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SEF WORKING PAPER 8/2020

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Working Paper 8/2020
ISSN 2230-259X (Print)
ISSN 2230-2603 (Online)

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Abstract

Many financially insolvent private pension funds have put Defined Benefit (DB) plans under a microscope over the last few decades. Despite government imposed rules to ensure minimum required funding, sponsors might choose to underfund the plans for short term benefits. This paper investigates the influences— plan and firm specific characteristics, and enforcement of full funding limits— on sponsor contributions (1991-2016) to DB pension plans in the US private sector. We apply Heckman model to the voluntary contributions to eliminate sample selection bias resulting from decisions to contribute only the legally required minimum. Allowing tax deductible contributions up to a full funding limitation has a positive marginal effect on voluntary contributions. Sponsors are less likely to contribute when the S&P stock return increases, but more likely when the 10-year treasury rate does. A lower pension plan funding ratio than required increases the likelihood of contribution.

Key words: Defined Benefit, Voluntary Contribution, Full Funding Limitation, Marginal Effects, Heckman Test.

Introduction

Defined Benefit **(DB)** pension plans have always been a significant part of the United States pension system and the consequences— on both firms and employees— of sponsor contribution decisions are attracting researchers and lawmakers due to the accumulated funding shortfall. This paper investigates influences on sponsor contributions due to changes in law and other sponsor and plan characteristics. By exempting contributions made to pension funds from federal corporate income tax, the internal revenue act of 1921 spurred the growth of the system. The opportunity for tax deductible contributions and tax exempt investment earnings of pension funds has led to the tax arbitrage hypothesis (Black 1980, Tepper 1981). The authors found that sponsors maintain a maximum level of funding. But, prior literature and statistical evidence on empirical contribution practice from Willis Towers Watson 2019[1] article and 2017 Pension Insurance Data Tables[2] are found to be partially inconsistent with such predictions. Negative net financial positions of single-employer DB pension plans have persisted over more than a decade. Plans insured by the PBGC (Pension Benefit Guaranty Corporation) were 15 billion overfunded and 625 billion dollars underfunded at the end of year 2016. There was a drastic drop in the mean funding status of defined benefit (DB) plans sponsored by companies in the Fortune 1000 from 102.5% in 2007 to 75.1% in 2008. The low mean funding status (less than 85%) continued until 2017-except in year 2013. Low contributions among other reasons (decrease in pension assets and increase in liability etc.) have contributed to this recent trend. A number of reasons—increased insurance premium, low borrowing cost, and the Tax Cuts and Jobs Act (TCJA) reducing federal corporate tax rates— contributed to spikes in contributions in last couple of years.

Hypothesis on full funding limitation rule

In contrast to previous research, we include external factors like national economic conditions and the full funding limitation rule along with firm and plan specific variables. The full funding limitation rule incentivises sponsors to contribute more than the minimum funding requirement by

giving a tax deductible contribution opportunity. So, we create two funding status variables of pension funds with respect to the minimum contribution requirement and the full funding limitation. We use S&P 500 total return and 10-year Treasury note rate as proxies of the economy. We believe that these proxies are adept for our study as the majority of pension assets are invested in equities and bonds.

We use voluntary contribution as our dependent variable following Chen, Yu, and Zhang (2013), because we believe it is a better measure to study the effect of the full funding limitation rule. Sponsors are legally obligated to make mandatory contributions whereas voluntary contributions depend on the sponsor's perception of the tax deduction options. We use data on single-employer (SE) defined benefit plans in the US private sector.

Discussion of findings

We divide the total sponsor contribution into mandatory and voluntary contributions using applicable pension laws and regulations. We address sample selection bias by using the Heckman test to allow us to study the firms which only make required contributions (i.e., no voluntary contribution) along with the firms which make voluntary contributions. However, we could not differentiate all the firms that did not make voluntary contributions from the firms that merely failed to report (Form 5500) the contribution made, and have treated the missing values occurring from the above two situations the same.

As expected, we find the funding status of pension funds to significantly affect sponsors decision to make voluntary contributions. Plans near the full funding limitation percentage are less likely to make voluntary contributions possibly due to losing the opportunity to make a tax deductible contribution on top of paying 10% excise tax on the excess amount. In contrast, the firms with funding status lower than the minimum required percentage are more likely to voluntarily contribute. Although these plans need to cover the deficit to reach the fully funded status by making mandatory contributions first, they show a pattern of regarding the tax arbitrage opportunity as a profitable investment option. The two proxies for economic conditions have opposing effects on the amount of

voluntary contribution sponsors make. The positive effect of the 10-year treasury rate on voluntary contribution may also be a result of the decreasing trend in both variables during the period. On the other hand, the negative effect of S&P 500 return sheds light on sponsors reducing voluntary contribution in good economic times as they may perceive that other investment opportunities are more beneficial for the firms.

We also find that financially healthy firms make larger voluntary contributions than their counterparts. *Pension Benefit Obligation* (i.e. the long term plan liabilities) and *normal cost* (i.e. the current plan liabilities) have a positive effect on voluntary contributions. The increase of current liability depends on various factors like the number of active participants, change in actuarial assumptions, etc. The positive effect may reflect the employers of plans with more active participants adjusting future payments with current ones by making voluntary contribution. An increase in PBO lowers the funding ratio of the fund and hence making voluntary contributions is more remunerative. Finally, to control for time-invariant firm characteristics, we use within estimators of time variant variables of our study. Consistent with our expectation, this changes the direction of the effect (e.g. *CapEx* and liabilities) and significance of some variables. Therefore, after considering unobservable firm fixed effects the coefficients of the explanatory variables are more consistent with our expectation and prior literature.

There is lack of significant prior literature on the US private sector pension plans that use the full funding limitation rule to explain voluntary sponsor contribution, which strongly affects the financial position of pension funds. This paper interprets the effect of this rule on voluntary contributions and the funding status of the pension plans. The latter application can be of use to study future scenarios under different circumstances.

US defined benefit (DB) pension background

The retirement income system—originally put in place to increase employee retention and decrease the necessity of governmental support for the elderly — soon (especially the DB plans)

became an investment tool for employers. But after a number of new laws the financial position of DB plans has been declining for a few decades. Despite large contributions to pension funds in recent years, the financial health of the largest US corporate plans edged up only slightly in the year 2019[3]. In some countries such as Canada, the provision for tax deductible employee contributions into private sector DB plans gives sponsors the option to increase the employee contribution to adjust to the increased costs over termination of the plan (Cohen, Bruce and Fitzgerald 2008). The absence of such provisions in the US makes it difficult for the sponsors to adjust to the additional cost especially in an economic downturn. Even with the decreasing number of new DB plans in last few decades, the total financial assets in both public and private DB pension plans as of 2016 were $12.4 trillion. So, a better understanding of sponsor contribution decisions is necessary to propose optimal planning rules for a pension system that has assets of this magnitude.

In 1974, the Employee Retirement Income Security Act (ERISA) established the Pension Benefit Guaranty Corporation (PBGC), a pension insurance program that guarantees employee benefits in private pension plans. The US experienced a significant shift to Defined Contribution (DC) plans for various reasons after the passage of ERISA. The decline in defined benefit plans has been linked partly to a shrinking equity premium as it has made it more expensive to fund pension liabilities (Selody 2007). However, this change in equity premium also affects defined contribution plans. Also, the Tax Cuts and Jobs Act changed tax deductions in ways that we believe will make DB plans more appealing.

Overfunding (funding more than the minimum required amount) gives sponsors the advantage of claiming a tax deduction even on the excess funding of the pension plan up to a certain deduction limit. In 1988 Congress enacted the full funding limitation on DB plans stating that only overfunded plans with assets less than 150% of the current liability can make tax-deductible contributions to the plan. The limit has since been increased and was 170% in 2003 (EGTRRA). After 2004 the fixed deduction percentage was revoked and until 2017 the annual deduction limitation of a single-employer DB plan was the greater of (1) minimum contribution required under Code Sec. 430 or (2) an alternative

amount computed under Code Sec. 404 (o)(1)(A) (applicable to at-risk-plans). Sponsors contributing in excess of the full funding limitation can carry it over and deduct it in succeeding years (Code Sec. 404 (a)(1)(E)), but a 10% excise tax will be applicable for each year it remains non-deductible (Code Sec. 4972(a)). Under the 2017 Tax Cuts and Jobs Act, businesses that sponsor a tax-qualified DB pension plan may have the opportunity to generate deductions on their 2017 return by making contributions to the plan during 2018. A deduction should be available to an extent if along with some other rules the contribution keeps the funding status of the plan within the 150-percent limit, measured in the specific way provided under the Code.

On the other hand, underfunding (funding less than the minimum required amount) a pension plan can result in tax penalties as the savings in the pension plan are accumulated at a pre-tax interest rate whereas corporate savings is accumulated at an after-tax interest rate. Before the enactment of ERISA, firms used to forgo the tax advantage of the full funding limit with a view to making unionized workers long-term bondholders in the firm. This lowers the occurrence of unions reducing productivity or demanding wage increases (Ippolito 1985). The introduction of the Pension Benefit Guaranty Corporation (PBGC) through ERISA has significantly reduced this bonding advantage of unions with firms.

Munnell and Soto (2004) suggest that the stock market boom and legislative changes reduced contributions to pension funds by one third during 1982-2001. They predicted that as the bear market drew to a close in the early 21st century, sponsors will be required to put more contributions into the fund to maintain ERISA's funding requirements. Pension assets increase and reach the full funding limitation percentage during economic booms making sponsor contributions unfavourable as contributions no longer remain tax deductible. Although an aging population required the sponsors to contribute more to the pension fund than before even in good economic times, elimination of the full funding limit further reduced corporate tax income of the government.

Minimum funding rules applicable to single employer DB plans were dramatically changed by the Pension Protection Act (PPA) of 2006. Final regulations issued in October 2009 implemented the new rules. The general requirement is that sponsors need to fully fund the present value of the benefits accrued or earned under the plan as of the beginning of the year (ERISA Sec. 303(a)(2)). The minimum contribution is based on plan assets and accrued liabilities and must be sufficient to amortize a funding shortfall of seven years. The applicable rules governing minimum required contribution vary, depending on whether plan assets are less than or equal to the plan's funding target for the plan year.

Literature Review

The recent financial crisis has shown that defined contribution plans leave the employees fully exposed as they share the market risk neither with their sponsors nor any insurance companies. And the volatility of funding ratios (i.e. Pension assets/ Liabilities) for DB plans makes it very difficult to predict the long run. Making the DB pension schemes more counter-cyclical through regulations and also overfunding during good financial times may lessen the burden during bad times (Yermo and Severinson 2010). More focus on DB pension plans is required to avoid the possibility of poor performance of retirement funds during periods of negative economic growth.

The portfolio of assets in a pension fund plays a significant role in the earnings of the pension scheme and hence the funding status of the plan. U.S. public pension funds with a higher level of underfunding per participant invest more in risky assets and use higher discount rates in order to report a better funding status. Increased risk-taking is negatively related to the performance of these funds (Andonov, Bauer, and Cremers 2017). In addition to the asset mix, sponsors also need to decide on various other aspects such as the ratio of internal and external financial sources in DB pension plans. In addition to the internal factors that affect pension funds, external factors are also considered while making the choice of contribution size.

The Wharton School at the University of Pennsylvania convened a Technical Review Panel to review the Pension Insurance Modelling System (PIMS) of the Pension Benefit Guarantee Corporation

(PBGC) including inputs, outputs, and model assumptions. The panel comprising ten experts provided a formal evaluation and a summary of the review (Mitchell 2013) finds that liabilities of Multi-Employer plans are more likely to be unpaid by PBGC, as and when necessary, compared to the Single-Employer plans. The 10-year projection used for PBGC has two impacts: On one side it increases the extent of uncertainty and on the other side it down-weights the liability that the agency has as some of the liabilities remain in effect long into the future (for more than one decade). But some argue that long-term projections will be infeasible for the PBGC as there are additional uncertainties like voluntary components of funding decisions, voluntary decisions over sponsorship of PBGC insured plans, pension-related legislative changes, and market returns of different risky assets classes, events which the future solvency of PBGC is more sensitive to**.** So, a revised projection needs to be made which will take these components into account.

Data

In our study, the key variables are voluntary pension contribution, pension assets, funding ratio, and the full funding limit percentage. Description of these variables are summarized in Table 1.

We have an unbalanced panel data with gaps for the period 1991-2016. The data encompass the effect of the enactment of the Tax Reform Act of 1986 (TRA 86), The Economic Growth and Tax Relief Reconciliation Act (EGTRRA) of 2000, the Pension Protection Act of 2006 (PPA), and especially the full funding limitation which are believed to change the perspective of sponsors towards their pension plans. The data also cover the period of the global financial crisis which distinctively shaped the variables that we are studying. Although FASB changed pension disclosure rules effective from 1998 through SFAS#132, the variables that we have used here were unaffected. Only DB pension plans under single employer programs have been covered here, as multiemployer programs have DB plans with different properties which make them incomparable with single-employer plans under the scope of this study. The data sources are: COMPUSTAT, CRSP, PBGC records, webpages[4] and IRS Form 5500. Most of the data were available online. We acquired Form 5500 for years 1991-1998 and year 2008

via two Freedom of Information Act (FOIA) requests to the US Department of Labor. The data for 2008 were image files that we transferred into excel files to use in our analysis. We merged the complete data using year and Employer Identification Number (EIN) from the abovementioned data sources. The observations in Form 5500 are reported by pension plans so we adjusted the information to get firm level data. If a firm had multiple DB pension plans, we have summed all of the plan-level data and obtained sponsor contributions for the firm as a whole. Then we dropped the observations of multi-employer plans and welfare benefit plans. We then found the voluntary contribution for years 1991-2010 using the formula mentioned in the article (Chen, Yu, and Zhang 2013). We have used the variable "excess contribution" reported in line number 38 of schedule SB files of IRS Form 5500 as the voluntary contribution from year 2011-2016.

Variables and Analysis

Sponsor contribution: Actual sponsor contributions to pension plans are taken from Form 5500. Voluntary contribution: Sponsor contributions can be divided into two parts: Mandatory pension contributions and voluntary pension contributions.

Income before extraordinary items: Extraordinary items are results of unforeseen events which are irregular in nature. We believe income before extraordinary items is more relevant in decisions about sponsor contribution instead of net income as it is a better gauge of operating performance.

Projected Benefit Obligation (PBO): The amount of contribution that must be made into a DB pension plan to cover all pension benefits earned by employees. The benefit calculation must be adjusted for expected future salary increases.

Underfunded dummy variable: When a company retirement plan's pension liabilities (PBO) exceed its pension plan assets (investment portfolio) then the plan is called an *underfunded* plan.

Excess funded dummy variable: When the funding ratio exceeds the full funding limitation percentage then we call it an e*xcessfunded* plan.

$$\text{UnderDummy}_{jt} = \text{Firm j's funding position for year t}$$

$$= \begin{cases} 1, & \text{Plan Assets}_{jt} < \text{PBO}_{jt} \text{ and} \\ 0, & otherwise \end{cases}$$

$$\text{Excessdummy}_{jt} = \text{Firm j's excess funding position over full funding limit for year t}$$

$$= \begin{cases} 1, & \text{Funding Ratio}_{jt} > \text{Full funding Limit and} \\ 0, & otherwise \end{cases}$$

$$\text{Funding Ratio} = \frac{\text{Pension Plan Assets}}{\text{PBO}}$$

Table 1 presents the description and sources of variables used in the analysis.

Table 2 presents basic descriptive statistics of the variables in hand. For the dependent variable voluntary contribution, the statistics are "0" for non-selected sample as these observations are unselected due to "0" voluntary contribution or missing values in any variables. Among a few other reasons, a sponsors' decision against contributing to the pension plan for some plan years or failure to file Form 5500 that year may lead to "0" or missing voluntary contribution. Both of these cases can be non-random as there are laws for voluntary contribution and penalties or waivers regarding failure to file form 5500.

All firm and plan specific explanatory variables except Plan assets and Capex have higher means in the selected sample (48%) than the non-selected sample (52%). This suggests that comparatively large firms are dominating the sample as these firms are more likely to contribute in excess of the minimum requirement. From Table 2 we can also see that the average S&P 500 return is higher for non-selected observations meaning lower observations of non-zero voluntary contribution during good economic years. The mean of *underfunded* (dummy variable of funding requirement cap) and *excessfunded* (dummy variable of funding over the tax benefit cap) show that the selected sample consists of more underfunded firms and fewer excess funded firms compared to the non-selected sample. The low mean (approximately 3%) of the *excessfunded* dummy can be due to the repeal of the full funding limitation based on the ratio percentage after year 2004.

Figure 1 shows the trend of total number of observations in the total sample, selected sample, and non-selected samples on *voluntary contribution* over the period 1991-2016. The selected sample

line (fims with non-zero voluntary contribution) had a spike in year 1998 which continued until 2008. This may be due to the increase in the full funding limitation percentage— tax deductible percentage of pension assets over pension liabailties— even though the total sample line (the number of DB plans) had a decreasing trend during that period. After the financial crisis of 2008 the number of records with missing values or "0" *voluntary contribution* has increased significantly. The patterns suggest that the decision by firm management to make a voluntary contribution to the pension plan is non-random in our data and it has been affected by the rules imposed by the government and the economic conditions during that period. Moreover, (PBGC, 2016)[5] shows that 55,024 plans have been hard frozen within the period of 2008-2015 only. This implies the existence of self selection bias and hence non-randomness of observations which affects research models.

Heckman Test

Heckman (1979) proved that in the case of a censored sample, the Heckman test allows the use of simple regression techniques to estimate behavioural functions free of selection bias. In our data the number of missing and "0" values of the variable "voluntary contribution" is significantly higher between 1991-1997 and from 2008 onwards. Even though there were no minimum requirements in year 2009, instances of voluntary contribution were low. Moreover, the Secretary of the Treasury is permitted to waive all or a portion of minimum funding requirements for a plan year if the sponsor is unable to satisfy the requirements without substantial business hardship. Therefore, we believe that the firms who decide to make voluntary contributions are different from the firms that decide against it. Hence we apply the Heckman test to address this problem.

Our sample includes all firms offering DB plans. Firms with missing values of explanatory variables are necessarily excluded from our analysis. But the dependent variable can have missing values as they will be considered non selected samples in the following analysis.

First stage (Probit model)

We first analyse the **selection model**, a Probit model that tests the likelihood of sponsors making voluntary contribution to the pension fund. *Underfunded* and *excessfunded* dummies are two select variables in this analysis.

In principle, sponsors tend to address the underfunded status of their pension plans to avoid them being labelled an "at-risk plan" or accumulating pension liabilities. So, plans that are underfunded in preceding years will have to adjust for the deficiencies of all previous years before making any voluntary contributions. In addition, it is very likely that the firms that keep their pension plans underfunded perceive the pension plans as liabilities and are indifferent to the tax arbitrage opportunity. On the other hand, having excess funding above the full funding rule can keep sponsors from contributing more than required until the plan assets fall below the funding limitation percentage. And a higher full funding limitation percentage may entice more firms to make voluntary contributions. Therefore, we believe that these two variables affect the decision to make voluntary contributions, but do not affect the amount of the voluntary contribution directly. Hence, these two variables are only included in the first stage (select model) of Heckman and not the second stage (original model). Variables depicting the financial condition of the country, i.e., *S&P 500 Return* and *10-year treasury* are also added as they may affect the decision to contribute, particularly after 2008.

Table 3 presents the marginal effects in the Probit regression on the probability of making voluntary contributions. The identifying variables are highly significant. A shift from not underfunded to underfunded increases the likelihood of voluntary contribution by 5.3 percentage points. This matches with our expectation as the underfunded firms may decide to make voluntary contributions to make up for the deficiency in the pension fund earlier. On the other hand, having an excess funding ratio over the full funding limitation decreases the likelihood of voluntary contribution by 5 percentage points. This is justified since voluntary contributions over this threshold can cost the sponsors 10% excise tax and no tax exemption on the extra contribution.

Another interesting outcome is a decrease in the likelihood of contribution by 36.3 percentage points with 1 percent increase in the S&P 500 return. This suggests that in good economic times sponsors are less likely to contribute, possibly because there are more profitable alternative investment options for the available funds. But this explanation conflicts with the positive marginal effect of the 10-year treasury rate. One potential explanation for these conflicting effects could be the higher average share of stocks relative to average share of bonds in pension plan assets during the majority of the time period. The statistics in the Willis Towers Watson article show that although the share of Fortune 1000 companies' pension assets invested in public equity has decreased to 37.6% from 54.5% in 2009[6], the shift occurred only during the last decade. This means with the increase in S&P 500 return, the value of pension plan assets also increases making voluntary contributions to the plan less necessary.

Second stage (regression model)

In this stage, we have again used all the firms with a matrix of explanatory variables. To address the skewness of the data and presence of observations with "0" and negative values we have used an inverse hyperbolic sine (IHS) transformation for all the monetary variables.

The IHS transformation can be expressed as:

$$sinh^{-1}(x) = \ln(x + \sqrt{1 + x^2})$$

where x represents the variable of interest and $sinh^{-1}$(x) represents the inverse hyperbolic sine transformation of x. This transformation mitigates to some extent the dominance of large firms on the regression as with the logarithmic transformation, but allowing negatives.

From this stage of Heckman test we estimate Inverse Mill's Ratio ($lambda = \frac{\phi\,(\gamma' X'_{1jt})}{\Phi(-\gamma' X'_{1jt})}$, where ϕ and Φ are the density and distribution function of a standard normal variable), and use it as a regressor in a simple OLS regression model with fixed effects to estimate the behavioural functions of interest.

We then add lambda as a regressor in the OLS with fixed effects (in Table 5) which mimics the Heckman with fixed effects. For the OLS with fixed effects we use within estimator and consider the following model.

$$Y_{jt} - \bar{Y}_j = \left(X_{jt} - \bar{X}_j\right)\beta + \left(\beta_j - \bar{\beta}_j\right) + \left(u_{jt} - \bar{u}_j\right)$$

$$\Longrightarrow \ddot{Y}_{jt} = \ddot{X}_{jt}\beta + \ddot{u}_{jt} \quad (1)$$

Where, $\bar{X}_j = \frac{1}{T}\sum_{t=1}^{T} X_{jt}$

and $\bar{u}_j = \frac{1}{T}\sum_{t=1}^{T} u_{jt}$

Since, $\beta_j = \bar{\beta}_j$, the firm fixed effect is eliminated. So, fixed effect estimator will be obtained by OLS regression of $\ddot{Y}$ on $\ddot{X}$.

Table 4 presents the result of the maximum likelihood estimates of the Heckman sample selection model using White sandwich variance estimator. Model 1 is the original regression model of the inverse hyperbolic sine transformed variables respectively.

In Model 1, the positive coefficients of the following variables suggest an increase in the *voluntary contribution* with an increase in *Assets* (359), *Revenue* (199), income before extraordinary item (3.54), and *PBO* (313). *Capex* (28) suggest that voluntary contribution and capital expenditure move in the same direction which contradicts previous study (Rauh 2006) which finds an inverse relationship between the two variables. The author found this result while studying nonlinear funding rules of DB pension plans in order to identify the effect of internal financial resources on corporate investment. He also suggests that if external finance is more expensive than internal finance then the prediction from the (Modigliani and Miller 1958) model will be false and firm expenditures will respond negatively to required contributions to pension plans. We also presumed that sponsors consider them to be investment substitutes. Furthermore, we have obtained a negative and significant coefficient for marginal tax rate after interest (-0.87) and opposite significant effects for the two

economic factors (*S&P 500 return and 10-year treasury rate*). The intercept of Model 1 reflects that on average sponsors make positive voluntary contribution when all other variables are zero.

The two ancillary estimates ρ and σ are also presented in the table. Here, ρ is the correlation coefficient between the error terms of the two equations and σ is the standard deviation of the error term of the original equation. The Wald test (chi-square) reported at the bottom of the output tests whether all coefficients in the regression model (except constant) are 0. The p-value of the test suggests that the null hypothesis of slope parameters (β_1' and β_2') being equal to "0" is rejected at 1% level of significance.

The lambda term is significant and negative – suggesting that the error terms in the selection and original equations are negatively correlated (since the coefficient on lambda = $\rho_{eu}\sigma_e$). So, other factors (unobservable to researchers but considered by the firms) that make voluntary contribution more likely tend to be associated with lower value of voluntary contributions for those who make them.

In Table 5, more variables are now significant indicating that after considering firm fixed effects these variables have significant impact on voluntary contribution. Except Marginal tax rate all other significant coefficients have the expected direction.

In Model 2, the standardized coefficients of assets (2224), cash flow (37.10), PBO (140), and normal cost (86.80) suggest that an increase in these variables increases voluntary contributions which coincides with our expectations and the current literature. As these variables suggest that the firm's business is performing better (or their pension liabilities are increasing) and hence they are capable of contributing more (or are required to contribute more) to their pension plans. To catch up on due pension liabilities, government pension funds need to use a greater share of their revenues (Drucker 2013). The same can be said for private pension funds. On the other hand, target normal cost is the minimum amount that the firm has to contribute so that the plan does not get classified as an underfunded plan unless the plan is already overfunded. Therefore, it was expected that *Normal cost*

will correlate positively with *voluntary contribution*. The authors suggest that the full funding limit in times of economic booms will reduce the tax deductible normal cost payments by increasing the assets of the pension funds (Munnell and Soto 2004).

With increasing pension plan assets pension funds ability to pay their due benefits increases and hence the decrease in *voluntary contribution* with one standard deviation increase in *plan assets* (-168) is justifiable. The sign of standardized coefficient of *Capex* (-333) now matches the literature after considering the firm fixed effects as opposed to its coefficient in the Heckman model (28) without fixed effects. That is, after controlling the time-invariant unobserved firm characteristics, increase in Capex results in a decrease in voluntary contribution as firms consider these to be two alternative investments.

The standardized coefficient of *marginal tax rate after interest* (-0.063) indicates that an increase in post financing marginal tax rate decreases *voluntary contributions*, which is counterintuitive. But the following two instances match the theory and have a positive coefficient of MTR: The Heckman model with the original variables (Table A-1 in Appendix) and the marginal effect of Probit model (Table A-3 in Appendix). Demeaning the MTR after interest, to remove the fixed effect, changes the sign from positive to negative in many cases and hence changes the direction of association for the variable. The negative standardized coefficient of *S&P 500 return* (-0.219) disagrees with the insignificant positive standardized coefficient of the *10-year treasury rate* (0.019). Fundamentally the 10-year treasury rate have higher impact on liabilities compared to investment. That could be a reason for the positive coefficient of the variable if we had not included the short term and long term pension liabilities; i.e. normal cost and PBO respectively, in the regression model. Inclusion of these two variables have controlled for much of this impact on the voluntary contribution. In addition to a higher share of stocks in pension plans, investors investing in treasury bonds during economic downturns and the opposite during economic booms where they are more open to buying riskier assets can justify the signs. So, it seems that once sponsors decide to make voluntary

contributions they make larger ones during stable economic times, matching the literature on the topic. Although stocks are likely to return more, especially during good financial times, it is also possible that they will be insufficient to pay the benefits when they are due. Therefore, the fact that in times of financial distress a decreasing discount rate decreases both the value of the risky plan assets and sponsors' capability to make any voluntary contribution during such times can be a reason for this finding. A positive coefficient of the variable *10-year treasury return* is consistent with the same theory.

We have added some additional tables in the appendix where we have tested the same models but with different set and forms of explanatory variables. Along with *Marginal Tax rate* a few other variables (e.g., *PBO, normal cost, and revenue*) have different direction and significance. The standardized Coefficient of 10-Year treasury rate coincides with the S&P 500 return (Table A-5 in Appendix) if we include all explanatory variables in the first stage (Probit model) of Heckman model.

Conclusion

In this paper we conduct tests on 1,893 US companies with defined benefit plans over the priod 1991-2016 to determine the predictive ability of the financial and actuarial information on sponsor contributions. The incorporation of a proxy for the full funding limitation is an addition to any previous literature in this topic. Also unlike most recent research, we have used voluntary contribution instead of total contribution. To the best of our knowledge, only Chen, Yu, and Zhang (2013) have used voluntary contribution to test moral hazard and tax arbitrage hypotheses**.** Our paper focuses on the effect of the full funding limit on pension contributions. Chen et al. have acknowledged the effect of full funding limit, but did not add the information in their model. They have addressed the financial crisis through a dummy variable whereas we included stock return and treasury rate to see the effect of economic conditions on contributions. We have data through 2016 and hence our data could better capture the effect of the crisis.

The number of non-zero sponsor contributions post financial crisis is radically smaller compared to pre financial crisis and there are missing values in *voluntary contribution* (dependent

variable) within the time period for many companies. This led us to believe that our sample selection is non-random. Our analysis also suggests there is selection bias in our research model and hence we apply the Heckman ML estimator to get a more consistent and unbiased estimator (Brown 2008). Our analysis shows that underfunded pension plans are more likely to get contributions whereas pension plans which exceed the full funding limitation are less likely. Stock returns and treasury returns have opposite effects on the likelihood of contributions. We have found company *assets, cashflow, PBO*, and *normal cost* have significant positive effects on contributions. In addition, our results suggest that the coefficients of firm *liabilities, Capex, marginal tax rate, pension plan assets*, and *S&P 500 return* are negative and significant. The significant coefficient of *lambda* (inverse Mill's Ratio) reinforces the justification of Heckman test.

Our motivation is to comprehend the factors that influence sponsors' pension plan contribution decisions to use them to make fair projection of the government liability for PBGC insured pension plans. The termination of the pension plan even when the funds are declared bankrupt proceed according to section 4041(c) of ERISA[7], which asserts that the financial health of the business is taken into consideration by PBGC. Therefore, financially stable companies are less likely to declare bankruptcy of their pension fund and to handover their plans to PBGC. Our result coincides with this expectation to an extent by showing that these firms make more voluntary contribution and hence are more capable of paying the due benefits in future. Also the funding position of the pension fund with respect to full funding limit percentage proves to be important in decision making process. At the same time, variables representing condition of the pension plans are found to be significant along with a variable (*S&P 500 stock return*) representing the economic condition of the country.

Tables and Figures

Table 1: Description and data sources of variables

Variables	Description	Sources
Voluntary contribution (Dependent variable)	Total contribution-mandatory contribution	Form 5500 from PBGC website and FOIA request
Asset Revenue Liability Income before extraordinary items*	Firm's income statement	Compustat
Cash flow (non-pension)	Net Income + Depreciation and Amortization+ Pension Expense	Compustat
Capex	Capital expenditure	Compustat
Marginal tax rate after interest	Post financing marginal tax rate	WRDS (Blouin, Core, and Guay 2010)
Normal cost	The actuarial present value of benefits accrued in the current year	Compustat
Projected Benefit Obligation (PBO)	Amount company needs to cover future pension obligations	Compustat
Pension assets	Pension plan assets	Compustat
S&P 500 return	S&P 500 total returns by year. It includes two components: the return generated by dividends and the return generated by price changes in the index	S&P 500 index return
10-year treasury rate	US 10-year treasury rate	US treasury
Full funding limitation percentage for excess funded dummy variable	Funding ratio limit up to which tax deductible contribution is allowed	US Master Pension Guide 2003, Pension Protection Act 2006

*Under U.S. and Canadian GAAP Definition extraordinary item represents unusual items designated by the company as extraordinary and presented after net income from continuing operations and discontinued operations.

Table 2: Descriptive Statistics of original Variables (All money variable measures are in millions)

	mean	Standard deviation	median
	Selected[a] (48%)	Selected	Selected
	Non-selected[b] (52%)	Non-selected	Non-selected
Voluntary contribution	53	271	2
	0	0	0
Asset	10860	80992	1236
	10479	55239	1602
Income before extraordinary items	312	1,963	37
	270	1,387	44
Liability	8,931	80,435	750
	8,437	55,151	1,007
Revenue	5,632	17,980	1,151
	5,329	17,291	1,268
PBO	1,182	4,642	123
	1,181	5,415	130
Plan assets	1,075	4,434	106
	1,083	4,841	119
Normal Cost	26	97	3
	24	97	3
Cash flow	635	2,765	98
	607	2,205	117
Capex (Capital expenditure)	344	1,320	45
	379	1,451	59
Marginal tax rate after interest	0.292	0.086	0.332
	0.289	0.088	0.332
10- year treasury	0.048	0.015	0.047
	0.048	0.019	0.048
S& P 500 return	0.091	0.188	0.109
	0.137	0.159	0.137
Under funded (dummy)	0.58	0.494	1
	0.52	0.5	1
Excess funded (dummy)	0.029	0.167	0
	0.04	0.197	0
Total observations **Selected**	**15,007**		
Non-selected	**16,007**		

[a] Selected sample consists of observations with non-zero voluntary contribution.

[b] Non-selected sample consists of the observations with either missing value or "0" for voluntary contribution.

Table 3 : Marginal Effects in Probit Regression for probability of voluntary contribution

Variables	Coefficients	Robust standard error
S&P 500 return	-0.363***	0.017
10-year treasury	0.989***	0.207
Under funded †	0.053***	0.007
Excess funded †	-0.050***	0.016
Observations	31,014	
pseudo-R-square	0.0144	

*** p<0.01, ** p<0.05, * p<0.1

(†) dF/dx is for discrete change of dummy variable from 0 to 1

Table 4: Heckman Test Results

	Model 1	
	IHS transformed variable	
VARIABLES	Coefficients	(robust s.e.)
Asset	359***	(76.70)
Income X	3.54*	(1.93)
Liability	71.70	(72.10)
Revenue	199***	(28.30)
Cash flow	4.89	(3.33)
Capex	28**	(11.60)
PBO	313***	(28.90)
Plan assets	-16.90	(1.74)
Normal Cost	1.61	(8.61)
MTR†	-0.87**	(0.37)
S&P 500 return †	0.93**	(0.44)
10- year treasury †	-101.50***	(5.44)
Constant	6.34***	(0.47)
Observations	31,014	
Dependent variable	IHS (voluntary contribution)	
Firm Fixed Effect	No	
Rho (ρ)	-.9998	
Sigma (σ)	14.07	
Lambda (	-14.05***	
Wald test	8964	
p-value	<0.001	

Table 5: Fixed Effect OLS model results

	Model 2	
	IHS transformed variable	
	Demeaned	
VARIABLES	Standardized Coefficients	(robust s.e.)
Asset	0.124***	(350)
Income X	0.003	(7.73)
Liability	-0.047***	(299)
Revenue	0.005	(104)
Cash flow	0.035***	(9.79)
Capex	-0.0409***	(80.70)
PBO	0.0230**	(63.10)
Plan assets	-0.0309***	(52.60)
Normal Cost	0.0243***	(23.90)
lambda	0.0534***	(2.77)
MTR†	-0.0628***	(1.38)
S&P 500 Return †	-0.219***	(0.58)
10-year Treasury †	0.0186	(8.23)
Constant	0.124***	(0.36)
Observations		16,705
R-squared		0.051
Firm Fixed Effect		Yes
adjusted-R-square		0.049

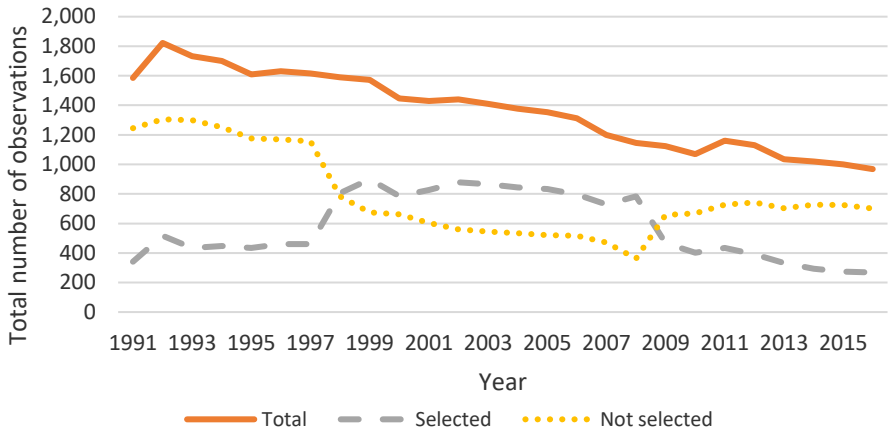
Notes:

*** p<0.01, ** p<0.05, * p<0.1

All except †-marked variables are inverse hyperbolic sine transformed for both models.

Income X is income before extraordinary items and MTR is Marginal tax rate after interest.

Figure 1: Number of Observations by Year for total sample, selected sample, and non-selected sample



Appendix

We present some additional Heckman tests with the same variables but in different formats. In addition to the robustness check, the effect of dominant firms and the real fixed effects of the private firms in the data have been observed through these tests. Table A-1 shows the coefficients of the non-transformed variables. The significance and the signs of some variables are different compared to Table 4. However, the lambda (Inverse Mill's Ratio) is significant here as well, which matches with our conjecture of the presence of sample selection bias. Table A-2 presents the coefficients of the demeaned variables. The significance and signs of the coefficients of this table mostly match those of Table 5. Table A-3 shows the marginal effects of all explanatory variables in the Probit stage of Heckman in addition to the two select variables (*underfunded* and *excessfunded*). So, we have added all IHS transformed firm and plan variables in the X'_{1jt}, a $K_j \times K_t$ vector of exogenous regressors. Tables A-4 and A-5 present the results of the series of tests that follow this new Probit model. Table A-4 has more significant variables when compared with Table 4. Revenue, PBO, and Normal cost now have significant negative coefficients which do not match with our expectations. But after considering fixed effects the signs change to the expected direction. Table A-5 shows the same direction, significance and similar scale for all but few (*normal cost, Lambda, and 10-year treasury rate*) variables compared with Table 5. The standardized coefficient (-0.011) of *Lambda* is now insignificant and negative. This may indicate that the sample selection bias was due to unobservable firm fixed effects and taking within estimators has changed the direction and significance of the coefficient. *10-year treasury return* (-0.021) is now negative and significant like *S&P 500 return*.

Table A-1: Heckman Test Results with variables with original forms (the money variables are in thousands of dollars)

	No HIS Transformation	
Variables	Coefficients	(robust s.e.)
Asset	-0.02	(0.34)
Income Before Extraordinary Item	-20.10	(20.80)
Liability	0.13	(0.32)
Revenue	-0.09	(0.83)
Cash flow	19.60	(19.30)
Capex	15.50	(14.60)
PBO	12	(12.80)
Plan assets	11.60	(11.40)
Normal Cost	257	(265)
Marginal tax Rate After Interest	4,818,000	(16,380,000)
S&P 500 return	-83,322,000***	(8,709,000)
10- year treasury	132,600,000	(159,600,000)
Constant	10,840,000	(10,480,000)
Observations	31,014	
Dependent variable	Voluntary contribution	
Firm Fixed Effect	No	
rho	-0.0198	
sigma	2.17e+08	
lambda	-4.296e+06***	
chi-square (Wald test)	558.8	
p-value	<0.001	

*** p<0.01, ** p<0.05, * p<0.1

Table A-2: Fixed Effect OLS model results with variables with original forms (the money variables are in thousands of dollars)

	No IHS Transformation	
Variables	Standardized Coefficients	(robust s.e.)
Asset	0.059	(.27)
Income Before Extraordinary Item	0.143	(12.70)
Liability	-0.108*	(0.27)
Revenue	0.135***	(1.12)
Cash flow	-0.158	(12.30)
Capex	-0.134***	(13.80)
PBO	-0.160	(11.10)
Plan assets	0.108	(15.50)
Normal Cost	0.180***	(278)
lambda	-0.062***	(3.00e+07)
Marginal Tax Rate After Interest	-0.013**	(2.27e+07)
S&P 500 Return	-0.012	(1.80e+07)
10-year Treasury	0.014*	(1.12e+08)
Constant		(4.96e+06)
Observations	16,705	
R-squared	0.043	
Firm FE	Yes	
adjusted-R-square	0.042	

*** p<0.01, ** p<0.05, * p<0.1

Table A-3: Marginal Effects in Probit Regression for probability of voluntary contribution (with firm and plan specific explanatory variables)

	IHS transformed variable (except †-marked variables)	
Variables	Coefficients	Robust standard error
Asset	-0.024***	0.009
Income Before Extraordinary Item	0.0001	0.0003
Liability	-0.054***	0.008
Revenue	0.040***	0.005
Cash flow	0.001***	0.0004
Capex	-0.005***	0.001
PBO	0.016***	0.003
Plan assets	0.008***	0.001
Normal Cost	0.008***	0.001
Marginal Tax Rate After Interest †	0.077*	0.043
S&P 500 return	-0.384***	0.017
10-year treasury	0.225***	0.224
Under funded †	0.069***	0.008
Excess funded †	-0.054***	0.016
Observations	31,014	
pseudo-R-square	0.032	

*** p<0.01, ** p<0.05, * p<0.1

(†) dF/dx is for discrete change of dummy variable from 0 to 1

Table A-4: Heckman Test Results with all explanatory variables in the Probit stage

	IHS transformed variable (except †-marked variables)	
Variables	Coefficients	(robust s.e.)
Asset	1.806***	0.260
Income Before Extraordinary Item	0.014	0.009
Liability	0.743***	0.220
Revenue	-0.755***	0.136
Cash flow	0.002	0.012
Capex	0.111***	0.038
PBO	-0.430***	0.099
Plan assets	-0.125***	0.033
Normal Cost	-0.228***	0.022
Marginal tax Rate After Interest †	-4.917***	1.309
S&P 500 return †	1.253***	0.446
10- year treasury †	-80.320***	6.804
Constant	-.374	1.417
Observations	31,014	
Dependent variable	Voluntary contribution	
Firm Fixed Effect	No	
rho	-.999	
lambda	-13.94***	
chi-square (Wald test)	1592	
p-value	<0.001	

*** p<0.01, ** p<0.05, * p<0.1

Table A-5: Fixed Effect OLS model results with lambda created in Table A-4

	IHS transformed variable (except †-marked variables)	
Variables	Standardized Coefficients	(robust s.e.)
Asset	0.135***	(0.371)
Income Before Extraordinary Item	0.004	(0.008)
Liability	-0.045**	(0.304)
Revenue	-0.001	(0.149)
Cash flow	0.034***	(0.009)
Capex	-0.041***	(0.082)
PBO	0.030***	(0.066)
Plan assets	-0.034***	(0.055)
Normal Cost	0.017	(0.036)
lambda	-0.011	(2.210)
Marginal Tax Rate After Interest †	-0.067***	(1.431)
S&P 500 Return †	-0.188***	(0.525)
10-year Treasury †	-0.021***	(5.859)
Constant		(0.260)
Observations	16,705	
R-squared	0.043	
Firm Fixed Effect	Yes	
adjusted-R-square	0.042	

*** p<0.01, ** p<0.05, * p<0.1

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Notes

[1] See "WTW Pension 100: Year-end 2017 disclosures of funding, discount rates, asset allocations and contributions" Willis Towers Watson *Insider*, May 2019.

[2] **Pension Benefit Guarantee Corporation** "2017 Pension Insurance Data Tables" facts sheet "Net Financial Position (1980-2018)" available at https://www.pbgc.gov/prac/data-books.

[3] See "Despite strong investment gains, financial health of largest U.S. corporate pension plans showed little improvement in 2019", Willis Towers Watson *Press release*, January 2020.

[4] For S&P 500 total returns by year see https://www.slickcharts.com/sp500/returns

For treasury rate see http://www.multpl.com/10-year-treasury-rate/table/by-year

[5] **Pension Benefit Guarantee Corporation** "2016 Pension Insurance Data Tables" facts sheet " PBGC-Insured Plans by Status of Benefit Accruals and Participation Freeze (2008-2015) " available at https://www.pbgc.gov/prac/data-books

[6] Willis Towers Watson, February 2018. "Global Pension Assets Study 2018." https://www.thinkingaheadinstitute.org/-/media/TAI/Pdf/Research-Ideas/GPAS-2018.pdf?modified=20180320143710

[7] ERISA § 4041(c), codified at 29 U.S.C. § 1341(c). (Kennedy-Luczak, Kathleen McInerney et al. 2018)

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