_{j,t-1}$ is the moving sum of the absolute value of discretionary accruals over the prior three years. We further incorporated firm characteristics in our regression: $LNSIZE_{j,t-1}$ is the natural logarithm of market value of stock, $BM_{j,t-1}$ is book-to market ratio at the end of fiscal year T, and $ROA_{j,t-1}$ is income before extraordinary items divided by total assets. Chen et al. (2001) and Hutton et al. (2009) documented that firms with greater market value and lower book-to-market ratio are more likely generate extremely negative skewness.

3.3. Descriptive Statistics

Table 1 presents the descriptive statistics for the proxies for stock price crash risk, pension risk-taking, and other control variables used in our multivariate analyses. The mean (median) of $NCSKEW_t$ and $DUVOL_t$, are -0.0697(-0.0847) and -0.0562 (-0.0694), respectively, which are roughly comparable to estimates reported in previous literature (Callen & Fang, 2013; Kim et al., 2011). The mean value of $CRASH_t$ is 0.12, which is exactly the same as the estimates by Kim et al. (2016). It suggests that 12 percent of the sample firm-years have firm-specific weekly returns that fall more than 3.2 standard deviations below the mean firm-specific weekly returns. The mean and median values of $\%EQUITY_{t-1}$ are 0.56 and 0.59, which are very similar to the estimates by Anantharaman and Lee (2014) and Guan and Tang (2018).

Table 2 presents a Pearson correlation matrix for the variables used in our multivariate analyses. The three metrics of stock price crash risk, $NCSKEW_t$, $DUVOL_t$, and $CRASH_t$ are highly significantly correlated with each other, indicating that they contain much the same information. $\%\,EQUITY_{t-1}$ is positively correlated with all three measures of firm-specific crash risk at the 1% significance level, suggesting that future firm-specific stock price crash risk increases with pension risk-taking.

VI. Empirical Results

4.1 Main results

The OLS regression results estimated from Equation (4) are shown in the first two columns in Table 3. The dependent variables are stock price crash risk: the negative coefficient of skewness of firm-specific weekly stock returns ($NCSKEW_t$) and the down-to-up volatility of firm-specific weekly returns ($DUVOL_t$). The independent variable is the percentage of equity invested in DB pension assets. The coefficients for $NCSKEW_t$ are significantly positive at the 1% level and $DUVOL_t$ is significantly positive at the 5% level, indicating that firms that invest in their DB plans' assets more aggressively experience future stock price crash more. As for the economic magnitude of the effect, an increase in the proportion of equity in DB plan assets by one standard deviation is associated with an increase in the negative skewness of stock returns of 0.1318*0.986=12 percentage points and is associated with an increase in the down-to-up volatility of 0.0514*0.5821=2.9 percentage points. The last column in Table 3 presents the marginal effects of a logit model of stock price crash risk. The dependent variable equals one if the firm experiences at least one stock price crash week in a given fiscal year ($CRASH_t$). The logit result shows that the proportion of risky assets invested in pension plans matters when it comes to whether or not firms experience crash risk. The results of Table 3 support the conjecture that pension risk-taking is associated with the future firm-specific crash risk. This is because managers with strong risk shifting incentives are likely to take greater pension-risks and such managers would be more likely to engage in bad news hoarding behaviors. Turning to the other control variables, we found several significant relationships between these control variables and stock price crash risk. More specifically, the coefficients on $SIGMA_{t-1}$, BM_{t-1}, and ROE_{t-1} are generally significant, consistent with prior studies (Kim et al., 2011; Kim & Zhang, 2016; Kim et al., 2016). It suggests that firms which experience more volatile stock prices, have more growth opportunities, and are more profitable are more likely to experience stock price crashes.

4.2 Contextual Analysis

The previous results suggest that the level of the firm's equity ratio in pension plans has a positive effect on its stock market crash risk. In this section, we aim to investigate to which extent this positive relationship is affected by the funding status in pension and default risk. We began by conducting tests as to whether firms with more underfunded pension plans exhibit higher sensitivity of stock price crash risk in response to pension risk-taking. Following Ruah (2006) and Franzoni and Marin (2006), we measured pension funding status by dividing the difference between the fair value of pension plan assets and projected pension benefit obligations, scaled by equity market value. A lower value of funding status indicates that a pension plan is not adequately funded. Table 4 displays the results of the sub-sample analysis using 80% of the funded ratio to split our sample into a subsample of firms with highly underfunded pension plans versus adequately funded pension plans. Given that credit rating agencies and ERISA, the Governance Accountability Office, consider a funded ratio above 80% to be adequate, we used an 80% threshold to split our sample. Prior literature shows that pension risk shifting is more pronounced for firms with more underfunded pension plans (Ruah, 2006; Franzoni & Marin, 2006; An et al., 2013; Guan & Tang, 2018). As expected, the results of the left panels in the Table 4 show that the effects of pension risk-taking on crash risk become significantly larger for firms with highly underfunded pension plans. Specifically, the coefficient of $NCSKEW_t$ (0.7795) becomes six times stronger and that of $DUVOL_t$ (0.4484) is eight times stronger than the results for all samples in Table 3. In contrast, the effects of pension risk-taking on stock price crash risk become weaker for firms having adequately funded pensions plans, compared to the results for all samples. Furthermore, the down-to-up volatility of firm-specific returns ($DUVOL_t$) is not statistically significant in firms that adequately funded their DB pension plans.

In a similar vein, we investigate whether firms with higher default risk exhibit higher sensitivity of stock price crash risk in response to pension risk-taking. We measure distress risk using a distance-to-default metric according to the KMV model[2]. Distance-to-default estimates the distance between the firm asset value and face value of debt, scaled by the standard deviation of asset value. Given that distance-to-default measure the distance between the expected value of the asset and the default point, higher distance-to-default corresponds to firms with low probabilities of default. Distress risk(DR) is measured by distance-to-default multiplied -1 and so that high DR means high default risk. Prior literature shows that managerial pension risk-taking incentives become greater for firms with high probabilities of default (Rauh, 2009; An et al., 2013; Anantharaman & Lee, 2014; Guan & Tang, 2018). Table 5 displays the results of the sub-sample analysis using the median of the default probability to split our sample into a subsample of firms with a high probability of default versus a low probably of default. As shown, all three columns in the left panel in Table 5, pension risk taking are highly significant and the effects are much larger compared to the results in Table 3. However, we found that the coefficients for the equity ratio in pensions for firms facing low default risk are insignificant regardless of the measure of crash risk. In particular, in the subsample of firms having high distress risk,

[2] The KMV distance-to-default model was first developed by Merton (1974) and then applied by KMV corporation. It has been widely applied in both academic research (Duffie & Singleton, 2003; Saunders & Allen, 2002; Vassalou & Xing, 2004; Duffie et al., 2007; Campbell et al., 2008) and practice.

the coefficient of $NCSKEW_t(DUVOL_t)$ is 0.2674 (0.1636), more than two times stronger than the results for all samples.

4.3 Robustness Check

Our arguments presuppose that pension risk-taking influences stock price crash risk. However, it is possible that both pension risk-taking and stock price crash risk are simultaneously determined by other omitted unobservable variables. In particular, any omitted firm characteristics could result in spurious correlations between pension risk-taking and stock price crash risk. To address the endogeneity concern, we implemented firm fixed-effect regression. The left panel in Table 6 reports the results of our firm fixed-effect regression. The findings are in line with the primary results in Table 4, confirming the robustness of our results.

In addition to including fixed effects, we use a change regression to address endogeneity concerns. Given that the approach control for the time-invariant factors affect both pension risk-taking and stock price crash risk, it confirms our findings. We regress the change of proxies of the stock price crash risk on the change in lagged value of the proportion of equity invested in pensions as well as the change of the lagged control variables. As shown in the right panels in Table 6, the coefficient of $\Delta\%\ EQUITY_{t-1}$is positively and statistically significant at both $NCSKEW_t$ and $DUVOL_t$, indicating that our findings were not affected by reverse causality issues.

V. Conclusion

We provide the first empirical evidence of the impact of risk taking strategy for corporate DB pension assets of future crash risk based on pension data obtained from Munnell et al. (2015) from 1990 to 2013. Using corporate DB pension assets allocation data, we report several important findings. Firms that invest in their DB plans' assets more aggressively experience future stock price crash more. These findings remain significant after considering potential endogeneity. Further analysis shows that the relationship between pension risk taking and future crash risk is significant in the firms with low funding ratios or high default risks. Overall, we present strong evidence that risk taking decision in DB pension asset can be a new additional predictor of future crash risk.

Our study makes important contributions in helping stakeholders and shareholders appropriately evaluate firms with DB pension plan, by recognizing the importance of DB pension asset allocation information. Our result also has important policy implications. We show that perisk investment has a significant relationship with future crash risk, and this relationship is prominent in the group with high default risk. This can have important implications for policymakers who should consider workers' retirement benefits and shareholder wealth.

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Table 1. Descriptive Statistics

This table presents the descriptive statistics for the variables used in the analysis to examine the impact of pension risk taking on stock price crash risk for a sample of 12845 firm-year observation for the 1991-2012 period. Descriptions and source of these variables are provided in Appendix A1.

Variable	N	Mean	Median	SD	Q1	Q3
NCSKEW t	12,845	-0.0697	-0.0847	0.9860	-0.5413	0.3507
DUVOL t	12,845	-0.0562	-0.0694	0.5821	-0.4164	0.2789
CRASH t	12,845	0.1297	0.0000	0.5036	0.0000	0.0000
EQUITY RATIO t-1	12,845	0.5600	0.5927	0.2184	0.4830	0.6926
NCSKEW t-1	12,845	-0.0670	-0.0823	0.9781	-0.5310	0.3401
DUVOL t-1	12,845	-0.0582	-0.0676	0.5725	-0.4114	0.2755
WRET t-1	12,845	-0.0279	-0.0154	0.0484	-0.0303	-0.0082
SIGMA t-1	12,845	0.0206	0.0177	0.0120	0.0129	0.0249
DTURN t-1	12,845	0.0638	0.0213	0.6514	-0.0962	0.1758
DACC t-1	12,845	0.0081	0.0090	0.0632	-0.0206	0.0388
LNSIZE t-1	12,845	6.8283	6.8635	2.0797	5.3512	8.2267
BM t-1	12,845	0.6475	0.5164	0.5708	0.3273	0.7931
ROE t-1	12,845	0.0317	0.1170	7.0720	0.0521	0.1800
LEVERAGE t-1	12,845	0.1972	0.1838	0.1449	0.0812	0.2892

Table 2 correlations

This table presents Pearson pairwise correlation coefficients between the regression variables. The full sample includes 12845 firm-year observations for the 1991-2012 period. Bold face indicates statistical significance at the 10% level. Descriptions of these variables are provided in Appendix A1.

		A	B	C	D	E	F	G	H	I	J	K	L	M
$DUVOL_t$	B	**0.8952**												
$CRASH_t$	C	**0.4060**	**0.302**											
$\% EQUITY_{t-}$	D	**0.0372**	**0.0284**	**0.0221**										
$NCSKEW_{t-1}$	E	0.0137	0.0133	-0.0020	**0.0277**									
$DUVOL_{t-1}$	F	**0.0174**	**0.0206**	0.0028	**0.0250**	**0.8920**								
$WRET_{t-1}$	G	0.0091	-0.0040	0.0114	**0.0802**	**-0.0210**	**-0.0322**							
$SIGMA_{t-1}$	H	-0.0042	0.0096	**-0.0184**	**-0.0915**	**0.0386**	**0.0436**	**-0.8890**						
$DTURN_{t-1}$	I	0.0097	0.0064	0.0169	0.0096	**0.0274**	**0.0291**	**-0.1067**	**0.1200**					
$DACC_{t-1}$	J	0.0038	-0.0028	**0.0188**	-0.0162	0.0043	0.0019	**0.0600**	**-0.0521**	0.0049				
$LNSIZE_{t-1}$	K	**0.0430**	**0.0252**	-0.0099	**0.0989**	**0.0525**	**0.0353**	**0.3365**	**-0.4582**	**0.0348**	**0.02110**			
BM_{t-1}	L	**-0.0368**	**-0.0252**	-0.0037	**-0.0770**	**-0.0349**	-0.0156	**-0.2762**	**0.3365**	**0.0175**	**-0.0438**	**-0.4775**		
ROE_{t-1}	M	0.0089	0.0128	0.0006	-0.0069	**-0.0343**	**-0.0316**	**0.0319**	**-0.0370**	**-0.0312**	**0.0226**	**0.0142**	**-0.0001**	
LEV_{t-1}	N	-0.0095	-0.0113	-0.0071	-0.0041	-0.0099	-0.0169	**-0.0380**	**0.0622**	**0.0199**	**-0.0570**	**-0.0210**	**0.0268**	**-0.0309**

Table 3 The impact of pension risk-taking on stock price crash risk

This table presents the results of the impact of pension risk-taking on stock price crash risk. The full sample includes 12845 firm-year observations for the 1991-2012 period. We estimate ordinary least squares(OLS) regressions from Equation (4) in column (1) and (2). The dependent variables are the negative skewness of firm-specific weekly return ($NCSKEW_t$) and the down-to-up volatility of firm-specific returns ($DUVOL_t$). The marginal effect of logit analysis is reported in column (3). The dependent variable is equal to one if firms experience one or more firm-specific weekly returns falling 3.2 standard deviation below the mean firm-specific weekly returns over the fiscal year. All other variables are defined in Table A1 in the Appendix. All specifications are estimated with year dummies and Fama-French 12 industry dummies. Standard errors reported in parentheses are clustered at firm level.

	OLS	OLS	Logit
	$NCSKEW_t$ (1)	$DUVOL_t$ (2)	$CRASH_t$ (3)
$\% \ EQUITY_{t-1}$	0.1319***	0.0514**	0.3978***
	(0.0412)	(0.0246)	(0.1377)
$NCSKEW_{t-1}$	0.0047	0.0024	0.0028
	(0.0103)	(0.0059)	(0.0295)
$WRET_{t-1}$	0.5537	0.2294	2.1050
	(0.3903)	(0.2219)	(1.8948)
$SIGMA_{t-1}$	3.0766*	1.7597*	6.6378
	(1.7323)	(1.0208)	(6.7759)
$DTURN_{t-1}$	0.0087	0.0011	0.0245
	(0.0148)	(0.0088)	(0.0398)
$DACC_{t-1}$	-0.0011	-0.0623	0.6333
	(0.1402)	(0.0840)	(0.4286)
$LNSIZE_{t-1}$	0.0118**	0.0017	-0.0252
	(0.0056)	(0.0034)	(0.0180)
BM_{t-1}	-0.0512***	-0.0297***	-0.1034
	(0.0184)	(0.0110)	(0.0724)
ROE_{t-1}	0.0012***	0.0011***	0.0024
	(0.0002)	(0.0001)	(0.0016)
LEV_{t-1}	-0.0834	-0.0625*	-0.0694
	(0.0607)	(0.0359)	(0.1920)
Constant	-0.2402***	-0.0901**	-2.0490***
	(0.0762)	(0.0454)	(0.2576)
Industry dummies	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes
Observations	12,845	12,845	12,845
r2	0.0101	0.0117	0.0180

Table 4 Subsample analysis: the effects of pension funding ratio

This table presents the results of the subsample analysis of impact of pension risk-taking on stock price crash risk. The left panel presents the results of the subsample firms with highly underfunded pension plans (funded ratio below 80%) and the right panel presents the results of the subsample firms with adequately funded pension plans (funded ratio above 80%). We measure pension funding status by dividing the difference between the fair value of pension plan assets and projected pension benefit obligations, scaled by equity market value. We estimate ordinary least squares(OLS) regressions from Equation (4) in column (1), (2), (4) and (5). The dependent variables are the negative skewness of firm-specific weekly return ($NCSKEW_t$) and the down-to-up volatility of firm-specific returns ($DUVOL_t$). The marginal effect of logit analysis is reported in column (3) and (6). The dependent variable is equal to one if firms experience one or more firm-specific weekly returns falling 3.2 standard deviation below the mean firm-specific weekly returns over the fiscal year. All other variables are defined in Table A1 in the Appendix. All specifications are estimated with year dummies and Fama-French 12 industry dummies. Standard errors reported in parentheses are clustered at firm level.

	Underfunded pension			Adequately funded pension		
	$NCSKEW_t$	$DUVOL_t$,	$CRASH_t$	$NCSKEW_t$	$DUVOL_t$,	$CRASH_t$
	(1)	(2)	(3)	(4)	(5)	(6)
$\% \ EQUITY_{t-1}$	0.7795**	0.4484**	2.8825***	0.1073**	0.0405	0.3385**
	(0.3349)	(0.1825)	(1.0734)	(0.0433)	(0.0262)	(0.1469)
$NCSKEW_{t-1}$	-0.0924*	-0.0429	-0.2085	0.0070	0.0041	0.0289
	(0.0499)	(0.0289)	(0.1435)	(0.0107)	(0.0062)	(0.0312)
$WRET_{t-1}$	-1.3165	-0.4370	-1.2630	0.6271	0.2392	3.3239
	(1.9835)	(1.0657)	(4.5574)	(0.4040)	(0.2342)	(2.3330)
$SIGMA_{t-1}$	-9.7570	-5.0098	1.8952	3.5198*	2.1178**	9.8608
	(9.0279)	(5.1395)	(22.4978)	(1.8069)	(1.0724)	(7.7916)
$DTURN_{t-1}$	-0.0147	0.0009	-0.0070	0.0151	0.0045	0.0037
	(0.0359)	(0.0241)	(0.1152)	(0.0157)	(0.0089)	(0.0446)
$DACC_{t-1}$	1.1295*	0.5573	3.7108	-0.0800	-0.0980	0.2954
	(0.5950)	(0.3545)	(2.4162)	(0.1515)	(0.0909)	(0.4614)
$LNSIZE_{t-1}$	0.0081	-0.0039	0.0143	0.0141**	0.0034	-0.0228
	(0.0342)	(0.0197)	(0.1017)	(0.0059)	(0.0036)	(0.0191)
BM_{t-1}	-0.0856	-0.0551	-0.0916	-0.0262	-0.0159	-0.0903
	(0.0614)	(0.0366)	(0.2425)	(0.0181)	(0.0108)	(0.0808)
ROE_{t-1}	-0.0257***	-0.0071	-0.0402	0.0014***	0.0011***	0.0028*

	(0.0088)	(0.0055)	(0.0477)	(0.0001)	(0.0001)	(0.0017)
LEV_{t-1}	0.4874	0.3975**	1.6931*	-0.1188*	-0.0884**	-0.0815
	(0.3412)	(0.1988)	(0.9705)	(0.0640)	(0.0382)	(0.2058)
Constant	-0.5589	-0.3436	-5.6684***	-0.2587***	-0.1026**	-2.0073***
	(0.4678)	(0.2537)	(1.4816)	(0.0796)	(0.0475)	(0.2764)
Observations	440	440	429	11,570	11,570	11,570
r2	0.0908	0.0921	0.1323	0.0094	0.0119	0.0180

Table 5 Subsample analysis: the effects of distress risk

This table presents the results of the subsample analysis of impact of pension risk-taking on stock price crash risk. The left panel presents the results of the subsample firms with high default risk and the right panel presents the results of the subsample firms with low default risk. We measure distress risk using a distance-to-default metric according to the KMV model, the distance between the expected value of the asset and the default point. We estimate ordinary least squares(OLS) regressions from Equation (4) in column (1), (2), (4) and (5). The dependent variables are the negative skewness of firm-specific weekly return ($NCSKEW_t$) and the down-to-up volatility of firm-specific returns ($DUVOL_t$). The marginal effect of logit analysis is reported in column (3) and (6). The dependent variable is equal to one if firms experience one or more firm-specific weekly returns falling 3.2 standard deviation below the mean firm-specific weekly returns over the fiscal year. All other variables are defined in Table A1 in the Appendix. All specifications are estimated with year dummies and Fama-French 12 industry dummies. Standard errors reported in parentheses are clustered at firm level.

	High Default Probability			Low Default Probability		
	$NCSKEW_t$	$DUVOL_t$,	$CRASH_t$	$NCSKEW_t$	$DUVOL_t$,	$CRASH_t$
	(1)	(2)	(3)	(4)	(5)	(6)
$\% \ EQUITY_{t-1}$	0.2674**	0.1636***	0.7737***	0.0110	-0.0549	0.1275
	(0.1054)	(0.0607)	(0.2993)	(0.1095)	(0.0651)	(0.3301)
$NCSKEW_{t-1}$	-0.0120	-0.0047	0.0460	-0.0053	-0.0012	0.0437
	(0.0233)	(0.0128)	(0.0610)	(0.0220)	(0.0127)	(0.0531)
$WRET_{t-1}$	-0.6988	-0.2525	-0.5087	0.4687	-0.0901	4.0678
	(0.9638)	(0.5443)	(2.6958)	(1.1998)	(0.9798)	(5.4684)
$SIGMA_{t-1}$	-6.8690	-3.3127	-8.6500	2.8793	0.3154	31.1980*
	(4.4110)	(2.5734)	(11.4713)	(5.0913)	(3.2836)	(17.2585)
$DTURN_{t-1}$	0.0028	-0.0050	-0.0026	0.0372	0.0085	0.0205
	(0.0243)	(0.0149)	(0.0600)	(0.0281)	(0.0159)	(0.0725)
$DACC_{t-1}$	-0.1261	-0.1648	1.1400	0.4548	0.0988	1.4793
	(0.3407)	(0.1898)	(0.9306)	(0.3822)	(0.2188)	(1.1181)
$LNSIZE_{t-1}$	-0.0077	-0.0080	-0.0158	0.0148	0.0055	-0.0000
	(0.0138)	(0.0080)	(0.0356)	(0.0135)	(0.0081)	(0.0439)
BM_{t-1}	-0.0659*	-0.0361*	-0.0141	-0.0555	-0.0190	-0.4775**
	(0.0340)	(0.0189)	(0.0892)	(0.0826)	(0.0513)	(0.2412)
ROE_{t-1}	0.0011***	0.0010***	0.0032	-0.0342	-0.0226	-0.1693
	(0.0002)	(0.0001)	(0.0021)	(0.0312)	(0.0246)	(0.1826)
LEV_{t-1}	-0.0084	0.0429	-0.3889	-0.0995	-0.0581	0.2373

	(0.1564)	(0.0866)	(0.4225)	(0.1858)	(0.1083)	(0.5267)
Constant	0.0075	-0.0293	-1.9544***	-0.2651	-0.0860	-2.5239***
	(0.1828)	(0.1062)	(0.4743)	(0.2058)	(0.1235)	(0.6590)
Observations	2,522	2,522	2,507	2,522	2,522	2,506
r2	0.0206	0.0286	0.0177	0.0183	0.0261	0.0280

Table 6 Regression analysis to address endogeneity issues

The table presents the results of approaches to addressing potential endogeneity issues. The left panel in the column (1)-(3) reports the results of firm fixed-effects regression and the right panel in the column (4)-(5) reports the results of the change regression.

	Firm fixed effects				Change regression	
	$NCSKEW_t$	$DUVOL_t,$	$CRASH_t$		$NCSKEW_t$	$DUVOL_t,$
$\% \ EQUITY_{t-1}$	0.1381**	0.0690**	0.0568*	$\Delta\% \ EQUITY_{t-1}$	0.2276***	0.1138**
	(0.0598)	(0.0351)	(0.0298)		(0.0811)	(0.0508)
$NCSKEW_{t-1}$	-0.0928***	-0.0491***	-0.0283***	$\Delta NCSKEW_{t-1}$	-0.5181***	-0.2667***
	(0.0096)	(0.0056)	(0.0048)		(0.0113)	(0.0062)
$WRET_{t-1}$	1.4277**	0.8953**	0.3638	$\Delta WRET_{t-1}$	0.6319	0.4595
	(0.5923)	(0.3481)	(0.2953)		(0.6396)	(0.3420)
$SIGMA_{t-1}$	5.5573**	4.0365***	1.5503	$\Delta SIGMA_{t-1}$	0.7685	0.8078
	(2.3494)	(1.3809)	(1.1713)		(2.6779)	(1.5311)
$DTURN_{t-1}$	0.0033	-0.0030	-0.0201***	$D\Delta TURN_{t-1}$	0.0131	0.0036
	(0.0142)	(0.0083)	(0.0071)		(0.0132)	(0.0080)
$DACC_{t-1}$	0.1335	0.0299	0.1188	$\Delta DACC_{t-1}$	-0.1505	-0.1292
	(0.1554)	(0.0913)	(0.0775)		(0.1348)	(0.0820)
$LNSIZE_{t-1}$	0.0695***	0.0471***	0.0311***	$\Delta LNSIZE_{t-1}$	0.0026	0.0020
	(0.0151)	(0.0089)	(0.0075)		(0.0050)	(0.0032)
BM_{t-1}	0.0098	0.0007	0.0231*	ΔBM_{t-1}	-0.0789***	-0.0619***
	(0.0243)	(0.0143)	(0.0121)		(0.0246)	(0.0145)
ROE_{t-1}	0.0010	0.0008	-0.0002	ΔROE_{t-1}	0.0010***	0.0006***
	(0.0013)	(0.0007)	(0.0006)		(0.0002)	(0.0002)
LEV_{t-1}	0.0314	0.0959	0.0544	ΔLEV_{t-1}	-0.1850	-0.0133
	(0.1100)	(0.0646)	(0.0548)		(0.1434)	(0.0878)
Constant	-0.5893***	-0.4331***	-0.1335*	Constant	0.0331	0.0132
	(0.1525)	(0.0896)	(0.0760)		(0.0524)	(0.0322)
Observations	12,845	12,845	12,845		11,260	11,196
r2	0.0118	0.0113	0.0062		0.2646	0.2083

Appendix

Table A1. Variable Definitions

Variables	Definitions
NCSKEW	The negative skewness of weekly stock price, calculated by taking the negative of the third moment of firm specific weekly returns for each year divided by the standard deviation of firm-specific weekly returns raised to the third power.
DUVOL	The down-to-up weekly volatility of stock price, calculated by the logarithm of the ratio of the standard deviation in the “down” weeks to the standard deviation in the “up” weeks. Down weeks are defined as those weeks when the returns were below the annual mean of firm-specific weekly returns, while up weeks are defined as those weeks when the weekly returns are above the annual mean.
CRASH	The indicate variable which takes one if firms experience firm-specific weekly returns that fall more than 3.2 standard deviations below the mean firm-specific weekly returns over the fiscal year, with 3.2 chosen to generate a frequency of 0.1% in the normal distribution.
% Equity	Pension risk-taking, measured as the proportion of equity invested in DB pension assets
RET	The mean returns, measured as the average firm-specific weekly return over the fiscal year.
SIGMA	The stock return volatility, measured as the standard deviation of firm-specific weekly returns over the fiscal year
DTURN	The share turnover, measured as the average monthly share turnover in the fiscal year minus the average monthly share turnover in the prior fiscal year.
DACC	The absolute value of discretionary accruals, measured as the moving sum of the absolute value of discretionary accruals over the prior three years. Discretionary accruals are estimated from the modified Jones model (Dechow, Sloan, and Sweeney, 1995)
LNSIZE	The firm size, measured as the log of the market value of equity at the end of fiscal year
ROA	The firm profitability, measured as the income before extraordinary item divided by equity market value
BM	The book-to market ratio at the end of fiscal year
FR	Pension funding ratio, calculated by dividing the difference between the fair value of pension plan assets and projected pension benefit obligations, scaled by projected pension benefit obligations
DISTRESS	Distress risk, calculated from distance-to-default following Campbell et al, (2008). Distance-to-default estimates the distance between the firm asset value and face value of debt, scaled by the standard deviation of asset value. Distress risk(DR) is measured by distance-to-default multiplied -1 and so that high DISTRESS means high default risk.