The impact of regulatory leeway when measuring longevity risk in Canadian corporate DB pension plans

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I. Abstract

Pension fund solvency has become a key challenge for both the public and private sector. There are numerous instances, current and past, where pension fund deficits have distressed the financial standing of an organization.

A genuine concern to the health of DB plans is the uncertainty in future changes to human mortality. In some cases this major risk factor manifests itself in underestimation of increased longevity. In others, where such trends are well known and quantifiable, regulations governing pension plans provide sponsors with some leeway to disregard the latest findings in making key assumptions.

We measure the effects of changes in mortality on Canadian DB pension plans. We introduce a model company pension plan to perform various simulations with the objective to estimate bounds for actuarial calculations. The outcome of this study highlights the capacity for plan sponsors to camouflage funding levels through the latitude given by the respective regulatory regime. Finally, our results shall reveal the potential impact on sponsors when policymakers tighten regulation as a result of an increased demand for transparency and accountability.

II. Background

Powered by a notable increase in life expectancy, there are active debates on the limits to human longevity with previous upper bounds having been surpassed[1]. Canada is no exception to this global trend with ample evidence that people are living longer. Male life expectancy at age 65 has increased from 14 years in 1975 to 17.8 years in 2005, and is forecast to reach 22.4 years in 2075[2].

These trends will inexorably lead to an expanding elderly age group thereby creating a structural demographic shift clearly depicted in the population pyramid of Figure 1. We compare the census-adjusted demographics numbers for 2013 with the top-heavier formation of the projected 2050 population data.

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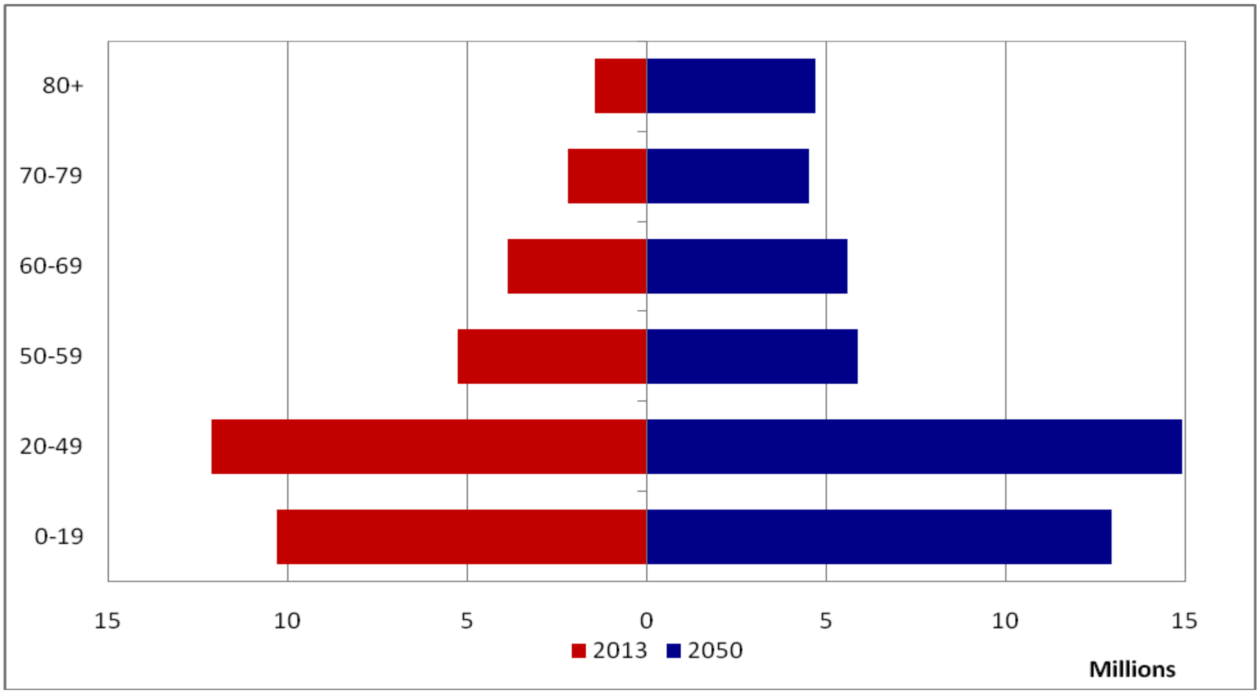
[1] "In search of Methuselah: Estimating the upper limits to human longevity". SJ Olshansky, BA Carnes, C Cassel. Science 2 November 1990: Vol. 250 no. 4981 pp. 634-640.
[2] Canadian Pension Plan Mortality Study. Actuarial Study No. 7 Office of the Chief Actuary. July 2009.

Figure 1-Population pyramid of 2013 vs. 2050



Note: Population in 2050 is calculated using a CANSIM projection scenario of medium-growth and historical trends (1981 to 2008). Source: Statistics Canada, Table 051-0001, accessed Dec 2013.

As expected, every specified age group experiences an increase in population in absolute terms. What the pyramid does not directly highlight is the relative change observed within each age group. In Table 1, we display the ratio of each age group to total population in percentage terms and its change from 2013 to 2050.

Table 1 - Relative population change in different age groups

Age Group	% of total population in 2013	% of total population in 2050	Change from 2013 to 2050
80+	4%	10%	**138%**
70-79	6%	9%	**49%**
60-69	11%	12%	5%
50-59	15%	12%	-19%
20-49	34%	31%	-11%
0-19	29%	27%	-9%

Note: Same source as Figure 1.

Noteworthy is the jump in ratio of retired population (70+) to "working age" population (20-70) from 16% in 2013 to 35% in 2050.

While improvements in longevity represent an achievement for mankind, this very accomplishment does also impact the cost of services provided to the elderly. Actuarial estimations of such costs are sensitive to underlying mortality assumptions[3]. Should life expectancy be significantly understated[4], projected costs of such services could soar in the future[5]. Since taxpayers fund the bulk of these expenditures, this development may result in a significant intergenerational transfer of wealth from future to current generations[6].

Together with health care, retirement provision comprises the bulk of these old-age related expenditures[7]. In a pension context, the upsurge in the expected number of post-retirement years signals a need for increased financial resources in retirement[8]. Evidence of underestimation of lifespan[9] raises the possibility of outliving retirement assets in a defined-contribution (DC) structure. Within defined-benefit (DB) schemes, the same outcome precipitates through a slightly more complex transaction mechanism.

Our goal is to measure the costs of increasing longevity on DB pension plans through a set of simulations. The results are discussed in various frameworks to consider their impact and significance.

III. Methodology

The proxy for demographics in a pension context is mortality rate. The Canadian Institute of Actuaries (CIA) has recently published a report introducing Canadian Pension Mortality (CPM) experience based on 2014 tables[10]. While not yet ratified, CPM is expected to dominate pension plan assumptions and eventually replace the widely used US-based UP94 projections[11]. Mortality data is an input to the following company pension model.

The Test Bed Model Corporation (TBMC) is defined to have one employee retiring annually for 35 years at age 65 with a starting pension of $ 1. This DB plan only covers pension benefits with no survivor or disability benefits. On a given valuation date, the windup cost of the plan is calculated based on mortality data as well as an assumed discount rate, indexation and salary growth. This model company provides a simple and replicable framework to consistently measure pension cost (PC) as the present value of the total cost of annuities as the TBMC workforce winds down. See Appendix B on further assumptions of the plan.

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[3] Mortality is the complement to longevity and is used from now on interchangeably.
[4] "Forecasting continuously increasing life expectancy: what implications?" Éric Le Bourg Ageing Research Reviews 11 (2012) 325–328.
[5] The standards of practice of the Canadian Institute of Actuaries have been aggressively adapted to this mortality uncertainty. In 2013 the CIA standards projected mortality rates forward from 1994 tables to 2020 using mortality projection scales and base pension costs on these tables. From 2014, they changed to "rates in accordance with a mortality table promulgated from time to time by the Actuarial Standards Board for the purpose of these calculations."
[6] "The international transfer of public pension promises". Robert Novy-Marx, Joshua D. Rauh, Cambridge, MA 02138 September 2008.
[7] Although health care costs will not be dealth with in this study, it is worth noting how they will be impact by such demographic trends. While the average cost of health care for all Canadians was $5948 per person in 2010, with ageing it will increase to $6223 for ages 65-69, $8721 for 70-74, $12050 for 75-79 and $20113 for 80-120.
[8] In a presentation at a Winnipeg CIA conference, Louis Adam noted that the cost of pensions using CIA standards might be underestimated because of recent mortality trends. See Actuarial Research Conference, Winnipeg, Session P4A, Projection Scales, L. Adam, 2012-08-03.
[9] "The 2011 Risks and Process of Retirement Survey" Mathew Greenwald and Associates, Inc. This Society of Actuaries' report (2012) shows increasing longevity as a major retirement planning risk; 4 in 10 retirees and pre-retirees underestimate their longevity by 5 or more years.
[10] Evidence proves the difference between US and Canadian mortality experience.
[11] See Appendix A for further details on mortality data preparation.

IV. Simulations:

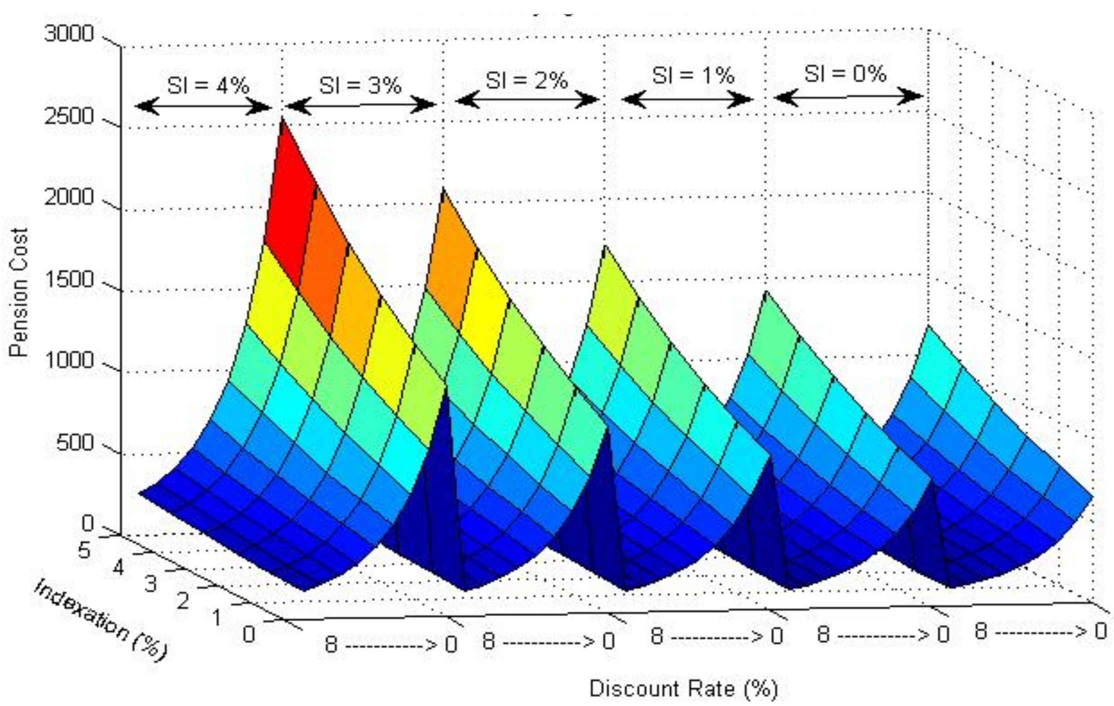
Besides demographics, the three major drivers of pension liabilities are:

(i) Discount Rate: the rate used by the sponsor to discount pension liabilities
(ii) Indexation: the level of protection for benefits against inflation
(ii) Salary Increase: the amount by which salaries rise every year

Keeping demographics constant by using UP94@2009 mortality data, we illustrate the tandem effect of other drivers on PC. As a rule of thumb, increasing the indexation and salary growth values along with decreasing discount rates result in significantly higher PC levels. In Figure 2, each of the 5 exponentially ascending surfaces represents PC for variable indexation and discount rates at a fixed salary increase (SI) indicated at the top.

Pension plans assets are mostly a function of contribution inflows and return on assets. Since a change in salary increase impacts both contributions and benefits, going forward we eliminate the impact of salary growth by setting it to a fix rate of 2.9%[12]. This allows us to focus on the liability side of a pension plan balance sheet. A graph of PC at the fixed salary increase of 2.9% is depicted in Figure 3.

Figure 2 – Drivers of pension liabilities with varying rates of discount rate, indexation and salary increase[13]



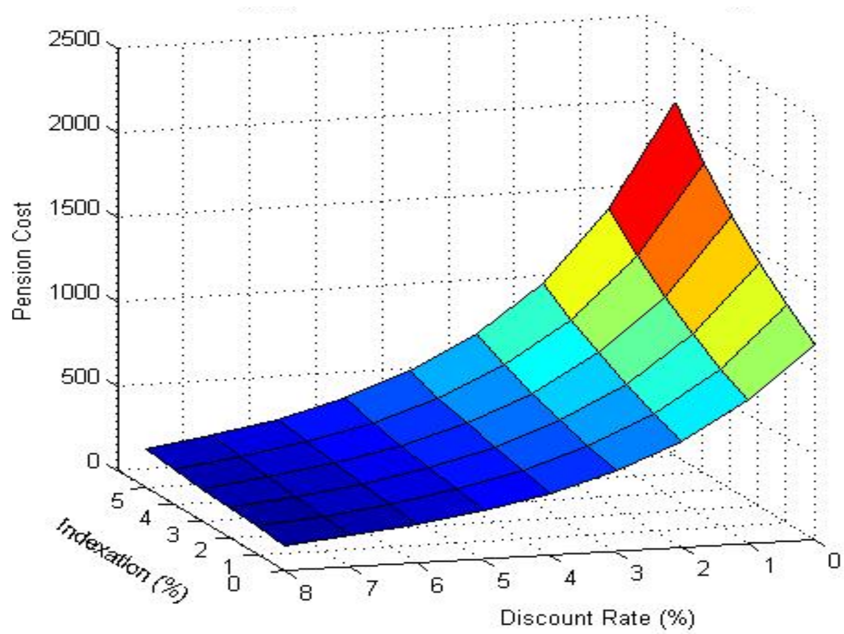
[12]We performed a logarithmic regression on the CANSIM v1558664 table of Average Weekly Earnings 2001-2012 unadjusted and including overtime. We found an annual rate of growth of salary of 2.917% with R2=.997. Based on this, we have chosen a salary rate of growth of 2.9% for our model, consistent with the approach used by the CIA Pension Experience Subcommittee in July 2013 CPM-RPP14 Mortality Tables Document 213060.

[13] A least square regression fit gives

$$PensionCost = 1173.80 * e^{-25.381*Discount} * e^{6.643*(Indexation+5*SalaryInc)}$$

with an adjusted R-squared of .968 for a variable range of SI: [0,4] DR: [0,8] IN: [0,5]. We see from this that the large discount parameter gives rise to a marginal Pension Cost reduction by a factor .776 for every 1% increase in discount rate. Figure 2 shows this by the steep "toboggan slide" in pension costs for each of the 5 salary increase levels. As a technical note, we introduced the variable (Indexation+5*SalaryInc) to avoid multicollinearity and assure technical considerations such as normality of the residues.

Figure 3 - Drivers of pension liabilities with varying rates of discount rate and indexation, SI=2.9%



In the above simulation, PC ranges from 150 to 2000 with a median of about 470. Due to the non-linear nature of the cost profile, variations in lower discount rate values lead to more pronounced changes in PC evident in the strictly ascending profile of Figure 3.

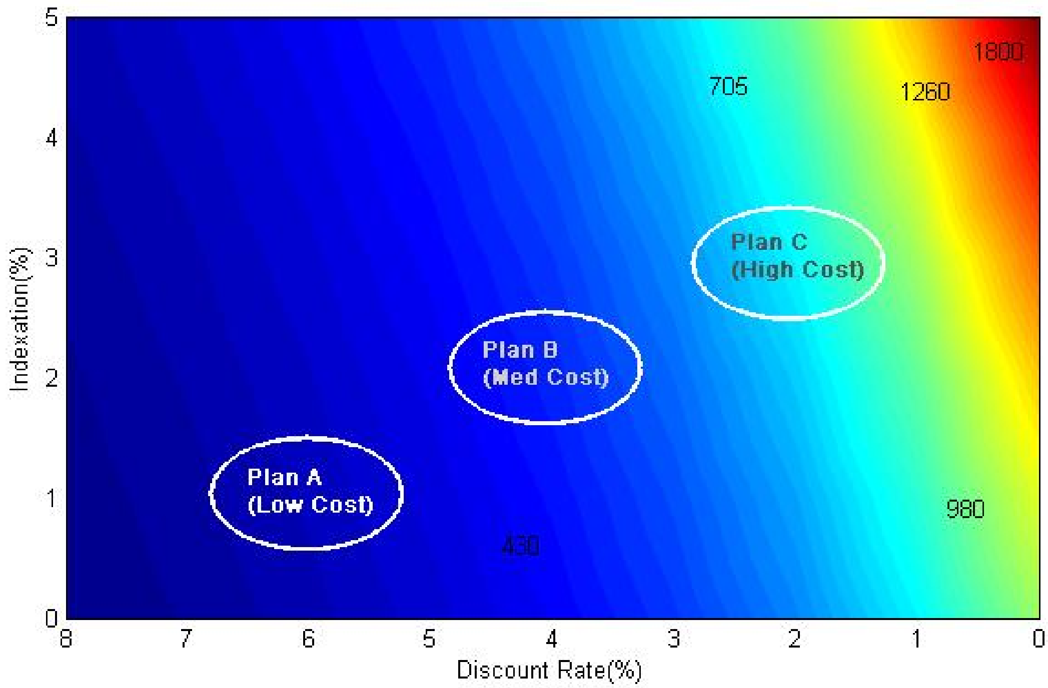
The broad range of input parameters used in our simulations is meant to provide a platform for comparison purposes. In reality such ranges are much more limited. We hence define three hypothetical pension plans with prescribed input parameters:

Plan type	Discount rate (%)	Indexation (%)
Plan A (low cost)	6	1
Plan B (med cost)	4	2
Plan C (high cost)	2	3

The respective regulatory regime under which DB plans operate restricts the parameters by setting upper and lower bounds. However, the ultimate decision on parameter values is up to the discretion of plan sponsors.

Figure 4 maps the iso-level graph of PC overlaid by the three hypothetical plans. This perspective reiterates the non-linearity of pension cost profile shown in Figure 2 & Figure 3 with higher cost impact observed in lower discount rate ranges.

Figure 4 – Pension cost iso-levels over a range of indexation & discount rate values



Pension Liabilities with Different Mortality Tables

The simulations presented so far were based on the prevalent UP94@2009 mortality table to demonstrate the impact of other drivers. We now examine the effects of demographics on PC. The three hypothetical plans outlined above are studied by changing mortality tables as the sole driver of pension liability.

Figure 5 – Impact of changing mortality tables on pension cost

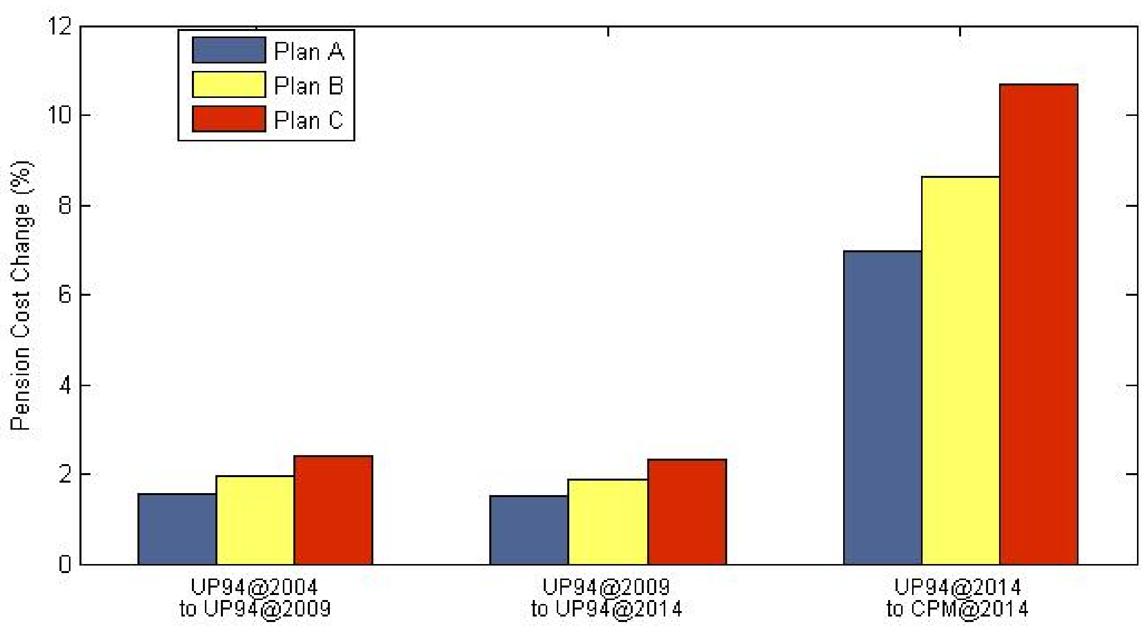


Figure 5 clearly illustrates that advancing UP tables increases PC by approximately 2%. However, shifting to the CPM method will push the cost much more significantly for all plan types.

As a well-understood measure in pension finance, the funding ratio captures the value of plan assets relative to its liabilities[14]. The simulations here assume a fully funded plan at the outset[15] with changes in PC translated to comparable variations in funding ratio. Based on Figure 5, switching to the proposed CPM@2014 mortality table from UP94@2014 results in the following drops in funding ratios for the three assumed plans:

Plan A (low cost)	Plan B (med cost)	Plan C (high cost)
-7%	-8.6%	-10.7%

The financial status of pension plans for regulatory and reporting purposes depends on the assumed mortality experience. While the change in funding ratio may appear insignificant in percentage terms, it can translate to large absolute dollar values. In order to exemplify the significance of a drop in funding ratio and make it more tangible, we compare it to actual company data.

Pension Liabilities with Different Mortality Tables Compared to Company Data

For a pension plan to be sustainable, built-in mechanisms should be in place to restore full funding within a pre-specified timeframe in case of shortfalls. Even though regulatory requirements and willingness of a sponsor to commit the necessary resources are paramount to put a pension plan back on track, these two elements are outside the scope of this study. This section focuses on the financial means of an organization and its fundamental capability to resume full funding in due time.

Let us treat funding ratio as the chief indicator of pension plan health and assume that only a 100% funded plan is financially sound[16]. Caution should also be exercised when interpreting these numbers in isolation, i.e. without taking external factors into account.

In this section the contingent increase in pension liabilities is set in relation to the financial strength of the plan sponsor. Besides revealing the scope of such shortfalls, this additional layer of analysis also indicates the time required to regain fully-funded status.

Initially, a few sample companies are selected based on the following criteria:

- Dividend paying Canadian public company with a large defined benefit corporate plan
- Follows GAAP accounting practices with published discount rate value used in pension liability calculations
- Roughly resembles the three hypothetical plans in terms of published discount rate

Further, the actual discount rates used by these pension plans are plugged into the pension model assuming a constant indexation[17]. The increase in pension cost is calculated when switching from

[14] This measure becomes more meaningful when it is clearly understood how values are calculated adjusted for some form of asset smoothing used and concepts employed to measure plan obligations.
[15] Other than for social insurance programs, i.e. PAYGO schemes, pension plans are designed with a funding target of 100% unless reasons for a different target have been clearly identified and the consequences of that target are well understood.
[16] myth 80% . However this single snapshot in time would become more meaningful when viewed as a time series.
[17] Indexation values are generally not disclosed in financial statements and are hence excluded from criteria. For simplicity we use constant indexation of 2% and SI=2.9% as previously discussed.

UP94@2014 to the proposed CPM@2014. For each company, the calculated change is applied to its pension benefit obligation (PBO)[18] and the added cost is compared to dividend payout.

Table 2 – Change in pension cost relative to company financials

Company	Actual discount rate (%)	Pension cost increase	Change in PBO relative to dividends paid in 2012
Bank	5.72	7.64%	0.17
Utilities	5.2	7.93%	0.25
Railway-1	4.28	8.47%	4.04
Railway-2	4.15	8.55%	2.14
Investment	3.5	8.96%	18.34
Technology	2	9.97%	0.99

Not surprisingly, “high cost” plans with lower discount rate assumptions demonstrate a higher increase in pension cost when adopting the more recent mortality rate. In the case of Railway-1, the 8.47% increase in PBO is almost 4 times the amount of dividends paid by the company in 2012!

V. Conclusions

Aging populations will undoubtedly put increasing strain on public and private DB plans in the decades ahead. Even though longevity improvements are factored into pension models, underestimation of these trends creates contingent liabilities in pension balance sheets.

The magnitude of pension promises are generally large relative to the size and/or financial strength of the sponsor. Even small upward deviations from baseline estimations translate to significant amounts. Our findings underscore not only the timely need to recognize these collateral liabilities but also the requirement to assess them appropriately. These actions will boost credibility, sustainability and viability of DB pension plans.

[18] PBO measures the funds needed to cover pension obligations accrued to a certain date.

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Appendix A – Mortality Data

The gender-specific UP94 table and its projections have been an industry standard in pension calculations over the last twenty years. The mortality table for years past 1994 is projected using AA improvement scales discussed in "Transactions of Society of Actuaries", 1995 Vol. 47, The 1994 Uninsured Pensioner Maortality Table, Society of Actuaries UP-94 Task Force. http://www.soa.org/library/research/transactions-of-society-of-actuaries/1990-95/1995/january/tsa95v4721.pdf

Recent studies have shown significant underestimation of longevity and have proposed a Canadian Pension Mortality (CPM) table in 2014 with BB improvement scales, see "Memorandum To Pension Experience Subcommittee from Bob Howard, February 13 2014 on CPM 2014 Mortality Tables. http://www.cia-ica.ca/publications/publication-details/214014

The mortality tables generally state the probability of a person dying at a given age. Our proprietary pension model requires an alternative representation of this data. As a result, the input mortality tables are transformed to life probability measures as follows:

$$For\ any\ x \geq 65, \qquad L(x) = \prod_{i=65}^{x} (1 - q(i))$$

where L(x) yields the probability of a person being alive at a certain age after retirement.

In this study we use the following four mortality tables: UP94@2004, UP94@2009, UP94@2014 & CPM@2014

Appendix B - TBMC (The Test Bed Model Corporation)

We propose here a simple company designed for the comparison of windup pension costs against a set of mortality alternatives. All birthdays and hires occur on January 1; deaths and compulsory retirements take place on December 31. All salaries and pensions are paid in a lump sum on January 1. There is exactly one TBMC employee, all male, of age 30-64 inclusive. There are no deaths, new hires, or pre-retirement terminations in this group of active employees - all of whom joined TBMC on January 1 on their 30th birthday and have 35 years of service at retirement. All surviving pensioners will be assumed to expire on December 31, the day before their 110th birthday.

The TBMC is a defined benefit pension plan allowing for benefit indexation on an annual basis after the first year (currently 2014), where the initial retirees receive a $1.00 pension benefit. An annuity due is computed annually for each retiring employee on January 1, and this annuity cost is discounted back to January 1, 2014. Discount rates can be constant or variable. The total cost of the annuities is then assembled on this date and is the basis for all of our comparisons.

All salaries are settable and increase by an annual set of amounts $\sigma = [\sigma_1, \sigma_2, \sigma_3, \ldots, \sigma_{35}]$ for the 35 years it takes until the current population is retired. The model could be amended to allow different populations and a parallel female cohort.

The above described model company provides a framework to consistently measure pension costs as the PV of the total cost of annuities as we wind down the TBMC workforce.