Pension Overhang and Corporate Investment*

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ABSTRACT

We exploit an exogenous, universal increase (decrease) in discount rates (pension liability) mandated by the Moving Ahead for Progress in the 21st Century Act (MAP-21) to identify the impact of pension overhang on investment. We find that firms with large unfunded pension liabilities increase investment by 13% after the MAP-21 induced decrease in pension liabilities. The effects are more pronounced for ex ante financially constrained firms, while pension-related cash flows have a minimal impact on the affected firms' investment policy. The reduction in pension liabilities is associated with favorable credit rating changes. Our results are consistent with, and incremental to, the effects of existing measures of debt overhang on investment.

Keywords: *Pension liability, corporate investment, overhang, leverage*

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1 Introduction

Defined benefit (DB) pension plans sponsored by U.S. corporations have approximately $2.4 trillion in assets as of 2015 with the present value of pension liabilities representing over 16% of total firm assets[1]. Yet, assets designated to pay future benefits amount to only approximately 85% of the pension liability, suggesting pension beneficiaries are material creditors to the firm. While the underinvestment problem caused by debt overhang (Myers (1977)) is well understood (Hennessy (2004), Hennessy and Whited (2007)), the impact of pension debt on firm investment policy is less clear (Rauh (2006), Bakke and Whited (2012)). In this paper, we exploit an exogenous, universal increase in pension discount rates mandated by MAP-21 (significantly decreased pension liabilities), to empirically investigate whether firm investment is affected by its unfunded pension liabilities.

Debt overhang reflects a wedge between the value of investment to the firm and the value to shareholders (Hennessy (2004)). Pension obligations are unique in regard to both the variable size of the liability as well as the collateral backing (invested pension assets). Pension beneficiaries are creditors to the firm to the extent a defined benefit (DB) pension plan is underfunded or may become underfunded in the future (Ippolito (1985*a*); Ippolito (1985*b*)). The unfunded pension liability is uncertain, variable and is exacerbated during periods of economic stress. In a default scenario, pensioners assume a relatively senior status that is generally at least *pari passu* to unsecured creditors and in many cases all, or a portion of the pension obligation may claim a senior status. The highly regulated nature of pensions along with the numerous stakeholders makes it difficult to restructure pension liabilities. As a result, the value of investment to a firm sponsoring a DB pension plan is less certain potentially exacerbating underinvestment due to debt overhang.

We examine investment policy resulting from a shock to firm pension liabilities due to MAP-21 in a difference-in-differences framework. MAP-21 was a transportation funding bill passed in 2012. The legislation initiated a higher interest rate methodology at which future pension disbursements are to be discounted, effectively lowering the present value of liabilities. The newly instituted discount rates were on average 200 basis points higher than existing rates. The change to discount rates was part of an offsetting revenue component of the law as lower, tax-deductible pension contributions were expected to increase corporate tax bills. The shock is plausibly exogenous to the firm's investment opportunity set as the discount rates are constant across firms and MAP-21 affected nearly all private plans covered under The Employee Retirement Income Security Act of 1974 (ERISA).

[1]U.S. Department of Labor Private Pension Plan Bulletin Historical Tables and Graphs 1975-2015

To test the effects of pension debt overhang, we develop a measure to proxy for the magnitude of the pension overhang in each year of the sample. We leverage the overhang construct devised by Hennessy (2004) and augmented as in Hennessy, Levy and Whited (2007) (HLW). Controlling for Tobin's Q, cash flow, and established measures of debt overhang we find an incremental impact attributable to overhang from unfunded pension obligations. A one standard deviation change in our *pension* overhang variable is associated with an approximate 5.5% change in investment. Comparatively, a one standard deviation change in the debt overhang measure is associated with an approximate 6.6% change in investment. Firms subject to a higher degree of pension overhang (above median), prior to MAP-21, ultimately increase investment by 13% as a consequence to the reduction in the pension liability. We observe no significant changes to investment for all firms with underfunded pension plans prior to the law change. The effects are strongest for entities most likely to face external financing constraints as proxied by the Size-Age index of Hadlock and Pierce (2010), the textual analysis index of Hoberg and Maksimovic (2015), cash holdings, and firm size. Additionally, we find evidence that firms encumbered by higher pension obligations have lower credit ratings on average. However post MAP-21, those firms with ex ante high pension overhang are more likely to experience beneficial rating action, consistent with an alleviation of their pension liability.

The future employee benefits associated with corporate defined benefit pension plans generate a long-term liability for the firm. If the firm has not accumulated sufficient assets dedicated to funding promised benefits, mandatory annual contributions are required to make up for the shortfall. Corporate investment policy for a financially constrained firm can therefore be affected through two separate channels: (1) the cash flow effects resulting from annual contributions and (2) the debt overhang effect associated with long-term unfunded pension obligations. Previous work has explored the cash flow channel with mixed results (Rauh (2006); Bakke and Whited (2012); Kubick, Lockhart and Robinson (2014); Dambra (2017)). Specific details of annual pension contributions present challenges to identifying the cash flow implications for investment. Namely, mandatory contributions are economically minor relative to both assets and cash flow (approximately 0.2% of assets for the median firm, 1% of cash flow) for the majority of firms in a given year. Additionally, a firm has optionality in its contributions above mandatory minimums providing plan sponsors the ability to smooth contributions over time. This paper examines an alternative channel in identifying the impact of pension funding on firm investment policy - the incremental overhang effect from unfunded pension liabilities.

The impact of pension liabilities on corporate policies has garnered increasing attention

over the past decade, yet remains relatively unexplored compared to traditional measures of firm leverage. Webb (2007) provides an exception in modeling the firm's investment decision in the context of underfunded pension liabilities. He argues the pension liability may affect both the decision to undergo and degree of risk taken on future investment. The relatively minor role of pension liabilities in the literature on corporate investment policy can be partially explained by the off-balance sheet presentation (prior to 2006) as well as the unique and complex features involved in determining pension liabilities. Shivdasani and Stefanescu (2009) and Campbell, Dhaliwal and Schwartz Jr (2011) highlight that pension obligations play an important role in corporate capital structure and can impact the ability to take on additional leverage. Shivdasani and Stefanescu (2009) find that for Compustat firms with a DB plan, accounting for the underfunded portion of pension plans increases their leverage ratio by about a third. Campbell, Dhaliwal and Schwartz Jr (2011) find that increases in mandatory pension contributions increase the overall cost of capital to firms that are already financially constrained. In addition, Jin, Merton and Bodie (2006) show the equity cost of capital for firms with DB plans reflects the risk of their pension plan, thus impacting the net present value of their investment opportunities.

We contribute to this literature by demonstrating that underfunded pension plans can inhibit investment through an overhang channel above and beyond the potential impact from pension-related cash flows. We emphasize the unique characteristics of pension liabilities which deserve consideration in the context of debt overhang. Empirical analysis of pension liabilities and corporate actions have potential endogeneity concerns given that a firm has varying degrees of flexibility in the choices to offer, freeze, terminate, and fund its pension plan. We take advantage of a universal shock to pension liabilities to mitigate these concerns.

2 Defined Benefit Pension Plans

2.1 Corporate Pension Schemes

There are two main types of corporate pension plans, defined benefit (DB) and defined contribution (DC). The key differentiating factor is in which party bears the full market and longevity risk associated with funding retirement benefits. For a DB plan, the sponsor (employer) bears this risk, while the individual beneficiary must manage these risks in a DC plan. DB pension plans provide an annuity, financed by the sponsor, to plan participants in retirement. The annuity payments are usually determined by employee tenure, age, salary and potentially various other inputs depending on the plan. Whereas in a DC pension, the plan sponsor is only required to make annual cash contributions to employees' individual

accounts based on a pre-specified benefit formula determined at the sponsor's discretion. As part of a DC pension plan, each employee is then responsible for the asset allocation of his or her own retirement account and assumes all associated asset and longevity risk. Importantly, DC plans do not create a long-term liability for the firm. We thus restrict the ensuing analysis and conclusions to firms with at least one DB pension plan.

A DB pension plan is governed under the rules laid out by ERISA. The liability is calculated as the present value of future benefit payments owed to plan participants. The law stipulates strict requirements for actuarial assumptions in determining longevity, how liabilities should be calculated, and for payments toward any unfunded plan liabilities through mandatory cash contributions. We provide additional details on mandatory contributions in Section 2.2. The total assets of a pension plan can be defined as the cumulative sum of all prior firm contributions, plus gains (losses) on invested assets, and less payouts to plan participants. The assets dedicated to the pension plan are held in a separate legal entity and cannot be accessed by the firm for corporate cash needs except for the purpose of paying out benefits and related pension plan expenses. In the case of a plan termination, the firm will garner any residual assets remaining after all benefits have been paid out to plan participants.

The funded status of a DB pension plan is defined as the ratio of dedicated pension assets to the pension liability. In any particular year, a plan may be underfunded (assets less than the liability) or overfunded (assets greater than the liability). The funded status is then subject to volatility from changes in both pension assets and liabilities. The ratio may be impacted by the returns on invested plan assets, employer contributions toward any funding shortfall, and changes to market or actuarial assumptions in calculating the liability. Firms can, and often do, fluctuate between an underfunded and overfunded status over time. In this paper, we focus on the changes MAP-21 imposed on determining the pension liability.

The total pension liability is the present value of all annuity payments owed to each workforce member covered under the pension plan. It is a function of numerous factors and actuarial assumptions including discount rates, longevity expectations, benefit structure as well as the size, age, and tenure of the part of the workforce covered by the plan. The accounting standards for determining DB plan liabilities differ between Securities and Exchange Commission (SEC) filings and IRS Form 5500 filings. The former must conform to Financial Accounting Standards Board (FASB) requirements while the latter must adhere to the stipulations set forth in ERISA. The pension liability, for ERISA purposes, is defined as the accumulated benefit obligation (ABO) - the present value of accrued benefits as described by the Internal Revenue Code (IRC). Unlike the projected benefit obligation (PBO) used

in SEC reporting, the ABO does not incorporate future expected changes in compensation levels. In general, FASB offers more discretion in terms of actuarial assumptions. The rules outlined by ERISA are the binding constraint with respect to determining annual mandatory contributions. The effects of MAP-21 only impact IRS filing data and do not change the standards for SEC reporting. We therefore restrict the pension data to the annual Form 5500 filings in our empirical analysis.

2.2 Moving Ahead for Progress in the 21st Century Act

MAP-21 was enacted with the primary purpose of reauthorizing government spending on U.S. transportation infrastructure. Signed into law in July 2012, the bill allotted for $105 billion of expenditures on highway, transit, bike, and pedestrian programs.[2] As part of the revenue to offset costs incurred, the bill mandated a change in the discount rates used to calculate single-employer defined benefit pension liabilities. The revenue raising component intended to increase taxable income on corporations by lowering tax-deductible contributions to pension plans.[3]

Corporate pension contributions are tax-deductible up to certain thresholds and are calculated on an individual plan basis. In general, a firm is required to make pension contributions equal to the sum of the normal cost and an installment of any funding deficit based on a seven-year amortization. The normal cost consists of all accrued benefits to participants for a plan-year and any annual expenses planned to be paid from the assets of the plan. The size of required plan contributions is based on the funding target attainment percentage (funded status hereon) as well as the total liability of the pension plan. By raising the effective discount rate, MAP-21 decreases the pension liability by ERISA standards, and hence the funding deficit. As a result, tax-deductible mandatory contributions also decrease, which ceteris paribus, should increase the tax liability assuming the firm only contributes the required amount.

Prior to MAP-21, as outlined in the Pension Protection Act of 2006 (PPA), discount rates were based on a 24-month average of investment grade corporate bond yields. The law effectively raised discount rates by changing the 24-*month* average to a 25-*year* average. Given the historically low interest rate environment following the financial crisis, the 25-year average corporate bond yields were considerably higher than the 24-month average yields.

[2]Additional details on the legislation and funding projections can be found at https://www.fhwa.dot.gov/map21/

[3]See the following link for CBO projections on MAP-21 budget implications https://www.cbo.gov/sites/default/files/cbofiles/attachments/hr4348conference.pdf

The published rates instituted are based on a window around the 25-year average rate and are 120-348 basis points higher.[4] If the corporate bond rate for any month does not fall within a 90-110% window of the 25-year average for that month, the minimum (maximum) rate used will be the 90% (110%) value of the 25-year average rate. The law in its original form intended for the window to widen, yet subsequent legislation has instituted the 90-110% window through 2020.

The discount rates used to determine the value of the liability are divided into three "segment rates." The segments are based on the expected timing of payable benefits and are divided into periods of zero-to-five years, five-to-twenty years, and greater than twenty years. The segment rates are published by the IRS on a monthly basis for the use of single-employer corporate DB pensions.[5] Figure 1 shows the equally-weighted average segment rates prior to and after the legislation took effect. Plans incorporate the published rate into actuarial estimates based on the plan year. The effective interest rate to discount future benefit payments will vary based on the demographics of plan participants. Consider a hypothetical firm with a young workforce that is entirely under the age of 40. Based on an average expected retirement age of 60+, the entire value of expected benefits would be discounted using the third segment rate. In this extreme scenario, the third segment rate would be equivalent to the effective interest rate. Naturally, the workforce will be far more diverse for the average firm and the impact of a particular segment rate on present value calculations will vary accordingly.

The changes to discount rates affect all firms in our sample, albeit not identically due to the noted demographic differences among workforces across firms. However, all three segment rates increased with the introduction of 25-year averages. Pension funding status, in large part due to the negative shock to pension liabilities, experiences a 14% increase from 2011 to 2012 for the average firm in the sample. Figure 2 shows a kernel density estimate of funded status prior to (2010-2011) and after (2012-2013) the shock to discount rates. A Kolmogorov-Smirnov test confirms these distributions are significantly different from each other (p-value of 0.00). In no other year in the sample does the average change by more than 5.6%. We exploit this plausibly exogenous shock to the pension liability in developing a causal argument for the effects of pension overhang on corporate investment policy. Dambra (2017) uses a similar methodology to investigate the cash flow effects of pension policy on corporate payouts and cash holdings. In contrast to our main result, he does not find an effect on firm investment.

[4] https://www.irs.gov/pub/irs-drop/n-12-55.pdf

[5] IRS minimum present value segment rates are published at https://www.irs.gov/retirement-plans/minimum-present-value-segment-rates

MAP-21 institutes a change in the discount rates used to measure the pension liability. It does not reduce the total disbursements owed to pension beneficiaries in retirement. The appropriate discount rate for pension liabilities is a topic of debate both in practice and academic literature. The cash flow stream to pensioners should be discounted at a rate that reflects the economic value of the claim (Sharpe and Treynor (1977)). Novy-Marx and Rauh (2011) suggest the Treasury yield curve as the appropriate benchmark for public entities given the protections granted to state employees. In the case of corporate pension plans, the use of historical market prices of unsecured debt obligations appears reasonable. The appropriate historical timeframe to measure these yields warrants consideration due to the long-term nature of future pension obligations and the variability of investment grade bond yields over time. Furthermore, the PBGC will assume payment up to certain thresholds should the firm fall short in a bankruptcy scenario. A debate on the appropriate discount rate is beyond the scope of this paper. However, the ensuing results suggest that corporate investment policy responds to the prevailing rates mandated by ERISA at a given point in time. If managers used an internal discount rate to measure their pension liability, we should not find effects on firm investment after the introduction of MAP-21.

2.3 Empirical Specification & Pension Overhang

In this paper, we document a positive impact on firm investment due to a reduction in pension underfunding. Similar to the overhang effects stemming from long-term debt, we argue the pension liability restricts investment as returns to capital expenditures, in part, accrue to plan beneficiaries. As the size of the pension liability grows, shareholders are increasingly less likely to participate in the returns from incremental investment. Furthermore, the size of the pension deficit is variable and can fluctuate materially based on returns to invested assets, firm contributions, and changes in inputs used in determining the associated liability. The uncertainty of the deficit could therefore exacerbate the overhang effects.

We examine the impact of an exogenous shock to the pension funding liability on firm investment policy through a difference-in-differences framework. Prior to the law change, we identify firms which may experience overhang effects from their unfunded pension liability, where the unfunded portion is a function of the weighted-average pension funded status and the total pension liability. Firms that are most encumbered by pension debt would be expected to experience the greatest overhang relief from the changes mandated by MAP-21. Near term cash flows generated by higher investment would accrue to shareholders at a higher rate at the expense of lower pension contributions. In our primary specification, we regress annual investment scaled by lagged capital stock on the interaction term of

$HighPenOverhang$ and $Post$ along with a series of controls which may impact investment policy,

$$\frac{I_{i,t}}{K_{i,t-1}} = \alpha_i + \eta_t + \beta_1(HighPenOverhang_i \times Post) + \beta_2 Q_{i,t-1} + \beta_3 \frac{CF_{i,t}}{K_{i,t-1}} + \beta_4 Overhang_{i,t}^{HLW} + \beta_5 Contributions_{i,t} + \epsilon_{i,t} \tag{1}$$

where the coefficient on the interaction between $HighPenOverhang$ and $Post$, β_1, is of primary interest. $Post$ is an indicator equal to one for all years in the sample after MAP-21 took effect. We separate the sample based on the median value of the pension overhang variable and denote $HighPenOverhang$ firms as those falling above the median in 2011, the year prior to the law change. We control for variables correlated with the investment opportunity set or which may suggest the firm is financially constrained including Tobin's Q, cash flow, and the HLW measure of debt overhang. In the full specification, we also control for the annual pension contributions. We want to ensure our results are not driven by an internal cash constraint alleviated by the lower pension contributions related to MAP-21. If the unfunded pension liability exerts overhang effects incremental to those of long-term debt, a higher value of pension debt overhang should serve as a hindrance to firm investment.

The pension overhang correction term represents the firm value to pensioners in the case of a default scenario. We develop a measure to proxy for the overhang effects stemming from DB plan deficits utilizing the basic construct of the debt overhang correction term of Hennessy (2004) and revisited by Hennessy, Levy and Whited (2007), Alanis, Chava and Kumar (2018):

$$Debt\ Overhang^{hlw} = \frac{D_t}{K_t} * RecoveryRate * \left[\sum_{s=1}^{20} \omega_{t+s}^{Moodys}[1 - 0.05(s-1)] \times r_{t+s}\right] \tag{2}$$

where $\frac{D_t}{K_t}$ represents the ratio of long-term debt to capital stock, the *Recovery Rate* is the recovery to debtholders by industry as in Altman and Kishore (1996) and ω_{t+s} represents the Moody's probability of default at time t, s years into the future (Keenan, Hamilton and Berthault (2000)).

To estimate the incremental effect of pension debt overhang, we construct a measure, *Pension Overhang*,

$$PensionOverhang_{i,t} = \frac{PenDeficit_{i,t}}{K_t} * RecoveryRate * \left[\sum_{s=1}^{20} \omega_{t+s}^{Moodys}[1 - 0.05(s-1)] \times r_{t+s}\right] \tag{3}$$

where

$$PenDeficit_{i,t} = (1 - WAFS_{i,t}) * PL_{i,t} \tag{4}$$

and

$$WAFS_{i,t} = \sum_{j} FS_{j,t} * \frac{PL_{j,t}}{PL_{i,t}} \tag{5}$$

in which PL denotes the pension liability for either firm (i) or plan (j). $WAFS_{i,t}$ is the firm-level weighted-average funded status (WAFS). For each year, the funded status of each plan, $FS_{j,t}$, is scaled according to the plan liability's contribution to the total firm U.S. pension liability. The equation follows HLW with the exception of replacing long term debt with the unfunded portion of the pension liability. We continue to assume a 5% amortization of the pension liability each year, consistent with the long-duration nature of pension obligations and required period to contribute toward pension deficits.[6] For example, if a particular sponsor had a single pension plan funded with assets equivalent to 80% of its ABO of $100 million, the $PenDeficit$ would be $20 million. The $PenDeficit$ variable is decreasing in firm WAFS and increasing in the total pension liability.

The funded status of each plan is weighted such that a smaller plan (by liability) with a high funded status would not have the same impact on $WAFS_{i,t}$ as a larger plan with a lower funded status. Unlike the debt overhang variable, *Pension Overhang* can appear as a negative value and indeed will be negative for a firm with a WAFS above 100%. In the case of default or plan termination, if a plan is overfunded, the residual value (after payments to beneficiaries) reverts to the firm. It is therefore feasible to have a "negative" overhang with respect to the pension liability.

Figure 3 displays the evolution of both the debt overhang and pension overhang variables throughout the sample period. The pension overhang variable experiences a dramatic drop from 2011 to 2012 consistent with higher discount rates, and a lower pension liability due to the implementation of MAP-21. Firms were given the option to elect into the discount rates mandated by MAP-21 in either plan year 2012 or 2013. Delayed adoption coupled with strong returns on invested pension assets during the post period aid in explaining the incremental fall in *Pension Overhang* relative to debt overhang.

The causal effect of the results rests on the assumption that the legally mandated change to interest rates is not disproportionately correlated with the investment opportunity set of firms experiencing high pension debt overhang. MAP-21 was intended to reauthorize

[6] Average duration of approximately 13-years as estimated by Towers Watson for 418 corporate pensions during the middle of our sample period.

spending for U.S. transportation infrastructure, while the changes to pension calculations were a source of offsetting revenue. Additionally, the law change impacts all firms, yet in a heterogeneous manner based on a firm's exposure to each of the three segment rates. MAP-21 redefines the segment rates based on a 25-year historical average of high grade corporate bond yields based on pre-defined maturities. While segment rates would have marginally differential effects based on pension beneficiary demographics, we see it as unlikely the universal nature of the law change was intended to impact firms with specific workforce demographics which are correlated with historical interest rates. Nonetheless, perhaps the effect may be unintended yet a correlation remains. For example, if the decrease in the pension liability disproportionately provided opportunities for firms in certain high growth industries, they would be expected to increase investment after the passage of MAP-21 exclusive of the law. We address this possibility in the main empirical specification by controlling for industry times year fixed effects.

Based on the dynamic impact of MAP-21, higher firm investment may be driven by other channels aside from debt overhang, but that are affected by a reduction in the pension liability. Motivated by prior research, we explore two of these potential channels in the empirical analysis—internal cash constraints and marginal tax rates. First, mandatory pension contributions decrease, which may relieve cash flow constraints on the firm. Rauh (2006) shows that contributions may indeed affect investment. Yet, in a subsequent analysis, Bakke and Whited (2012) find support for cash flow implications of mandatory contributions with respect to R&D spending, inventories, receivables, and employment, but no effect on investment. The authors point out the relatively small size of mandatory contributions relative to total assets is unlikely to have a significant impact on investment policy. Similarly, we observe that mandatory contributions only account for 1% of total cash flows based on the median of our sample - a fraction unlikely to materially impact cash flow intensive firm policies such as investment. Franzoni and Marin (2006) and Franzoni (2009) find evidence that firms with underfunded plans are overvalued and under-invest offering a cash flow explanation for their findings. The evidence we present in this paper is consistent with these prior results, yet provides support for the pension debt overhang channel in driving the negative effects on investment.

Second, the effect on taxable income, due to lower tax-deductible contributions, may encourage firms to seek alternative tax shelters. Investment may then increase for the sake of deducting depreciation expense. Alternatively, firms may increase total interest-bearing debt for the associated tax-deductible interest expense. Firms with the highest marginal tax rates would be expected to experience the largest impact from lower pension contributions.

Although mandatory contributions will decrease as a result of MAP-21, firms may still make voluntary pension contributions which remain tax-deductible up to a threshold well in excess of full funding. This option could attenuate the incentives for a firm to seek additional shelters for taxable income. In the empirical analysis that follows, we do not find support that either of these factors are driving the changes to corporate investment policy.

3 Data and Summary Statistics

We use IRS Form 5500 filings from 2009 through 2015 as the primary source of DB pension plan data. These forms are submitted annually, at the plan level, by sponsors of U.S. pension plans. We utilize the detailed information provided on firm assets and liabilities, firm contributions to plans, and discount rates. The sample is restricted to single-employer DB plans and on the ability to merge with Compustat by employer identification number (EIN). If the Form 5500 data cannot be matched to a Compustat EIN it is dropped from the sample. All individual plan level data are aggregated at the firm-year level.

3.1 Sample Selection

Pension data from SEC filings are not used due to various shortcomings specific to this analysis and consistent with those documented in prior literature. Generally accepted accounting principles (GAAP) allow for far greater leniency in actuarial assumptions relative to those required by the IRC. The change in discount rates mandated by MAP-21 would not be directly applicable to GAAP standards. Plan funded status, mandatory pension contributions, and related penalties are enforced by the IRS based on ERISA and IRC standards as opposed to GAAP. Based on the sources used, international pension data is not included in our analysis.

The remaining sample consists of 3,461 firm-year observations for 590 unique firms after removing financials, and firms with negative or missing total assets, sales, or capital stock. Based on the sample, the Form 5500 data accounts for approximately 60% of total pension liabilities reported on SEC form 10-K. Non-U.S. pension plans, small plans, an inability to match on EIN and differences in pension accounting between IRS and SEC documents account for the remainder.

Table 1 provides descriptive statistics on the complete sample. Relative to the Compustat universe, firms sponsoring DB plans are larger, have higher total leverage and higher cash flow. These discrepancies are consistent with the nature of a typical DB pension plan

sponsor—older, industrial firms that are part of industries characterized by high tangibility (manufacturing, auto, etc.). Panel A provides descriptive statistics on key firm-level variables, while Panel B reports statistics specific to pension characteristics. Both panels are then further divided into three columns including the full sample and then by high versus low pension overhang firms denoted by above or below median. High pension overhang firms are characterized by an above median unfunded pension liability.

High pension overhang firms are generally smaller, have higher leverage, and pension liabilities comprise a larger share of total assets - indications that as a group, these firms may face greater financial constraints. The average plan in the sample has over 14,000 participants of which most are already in retirement (33% active participants on average). The average firm in our sample sponsors three distinct defined benefit pension plans.

4 Empirical Results

We explore two primary questions in this section: (1) does the overhang stemming from the pension deficit have an incremental impact on investment after controlling for Tobin's Q, cash flow, and HLW debt overhang and (2) does the reduction in the pension liability resulting from MAP-21 encourage firm investment? We first document the incremental impact that the pension overhang variable has on investment in a panel regression framework. We then extend the analysis to a difference-in-differences estimation to examine the impact of MAP-21 on firms with a higher degree of pension overhang prior to MAP-21. We further explore the impact on long-term credit ratings, cross-sectional results for financially constrained firms, and alternative explanations which may be driving our results.

4.1 Pension Overhang and Investment

We begin by examining the nonparametric relationship between investment and the WAFS of the firm in Figure 4. Rauh (2006) produces similar estimates in describing the relationship between funded status and investment.[7] The figures reveal a striking resemblance despite the sample periods differing by more than a decade. It appears the positive relationship between funded status and scaled investment is persistent across time. Likewise, we find the relationship levels off as the plan nears 100% funded status. Given the noted concerns with the causal impact of mandatory pension contributions, our ensuing analysis seeks to shed further light on the channel which may be driving the relationship between investment and funded status.

[7] Consistent evidence reproduced by Bakke and Whited (2012)

Table 2 reports the estimates from a fixed effects model controlling for Tobin's Q, cash flow scaled by capital stock, and financial overhang following HLW. The table shows the incremental impact of each factor on investment. Coefficients for the stated variables are in line with prior results presented in the overhang literature. The number of observations decreases in columns (2)-(6) as our calculation of the overhang variable excludes non-rated firms. The average firm in our sample is rated BBB. To the extent the average of non-rated firms carry an average credit rating below BBB, our results may provide a conservative estimate as lower rated firms would be expected to experience a higher overhang effect. Most notably, column (3) includes the variable of interest, *Pension Overhang*. The overhang effect attributable to the funding deficit has a negative and statistically significant impact on firm investment. A one standard deviation increase in pension overhang suggests an approximate 1% percentage point decrease in investment to capital stock. This equates to a 5.5% change in investment. For reference, column (2) shows a one standard deviation increase in the HLW debt overhang measure is associated with an approximate 6.6% decrease in investment.

The coefficient on the overhang measure in column (2) does not have a statistically significant impact on investment. The sample is restricted to firms with a defined benefit pension plan that have a credit rating—generally larger, mature firms, with greater access to capital markets. We would expect these firms to be less sensitive to the debt overhang correction term when the pension liability is excluded. Shivdasani and Stefanescu (2009) suggest firms do consider the pension liability in maximizing the capital structure of the firm. In column (5) we separate HLW debt overhang into terciles and find a significant negative effect on investment driven by those firms in the tercile experiencing the highest degree of debt overhang. The middle tercile is omitted in the regressions. The magnitude of the coefficient suggests these firms experience a 1.7 percentage point lower level of investment to capital stock or approximately a 10% lower rate of investment.

Lastly, in column (6), we include mandatory firm cash contributions to pension plans, scaled by lagged capital stock, as an explanatory variable in the regressions. The coefficient on the *Pension Overhang* variable remains significant and little changed after controlling for cash contributions. If investment policy is impacted through an internal cash flow channel we would expect to see higher cash contributions to negatively impact capital expenditure spending. This is not the case. The economic magnitude of the coefficient on *Pension Overhang* remains largely unchanged across specifications. The immaterial effect of cash contributions on investment is consistent with the results documented by Dambra (2017) and Bakke and Whited (2012). The null result may be due to the relatively small magnitude of annual contributions relative to firm size or because firms have the optionality to contribute above

the mandatory minimum in any given year and credit such contributions to future years' required contributions. In untabulated results, we substitute total employer contributions for the annual mandatory minimum—the coefficient remains insignificant while remaining effects are left largely unchanged.

Table 3 tests the impact of MAP-21 on the underinvestment caused by pension overhang. As mentioned above, MAP-21 brought relief to companies with a high pension overhang, and given the findings in Table 2 we expect to see an increase in investment by these companies. We test this implication in a difference-in-differences framework according to equation 1.

We leverage the same control variables shown in Table 2. We control for cash contributions, which may have been alleviated by an increase in funded status. We identify firms as "High Pension Overhang" if they fall above the median of *Pension Overhang* in 2011, the year prior to the passage of MAP-21. The main specification is in column (1) where a dummy for $HighPenOverhang$ is interacted with a dummy for *Post*, an indicator for all years in the sample after the law was passed and higher discount rates took effect.[8] The coefficient on β_1 indicates that high pension overhang firms increase investment by 2.4 percentage points after the passage of MAP-21, which equates to a 13% change relative to investment levels prior to the law. Column (2) includes industry times year fixed effects. If certain industries benefited to a relatively greater extent then the results may not be driven by higher discount rates. The effects on investment are largely unchanged and remain highly significant.

Similar to $HighPenOverhang$, in column (3), we use an indicator variable for all firms which have a funded status below 100%. Our finding is not being driven by the firms with underfunded pensions as a whole, but rather those which experience a higher degree of pension overhang. Both the funded status of the firm as well as the size of the total pension liability should play a role in firm policy. Both of these factors are accounted for in our measure of pension overhang. The direction and magnitude of coefficients on all controls remain largely unchanged across specifications.

Table 4 shows the investment behavior of above median overhang firms by year. In this table we regress $HighPenOverhang$ on year dummies for each year in the sample omitting 2009. Column (1) excludes control variables while column (2) includes the full set

[8]We conservatively define post to include calendar year 2012. The law was first introduced to Congress in early 2012 at which point firms may have anticipated the passing and increased capital investment in the 2nd-4th quarters. Alternatively, investment may respond with a lag. In untabulated results, we define *Post* as beginning in calendar year 2013 and the results are economically and statistically stronger.

of independent variables used in the prior analysis. We find no material differential impact on investment up to and including 2012, the year in which MAP-21 was passed. The impact in years 2013-2015 indicate a substantial increase in investment for firms which were ex ante exposed to the greatest pension overhang effects.

4.2 A Closer Look at the Impact of Cash Contributions

The incorporation of higher discount rates as part of MAP-21 reduces both the pension liability as well as the mandatory cash contributions, which are calculated as a function of the funding status of the plan. In Table 5 we investigate whether our result is driven by those firms with the highest mandatory contributions in the pre- period. We divide the sample based on median mandatory cash contributions to the pension fund prior to MAP-21. Since we cannot accurately estimate 2012 mandatory contributions had MAP-21 not been enacted, we use the average contributions from 2009-2011 as a proxy for high expected future contributions. Firms identified as having "Low Contributions" actually exhibit an economically larger change in investment in the post period. The regression results show significant point estimates in each subsample and of a magnitude similar to those shown in Table 3 for the full sample. Table 5 suggests the relief experienced in annual mandatory cash contributions to the firm's pension is not the primary constraint on investment.

The results do not point to one subsample facing higher impediments to investment than another, but rather different sensitivities to cash flow and HLW debt overhang. Cash flow has a higher impact on firms in the "Low Contribution" sample while HLW debt overhang affects "High Contribution" firms to a greater extent.

4.3 Firm Credit Ratings

Due to the claim on future cash flows, the magnitude of firm pension obligations impact the ability to pay and the potential recovery rate of the marginal creditor. If an underfunded plan terminates, either voluntarily or involuntarily, the PBGC assumes control of the plan and can file a claim against the company's existing assets. The degree of pension leverage would then be expected to be negatively correlated with firm credit ratings. Indeed, rating agencies are rather transparent in their treatment of pension liabilities: "Standard & Poor's Ratings Services views unfunded liabilities relating to defined benefit pension plans and retiree medical plans as debt-like in nature... By accepting a portion of their compensation on a deferred basis, the employees essentially become creditors of the company."[9] Carroll

[9]See Standard and Poor's (2004)

and Niehaus (1998) find supportive evidence that pension sponsors with underfunded plans experience lower credit ratings.

We test these implications in an ordered probit and Table 6 reports results consistent with previous findings. The dependent variable is the firm's S&P long-term credit rating reported by Compustat scaled from 1 to 20 with 1 representing a "AAA" rating and 20 a "CC" rating. The post period in these regressions excludes 2012. We want to account for a potential lag in rating changes as well as the lag in IRS Form 5500 reporting, which is not reported until approximately 7 months after the end of the plan year. Reporting could then be more than halfway into 2013 for a plan year ended in 2012.[10]

In column (1), we test whether *HighPenOverhang* firms experience an effect on their credit rating in the post period. The negative and significant coefficient confirms these firms have a higher probability to benefit from favorable rating action after the passage of MAP-21. All control variables are highly significant and appear to impact ratings with the expected sign. All columns include both year and industry fixed effects to control for changes in rating standards over time (Blume, Lim and MacKinlay (1998)). Column (2) suggests pension leverage, defined as the unfunded portion of the aggregate U.S. pension liability scaled by assets, is associated with lower credit ratings. Carroll and Niehaus (1998) highlights the differential impact for underfunded versus overfunded liabilities. If a firm with an overfunded aggregate pension liability attempts to revert the surplus it faces steep tax consequences such the impact on ratings is likely not symmetrical. Column (3) differentiates between firms with underfunded versus overfunded plans. *Pension Leverage Under* is the scaled unfunded portion of the pension liability if the firm has insufficient dedicated pension assets to cover liabilities and zero otherwise. We define *Pension Leverage Over* in a similar manner for firms with overfunded pension liabilities. The positive and highly significant coefficient on *Pension Leverage Under* indicates the result in column (2) is driven by underfunded plans. Consistent with prior findings, we observe that overfunding the pension liability does not appear to have a beneficial impact on firm ratings.

We follow Alp (2013) in interpreting the economic magnitude of the effects for the ordered probit. Evaluating the model at the mean values for all variables suggests the average hypothetical firm would be rated "BBB+". This compares to an average rating of between "BBB" and "BBB-" in our sample. Based on the magnitude of the coefficient on the interaction term in column (1), *HighPenOverhang* firms experience a one-third notch better rating in the post period. For reference, based on the estimate in column (2), a one standard deviation change in *Pension Leverage* and *Debt/Assets* equates to a one-quarter

[10]Results are qualitatively and quantitatively similar when post is defined as including 2012.

and one-half notch change, respectively.

4.4 Pension Overhang and Measures of Financial Constraint

Firms facing higher costs in accessing external capital markets may experience an outsized benefit from the passage of MAP-21. We investigate if firms facing tighter financing constraints (incremental to pension overhang effects) increased investment more after the passage of MAP-21. We utilize measures of financial constraints which may capture an incremental impact to the negative effect pension overhang has on firm investment.

We employ the financing constraints index of Hadlock and Pierce (2010), also called the Size-Age index since it is a function of the log of book assets, its squared value, and the age of the company. Hadlock and Pierce (2010) argue this index is a particularly useful predictor of financial constraints relative to prior proxies such as the Kaplan-Zingales index.[11] These authors also show that firms with high cash holdings experience greater financial constraints consistent with a theory of precautionary holdings, thus we also segment our sample by the ratio of cash holdings to book assets.

We complement the Size-Age index with the financing constraints index of Hoberg and Maksimovic (2015), this index is based on textual analysis of firms' 10-K reports, in particular the Capitalization and Liquidity subsection. Hoberg and Maksimovic (2015) construct different scores for financing constraints, we use their overall measure for delay investment score. In addition, we explore the interaction with small firms as defined by their book assets. We abstain from separating the sample by credit ratings as these are factored into our measure of pension overhang.

We create an indicator that equals 1 if a firm is above (below for size) the median value variable in the year prior to MAP-21 passage and then interact this indicator with our $HighPenOverhang$ and $Post$ indicators. We present the results from these triple interactions in Table 7. Single interaction terms are omitted for brevity. Results are consistent with our hypothesis that MAP-21 created greater relief for incrementally financially constrained firms. High overhang companies with more restrictive financial constraints—as measured by the Size-Age index prior to passage of the law—increased their investment 3.2 percentage points after MAP-21. Results for the Hoberg-Maksimovic textual analysis index are very similar in magnitude, while the lower statistical significance could be due to the decrease in sample size. The Hoberg-Maksimovic measure does not include firms without a machine

[11] We also refrain from using the Kaplan-Zingales or Whited-Wu index since their computation include measures of leverage which create a mechanical correlation with debt overhang.

readable subsection on capitalization and liquidity in the 10-K. Firms with high cash holdings and high pension overhang increased investment by approximately 4.2 percentage points in the post period. The coefficient on the triple interaction with small firms is not significant, yet the direction and magnitude of the point estimate is consistent with these firms experiencing a higher degree of financial constraint prior to MAP-21.

4.5 Marginal Tax Rates as Alternative Explanation

The changes to pension discount rates as part of MAP-21 were intended to raise additional revenue for the government by lowering tax-deductible pension contributions. Thus, high marginal tax firms prior to the law change may seek other forms of tax shelters such as increasing investment for purposes of the depreciation expense deduction. In Table 8, we explore this alternative hypothesis which may impact investment policy. We test whether an increase in investment is driven by firms with ex-ante high marginal tax rates. Ex ante, firms with the highest marginal tax rates would experience the greatest benefit from the the pension contribution tax shield. These firms may have a material incentive to shelter earnings through different means after the law change. Shivdasani and Stefanescu (2009) document the material tax benefits gained from pension contributions, notably from firms sponsoring larger plans. Despite the decrease in mandatory contributions, firms may still receive favorable tax treatment on pension contributions up to certain limits of their funded status. The ability to contribute beyond the minimums however, would be expected to reduce the incentives to seek alternative tax shelters.

We merge marginal tax rates from John Graham's website with our dataset.[12]We use an indicator variable, denoted as "High Tax" for firms with above median marginal tax rates prior to the implementation of MAP-21. We find no significant results for the models using investment as a dependent variable. Although alternative tax shelters are worth exploring, the results suggest that tax implications do not explain the previous findings.

5 Conclusion

In this paper, we develop a measure of pension overhang attributable to the shortfall in unfunded liabilities. We find an incremental impact of the pension overhang variable on capital expenditure spending, while controlling for the measures correlated with the investment opportunity set and those shown to drive investment policy. The exogenous shock to discount

[12]https://faculty.fuqua.duke.edu/ jgraham/taxform.html

rates induced by MAP-21 offers us a unique ability to form a causal argument. Prior literature has focused on the cash flow effects of pension policy and their impact on investment, yet report either null or mixed results. Prior findings examining pension related cash flows face challenges related to the small economic magnitude of annual mandatory contributions and an endogeneity concern given a firm's ability to voluntarily contribute above the required funding amount. This paper sheds light on the relationship between corporate investment policy and unfunded pension liabilities through an alternative lens—pension debt overhang.

Our findings have important implications for policymakers. A legal change to the calculation of a firm's liabilities have dynamic effects and real economic implications for investment. In this paper, we do not take a stance on the optimal, market-driven value of the pension liability, but rather examine firm policy in response to a shock to the valuation of outstanding liabilities. The results indicate that single-employer pension plan sponsors do not manage corporate policy toward either an optimal or market-implied discount rate. Rather, the rates mandated by legislation impact policy decisions through their effect on firm leverage.

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6 Tables & Figures

6.1 Figures

Figure 1: This figure shows the equally-weighted average discount rates prior to and after the MAP-21 legislation took effect. The solid line represents the unadjusted rate, while the dashed line provides the adjusted rate based on average 25-year investment grade corporate bond yields. Data is available directly through IRS website.

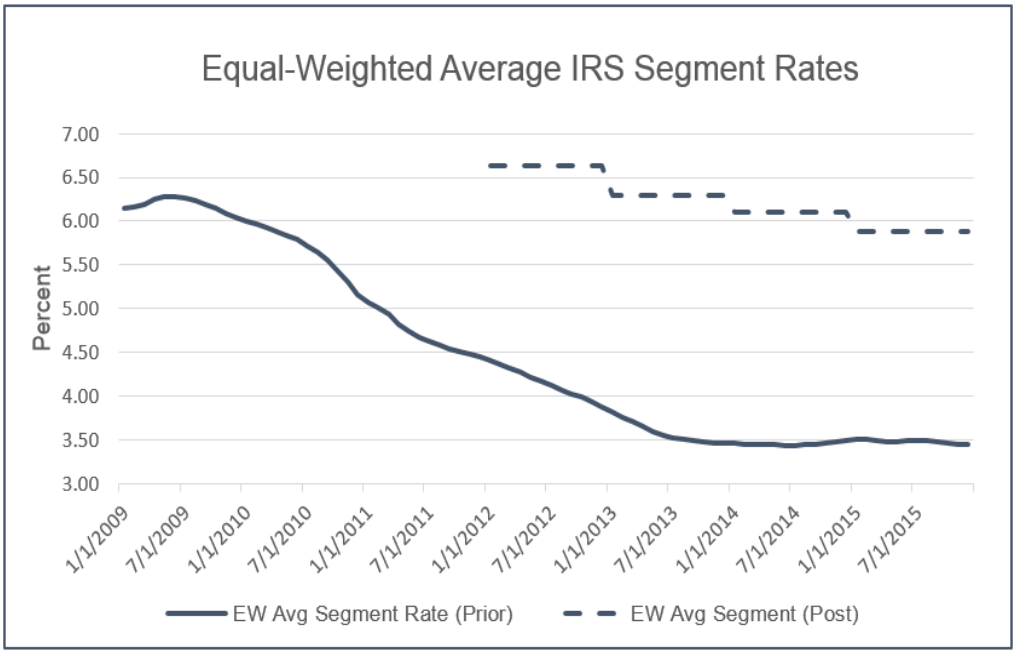


Figure 2: Figure 2 shows a kernel density plot of plan funded status both prior to (2010-2011) and after (2012-2013) the effects of higher discount rates imposed by MAP-21

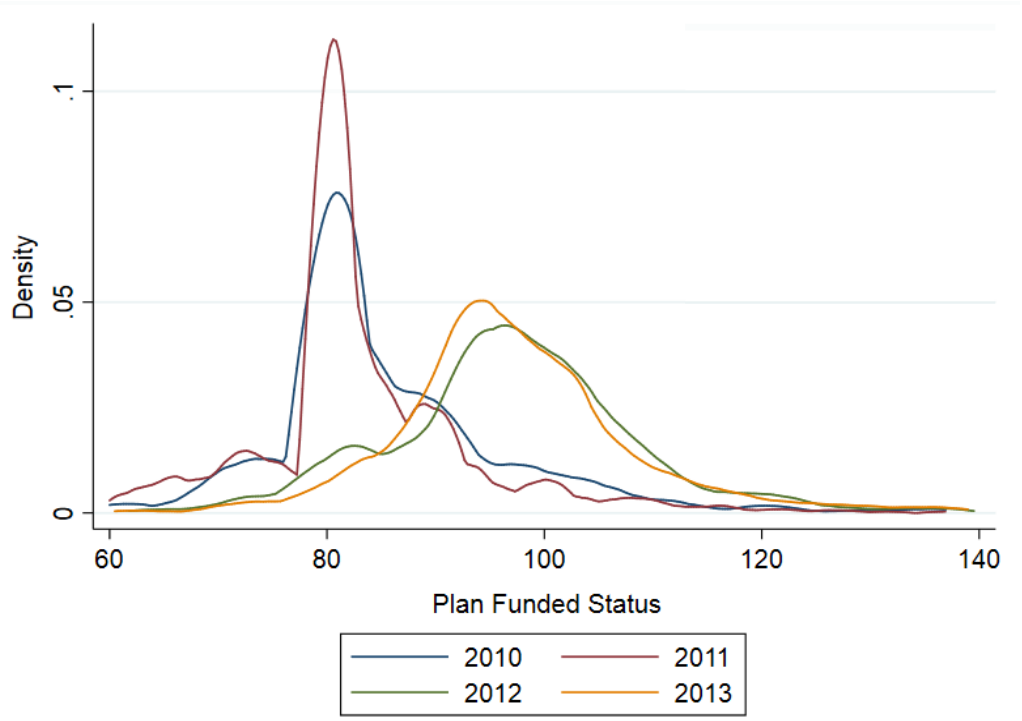


Figure 3: Figure 3 documents the change in overhang variables across the sample period. To note, the pension overhang variable is constructed so that it can take negative values, unlike the traditional debt overhang measure. Debt overhang is constructed following Hennessy, Levy, Whited (2007). Pension Overhang is constructed as

$$PenOverhang_{i,t} = \frac{PenDeficit_{i,t}}{K_t} * RecoveryRate * \left[\sum_{s=1}^{20} \omega_{t+s}^{Moodys}[1 - 0.05(s-1)] \times r_{t+s}\right]$$

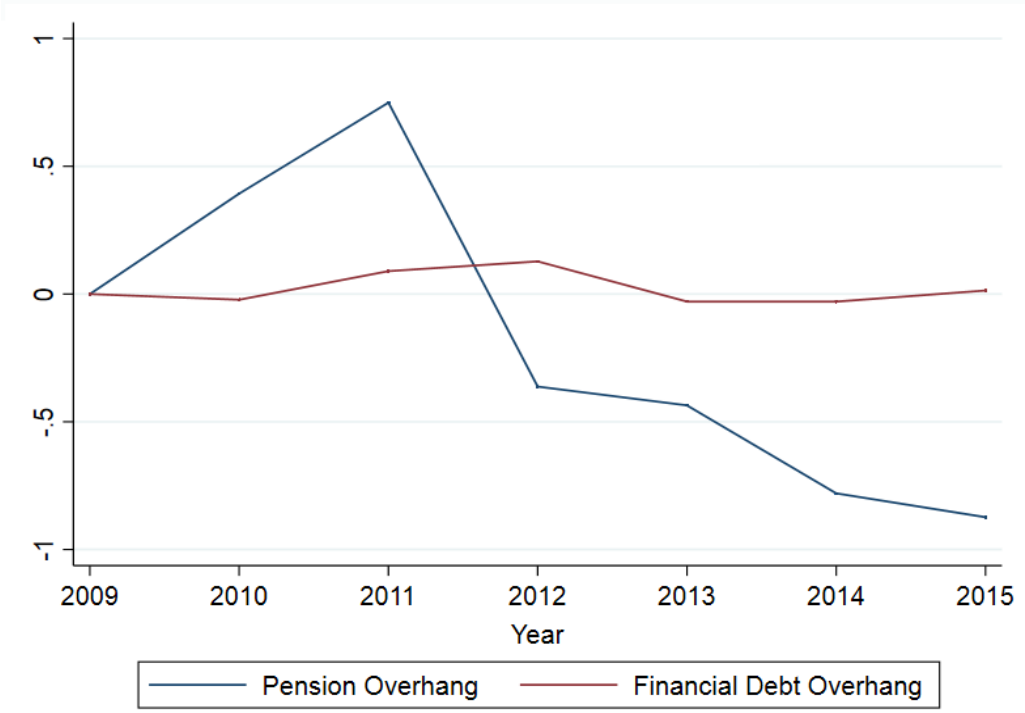
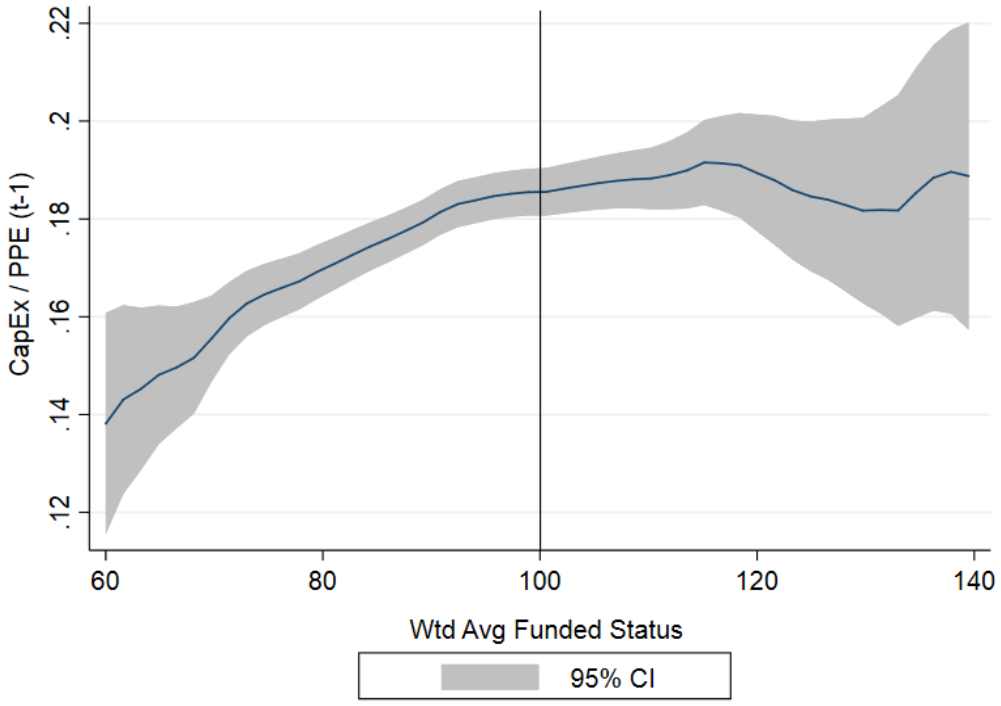


Figure 4: Figure 4 shows the results of a kernel regression using the Epanechnikov kernel. Results are from a pooled regression. 95% confidence intervals are designated by the shaded region. The y-axis is capital expenditures scaled by lagged capital stock. The x-axis is the weighted-average funded status for the all firm pension plans.



6.2 Tables

Table 1: Summary Statistics

Table 1 provides summary statistics for the 3,461 firm-year observations for 590 unique firms. Inclusion in the final dataset results from the intersection of the Compustat database and IRS Form 5500 data. Financial firms (SIC 6000-6799) and utilities (SIC 4900-4999) are excluded. Panel A describes variables solely based on data available in the Compustat dataset. Panel B provides characteristics of pension variables as reported by Form 5500 filings and associated schedules. Firm level presents aggregated information in the case firms have multiple defined benefit plans. Plan level presents statistics based on a disaggregated basis. Results for the full sample are shown alongside the split sample based on the above (high) or below (low) median measure of pension overhang prior to the onset of MAP-21.

Panel A **Compustat Variables**

	Full Sample				**High Pension Overhang**				**Low Pension Overhang**			
	Mean	Med	SD	N	Mean	Med	SD	N	Mean	Med	SD	N
Assets - Total (mm)	12,921	3,005	30,236	3424	11,222	3,590	25,146	1022	25,067	8,866	41,325	1022
Cash/Assets	0.10	0.08	0.08	3423	0.10	0.08	0.08	1022	0.09	0.07	0.07	1022
Liab/Assets	0.64	0.60	0.24	3414	0.75	0.71	0.23	1019	0.63	0.60	0.19	1022
Debt/Assets	0.25	0.22	0.20	3410	0.32	0.27	0.21	1019	0.27	0.25	0.17	1022
Tobin's Q	1.64	1.46	0.72	3210	1.53	1.39	0.53	919	1.83	1.61	0.82	993
EBITDA/Sales	0.15	0.14	0.10	3424	0.14	0.13	0.08	1022	0.19	0.18	0.11	1022
Capex/Assets	0.04	0.03	0.04	3424	0.03	0.03	0.03	1022	0.05	0.04	0.04	1022
Capex/K_{t-1}	0.18	0.16	0.10	3424	0.18	0.16	0.09	1022	0.19	0.18	0.09	1022
R&D/Assets	0.02	0.02	0.02	2279	0.02	0.02	0.02	738	0.02	0.01	0.03	684

Panel B **Pension Variables**

Firm level

	Full Sample				**High Pension Overhang**				**Low Pension Overhang**			
	Mean	Med	SD	N	Mean	Med	SD	N	Mean	Med	SD	N
Participants/Tot Emp	1.07	0.78	1.16	3360	1.30	1.02	1.15	1001	0.73	0.60	0.77	1016
Pen Liab/Tot Assets	0.15	0.09	0.17	3422	0.21	0.16	0.18	1022	0.08	0.04	0.10	1022
Pen Assets/Tot Assets	0.15	0.10	0.17	3417	0.21	0.16	0.19	1021	0.09	0.05	0.11	1020
Mand Cont/Tot Assets	0.004	0.002	0.01	3424	0.01	0.003	0.01	1022	0.002	0.001	0.003	1022
Mand Cont/EBITDA	0.04	0.01	0.08	3423	0.05	0.02	0.07	1022	0.01	0.004	0.03	1022
Wtd Avg Funded Status	93.30	92.88	14.68	3424	90.25	90.39	12.23	1022	96.71	95.58	15.58	1022
Plan level												
Funded Status	97.18	94.33	35.85	5233	91.19	92.13	14.71	1838	103.98	97.03	46.17	1677
Discount Rate	5.96	6.00	0.51	5136	5.98	6.00	0.50	1809	5.95	6.00	0.52	1609
Eff Interest Rate	6.58	6.42	9.17	5233	6.45	6.42	0.39	1837	6.46	6.42	0.44	1677
Avg Retirement Age	62.45	63	2.62	5085	62.14	62	3.73	1790	62.24	62	1.66	1583
Total Participants	14,710	2,507	43,967	5234	20,059	4,830	47,347	1838	16,540	2,747	46,465	1677
Active Part %	0.33	0.31	0.23	5200	0.28	0.25	0.20	1814	0.37	0.38	0.23	1673
Plans per Firm	3.26	2	3.65	5234	3.78	3	3.26	1838	4.07	2	5.03	1677

Table 2: Incremental Effect of Pension Overhang

This table is a regression of capital expenditures scaled by lagged capital stock on *Tobin's Q*, *Cash flow*, *Overhang*, *Employer Contributions* and the novel measure of pension overhang, *Pension Overhang*. Tobin's Q is the market value of equity plus the book value of debt divided by the book value of assets. Tobin's Q is lagged one year. The cash flow variable is constructed following Rauh (2006) to account for non-cash pension expense. Cash flow is scaled by lagged capital stock. Low (High) Overhang is an indicator variable equal to 1 if the firm-year is in the lower (top) tercile of Overhang. Employer contributions are reported in plan Form 5500 filings and aggregated to the firm level.

	(1) Capex/PPE$_{t-1}$	(2) Capex/PPE$_{t-1}$	(3) Capex/PPE$_{t-1}$	(4) Capex/PPE$_{t-1}$	(5) Capex/PPE$_{t-1}$	(6) Capex/PPE$_{t-1}$
Tobin's Q	0.050***	0.056***	0.057***	0.056***	0.056***	0.056***
	(7.382)	(7.729)	(7.923)	(7.811)	(7.797)	(7.795)
Cash flow	0.025***	0.020***	0.019***	0.018***	0.020***	0.020***
	(3.730)	(2.748)	(2.761)	(2.599)	(2.839)	(2.831)
Overhang		−0.086		−0.071		
		(−1.364)		(−1.116)		
Low Overhang					−0.005	−0.005
					(−0.752)	(−0.755)
High Overhang					−0.017**	−0.017**
					(−2.162)	(−2.143)
Pension Overhang			−1.009***	−0.936***	−0.955***	−0.974***
			(−4.037)	(−3.479)	(−3.761)	(−3.745)
Employer Contributions						0.012
						(0.180)
Firm	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3,190	1,964	1,967	1,964	1,964	1,964
Within R^2	0.14	0.19	0.2	0.2	0.2	0.2
Adj. R^2	0.59	0.65	0.65	0.66	0.66	0.66

Clustering for standard errors at the firm-level for all specifications.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3: Difference-in-Differences - Pension Overhang and MAP-21

This table presents a difference-in-differences analysis of capital expenditures scaled by lagged capital stock:

$$\frac{I_{i,t}}{K_{i,t-1}} = \alpha_i + \eta_t + \beta_1(High\ Overhang \times Post) + \beta_2 Q_{i,t-1} + \beta_3 \frac{CF_{i,t}}{K_{i,t-1}} + \beta_4 Overhang_{i,t} + \beta_5 Contributions_{i,t} + \epsilon_{i,t}$$

HighPenOverhang is an indicator variable that takes the value of 1 if a firm falls above the median *Pension Overhang* in the year prior to MAP-21. *Post* is an indicator variable for all years after the passage of the legislation (2012). $Underfunded$ is an indicator equal to 1 if a firm's WAFS was under 100% in the year prior to MAP-21. We control for $Tobin's\ Q$, $Cashflow$, *Overhang*, *EmployerContributions*. Tobin's Q is the market value of equity plus the book value of debt divided by the book value of assets. Tobin's Q is lagged one year. The cash flow variable is constructed following Rauh (2006) to account for non-cash pension expense. Cash flow is scaled by lagged capital stock. Employer contributions are reported in plan Form 5500 filings and aggregated to the firm level.

	(1) Capex/PPE$_{t-1}$	(2) Capex/PPE$_{t-1}$	(3) Capex/PPE$_{t-1}$
HighPenOverhang × Post	0.024***	0.024***	
	(3.345)	(3.453)	
Underfunded × Post			0.013
			(0.937)
Tobin's Q	0.058***	0.051***	0.057***
	(8.055)	(7.071)	(7.743)
Cash flow	0.018**	0.025***	0.020***
	(2.523)	(3.425)	(2.816)
Overhang	−0.088	−0.083	−0.092
	(−1.477)	(−1.403)	(−1.526)
Employer Contributions	−0.035	0.070	−0.057
	(−0.605)	(1.060)	(−0.973)
Firm	Yes	Yes	Yes
Year	Yes	No	Yes
Industry × Year	No	Yes	No
Observations	1,873	1,873	1,910
Within R^2	0.21	0.17	0.19
Adj. R^2	0.66	0.64	0.66

Clustering for standard errors at the firm-level for all specifications.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4: High Pension Overhang and Investment—Year Indicators

This table presents a test of the parallel trends assumption. The regression estimates the impact of high pension overhang on capital expenditures by year. *HighPenOverhang* is an indicator variable that takes the value of 1 if a firm falls above the median *Pension Overhang* in the year prior to MAP-21. We control for $Tobin's\ Q$, $Cashflow$, *Overhang*, *Employer Contributions*. Tobin's Q is the market value of equity plus the book value of debt divided by the book value of assets. Tobin's Q is lagged one year. The cash flow variable is constructed following Rauh (2006) to account for non-cash pension expense. Cash flow is scaled by lagged capital stock. Employer contributions are reported in plan Form 5500 filings and aggregated to the firm level.

	(1) Capex/PPE$_{t-1}$	(2) Capex/PPE$_{t-1}$
HighPenOverhang × Year 2010	0.004	−0.009
	(0.506)	(−1.114)
HighPenOverhang × Year 2011	0.010	0.000
	(1.038)	(0.007)
HighPenOverhang × Year 2012	0.015	0.005
	(1.382)	(0.467)
HighPenOverhang × Year 2013	0.034***	0.020*
	(3.245)	(1.869)
HighPenOverhang × Year 2014	0.040***	0.025**
	(3.271)	(2.043)
HighPenOverhang × Year 2015	0.049***	0.037***
	(4.164)	(3.284)
Tobin's Q		0.058***
		(8.174)
Cash flow		0.018**
		(2.551)
Overhang		−0.087
		(−1.473)
Employer Contributions		−0.018
		(−0.297)
Firm	Yes	Yes
Year	Yes	Yes
Observations	2,044	1,873
Within R^2	0.11	0.21
Adj. R^2	0.61	0.66

Clustering for standard errors at the firm-level for all specifications.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 5: Segmented Sample by Cash Contributions in 2011

This table presents a difference-in-differences analysis of capital expenditures scaled by lagged capital stock. We segment the sample by the cash contribution a firm made into its pension fund in 2009-2011. Low (High) Contribution represents firms whose cash contributions are below (above) the median of all cash contribution from 2009-2011. *Post* is an indicator variable for all years after the passage of the legislation (2012). We control for *Tobin's Q*, *Cash flow*, *Overhang*, *Employer Contributions*. Tobin's Q is the market value of equity plus the book value of debt divided by the book value of assets. Tobin's Q is lagged one year. The cash flow variable is constructed following Rauh (2006) to account for non-cash pension expense. Cash flow is scaled by lagged capital stock. Employer contributions are reported in plan Form 5500 filings and aggregated to the firm level.

	(1) Low Contributions	(2) High Contributions
HighPenOverhang × Post	0.037***	0.014*
	(2.592)	(1.708)
Tobin's Q	0.049***	0.071***
	(5.446)	(7.017)
Cash flow	0.026**	0.010
	(2.251)	(1.099)
Overhang	-0.003	−0.170***
	(-0.035)	(−3.929)
Employer Contributions	−0.127	0.023
	(−1.005)	(0.452)
Firm	Yes	Yes
Year	Yes	Yes
Observations	938	935
Within R^2	0.18	0.27
Adj. R^2	0.68	0.64

Clustering for standard errors at the firm-level for all specifications.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 6: Impact on Firm Credit Ratings

Table 6 reports results from an ordered probit model. The dependent variable is the Standard & Poor's long-term credit rating for the firm ordinally ranked from 1 to 20. A value of 1 is indicative of a "AAA" credit rating, while a value of 20 is equivalent to "CC". *HighPenOverhang* is an indicator variable that takes the value of 1 if a firm falls above the median *Pension Overhang* in the year prior to MAP-21. $Post_2013$ is an indicator for years 2013-2015. *Pension Leverage* is the scaled difference in the ABO less dedicated pension assets aggregated at the firm-year level. *Pension Leverage Under* is the scaled unfunded portion of the pension liability if the firm has insufficient dedicated pension assets to cover liabilities and zero otherwise. *Pension Leverage Over* is the scaled overfunded portion of the pension liability if pension assets exceed obligations and zero otherwise. *Debt/Assets* includes short- and long-term debt. The market beta is calculated for each firm. *InterestCoverage* is EBITDA divided by interest expense. $EBITDA/Sales$ is EBITDA divided by total revenue.

	(1) Credit Rating	(2) Credit Rating	(3) Credit Rating
HighPenOverhang × Post *2013*	-0.193** (-2.21)		
Pension Leverage		8.462*** (5.62)	
Pension Leverage *Under*			8.448*** (5.28)
Pension Leverage *Over*			-1.630 (-0.45)
Debt/Assets	2.873*** (6.21)	2.800*** (6.32)	2.835*** (6.36)
Beta	1.235*** (5.39)	1.158*** (5.67)	1.172*** (5.79)
Assets	-0.697*** (-11.37)	-0.761*** (-12.73)	-0.756*** (-12.67)
Market/Book	-0.718*** (-8.16)	-0.817*** (-9.62)	-0.824*** (-9.85)
Interest Coverage	-0.012*** (-5.29)	-0.011*** (-5.92)	-0.011*** (-5.81)
EBITDA/Sales	-2.511*** (-3.15)	-2.522*** (-3.35)	-2.427*** (-3.26)
Year	Yes	Yes	Yes
Industry	Yes	Yes	Yes
N	1,852	2,024	2,024

Clustering for standard errors at the firm-level for all specifications.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 7: Financial Constraints and Pension Overhang

Table 7 displays regression results including interaction terms for various measures of firm financial constraints. *High* designates a firm falling above the median for each financial constraint proxy in the year prior to MAP-21. The $Size - Age$ Index is defined in accordance with Hadlock and Pierce (2010). $Hoberg - Maksimovik$ represents the financing constraints index based on textual analysis of Hoberg and Maksimovic (2015). *Cash* references cash and cash equivalents scaled by total assets. *Small* references firm size based on total assets. *Post* is an indicator variable for all years after the passage of the legislation (2012). We control for $Tobin's\ Q$, $Cash\ flow$, *Overhang*, *Employer Contributions*. Tobin's Q is the market value of equity plus the book value of debt divided by the book value of assets. Tobin's Q is lagged one year. The cash flow variable is constructed following Rauh (2006) to account for non-cash pension expense. Cash flow is scaled by lagged capital stock. Employer contributions are reported in plan Form 5500 filings and aggregated to the firm level.

	(1) Capex/PPE$_{t-1}$	(2) Capex/PPE$_{t-1}$	(3) Capex/PPE$_{t-1}$	(4) Capex/PPE$_{t-1}$
HighPenOverhang × Post × High Size-Age	0.032**			
	(2.011)			
HighPenOverhang × Post × High Hoberg-Maksimovic		0.031*		
		(1.741)		
HighPenOverhang × Post × High Cash			0.042***	
			(3.115)	
HighPenOverhang × Post × Small				0.028
				(1.344)
Tobin's Q	0.058***	0.059***	0.058***	0.058***
	(8.117)	(6.552)	(8.162)	(7.912)
Cash flow	0.019***	0.021**	0.018**	0.018***
	(2.728)	(2.245)	(2.502)	(2.617)
Overhang	−0.075	−0.067	−0.069	−0.083
	(−1.277)	(−1.011)	(−1.167)	(−1.481)
Employer Contributions	−0.031	−0.043	−0.037	−0.032
	(−0.514)	(−0.560)	(−0.640)	(−0.565)
Firm	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
Observations	1,861	1,375	1,873	1,873
Within R^2	0.21	0.23	0.22	0.21
Adj. R^2	0.66	0.66	0.66	0.66

Clustering for standard errors at the firm-level for all specifications.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 8: Effect of Marginal Tax Rates

In this table we explore an alternative channel, tax shields from depreciation expense. *High Tax* is an indicator variable that takes the value of 1 if a firm falls above the median marginal tax rate in the year prior to MAP-21. *Post* is an indicator variable for all years after the passage of the legislation (2012). We control for *Tobin's Q*, *Cash flow*, *Overhang*, *Employer Contributions*. Tobin's Q is the market value of equity plus the book value of debt divided by the book value of assets. Tobin's Q is lagged one year. The cash flow variable is constructed following Rauh (2006) to account for non-cash pension expense. Cash flow is scaled by lagged capital stock. Employer contributions are reported in plan Form 5500 filings and aggregated to the firm level.

	(1) Capex/PPE$_{t-1}$	(2) Capex/PPE$_{t-1}$	(3) Capex/PPE$_{t-1}$
High Tax Rate × Post	−0.006	−0.007	−0.007
	(−0.816)	(−0.816)	(−0.823)
Tobin's Q	0.049***	0.058***	0.058***
	(6.942)	(7.897)	(7.897)
Cash flow	0.026***	0.019***	0.019***
	(3.761)	(2.830)	(2.810)
Overhang		−0.086	−0.091
		(−1.214)	(−1.337)
Employer Contributions			−0.046
			(−0.796)
Firm	Yes	Yes	No
Year	Yes	Yes	Yes
Observations	2,922	1,808	1,808
Within R^2	0.15	0.21	0.21
Adj. R^2	0.60	0.68	0.68

Clustering for standard errors at the firm-level for all specifications.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

7 Appendix

Variable Description

Variable	Source	Description
Tobin's Q	Compustat	(at - ceq - txdb + csho*prcc_f) / at
Cash flow	Compustat	ni + dp + xpr
Credit Ratings	Compustat; S&P	Long-term credit rating
Beta	CRSP, Compustat	Regressions of stock returns on vwretd
Assets	Compustat	at
Debt/Assets	Compustat	dt/at
Market/Book	Compustat	(at+mkvalt-teq)/at
Interest Coverage	Compustat	EBITDA / xint
EBITDA/Sales	Compustat	EBITDA / revt
Plan Funded Status	Form 5500	Line 14
Mandatory (Employer) Contributions	Form 5500	Line 34
Plan Liabilities	Form 5500	Line 3d
Debt Overhang	Compustat; Form 5500; Moody's; Altman and Kishore (1996)	See equation (2)
Pension Overhang	Compustat; Form 5500; Moody's; Altman and Kishore (1996)	See equation (3)
High Tax Rate	John Graham Website	Marginal tax rates

Table A1: Measurement error consistent estimation.

This table presents the incremental effects of pension overhang using the higher-order cumulants estimator of Erickson, Jiang, and Whited (2014). This estimator is robust to measurement errors in Tobin's Q. The equation estimated is

$$\frac{I_{i,t}}{K_{i,t-1}} = \alpha_i + \eta_t + \beta_1 Q_{i,t-1} + \beta_2 \frac{CF_{i,t}}{K_{i,t-1}} + \beta_3 Overhang_{i,t} + \beta_4 Pension\ Overhang_{i,t} + \epsilon_{i,t}$$

All variables are defined in the Appendix. Low (High) Overhang is an indicator variable equal to 1 if the firm-year is in the lower (top) tercile of Overhang. The highest order of cumulants used in all regressions is 5.

	(1) Capx/PPE$_{t-1}$	(2) Capx/PPE$_{t-1}$	(3) Capx/PPE$_{t-1}$	(4) Capx/PPE$_{t-1}$	(5) Capx/PPE$_{t-1}$	(6) Capx/PPE$_{t-1}$
Tobin's Q	0.175***	0.188***	0.187***	0.184***	0.189***	0.188***
	(4.816)	(6.586)	(6.822)	(6.670)	(6.747)	(6.747)
Cashflow	-0.014	-0.022**	-0.023**	-0.022**	-0.023**	-0.023**
	(-1.241)	(-2.032)	(-2.139)	(-2.109)	(-2.149)	(-2.156)
Overhang		-0.068		-0.052		
		(-0.946)		(-0.742)		
Low Overhang					-0.002	-0.001
					(-0.619)	(-0.608)
High Overhang					-0.002	-0.002
					(-0.858)	(-0.828)
Pension Overhang			-1.065***	-1.014***	-1.060***	-1.105***
			(-4.115)	(-3.751)	(-4.080)	(-4.074)
Employer Contributions						0.030
						(0.524)
Firm	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3190	1964	1967	1964	1964	1964
ρ^2	0.25	0.33	0.34	0.34	0.34	0.34

* p <0.10, ** p <0.05, *** p <0.01