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ABOUT THIS REPORT:

This project adapts results from theoretical, stylized work on pension design, to explore a form of Target Benefit (TB) plan that allows for structured, transparent intergenerational risk sharing (IRS). It compares the IRS plan design with the traditional Defined Benefit (DB) design, based on five broad areas of comparison: affordability (average cost), sustainability (volatility of costs), efficiency, adequacy of benefits, and fairness.

The TB design presented in this project is simple and transparent, especially compared with some of the target benefit plans that have been implemented, and yet works well to meet the needs of both contributors and beneficiaries.

Risk Sharing Pension Plans

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1 Introduction

The traditional Defined Benefit (DB) pension has been in decline for some time across the globe, though it has proved somewhat more resilient in Canada than elsewhere. The DB plans instigated in the 1970's are not necessarily suitable for today's economic or demographic climate. The benefits are not portable, but today's workers are likely to change jobs far more frequently than those in employment 30 years ago. Even the standard benefit, incorporating a 60% survivor's pension, seems old fashioned in a modern era of dual earning couples, and, incidentally, increases the longevity risk exposure of the plan. Most of all, the assumption that the equity risk premium would subsidise a large part of the pension cost, which paid off handsomely in the 1980's and 1990's, has not proved to be realistic over the past 15 years. The long period of high equity returns and high interest rates that sustained the relatively generous pensions provided through the 1980s and 1990s can no longer be relied upon to subsidise future costs. However, the 60% equity investment benchmark has proved very tenacious in pensions management; maintaining this reliance on volatile market returns is more feasible if we insert more flexibility into the funding and benefit structure of workplace pension plans.

We see this increased flexibility in practice in some areas. The Defined Ambition plans implemented in the Netherlands are seen as early examples of risk sharing plans Bovenberg *et al.* (2016). The New Brunswick Public Sector Pension Plan (NBPSPP) is a well known Canadian example of a target benefit plan, implemented to replace an underfunded traditional final average salary DB plan. The NBPSPP risk sharing protocol is more complicated than the Target Benefit design in this paper, with a series of controls that starts with increasing contributions, and proceeds through reducing cost of living adjustments, and ultimately, if necessary, reducing the benefits in payment.

Benefit flexibility is resisted by labour unions and other employee representative groups, who typically regard the traditional, final salary DB pension as the 'gold standard' of retirement provision. But there are real risks to members of traditional DB plans, that are often overlooked in these discussions. Specifically there is risk to the job security of active members when a large pension deficit threatens the solvency of their employer, and risk to the retirement income security of active members and retirees when a firm enters bankruptcy or is taken over, or winds the plan up with insufficient funding.

The popular replacement for the employer sponsored DB plans through the last 25 years has been the Defined Contribution (DC) plan, where there is no risk pooling, and the pen-

sion plan is merely a convenient tax vehicle for individual employee's retirement savings. However, there is also an increasing awareness of the problems associated with Defined Contribution (DC) plans, especially since the 2007/8 financial crisis. Many commentators echo the conclusions of Cooper (2013) that DC plans are '*not fit-for-purpose*'. DC benefits are uncertain, annuities are expensive, and stock markets are volatile. A lucky worker may build up retirement funds during boom times, and retire when interest rates are high, but the unlucky cohorts may find their retirement funds decimated by market volatility late in the accumulation phase, and then face the second blow of low interest rates in retirement, creating seriously inadequate retirement income streams. The burden of managing DC assets through retirement is a significant challenge for retirees, who cannot be expected to have the sophisticated financial expertise required for such a complex problem. Governments that encourage employer sponsored pensions, through tax incentives or otherwise, may resent giving up tax income to support plans that are perceived to be unfair or inadequate.

As neither pure DB nor pure DC, in their traditional forms, appears to meet the needs of sponsors, workers and retirees, there is developing interest in hybrid designs, that combine elements of DC and DB plans. Popular examples include the DB-underpin (also known as floor offset), Cash Balance, and second-election options. However, many DB underpin plans have been wound up as the DB guarantee became too costly; Cash Balance plans carry significant (and largely unacknowledged) risk to sponsors during the accumulation phase, while leaving the members with all the decumulation risk, including interest rate, longevity and dissipation (Hardy *et al.*, 2014). Second election options, which allow a one-time transfer from DC to DB, are rare, and are more expensive and less sustainable than standard DB plans (Zhu *et al.*, 2018).

More sustainable developments fall in a very broad category of pension designs designated 'Target Benefit' (TB) or 'Defined Ambition' plans. These range from plans with fixed contributions, but with some potential risk pooling of benefits (essentially a collective DC plan) to plans which are almost identical to traditional DB, but with the potential to reduce benefits in sufficiently exigent circumstances. In between the 'almost DC' and 'almost DB' types there is a range of potential forms of TB plans, where both contributions and benefits may be adjusted in response to investment and demographic experience.

1.1 Pension design criteria

The objective of our work is to explore pension plan designs in relation to the following criteria.

Affordability: An affordable plan has a total contribution rate that is, on average, within a range deemed acceptable by the sponsor and members.

Sustainability: A plan that is affordable, based on average costs, may be unsustainable if the volatility of costs is very high. A sustainable plan can be managed such that costs remain within some predetermined limits even when economic conditions are unfavourable.

Efficiency: A pension plan is efficient if contributions are used effectively to provide adequate incomes in retirement. It would be inefficient for a plan to carry large surpluses, indicating that too much capital has been collected. It would also be inefficient for a plan to give benefits far above expectations or far above the requirements of the adequacy criterion, as, again, that would indicate that excessive contributions have been collected.

Adequacy: A plan provides adequate pensions if the benefits are predictable and sufficient. Predictability means that employees can plan for retirement, and can reasonably expect that benefit promises and/or projections will be realised. Sufficiency means that, over a full working lifetime, an employee accrues sufficient retirement income to maintain their lifestyle through their retirement, taking into consideration statutory benefits and usual life changes.

Fairness: This criterion is probably the hardest to capture quantitatively or qualitatively. There are several different aspects to fairness. Some that we have considered are:

- Variation in costs and benefits for different generations.
- Variations in costs and benefits for different sub-populations, within the same cohort.

We note that the affordability and efficiency criteria relate primarily to the interests of the plan sponsor, and of the current employees for cost-sharing plans. On the other hand, the adequacy and fairness criteria are of greater interest to plan members, in active service or

in retirement (especially those who remain in the plan to retirement). Sustainability is of prime interest to the plan sponsor, insofar as it reflects the level of uncertainty in costs, but also to plan members, as it relates to the security of their long term benefits.

2 A model pension plan

In this paper we compare a traditional DB plan with a flexible TB plan, based on the same benefit and contribution structure. The comparison is made by developing parallel models of a DB and a TB pension plan, based on common demographic and economic variables. We use stochastic simulation to project the distribution of assets and liabilities for the two plans, and compare the results based on the five criteria listed above. The model is designed to be somewhat simplified, for ease of interpretation – for example, we assume all cash flows occur at the start or end of each year – but it captures sufficient characteristics of a real world plan to be useful for a broad comparison of different forms of risk sharing, and of the impact of adjusting assumptions.

In developing the results, we have followed the academic literature on risk sharing pension plans by assuming that the full contribution risk falls on the workers. That is, explicitly or implicitly, all the contributions are met by taxing the salaries of the active members. We recognise that in practice, the employer bears a significant amount of risk. In future work we will model the allocation of risk to shareholders as well as employees and retirees.

As we are interested in the perspective of current plan sponsors and members, we have used a time horizon of 30 years. This is very much shorter than most of the academic literature on sustainable design and intergenerational transfers, but is better aligned with the interests of current stakeholders.

2.1 Demographic and economic models

The starting values for the number of members at each age, along with average salaries and average service, are shown in Figure 1. The average salary curve is also used throughout the projection as a promotional salary scale.

The projection of plan membership is deterministic. The pre-retirement service table and post retirement mortality tables are given in the appendix of Hardy *et al.* (2020).

For the economic variables, we have used the Wilkie economic scenario generator (ESG)

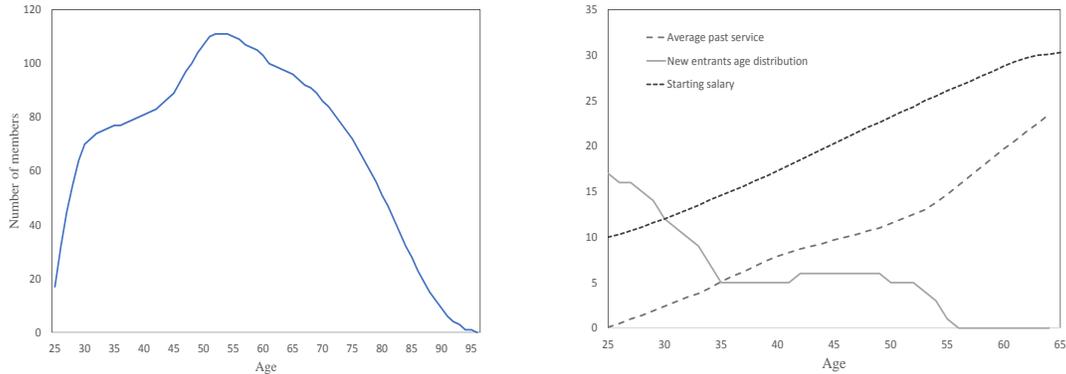


Figure 1: Model pension plan membership information. The left side shows the number of workers/retiree at each age at the start of the projection, and the right side shows salary and service assumptions at the start of the projection, and also shows the age pattern of new entrants.

(Wilkie (1984)), fitted to US 1951-2014 data, using parameters from Zhang *et al.* (2018), slightly adapted.

The plan assets are assumed to be invested in a mix of equities and long-dated risk free bonds, rebalanced to maintain the proportions at each year end.

2.2 Funding and solvency

We assume that plans are valued using a Projected Unit Credit (PUC) method for the going-concern, funding valuation, and a Traditional Unit Credit (TUC) valuation for solvency. The solvency valuation uses a more conservative discount rate than the going-concern valuation, but does not allow for cost of living adjustments to benefits, as these are assumed to be suspended on wind-up.

Each plan is assumed to be 100% funded on the going concern basis at the start of the projection.

For each plan, we assume that wind up will be triggered if the solvency A/L ratio falls below 50%. In this event, active members will be provided with a deferred, un-indexed pension equal to their accrued benefit, reduced in proportion to the solvency A/L ratio. Pensions in payment will be reduced in the same proportion. We assume these benefits are

provided through a bulk buy-out, so that there are no further contributions from active members, and no further risk of benefit reduction. The wind-up criterion is intended to be illustrative rather than descriptive or prescriptive. The point is to explore the probability and impact of wind-up, under relatively simple assumptions.

2.3 Contributions and benefits

The DB plan

The accrual rate of the DB plan is 1.8%, and the pension is based on the average of the final three years' salary. On death or withdrawal before retirement age, a lump sum is paid, equal to the actuarial value at exit of the deferred pension. The pension is paid as an annual life annuity-due.

Cost of living adjustments are funded, up to a maximum of 3%, and are paid in full unless the plan is wound up, in which case benefits are no longer indexed.

Employees pay the Normal Contribution based on the going concern valuation, adjusted for funding surplus or deficit as follows:

- If there is a deficit, based on the solvency valuation, employees pay additional contributions amounting to 10% of the deficit, but with a cap of 30% of salaries on the total contribution.
- If the going concern valuation shows a surplus of more than 20% of the liabilities, then contributions are reduced by an amount representing 20% of the excess surplus (i.e. above 20%), subject to a minimum total contribution rate of 0%.

The TB plan

The target TB plan benefits are identical to the DB plan benefits. However, in the TB plan, benefits and contributions are both adjustable, in contrast to the DB plan where contributions are adjustable, but benefits are fixed.

For the TB plan, when the solvency valuation indicates a deficit, contributions are adjusted up, and retiree benefits are adjusted down. When the going-concern valuation indicates a surplus of more than 20% of the liability value, contributions are adjusted down and retiree benefits are adjusted up. The contribution and benefit adjustments are determined

such that deficits are expected to be eliminated over 10 years, and surpluses over 5 years, consistent with the contribution adjustments for the DB plan. The precise mechanics of the allocation of deficit or surplus to active workers and retirees is described in Hardy *et al.* (2020).

The 30% contribution cap applied in the DB case is not applied in the TB case, as the risk sharing achieves a similar goal.

3 Comparing the DB and TB plans

To assess the advantages and disadvantages of the two plans, we consider three metrics:

1. The **average total contribution** rate across all projections. For each individual projection, we average the total contribution rate over the 30 year projection, or up to the time of default if that occurs. This measures affordability.
2. The **estimated probability of default**; this is the number of projections where default occurred, divided by the total number of projections. This measures sustainability.
3. An **income stability measure** derived from Zhu *et al.* (2020a), and described in detail in Hardy *et al.* (2020). The income stability measure captures the difference between the projected, target values for income and the actual emerging values, for employees as they progress from active service into retirement. In active service, the expected and actual income values differ through the additional contributions, or contribution reductions, that apply when the plan is in deficit or has excess surplus. In retirement, for the DB plan, the actual and expected income differs only when the plan is wound-up, with proportionate reduction in benefits in payment. For the TB plan, there are more frequent and less severe changes in benefits, based on the deficit and surplus adjustments applied.

Note that lower values of the Income Stability measure are preferred to higher values.

The results for the average contribution and probability of default for the two plans are shown in Figure 2. The x -axis indicates the proportion of the plan assets invested in equities.

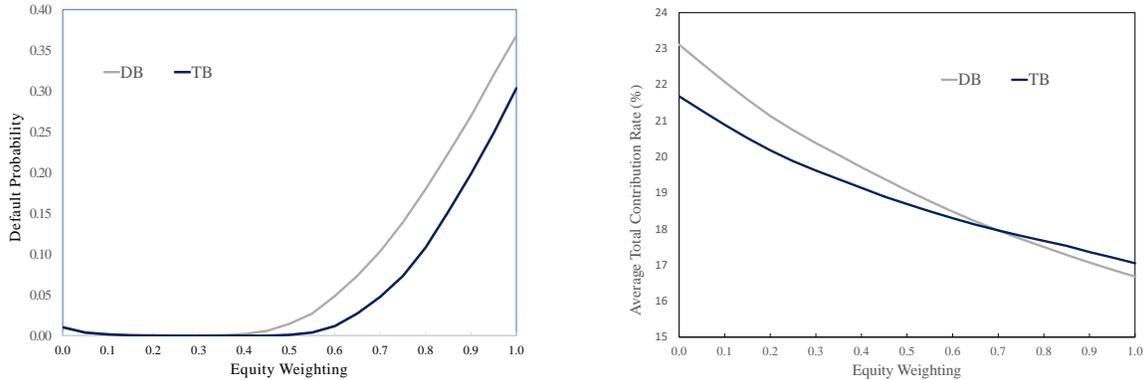


Figure 2: Default probabilities (left side) and average contribution rates (right side) for the DB plan and TB plan by equity weight; 10,000 projections.

On the left side we see default probabilities by equity weighting. At higher equity weightings, the default risk is much lower for the TB plan than for the DB plan; with 60% equity investment, the default risk for the TB plan (over the 30-year horizon) is around 1%, compared with 5% for the DB plan.

In the right hand plot, we show the average contribution rates for the two plans, for different equity weightings. With 60% equity investment the contribution rates are very close. This is interesting, as the 60% equity weighting is often used as a benchmark, and these results show that at this level, the TB plan achieves a lower default risk than the DB plan, without additional cost.

At very high equity weightings, the DB plan has a lower average contribution rate, partly because it is more likely to wind up, whereas the TB plan is more likely to continue, with high contribution rates to help erase the deficit.

In Figure 3 we show the curves of the income stability measure for several cohorts. We see that for the age 30 cohort, the TB plan has improved the stability metric, at all equity weightings. The same is true for the age 40 cohort, but the difference is small. At age 50, the curves are almost indistinguishable. At age 60, the difference is more significant, with the DB plan offering more income stability than the TB plan. This is not surprising; the TB plan offers more predictable income in employment, as the contribution rate volatility is much lower, but slightly more uncertainty in retirement through the adjustments in benefits. At age 60, there are only five years of employment remaining to enjoy the advantage

from contribution stability, which is not long enough to offset the disadvantage in benefit stability.

Only a small number of new entrants to the plan will be over age 50, so the TB plan appears superior to the DB plan going forward, considering the entire path through active service and retirement as a whole. New entrants at all ages up to 55 will be no worse off, based on this metric, than if they had joined the traditional DB plan – and at younger entry ages they are considerably better off.

4 Transition from DB to TB

The TB plan operates under a different informal social contract to the DB plan. Under a funded DB plan, in principle, workers pay for their own retirement benefits through their own working lifetimes, so that they should not need to be funded by contributions from the cohorts that follow them. However, in practice, shortfalls and surpluses in the assets supporting accrued benefits do arise, as a result, perhaps, of mismatched assets and liabilities, or over-optimistic valuation assumptions. This creates an intergenerational transfer of risk and funds, as shortfalls in investment returns on retiree funds are offset by additional contributions paid by current workers, or as surplus built up while a person is working may be distributed after they have retired to the next generation of workers, through contribution reductions.

Under the TB plan, workers and retirees share deficits and surpluses. This means that intergenerational transfers are used to smooth the benefits and contributions, rather than just the benefits, and that the mechanism for transfer is more transparent. The result, as we have illustrated in the previous section, can be beneficial from the perspective of reduced risk and improved income stability. However, at transition, some cohorts will be disadvantaged if the new plan is not phased in. Those near or in retirement have, through their working lives, effectively underwritten the benefits of the cohorts before them. After transition, they must take part in the risks of the plan. They may be seen as getting the worst of both systems.

The response to this problem, developed in Zhu *et al.* (2020b), is to allow for a phasing in of the risk sharing, by allocating different partial participation rates for different cohorts in place at transition.

We illustrate with an example, involving the DB and TB plans described in the previous

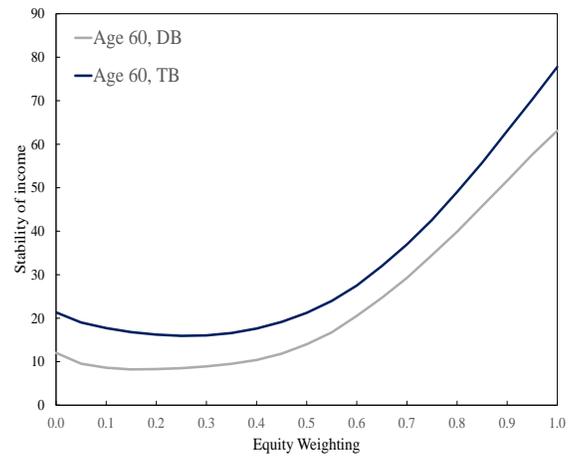
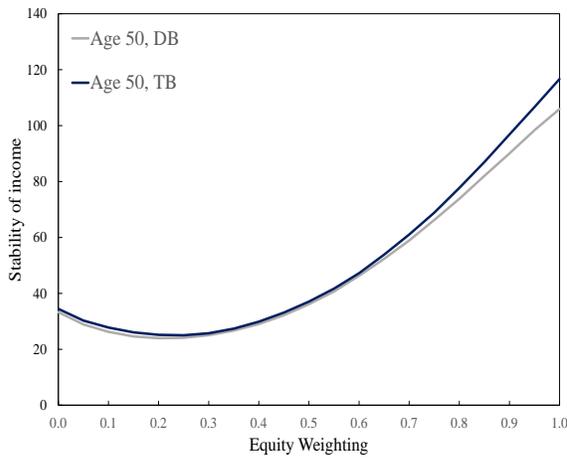
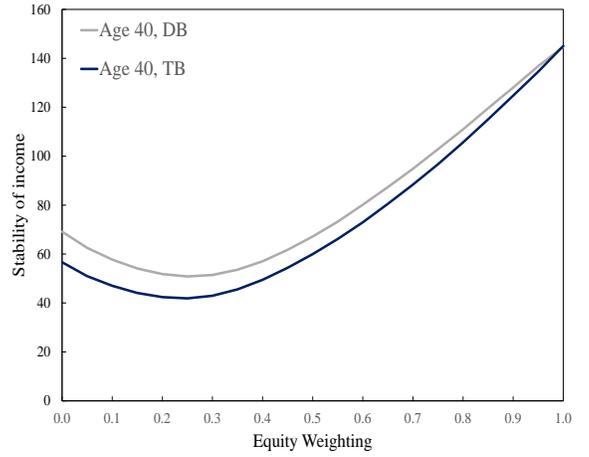
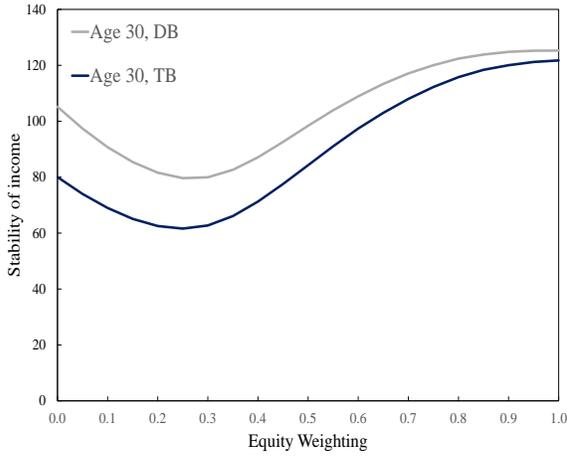


Figure 3: Stability metrics for DB plan and TB plan by equity weight (lower values indicate more stable income streams); 10,000 projections.

sections. Suppose the DB plan is considering a transition to the TB plan. We assume that all those in employment at the time of transfer participate fully in the contribution side of the risk sharing of the TB plan immediately on transition. In order that no member is disadvantaged by the transition, current retirees, and some active workers near to retirement, will not fully participate in benefit adjustments. For each age group at transition, we determine a factor between 0% and 100% that indicates their participation in benefit adjustments after transition. This factor continues to apply throughout their remaining lifetime. The participation factor is determined to ensure that the downside income stability measure is the same for each cohort before and after transition. The resulting participation factors are shown Figure 4, assuming a 60% equity weighting for the plan, and that the plan is fully funded on a going-concern basis at transition.

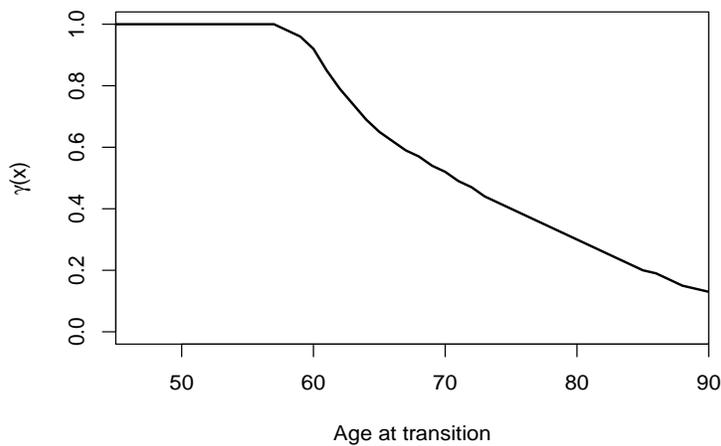


Figure 4: Participation factors for fair transition from DB to TB; 60% equity weighting, fully funded at transition.

5 Changing dependency ratio

If a pension plan is to be sustainable, it should be robust to demographic shifts. In this section, we consider a scenario where the initial population is the same as in previous sections, but with fewer new entrants, and with new entrants that are older, on average, than in the examples above. Under this scenario, the average age of the active plan membership increases from 47.0 to 53.2 over the course of the 30-year projection.

In Table 1 we show statistics for the DB and TB plans, comparing the benchmark model with the ageing demographics model. Figures assume an equity investment weight of 60%.

	DB		TB	
	Benchmark	Ageing	Benchmark	Ageing
Default Risk	4.87%	6.7%	1.2%	1.3%
Average Contribution Rate	18.5%	19.5%	18.3%	19.5%
Stability Measures				
Age 30	108.9	111.3	97.4	103.8
Age 45	61.9	63.0	59.1	59.2
Age 60	20.5	22.2	27.5	28.0
Age 75	6.6	7.0	14.2	14.2

Table 1: Comparison of benchmark plan with plan using ageing workforce; 10,000 projections, 60% equity investment weighting.

We see that in terms of default risk, the TB plan is more robust than the traditional DB plan. In both cases, the ageing workforce model creates increases in the average contribution rates, and in the stability measures. The impact on plan members is most significant for younger workers, and for those near retirement for the traditional DB plan.

6 Heterogeneous plan membership

For many organisations that have retained DB plans, a single plan covers all pensionable appointments, from the lowest to the highest ranks. There are differences in the average experience of salaried and non-salaried employees that impact the costs and risks of the plan.³ In this section we explore the implications of the fact that non-salaried workers have a much flatter earnings progression than salaried employees. Typically, there is a short initial period of increases, after which wages are relatively flat. An additional source of heterogeneity is the different life expectancy of non-salaried workers compared with salaried. We do not consider that here, but some illustration of the impact is shown in Hardy *et al.* (2020).

To illustrate the effect of salary heterogeneity on plan costs, we run the DB and TB models, assuming a 100% non-salaried workforce. We assume promotional salary increases apply up to age 30, after which only inflationary salary growth applies. The in-force salary and

³We use ‘non-salaried’ to refer to lower paid workers, typically employed in manual or junior clerical roles, while ‘salaried’ refers to employees in managerial streams.

pension assumptions are adjusted in proportion. The effect is that a non-salaried worker starting employment at age 25, on the same starting income as a salaried worker, earns around 40% of their salaried colleague at retirement.

Summary results are shown in Table 2. We show the default rates, average total contribution rates, and average replacement rates for the non-salaried employees, together with the results for salaried employees. The table shows that the default risk and contribution rates are substantially lower for the non-salaried workforce. The implication of this is that where non-salaried and salaried employees are in the same plan, and paying the same contribution rates, there is a significant subsidy of the salaried workers by the non-salaried. Furthermore, sharing the plan with the salaried workers significantly increases the default risk for the non-salaried workers – their plan could wind-up, and their benefits could be reduced, because of the additional cost and volatility created by the salaried workers. Table 2 illustrates that neither the traditional DB plan nor the TB plan satisfy the fairness criterion, which says that heterogeneous groups should be treated equitably within the plan. This feature of traditional DB plans is quite well known, at least anecdotally, amongst pension actuaries. It is therefore surprising that labour unions representing the non-salaried workers are champions of the traditional, final average salary DB plan.

There are several ways to mitigate the disparity between salaried and non-salaried workers, with respect to the cost and security of their pension benefits.

- (1) Run two separate plans. This is a fairly common solution, but can lead to problems of governance. If all employees are in the same pension plan, then the interests of managerial level employees are aligned with those of the non-salaried employees, at least in terms of the security of the benefits. With separate plans, there is a risk that the non-salaried employee plan is less well-funded than the salaried employee plan.
- (2) Impose a cap on pensionable salary. If most salaried employees exceed the cap over the last few years of employment, then their results will look more like the non-salaried employees. The maximum benefit payable under the Canadian Income Tax laws creates a natural cap on pensionable salary, although some plans offer top-up benefits for the highest paid workers, thereby undoing the mitigating effects of the cap.
- (3) Use a career average revalued earnings (CARE) plan design. In the DB and TB plans discussed above the pension benefit is based on the employee's final average salary, while the contributions are based on the earnings over the employee's whole

	Default Rate	Ave. Contn Rate	Ave. Replacement Rate
DB, Salaried	4.9%	18.5%	42.5%
DB Non-salaried	0.2%	14.4%	43.5%
TB Salaried	1.20%	18.3%	42.4%
TB Non-salaried	0.04%	14.7%	43.5%

Table 2: Default rates, average total contribution rates and average replacement rates for DB and TB plans, assuming 100% non-salaried workforce; based on 10,000 projections.

career. It is easy to see why a steeper salary scale will give more expensive, and more variable benefits than a flat salary scale, relative to the contributions. Under the CARE design, the benefits are based on the worker’s career average earnings, revalued for inflation to retirement. This will reduce the unfairness with respect to heterogeneity for both the DB and TB plans. An example is shown in Hardy *et al.* (2020).

7 Conclusion

In this paper we have compared a traditional DB plan to a TB plan, with target benefits equal to those in the DB plan.

The comparisons between the different designs were based on the five loose criteria outlined in Section 1.1 – that the design should be affordable, sustainable, efficient, adequate and fair. These criteria address both the needs of the contributors to the plan, and the beneficiaries. We found that the traditional DB plan may be deemed affordable (based on average costs), but is not highly sustainable. Furthermore, the main selling point of the traditional DB plan, the adequacy and predictability of the benefits, is severely undermined by the possibility of default. In contrast, the TB plan offers a more stable income, taking both pre- and post-retirement periods into consideration. More stable costs improve the efficiency and sustainability of the pension plan.

In reviewing the fairness of the pension design, we considered two aspects. The first is the effect of transitioning from DB to TB, which is beneficial for younger lives, but not for older. We showed that this can be mitigated with a phased transition. The second aspect of fairness considered is a more embedded problem, that of equal treatment of different

employee groups. We examined this by comparing costs and benefits for salaried and non-salaried workforces. Both the DB plan and the TB plan failed to treat the two groups equitably. However, the difference can be mitigated with a CARE plan design.

The TB design presented in this paper is simple and transparent, especially compared with some of the target benefit plans that have been implemented, and yet works well to meet the needs of both contributors and beneficiaries. Unlike many current DB plans, the cost of living adjustment is not treated as an expendable addendum to the pension, and although the pension is adjustable, the value of this flexibility in terms of avoiding insolvency makes the trade-off worthwhile to members, based on the lifetime income stability measure considered in this paper.

8 Acknowledgements

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