National Pension Hub

FINAL REPORT

Risk Shifting Versus Risk Management:

Canadian Pension Plan Liability Discount Rates

Authors: Sally Shen
Global Risk Institute
Serguei Zernov

July 2020

ABOUT THIS REPORT:

The design of a pension plan should reflect preferences of the stake holders and be resilient to economic, financial and demographic stresses.

Observers have often assumed that moral hazard plays a role in pension fund asset allocation. However, based on our empirical findings, it is fair to highlight that, in Canada, discount rates are a reflection of risk preferences, rather than of regulatory structure or political incentives.

Risk Shifting Versus Risk Management – Canadian Pension Plan Liability Discount Rates *

Sally Shen Serguei Zernov

July 14, 2020

1 Introduction

Defined benefit pension plans play an important role in societies and economies of different countries assuring financial well-being for retirees and arguably contributing to social welfare. In order to perform their role, pension plans need to be designed and implemented in a way that is fair, in a defined sense, for all the stake holders - cohorts of plan members, plan sponsors, and tax payers. The design of a pension plan should reflect preferences of the stake holders and be resilient to economic, financial and demographic stresses.

This paper studies choices with respect to parameters of the plan design and investment strategies in the context of the regulatory environment and their institutional organisation. Our objective is to infer whether these choices are driven by preferences of the plan members or rather by opportunities of unfair risk transfers that are possible thanks to perverse regulatory incentives. If the latter is the case, then the plans fail their objective of improving social welfare by contributing to social tensions and potentially failing in delivering the pension promise to the members.

Studies of investment strategies of the U.S. public pension plans (see, for example, Andonov et al. (2017)) demonstrate empirical evidence of risk shifting from plan members and plan sponsors to tax payers under the existing regulatory incentives. Our study analyses data on the Canadian defined benefit pension plans and does not find evidence of such risk transfer behavior which can be interpreted as a testament of better designed regulatory environment in which Canadian public plans operate.

 Researchers gratefully acknowledge the use of data from CEM Benchmarking, a Toronto-based global benchmarking firm. We are grateful for the valuable suggestions from Chris Flynn, Alex Beath, Michael Reid, Aleksander Andonov, Alex LaPlante, Bernard Morency, Dani Goraichy, Bob Baldwin, Sara Aghakazem, Hugh O'Reilly, Marlene Puffer and Drew McFadzean.

2 Regulatory environment, incentives, and discount rates for DB plans

For pension plan actuaries, the term *discount rate* refers to the rate at which future pension liabilities are discounted to arrive at their present value. The discount rate selected by plan managers plays a key role in determining whether plans have sufficient assets to meet future pension obligations. A funding valuation[1] of Canadian pension plans allows considerably more discretion in setting the going concern discount rate than an actuarial solvency discount rate. This is because the going-concern discount rates reflect the expected return on investments in accordance with the pension plans investment policy and strategic allocation, while the solvency discount rates are tightly linked to market bond yields. Choosing a reasonable going-concern discount rate is crucial for plan sustainability and affordability. Getting to a realistic, but not overly prescriptive, discount rate is difficult. If the rate is excessively high and investment returns fail to meet that hurdle, younger and future plan members bear the enhanced contribution risk and/or the risk of reduced benefits due to a funding shortfall. If the discount rate is too low, the solvency funding requirements will be more difficult to meet and current members may need to pay more than necessary for their pensions or benefits.

Defined benefit (DB) funds are typically under the collective pension schemes in which the pension assets of multiple generations are pooled together. It is well documented that DB retirement systems allow for both intergenerational and intrageneratonal risk-sharing (Merton (1983); Shiller (1999)). When it comes to funding valuations, the risk-sharing nature of DB pension funds creates conflicting incentives on determining the going concern discount rates and on the asset allocation strategies, particularly when the DB pension funds are challenged by shortfalls risks. On the one hand, in a low-for-long interest rate environment and aging demographics, existing risk management theory suggests pension funds should set discount rates lower (see Black (1989), Bodie et al. (1992) Lucas and Zeldes (2009) and Rauh (2008)) to reflect the increasingdeclining duration of the liability risk. A lower going-concern discount rate is associated with a lower risk asset allocation strategy. However, a lower risk investment strategy may not generate sufficient returns to close the solvency gaps (Mayers and Smith Jr (1987) and Froot et al. (1993)) possibly leading to bankruptcy or funding failures (Smith and Stulz (1985)). On the other hand, underfunded plansdistressed funds have incentive to select a higher going concern discount rate and in turn increase their allocation to risky assets so as to reduce the reported value of their plan liabilities. Financial theory (Jensen and Meckling (1976), Shen et al. (2019)) also suggests severe underfunded plans to invest in riskier assets to achieve a higher return on pension assets, in hopes of shrinking the funding gap and reducing future mandatory pension contributions. If higher returns do not materialized, the downside would be likely picked up by future generations given the intergenerational risk-sharing feature of DB plans. Andonov et al. (2017) provide empirical evidence to support the hypothesis that the regulatory link between the liability discount rate and the expected rate of return on assets creates risk shifting incentives to the U.S. public funds.

This paper revisit this contention by empirically examining the conflicting motives influencing decisions on going-concern discount rates for Canadian public and corporate DB pension plans. Our research is based on self-reported data of Canadian pension

[1] A funding valuation is an assessment of the long-term financial health of a pension plan. The valuation establish a target level for pension assets, future contributions together with future investment returns, in order to prove sufficient to pay future pension benefits.

funds. Since the selection of discount rates may vary between jurisdictions and our data has limited access to fund-level regulatory information, not all results are comparable and the analysis is not possible for each jurisdiction.

Evidence of behaviors by DB plans that results in unfair risk transfers is well documented in the literature. The U.S. pension plans play a prominent role in these studies due to their large size, social and political importance, and availability of the data. Numerous studies (Bodie et al. (1985), Brown (2008) and Guan and Lui (2016)) find a positive relation between funding risk and pension investment risk for the U.S. corporate pension plans and verify the presence of risk shifting behavior in the U.S. pension investment. Andonov et al. (2017) show that U.S public pension funds invest aggressively in order to manipulate their liability discount rate and the reported funding level.

Opinions on risk shifting incentive of Canadian pension funds is mixed. Chandler (2019) shows that selections of going-concern discount rates for most Ontario DB pension funds reflects changing market interest rates and hence adheres to risk management incentive. However, Landon and Smith (2019) find considerable risk associated with the relatively high pension fund discount rates used by many pension plan sponsors in Canada, justified as essential for achieving pension plans affordability. Hamilton (2014) argues discount rates used by all public sector plans are too high and that the discount rate should be aligned with the long-term Canadian bond yields. Ambachtsheer (2016) applies game theory and argues that Canadian pension funds are shifting risks to taxpayers and younger members.

Although Canadian pension funds have increased their allocation to risky assets from less than 50% in 1992 to more than 65% in 2017, we do not find significant evidence supporting risk shifting incentives. First, our empirical results display a negative relationship between the maturity of the plan and the percentage of pension assets allocated to risky financial instruments. Funds with more retired members are generally more likely to face financial distress. We show a 10% increase in the retiree ratio is associated with a 1.4% reduction of risky portfolio. Second, we also find that more mature pension funds tends to select a lower going-concern discount rate. In particular, a 10% increase in the retiree ratio is associated with a 9.2 basis points decrease in the selection of going concern discount rate. Third, we also show a significantly positive relationship between the Treasury yield and the sample discount rate. We find that every 100 basis point decrease in the government bond yield is associated with a decrease in the discount rate of about 36 basis points. The empirical evidence is consistent with the risk management hypothesis.

In comparison with the U.S. DB plans, we summarize three reasons that Canadian funds (both public and corporate) are not motivated to engage in risk shifting behavior. The first reason is attributable to the Canadian pension guarantee scheme. A pension guarantee scheme is a contract between a plan insurer (i.e. the pension Benefits Guarantee Fund (PBGF)) and a plan sponsor. According to Sharpe (1976), this contract is essentially the transfer of a put option written on the sponsors pension assets with a strike price equal to the amount of the sponsors pension obligations. The put-option alike guarantee provides members of DB pension plans the ultimate protection, but also creates incentives for distressed funds to scale back their pension contributions and to aggressively invest in an effort to narrow the funding gap. In Canada, pension sponsors bear the solvency risk. PBGF is only responsible for the pension benefit of Ontario members[2] and beneficiaries of privately sponsored single-employer defined benefit pension plans in the event of plan

[2]Ontario employees in a defined-benefit, registered pension plan that is regulated and registered with a supervisory authority in Canada.

sponsor insolvency. Only the first $1,000[3] of monthly payments are fully guaranteed, excluding benefit improvements granted within the last 3 years. This guaranteed pension benefit is far less than the amount of the sponsors pension obligations. In addition, younger members are generally not covered and the insurance premium is aligned with the plan's funding status.

In general, the Canadian pension guarantee scheme does not provide full guarantee to distressed funds, hence reducing the incentives to invest aggressively. In contrast, the Pension Benefit Guaranty Corporation (PBGC) in the U.S. guarantees fully the vested pension benefits earned before the earlier of the plans termination date or the date the employers initial bankruptcy filing. PBGC acts as the ultimate guarantor of failed U.S. corporate DB plans. The cost of the PBGC option is not fully aligned with its economic value, as the current insurance premium structure is largely flat, only partially reflecting the riskiness of the expected future claims from plan terminations.

The second reason is attributable to the financial health of the DB plans. According to Guan and Lui (2016), severe plan under-funding is a necessary condition for risk-shifting behavior. The first 2019 Quarterly Update report of Financial Service Commission of Ontario (FSCO) on estimated solvency funded status of DB plans in Ontario show that the median solvency ratio of Ontario DB plans is 96%, while 36.6% of plans had a solvency ratio greater than 100% and 84.9% plans are above the solvency basis of 85%. In general, Canadian DB plans are sufficiently funded with only about 4% classified as significantly underfunded, i.e. with funding of less than 70%. This is not the case in the U.S. - a study by The Pew Charitable Trusts *The State Pension Funding Gap 2017* found that 20 U.S. state pension plans are less than two-thirds funded, and 5 states have pension plans that are less than 50 percent funded.

The last reason why Canadian DB plans are not motivated to engage in risk shifting behavior is related to the going-concern discount rate policy for the Canadian DB plans. Office of the Superintendent of Financial Institutions (OSFI) does not prescribe a specific methodology for selecting the discount rate but believes that the rate used by the actuary should not exceed a certain level. For instance, based on current market conditions, the discount rate for a plan whose investments include no more than 50% of fixed-income securities should not exceed 6.00%, before all expenses other than those related to active investment management[4].

The selection of a going-concern discount rate should also reflect the current market yields. Guidance for actuaries in Canada specifies that for a plan where assets are invested in part in treasury bills or bonds, and are expected to be invested that way indefinitely, the best estimate of the long-term investment return on that class of assets may be reasonably viewed as the market yield on the particular investments or the yield on a market index representative of such investments at the calculation date, adjusted to reflect an allowance for reinvestment and the effect of possible changes in interest rates on future investments, if appropriate[5]. However, the U.S. actuarial standards does not require plan managers to adjust the discount rates in response to the change of market yields or imposes a maximum rate under a certain asset mix.[6] Overall, it is the governance structure of

[3] http://www.cba.org/cba/cle/PDF/Pens10_W9_chart.pdf

[4] Preparation of Actuarial Reports for Defined Benefit Pension Plans, October 2017 http://www.osfi-bsif.gc.ca/eng/pp-rr/ppa-rra/af-ac/pages/actgde.aspx#2.8.1

[5] Committee on Pension Plan Financial Reporting, Revised Educational Note– Determination of Best Estimate Discount Rates for Going Concern Funding Valuations https://www.cia-ica.ca/docs/default-source/2015/215106e.pdf

[6] Selection of Economic Assumptions for Measuring Pension Obligations, Actu-

Canadian pension plans –independent boards, supported by the right management and outside professional advice, that helps maintain the sustainability of the Canadian pension system and shapes the Canadian pension model.[7]

3 Discount Rate Data

We use the data from **CEM Benchmarking Inc.** on Canadian defined benefit pension plans to investigate the conflicting motives in the selection of going-concern discount rates in which both risk shifting and risk management incentives are likely to be present. On the liability side, the CEM data provides information on plan maturities, indexation policy, and liability discount rates. The discount rates reported in the CEM database corresponds to the "going concern" valuation approach, in which the rate reflects the expected rate of return on plan assets. As of 2012 this rate of return excludes consideration of potential "excess" gains earned from active management. The Canadian actuarial guidance specifies "the actuary may assume, if appropriate based on the circumstance of a particular plan that any additional active management fees are fully offset by additional value added returns" On the assets side, CEM has detailed data on the strategic and realized asset allocations of pension funds. We define the percentage allocated to risky assets as a sum of the realized allocation weights to equity and alternative asset classes. Alternative assets include investments in real estate, private equity, hedge funds, commodities, natural resource and infrastructure.

Pension plans in Canada are regulated at either the federal or provincial level under the Pension Benefits Act (PBA). Provinces, as well as the federal government, each operate under their own version of the act, as determined based on the jurisdiction in which plan employees work. Each also has its own regulator that enforces the PBA. For instance, pension plans in Ontario are regulated by the Financial Services Regulatory Authority (FSRA, formerly FSCO), the federal government by the Office of the Superintendent of Financial Services (OSFI), Quebec by the Régis and so on. Selection of going concern discount vary depending on plan type (private, provincial, federal, and social security) and provincial jurisdictions. Although our sample observations are not identified by regimes and funds are anonymous, Chandler (2019) compares pension funds' going-concern discount rates across several Canadian jurisdictions and shows no significant difference. **Table 1** presents summary statistics for core characteristics of the pension plans sampled. **Panel A** depicts 2,453 observations from annual surveys of 256 Canadian pension funds over the 1992-2017 period. Note that it is an unbalanced panel as there are funds exiting, entering and re-entering the database over that period. Private sector and public sector pension plans are identified separately in the CEM data. The CEM database splits the private funds into two "corporate" and "other" two types of pension funds. Public funds support public plans; corporate and other funds support private plans. Most of the observations made relate to corporate funds (1,325) alongside data from 739 public funds and 389 "other" funds. According to Andonov et al. (2017), "other" category is mainly composed of multi-employer or Taft-Hartley funds, often referred to as "union" funds. It may also refer to "mixed" funds.

arial Standards Board September 2013 https://www.actuarialstandardsboard.org/wp-content/uploads/2014/02/asop027_172.pdf

[7]The Evolution of the Canadian Pension Model Practical Lessons for Building World-class Pension Organizationshttps://www.cwretirement.com/wp-content/uploads/2017/11/WBG-The-Evolution-of-the-Canadian-Pension-Model.pdf

Average Annual Percentage of Retired Members to Total Plan Members

Panel B shows the ratio of retired members to total plan members, in aggregate and separately, by pension type. It reveals that this ratio increased from 25.14% in 1992 to 46.43% in 2017. The trend is mainly driven by an aging population and low fertility rate. Corporate DB plans had an average retiree/member ratio of 55.68% in 2017, which is much higher than the retiree/member ratio in both public and mixed plans. Within corporate plans, the average number of retired members has exceeded the average number of active members since 2013. The plans being closed to new members is the main reason. According to the CEM data, more than half of the corporate funds exited the database during the period 1992-2017. Average active members reduced from 9,372 to 7,948 between 1993 and 2017 while the average number of retired members grew from 3,794 to 7,967 during the same period.

Annual Average Reported Discount Rates

Panel B also shows the discount rate surveyed over the sample period. On average, corporate plans choose a lower discount rate than public funds. Corporate plans have, on average, more conservative allocations of risky assets (such as unlisted real estate, private equity, and other alternative assets) which leads to lower expected returns (see Shen and Zernov (2019)). Corporate funds are mostly invested in the public equity market and in fixed incomes due to the lack of access to alternative assets. Until recent years, only a small portion of corporate pension assets were allocated to alternatives. It is usually much more costly to invest and manage illiquid assets, and only large public pension funds can obtain the risk premium from the private equity market due to this market's high external active management fees. The discount rates of Canadian plans has decreased over time following the trend of the treasury yield, moving from an average reported rate of 7.77% in 1992 to 5.24% in 2017. We analyze the discount rate relative to the risk-free rate later in this report. Public funds have the highest reported average discount rate, while the historical difference between public and corporate funds is less than 0.5%.

Annual Average Inflation Protection

Panel B also reports the inflation protection policy across funds. "Inf." is a dummy variable taking a value of one if a pension fund provides a contractual inflation protection and zero if indexation is eliminated. For example, in 2017 40.15% of the Canadian pension funds provide inflation protections. However, very few funds provide full inflation protections nowadays and choose a partial indexation policy by either make it conditional on funding position or ad hoc, while this information is not displayed in the table. Once the plan faces financial distress, plan administrators seek palatable solutions to reduce liabilities. Reduction in inflation protection was a frequent solution with consequences that are not immediately felt, unlike an increase in contributions. In most sample periods, public pension funds are more likely to provide inflation protection than corporate funds. For instance, in 2003 about 78% of Canadian public funds provided inflation protection, but only half of the corporate funds do so. The increasing inflation protection rate for corporate plans is caused by survivorship bias. DB funds in private sector that choose a zero indexation policy are usually insolvent and some are close to bankruptcy. Therefore, the remaining corporate funds in our database are more likely to be sufficiently funded. These survived funds are more likely to provide inflation protection hence bias the average

inflation protection rate upwards.

Historical Densities of Discount Rates

Figure 1 uses a violin plot to display the historical discount rates from 1992 to 2017. The circle in each plot marks the median discount rate for the year, a box indicating its interquartile range, and spikes extending to its upper and lower adjacent values. The shape of each violin plot represents the density of the data estimated by the univariate kernel density estimation approach.

As can be seen, the median discount rate declines over the sample period. The dispersion of surveyed discount rates varies and shifts downwards as well, from a range of 6% to 10% in 1992 to a range of 3.3% to 6.9% in 2017. For most of those years, distribution of the discount rate skewed to the left with low-rate tails.

Figure 1: **Historical Densities of Liability Discount Rates**

This figure displays the violin density plot of liability discount rate over the sample period 1992-2017. We drop the observations that are below the $5^{\mathbf{th}}$ *percentile of yearly observations, as these tail observations are likely being reported as real rates but not nominal rates.*

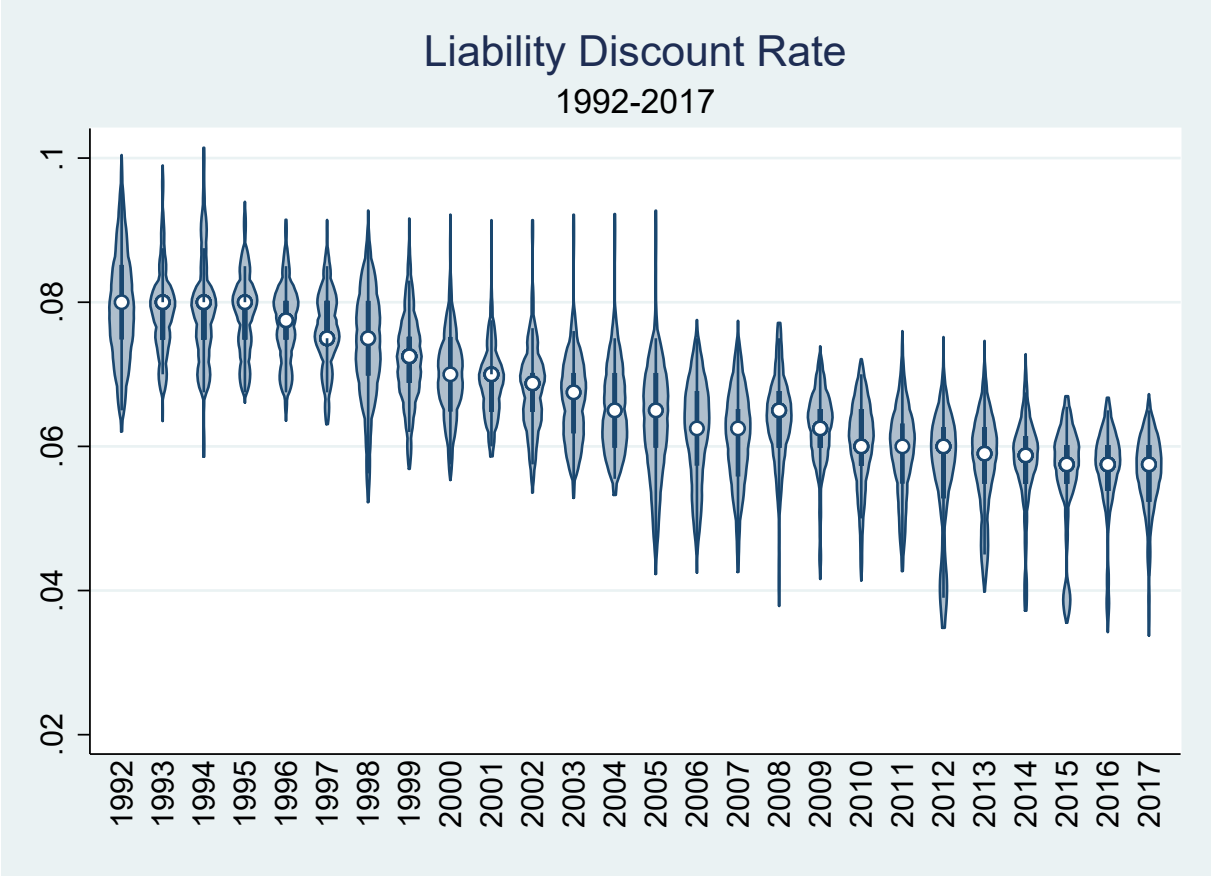
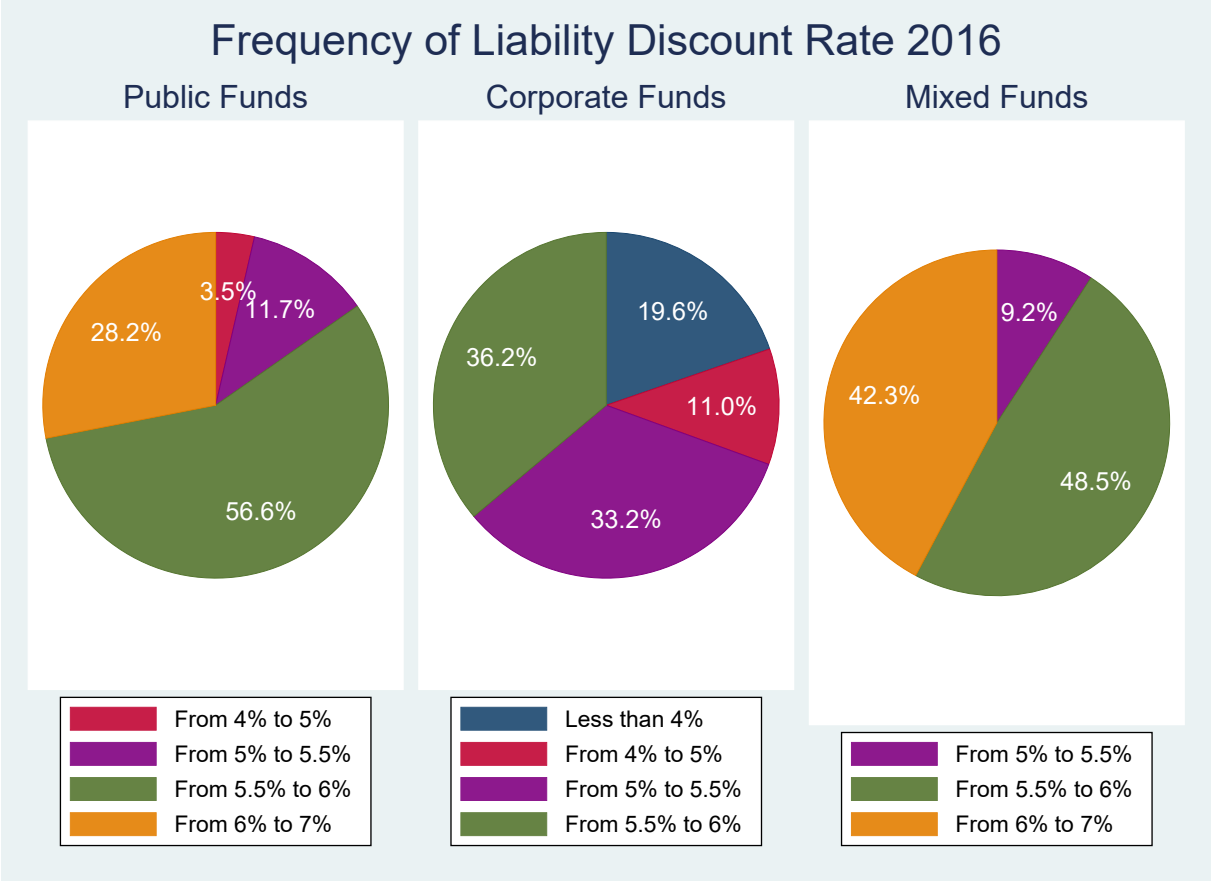


Figure 2 presents the difference in the frequency of discount rates among fund categories over the selected sample period. In 2016, 28.2% of public funds were using an discount rate between 6% to 7%, while 42.3% of mixed funds were in the same range. Corporate funds chose the lowest discount rate with 19.6% of funds using less than 4%. None of the funds in the 2016 sample used discount rate higher than 7%. By way of

contrast, in 1996, more than 80.2% of public funds, 76.6% of corporate funds and 84.3%of mixed funds used discount rates greater than 7%.

Figure 2: **Frequency of Liability Discount Rate.**

This figure compares the frequency of discount rate for funding purpose of the year 2016, 2012, 2008, 2004, 2000 and 1996 for the three types of pensions funds. Remark, to view the animation, the document had to be opened in the Adobe Reader. Remark: the textbox "From a% to b%" means $[a\%, b\%)$.



To illustrate how discount rates have been trending among Canadian pension plans, **Figure 3** plots the average percentage allocation to risky assets[8], the discount rate of these funds, as well as the ten-year Canadian Treasury Bond yield over time. The plot shows a downward sloping line for the discount rate used by Canadian pension funds. The slope of the discount rate line is much flatter than the declining risk-free rate curve. The slope difference between the discount rate line and the 10-year interest rate curve indicates that, on the one hand, following the Canadian Institute of Actuaries (CIA) guideline [9] Canadian pension plans tend to adjust the discount rate following the dynamics of the long-term yield while, on the other hand, they maintain a flatter declining rate to offset the faster declines in the risk-free rate (and overall expected asset returns) with an increased allocation to risky assets.

[8]Risky assets include the public equity, private equity, real estate and other alternative assets such as commodities, natural resources, infrastructures and hedge funds.

[9]https://www.cia-ica.ca/docs/default-source/2015/215106e.pdf

Over the sample period, Canadian funds have increased their allocation to risky assets by 10%, from 55% in 1992 to 65% in 2017. In response to increasing solvency pressure, "low-for-long" interest rates and low equity market returns, fund managers sought riskier investment opportunities in order to meet their funding obligations.

4 The Impact of Regulation on Risk Shifting Incentives

Discount rate reflects risk preferences of the plan sponsors, given the demographics of the plan and regulatory environment. Andonov et al. (2017) show that Canadian pension funds have made very different discount rate choices than U.S. pension funds. Large Canadian public pension plans tend to use discount rates at least two percentage points lower than those used by U.S. public pension plans.[10] Two factors contribute to this: regulations differ between countries (the U.S. being more lenient) and there is a more aggressive appetite for risk in the U.S. which has been built into their institutional culture and incentives.

Figures 4 and 5 compare the discount rates of public and corporate funds between U.S. and Canada, against the long-term risk-free rate of each country (10-year treasury bonds) as well as the allocation to risky assets. Let's first compare the discount rates of public plans of the two countries. U.S. public pension funds, on average, use much higher rates than Canadian funds. Among U.S. funds, public plans maintained steady discount rates at around 7.5%-8.0% during the sample period 1993 to 2017, while Canadian public funds reduced their discount rates below 6% subsequent to 2012. The difference is partially driven by the discount rate policy. Without being overly prescriptive, OSFI sets a discount rate ceiling conditional on the asset mix policy, contemporaneous market conditions, and future expected returns. However, there is no maximum-rate policy applied to the U.S. public plans. In addition, although both countries use the expected rate of return on plan assets, Canadian going-concern discount rate excludes the gains earned from active management. That is, the Canadian funds set an expected return that only reflects passive management in accordance with their investment policy.

Next, we compare the discount rates of public and corporate plans. The average discount rate difference between Canadian public and corporate funds is less than 1% (see **Table** 1), which is dramatically smaller than the difference between U.S. public and corporate funds. For the purpose of going-concern valuation, the discount rate policies applied to Canadian public and corporate funds are basically identical. The subtle difference between public and corporate plans is a reflection of their respective risk preferences. In the U.S., the discount rate applied to corporate funds decreased from 8.2% in 1993 to 3.8% in 2017, closely following the trend in interest rates. The difference between the discount rate of U.S. public and corporate funds is driven by U.S. pension regulation. U.S. public pension funds follow the Government Accounting Standards Board (GASB) guidelines for discounting liabilities, which allow them to measure their discount rates on the expected rate of return on their assets (Brown and Wilcox (2009)). GASB also provides legal protection to cover underfunded positions. U.S. corporate funds follow different approaches for determining the discount rate used in funding valuation. The Treasury Department

[10] A Society of Actuaries report found that the median discount rate for a U.S. state or city public pension plan in 2014 was 7.6 percent. See Lisa Schilling, "U.S. Pension Plan Discount Rate Comparison 20092014" (article by the Society of Actuaries, Schaumburg, IL, September 2016).

currently requires plans to use a 25-year average of high-grade corporate bonds when setting discount rates. The Financial Accounting Standards Board (FASB) requires use of current high-grade corporate bonds, for accounting purposes, when matching pension benefit cash flows. The Pension Benefit Guaranty Corporation (PBGC) requires that a 24-month average of high-grade corporate bonds be used to determine PBGC required contributions. Thus, corporate funds are restricted from managing their plans by modifying their asset allocation.

Next, let's look into the asset allocation strategies of the two countries. In general, Canadian funds on average are much more conservative than the U.S. funds. Figure 4 shows over the sample period, the Canadian public funds have increase their allocation to risky assets from less than 50% to about 70%, while it remained close to 60% for the corporate funds over the reported period. The U.S. public funds invest more aggressively. By the end of 2017, public funds' average allocation to risky assets approached 80%. Andonov et al. (2017) argue the aggressive investment behavior of U.S. public funds is an evidence of risk shifting. The curve for the U.S. corporate plans moves dramatically. Before the 2008 financial crisis, the risk exposure has reached to 75%, but has declines sharply to 55% by 2017. Guan and Lui (2016) find empirical evidences support the risk shifting behavior of U.S. corporate plans and they argue it is the PBGC that creates the risk shifting incentives. However, Rauh (2008) shows against the risk shifting hypothesis of the U.S. corporate plans.

Last, we compare the yield curves with the discount rates of the two countries. Canadian public DB pension plans accept a smaller but growing gap between the going-concern discount rate and the long-term yield as compared with U.S. public plans. While the gap is much bigger than those used in other contexts, such as U.S. corporate pension plans (which tend to use a lower, corporate bond rate to set their discount rates) and the Netherlands, in which the Dutch central bank sets discount rates tightly close to the Government bond rate. One of the crucial assumptions underpinning the Canadian pension model is the selection of a realistic discount rate. The growing gap between market yields and discount rates observed in Figure 4 for both public and corporate plans reflects the intention to generate higher expected real returns, to offset the continuously declining risk-free rate, by increasing their allocation to risky assets. This may indirectly reflect the risk-return objectives of Canadian pension plans. Canadian corporate DB pension plans follow long-term yield trends, more closely than public funds, when setting their discount rates. Their non-speculative risk preference is partially driven by the more stringent solvency regulations governing corporate funds. As a result, corporate plan administrators choose more conservative portfolios and lower discount rates than public fund administrators.

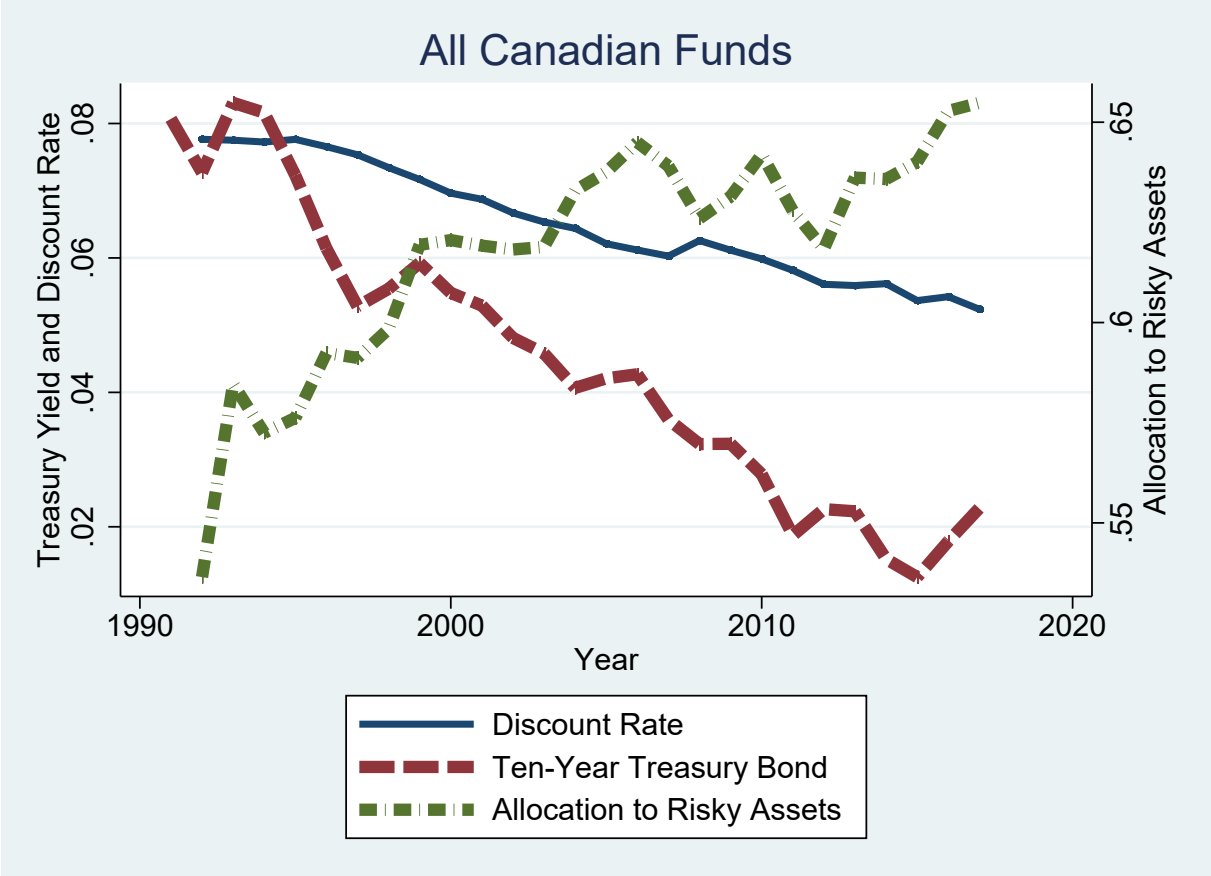
Although Canadian funds (both public and corporate) also use the investment return expected on their assets to value liabilities, they choose a much lower rate than the average rate used by U.S. public plans. This difference between the two countries' discount rate can be explained by regulation induced risk shifting incentives. The GASB regulations for U.S. public funds have two crucial incentive consequences. First, the GASB guideline creates an incentive for U.S. public funds to understate their liabilities by reporting a higher discount rate. Secondly, it creates a link between the discount rate and the expected rate of return on assets. Empirically (see Andonov et al. (2017)), it appears that U.S public fund sponsors have incentive to increase their allocation to risky assets to, effectively, project higher expected returns. In so doing they justify a higher discount rate to, essentially, lower the reported value of their plan liabilities. From the corporate plan perspective, numerous studies (Sharpe (1976), Guan and Lui (2016), Rauh (2008), and Brown (2008))

have shown that the PBGC can create incentives for those heavily underfunded U.S. DB plans to invest aggressively, because the PBGC provides distress funds a put-option style ultimate protection.

The economic and political consequences of acting on regulation-induced incentives is severe. On the one hand public funds, especially those underfunded ones, may strategically maintain higher discount rates by increasing their allocation to risky assets with higher expected returns. This phenomenon is also deemed a moral hazard problem[11]. Aggressive risk-taking, on the part of fund sponsors, could challenge sustainability of the pension system. Additionally, government entitles could contribute to an unsustainable pension system, if they permit excessive discount rates to camouflage situations where funds are losing assets rapidly and their ability to fulfill the future projected future pension benefits is deteriorating. Currently, the entities following this misleading behaviourthose entities committing this fraud suffer little political consequences for transferring the unfair economic cost of under-funding to future generations of fund members and taxpayers.

Figure 3: **Asset Allocation and Liability Discount Rates.**

All Canadian Funds 1992-2017

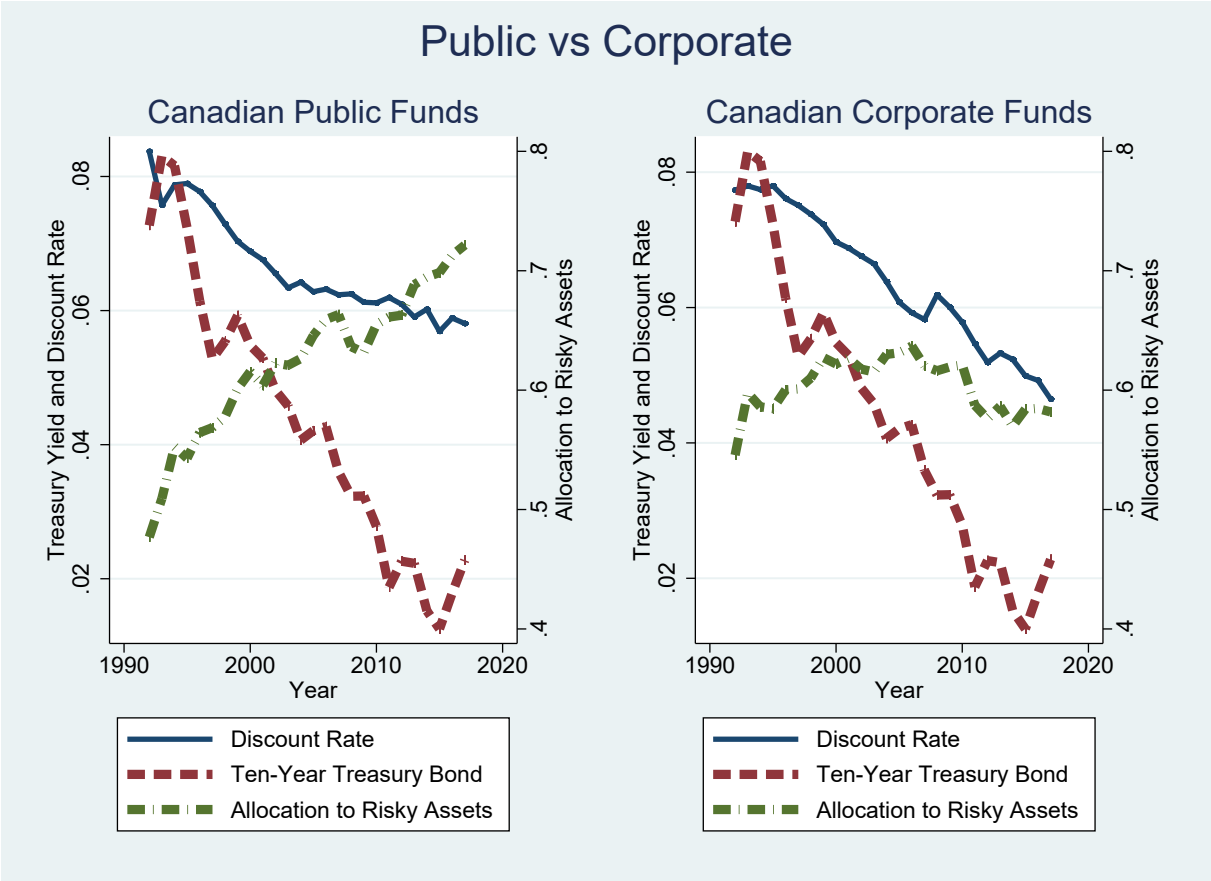


Funding regulations in Canada vary considerably by province. In all jurisdictions plan sponsors bear the funding risk. Often the sponsor is also the employer, especially where

[11]In economics, moral hazard occurs when someone increases their exposure to risk when insured, especially when a person takes more risks because someone else bears the cost of those risks. A moral hazard may occur where the actions of one party may change to the detriment of another after a financial transaction has taken place.

Figure 4: **Asset Allocation and Liability Discount Rates.**

Canadian Public Funds vs. Corporate Funds 1992-2017



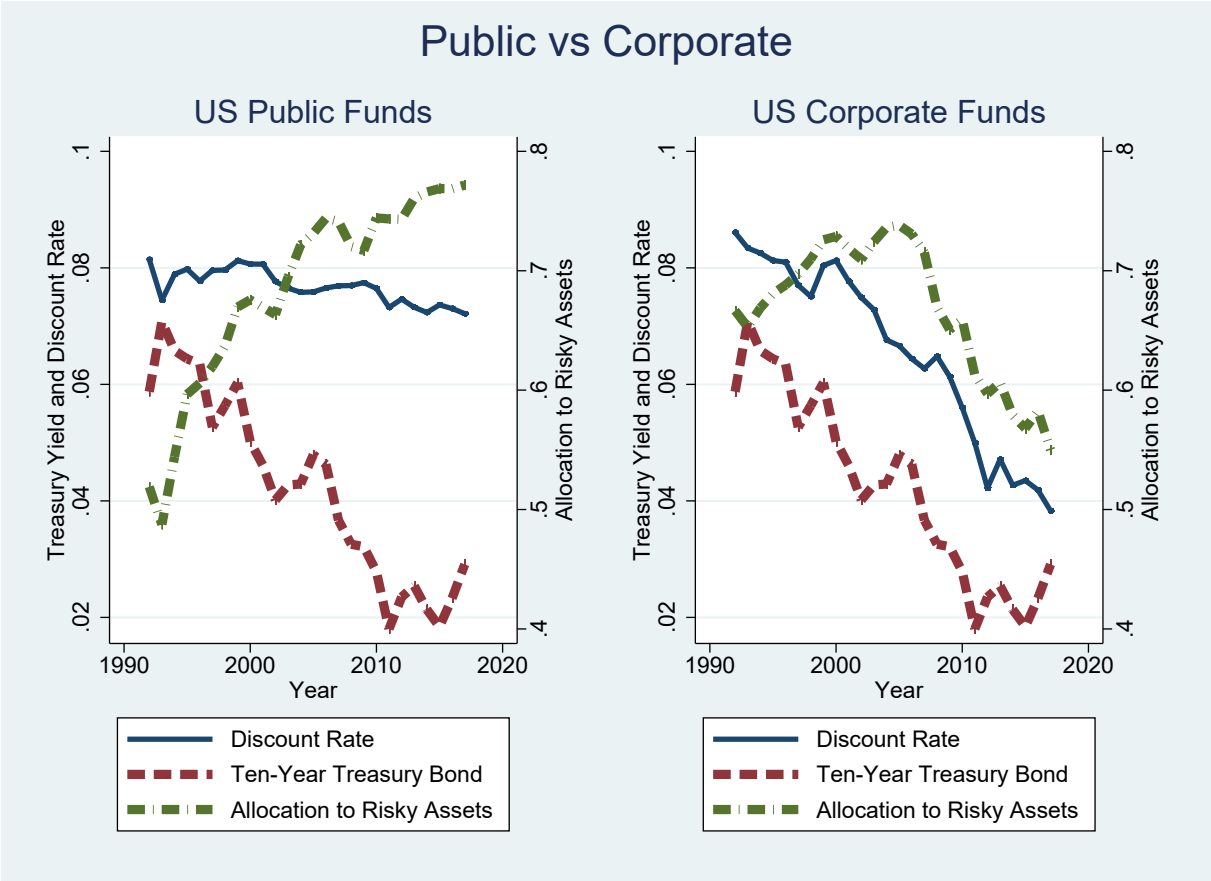
single employer pension plans exist. Sponsors must bring their plans into balance should they experience deficits. If sponsors become insolvent, then members receive reduced pensions in all provinces. That said, Ontario has a pension benefit guarantee fund (the PBCF) that covers a prescribed maximum amount, after which members' benefits are reduced. However, the insurance premium structured by PBGF is not flat, it has to reflect the riskiness of the expected future claims from plan terminations. Unlike with US corporate plans, there is no single party in Canada that can provide absolute legal protection for underfunded public or corporate plans in Canada. In general, the Canadian pension guarantee scheme largely limit the motive of risk shifting.

Looking at **Figures 3** and **4**, we see evidence that Canadian plans do not use the discount rate to manipulate funding status. These show that Canadian plans, on average, use much more reasonable discount rates that align closely to the dynamics of the 10-year treasury bond rates as. Additionally, there is no significant difference between the discount rates used by public and corporate pension funds. However, some pension regulators in Canada such as Landon and Smith (2019) argue that high discount rates used by many Canadian public sector pension plans evidence risk shifting incentives, and that those public plans will not have enough assets to meet their future obligations.

To test the risk-shifting incentives hypothesis, we follow the Andonov et al. (2017) methodology. First, we examine the relationship between the allocation to risky assets and fund maturity. Turning to financial literature (e.g. Black (1989), Bodie et al. (1992) and Sundaresan and Zapatero (1997)), arguments have been made that investing in risky

Figure 5: **Asset Allocation and Liability Discount Rates.**

U.S. Public Funds vs. U.S. Corporate Funds 1993-2017



assets can help younger pension funds hedge against increases in future pension benefits, especially if the promised benefits are inflation protected. Rauh (2008) finds a negative relationship between risk-taking and fund maturities among U.S. corporate pension funds, which suggests that as cash flows from promised pension benefits become less uncertain, private pension funds take less investment risk. We use the following pooled panel regression to investigate the relationship between the percentage allocated to risky assets ($\%Risky_{i,t}$)[12] and the percentage of retired members ($\%Retired_{i,t}$) for pension fund i in sample period t.

$$\%Risky_{i,t} = \beta_0 + \beta_1 \%Retired_{i,t} + \beta_2 X_{i,t} + \beta_3 Y_t + \beta_4 f_i + u_{i,t} \quad (1)$$

where $X_{i,t}$ refers to the control variables which include the long-term interest rate, fund size, inflation protection policy as well as a public plan dummy variable, Y_t refers to the year fixed effect and f_i is the fund fixed effect and $u_{i,t}$ is the idiosyncratic error.

Table 2 shows that pension funds, that have a higher proportion of retired members, invest less in risky assets. This is consistent with the financial literature. Column 1 indicates that a 10% increase in the percentage of retired members is associated with a 1.359% reduction in the allocation to risky assets. In contrast to other funds (corporate

[12]The risky assets include allocation to equity and alternative asset classes such as private equity, real estate, commodities, hedge funds and natural resources.

or mixed), column 5 shows that more mature Canadian public funds invest significantly more in risky assets. The coefficient of the interaction term $\%Retired \times Public$ depicts the difference of the effect of maturity on risk-taking between public and non-public funds. As evidenced in column 5, a 10% increase in the percentage of retired members is associated with a 1.924% decrease in allocation to risky assets. However, for the Canadian public funds, a 10% increase in the percentage of retired members is associated with 0.875% $[10\% \times (0.2799 - 0.1924)]$ increase in the allocation to risky assets. This positive relationship suggests evidence of risk-shifting incentives among Canadian public funds. However, we note that the positive relationship is not statistically significant based on the Wald test.

Results in **Table 2** also indicate that as Treasury yields declined, Canadian pension funds, especially the public funds, increased their allocation to risky assets. Based on column 3, a one-percentage-point decline in the yield on ten-year Canadian Treasuries is associated with a 0.6201% increase in risk taking by Canadian non-public funds and a 2.1854%[13] $[-0.01 \times (-0.6201 - 1.5653)]$ increase in their allocation to risky assets, where the interaction term, $Yield \times Public$, depicts the difference between public and non-public funds in their response to the long-term yield dynamics.

As also shown in column 8, the interaction term $\%Retired \times Public$ becomes less significant when controlling the long-term interest rate effect on public funds relative to non-public funds, $Yield \times Public$. A one percentage-point decrease in the long-term interest rate is associated with a 1.59% greater increase in the allocation to risky assets for the public funds than for the non-public funds. The significant difference-in-difference yield effect $Yield \times Public$ verifies the influence of risk management incentives and offsets the influence of risk-shifting incentives for public funds. Compared with the regulation induced risk-shifting incentives among U.S. public plans (see Andonov et al. (2017)), risk-shifting incentives among Canadian public funds are negligible.

Discount rates should reflect the timing and riskiness of future cash flows. Thus, a pension fund with a higher percentage of retired members should use a lower discount rate than would be applied by less mature funds. This is because more mature pension funds have shorter duration of liabilities than younger funds. Also younger pension plans with net-positive projected cash flows have a higher tolerance to extended drawdowns, as they are not forced to sell assets in a downturn to meet liquidity demands hence, they prefer a higher discount rate. Lucas and Zeldes (2006) and Benzoni et al. (2007) argue that mature funds should use lower discount rates because their projected liabilities are more akin to those of short-duration bonds than to equities.

However, the risk-shifting incentives hypothesis points out that public funds that are more mature invest more in risky assets and will use higher (rather than lower) discount rates. To test the relationship between fund maturity, allocation to risky assets and discount rates, we estimate the following pooled panel regression model with year and fund fixed effects:

$$LDR_{i,t} = \gamma_0 + \gamma_1 \%Risky_{i,t} + \gamma_2 \%Retired_{i,t} + \gamma_3 X_{i,t} + \gamma_4 Y_t + \gamma_5 f_i + \varepsilon_{i,t} \quad (2)$$

where $LDR_{i,t}$ represents the liability discount rate of fund i in year t. $X_{i,t}$ captures the control variables and $\varepsilon_{i,t}$ is the idiosyncratic error. In all regressions, we independently double cluster the standard errors by pension fund by year.

Table 3 (columns 1 and 7) present no significant relationship between the asset allocation to risky assets and the discount rate, whereas this relationship becomes significantly

[13] Wald test shows that sum of the two coefficients on $Yield$ and $Yield \times Public$ is significantly negative.

positive for the non-public funds once we add fund-type dummies. For instance, columns 8 and 9 show that the allocation to risky assets is positively related to discount rates for non-public funds. As shown in column 8, a 10% increase in risky asset allocation is associated with a 9.4 basis points increase in the discount rate for non-public funds. The magnitude of the discount rate - risk taking relationship is reduced, negatively, by twice as much for the Canadian public pension funds. As shown in column 9, the interaction term $\%Risky \times Public$ captures the difference between the effect of changing risk allocation on the discount rate for Canadian public and non-public funds. For every 10% increase in risky asset allocation, public funds adjust their discount rate downwards by 19 basis points more than they adjust the discount rate for non-public funds. Jointly, a 10% increase in risk taking is associated with a 10 basis points $[0.1 \times (0.0090 - 0.0190)]$ decrease in the discount rate at 10% significance level for Canadian public funds. Using discount rates to manipulate asset allocations can be interpreted as an indication that public plans use their freedom from regulatory oversight to meet their risk-return preferences.

Generally, more mature pension funds tend to use lower discount rates. For example, column 1 shows that a 10% increase in the retiree/member ratio is associated with a 9.2 basis points decrease in the discount rate. The interaction term $\%Retired \times Public$ depicts the relationship between the maturity of the plan and the discount rate for public plans relative to non-public plans. Without controlling the public dummy effect, both columns 3 and 6 present a significantly higher maturity effect on the discount rate for public funds than for non-public funds, with positive coefficients on the interaction term $\%Retired \times Public$ at a 1% significance level. Column 6 shows that a 10% increase in the percentage of retired members is associated with a 2.1 basis points $[0.1 \times (-0.0099 + 0.0120)]$ increase in the LDR. According to the Wald test, this positive relationship is statistically insignificant. Column 9 also shows that the positive difference-in-difference coefficient on $\%Retired \times Public$ becomes insignificant when introducing a public dummy variable. Therefore, there is no solid evidence of risk-shifting incentives.

In line with financial theory, **Table 3** shows that the Treasury yield is positively associated with the discount rate. Based on column 1, a 100-basis-point decrease in the government bond yield is associated with a decrease in the discount rate of 35.67 basis points for Canadian pension funds. This differs from the U.S. public funds (see Andonov et al. (2017)), as the interaction term $Yield \times Public$ has no statistical relationship with the discount rate, indicating that the discount rates of both Canadian public and corporate funds reflect the trend of interest rates and there is no evidence of risk-shifting incentives among Canadian funds.

In summary, empirical findings in **Tables 2 and 3** do not show evidence of risk-shifting incentives among Canadian (public) pension funds. It is statistically significant that the going concern valuation in Canada does not create a moral hazard problem. In comparing US public plans to Canadian plans (see Andonov et al. (2017)), we conclude funding regulations create risk shifting incentives. Without absolute underfunding guarantees, both US corporate plans and Canadian pension plans establish discount rates that reflect the risk preferences of their sponsors. In other words, Canadian funds of all different types follow the fiduciary duty in terms of reporting their discount rates.

5 Conclusion

The study reveals that more mature pension funds allocate less to risky assets and adopt lower discount rates than younger funds. Although public funds tend to have higher

allocations to risky assets than corporate funds (in response to an aging liability), risk-return preferences are much greater than risk shifting incentives. Observers have often assumed that moral hazard plays a role in pension fund asset allocation. However, based on our empirical findings, it is fair to highlight that, in Canada, discount rates are a reflection of risk preferences, rather than of regulatory structure or political incentives.

References

Ambachtsheer, K. P., 2016. The Future of Pension Management: Integrating Design, Governance, and Investing. John Wiley & Sons. 3

Andonov, A., Bauer, R. M., Cremers, K. M., 2017. Pension fund asset allocation and liability discount rates. The Review of Financial Studies 30 (8), 2555–2595. 1, 2, 3, 5, 9, 10, 12, 14, 15

Benzoni, L., Collin-Dufresne, P., Goldstein, R. S., 2007. Portfolio choice over the life-cycle when the stock and labor markets are cointegrated. The Journal of Finance 62 (5), 2123–2167. 14

Black, F., 1989. Should you use stocks to hedge your pension liability? Financial Analysts Journal, 10–12. 2, 12

Bodie, Z., Light, J. O., Morck, R., Taggart Jr, R. A., 1985. Corporate pension policy: an empirical investigation. Financial Analysts Journal 41 (5), 10–16. 3

Bodie, Z., Merton, R. C., Samuelson, W. F., 1992. Labor supply flexibility and portfolio choice in a life cycle model. Journal of economic dynamics and control 16 (3-4), 427–449. 2, 12

Brown, J. R., 2008. Guaranteed trouble: the economic effects of the pension benefit guaranty corporation. Journal of Economic Perspectives 22 (1), 177–198. 3, 10

Brown, J. R., Wilcox, D. W., 2009. Discounting state and local pension liabilities. American Economic Review 99 (2), 538–42. 9

Chandler, D., 2019. Patterns of going concern discount rate. Society of Actuaries March. 3, 5

Froot, K. A., Scharfstein, D. S., Stein, J. C., 1993. Risk management: Coordinating corporate investment and financing policies. the Journal of Finance 48 (5), 1629–1658. 2

Guan, Y., Lui, D., 2016. The effect of regulations on pension risk shifting: Evidence from the us and europe. Journal of Business Finance & Accounting 43 (5-6), 765–799. 3, 4, 10

Hamilton, M. P., 2014. Evaluating public-sector pensions: How much do they really cost? CD Howe Institute Commentary 403. 3

Jensen, M. C., Meckling, W. H., 1976. Theory of the firm: Managerial behavior, agency costs and ownership structure. Journal of financial economics 3 (4), 305–360. 2

Landon, S., Smith, C. E., 2019. Managing uncertainty: The search for a golden discount-rate rule for defined-benefit pensions. CD Howe Institute Commentary 530. 3, 12

Lucas, D., Zeldes, S. P., 2006. Valuing and hedging defined benefit pension obligationsthe role of stocks revisited. Northwestern University and Columbia University, working paper, September. 14

Lucas, D. J., Zeldes, S. P., 2009. How should public pension plans invest? American Economic Review 99 (2), 527–32. 2

Mayers, D., Smith Jr, C. W., 1987. Corporate insurance and the underinvestment problem. Journal of Risk and Insurance, 45–54. 2

Merton, R., 1983. on the role of social security as a means for efficient risk-bearing in an economy where human capital is not tradeable, i z. bodie och jb shoven (eds.) financial aspects of the us pension system. 2

Rauh, J. D., 2008. Risk shifting versus risk management: Investment policy in corporate pension plans. The Review of Financial Studies 22 (7), 2687–2733. 2, 10, 13

Sharpe, W. F., 1976. Corporate pension funding policy. Journal of financial Economics 3 (3), 183–193. 3, 10

Shen, S., Pelsser, A., Schotman, P., 2019. Robust hedging in incomplete markets. Journal of Pension Economics & Finance 18 (3), 473–493. 2

Shen, S., Zernov, S., 2019. A benchmark study of canadian pension fund asset allocation. 6

Shiller, R. J., 1999. Social security and institutions for intergenerational, intragenerational, and international risk-sharing. In: Carnegie-Rochester Conference Series on Public Policy. Vol. 50. Elsevier, pp. 165–204. 2

Smith, C. W., Stulz, R. M., 1985. The determinants of firms' hedging policies. Journal of financial and quantitative analysis 20 (4), 391–405. 2

Sundaresan, S., Zapatero, F., 1997. Valuation, optimal asset allocation and retirement incentives of pension plans. The Review of Financial Studies 10 (3), 631–660. 12

Table 1: **Summary Statistics**

This table provides descriptive statistics for pension fund maturity, discount rate and inflation protection policy. Panel A presents the total number of funds and total number of sample observations of different fund type. Panel B shows the annual average percent of retired members over total plan members; annual average reported liability discount rate; and annual average contractual inflation protection of benefits Mat shows the average ratio of retired members to the total plan members. DR presents the percentage value of liability discount rate. Inf. is a dummy variable taking a value of one if a pension fund provides a contractual inflation protection. All numbers are in percentage.

Type	All Funds			Public			Corporate			Others		
Panel A: Total number of Canadian pension funds and observations												
Funds	256			61			155			40		
Obs.	2453			739			1325			389		
Panel B: Summary Statistics over Sample Period 1992-2017												
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Year	Mat.	DR	Inf.	Mat.	DR	Inf.	Mat.	DR	Inf.	Mat.	DR	Inf.
1992	25.14	7.77	NA	NA	8.38	NA	25.14	7.73	NA	NA	7.29	NA
1993	27.06	7.75	NA	23.02	7.57	NA	29.11	7.80	NA	15.88	7.58	NA
1994	28.80	7.72	32.65	29.84	7.88	52.17	31.04	7.74	25.81	15.11	7.38	30.76
1995	30.39	7.76	35.29	30.10	7.90	60.00	33.59	7.80	26.98	14.93	7.29	28.57
1996	31.61	7.66	41.90	31.12	7.78	60.71	34.17	7.61	33.33	18.79	7.65	42.85
1997	33.27	7.53	49.48	33.61	7.57	67.74	34.70	7.51	37.50	18.89	7.63	60.00
1998	33.74	7.34	48.07	32.82	7.29	66.67	37.36	7.38	36.67	18.21	7.29	57.14
1999	33.23	7.17	45.45	32.59	7.03	66.67	37.35	7.23	33.33	14.11	7.17	57.14
2000	35.20	6.96	43.81	32.31	6.88	58.62	39.14	6.97	35.48	19.96	7.11	50.00
2001	36.09	6.87	47.47	36.61	6.76	67.74	39.59	6.88	43.75	17.87	7.17	38.46
2002	35.00	6.67	52.04	35.35	6.55	67.85	38.35	6.76	55.26	20.41	6.53	40.00
2003	36.50	6.53	52.08	38.84	6.34	77.78	40.06	6.65	50.00	20.35	6.46	41.18
2004	35.00	6.44	45.26	34.67	6.42	64.00	39.71	6.38	47.83	22.17	6.66	42.11
2005	37.48	6.21	42.99	34.67	6.28	57.14	42.11	6.08	55.81	23.58	6.55	33.33
2006	37.31	6.12	40.20	37.19	6.32	51.61	41.68	5.92	46.67	20.23	6.39	33.33
2007	40.46	6.03	48.00	39.12	6.24	59.38	45.88	5.82	48.89	25.13	6.32	40.00
2008	37.74	6.26	51.11	38.03	6.25	56.25	42.51	6.19	51.22	24.59	6.46	35.00
2009	40.12	6.12	50.54	39.18	6.12	60.00	44.88	6.01	50.00	24.59	6.47	35.29
2010	39.93	5.99	46.32	38.11	6.12	56.67	45.41	5.78	47.83	25.56	6.35	26.31
2011	42.75	5.82	51.69	42.18	6.20	56.67	47.85	5.47	55.81	27.23	6.10	31.25
2012	43.16	5.61	43.82	39.89	6.09	48.27	48.52	5.19	46.67	27.69	6.24	26.67
2013	45.13	5.59	47.78	39.77	5.91	53.33	51.54	5.33	48.89	29.27	6.01	33.33
2014	43.67	5.62	47.19	38.79	6.02	48.48	50.44	5.23	51.22	30.13	6.06	33.33
2015	43.83	5.37	43.75	39.91	5.69	45.16	50.08	4.99	50.00	27.43	6.16	18.18
2016	44.20	5.42	48.75	34.43	5.89	53.13	55.43	4.92	51.43	30.60	6.00	30.77
2017	46.43	5.24	50.68	39.52	5.81	51.72	55.68	4.65	59.38	34.05	5.73	25.00

Table 2: **Allocation to Risky Assets**

The dependent variable is the percentage allocation to risky assets based on the realized asset allocation of Canadian pension funds. The risky assets include allocation to equity and alternative asset classes such as private equity, real estate, commodity, hedge fund and natural resource. As explanatory variables, the panel model includes $\%Retired$, the percentage of retired members among all sample Canadian pension funds; $\%Retired \times Public$, an interaction term capturing the retired members among Canadian public funds; $Yield_{t-1}$, the 10-year Canadian treasure yield at the beginning of the year; $Yield_{t-1} \times Public$ an interaction term capturing the yield effect on public funds; $LogSize$, the logarithm of total pension fund assets; $Inflation$, the percentage of indexation coverage; $Liability$, the percentage of liability associated with retirees; $Public$, the dummy variable for public funds; and $Corporate$, the dummy variable for corporate funds. We independently double-cluster the robust standard errors by pension fund and by year. We report standard errors in brackets. $*$, $**$ and $***$ indicate significance levels of 0.10, 0.05 and 0.01, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Dependent variable: Percentage allocation to risky assets							
$\%Retired$	-0.1359***	-0.1541***	-0.1417***	-0.1488***	-0.1942***	-0.1186***	-0.1286***	-0.1586***
	(0.0435)	(0.0471)	(0.0459)	(0.0539)	(0.0534)	(0.0430)	(0.0453)	(0.0549)
$\%Retired \times Public$		0.1064**	0.1515***	0.1507*	0.2799***			0.1460*
		(0.0445)	(0.0520)	(0.0749)	(0.0883)			(0.0799)
$Yield_{t-1}$	-1.1166***	-1.1697***	-0.6201**	-0.6503	-1.1401***	-0.5991*	-0.4232	-0.5363
	(0.2671)	(0.2678)	(0.3050)	(0.3326)	(0.2693)	(0.3089)	(0.3261)	(0.3284)
$Yield_{t-1} \times Public$			-1.5653***	-1.5714***		-1.4116***	-1.9056***	-1.5932***
			(0.4284)	(0.5917)		(0.3989)	(0.5804)	(0.5931)
$LogSize$	0.0126**	0.0096*	0.0112**	0.0109*	0.0132***	0.0154***	0.0104*	0.0106*
	(0.0060)	(0.0057)	(0.0057)	(0.0058)	(0.0058)	(0.0060)	(0.0059)	(0.0059)
$Inflation$					0.0020		0.0007	0.0016
					(0.0126)		(0.0124)	(0.0125)
$Liability$							0.0219*	0.0206*
							(0.0116)	(0.0117)
$Public$				0.0277	-0.0833**		0.0912***	0.0303
				(0.0431)	(0.0312)		(0.0318)	(0.0428)
$Corporate$				0.0314	0.0419*		0.0252	0.0312
				(0.0171)	(0.0167)		(0.0163)	(0.0172)
R^2	0.0843	0.0944	0.1196	0.1195	0.1041	0.1164	0.1194	0.1229
Obs.	2121	2121	2121	2121	2121	2121	2121	2121
No. funds	235	235	235	235	235	235	235	235
Fund FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 3: **Liability Discount Rate**

This table estimate the panel model (2). The dependent variable is the liability discount rate of sample Canadian pension funds. We omit the observations that report 0 discount rate in the survey data. The risky assets include allocation to equity and alternative asset classes such as private equity, real estate, commodity, hedge fund and natural resource. As explanatory variables, the panel model includes $\%Retired$, the percentage of retired members among all sample Canadian pension funds; $\%Retired \times Public$, an interaction term capturing the retired members among Canadian public funds; $Yield_{t-1}$, the 10-year Canadian treasure yield at the beginning of the year; $Yield_{t-1} \times Public$ an interaction term capturing the yield effect on public funds; $LogSize$, the logarithm of total pension fund assets; $Inflation$, the percentage of indexation coverage; $Liability$, the percentage of liability associated with retirees; $Public$, the dummy variable for public funds; and $Corporate$, the dummy variable for corporate funds. We independently double-cluster the robust standard errors by pension fund and by year. We report standard errors in brackets. $*$, $**$ and $***$ indicate significance levels of 0.10, 0.05 and 0.01, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Dependent variable: Liability discount rate								
$\%Risky$	0.0052	0.0047	0.0048	0.0052	0.0054	0.0058	0.0047	0.0094**	0.0090**
	(0.0037)	(0.0038)	(0.0037)	(0.0039)	(0.0037)	(0.0037)	(0.0041)	(0.0044)	(0.0045)
$\%Risky \times Public$		0.0019				-0.0045	0.0023	-0.0195**	-0.0190**
		(0.0018)				(0.0033)	(0.0025)	(0.0077)	(0.0077)
$\%Retire$	-0.0092***	-0.0092***	-0.0106***	-0.0092***	-0.0074***	-0.0099***	-0.0074***	-0.0064***	-0.0077***
	(0.0021)	(0.0021)	(0.0022)	(0.0021)	(0.0021)	(0.0024)	(0.0021)	(0.0022)	(0.0025)
$\%Retire \times Public$			0.0067***			0.0120***			0.0054
			(0.0019)			(0.0041)			(0.0044)
$Yield$	0.3567***	0.3558***	0.3525***	0.3555***	0.3399***	0.3340***	0.3397***	0.3523***	0.3473***
	(0.0189)	(0.0188)	(0.0189)	(0.0201)	(0.0196)	(0.0197)	(0.0214)	(0.0223)	(0.0230)
$Yield \times Public$				0.0038			-0.0030	-0.0718	-0.0589
				(0.0306)			0.0390	(0.0480)	(0.0488)
$LogSize$	-0.0001	-0.0002	-0.0003	-0.0001	0.0001	0.0000	-0.0001	0.0000	0.0000
	(0.0003)	(0.0003)	(0.0003)	(0.0004)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
$Inflation$					-0.0016*	-0.0017*	-0.0017*	-0.0018**	-0.0018*
					(0.0009)	(0.0009)	(0.0010)	(0.0009)	(0.0009)
$Liability$					-0.0031***	-0.0032***	-0.0031***	-0.0030***	-0.0031***
					(0.0011)	(0.0011)	(0.0011)	(0.0011)	(0.0011)
$Public$								0.0168***	0.0139**
								(0.0057)	(0.0062)
$Corporate$								-0.0009	-0.0002
								(0.0014)	(0.0015)
R^2	0.5541	0.5589	0.5625	0.5549	0.5526	0.5625	0.5583	0.5700	0.5710
Obs.	1901	1901	1901	1901	1901	1901	1901	1901	1901
No.funds	216	216	216	216	216	216	216	216	216
Fund FE	Yes	Yes	Yes	Yes	Yes	yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes