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## **Assessing the sustainability of the Federal Government's Public Service Pension Fund**

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at the University of Ottawa



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## **ABSTRACT**

This report examines whether the public service pension fund of the federal government is sustainable. This is done by imposing various assumptions - on the population of the federal workforce, member contribution rate, and rates of return on different asset classes in the long run - to create a projection of the contributions, retirement obligations, and investment earnings of the pension fund from 2018 until 2060. Overall, it was determined that the pension fund is sustainable over the projection horizon.

## **I. INTRODUCTION**

The sustainability of the Government of Canada pension fund for its employees impacts the lives and well-being of hundreds of thousands of Canadians. Sustainability, with respect to pension funds, is defined as whether or not there is enough income coming from contributions and investments earnings to cover the cost of liabilities (i.e retirement benefits). The goal of this report is to determine whether or not the pension fund account of the Government of Canada is sustainable.

This is done through examining the account which is responsible for keeping track of pension obligations—post April 2000—namely, the Pension Fund account. The opening balance, contributions, investment earnings, and retirement benefits being given out are projected.

We have found that the Pension Fund account is sustainable in the long run (until 2060). The Pension Fund account will have enough income generated from investment earnings, and from contributions such that it is able to fulfill all retirement benefit obligations.

The report below begins with a brief history of the Public Service Pension Plans purely for context purposes, followed by detailed descriptions of the assumptions and methods involved in creating the projections. Then a discussion is followed after the assumptions section. The last section concludes the report.

For the Pension Fund account, historical data is obtained from the triennial actuarial reports made by the Chief Actuaries Office. Data is also obtained from Statistics Canada, IFSD, and the Treasury Board Secretariat for various purposes mentioned below.

## **II. HISTORY OF THE PUBLIC SERVICE PENSION PLANS**

The history of the Federal Public Service Pension plan can be encapsulated by describing what occurred with contributions before and after the creation of the Public Sector Pension Investment Board (PSPIB).

### **ACTS THAT CAME BEFORE THE PSPIB ACT**

Before April 1, 2000 (before creation of the PSPIB) all contributions went into an account called the Superannuation Account under the Public Service Superannuation Act (PSSA), which came into effect on January 1, 1954. Before January 1st, 1954 the accounts were called, the Civil Service Superannuation Act (CSSA), established on July 19, 1924, which essentially performed the same functions as the PSSA, however, it gave different rights and benefits to its contributors (public servants). The PSSA, unlike CSSA, made benefits a right once the employee left the public service.<sup>1</sup>

## **WHERE CONTRIBUTIONS WENT BEFORE APRIL 1, 2000**

A Superannuation Account is an account that records employee/employer contributions made before April 1, 2000, but holds no actual assets. No formal debt instruments are issued and the account simply portrays a notional (existing only in theory) portfolio of long-term bonds. Government of Canada legislation requires that interest earnings on these long-term bonds be credited quarterly to the account under the assumption that the amount in the Superannuation Account is notionally invested in 20-year Government of Canada bonds. The rate at which the interest was calculated was a 20-year moving average of long-term bond rates. This rate has been recently changed, and under this new rate, the interest rate (or discount rate) is the average of the end of year long term bond yields.<sup>2</sup>

Currently, the pension obligations that are linked to service before the year 2000 are unfunded, meaning the pension obligations that the Government of Canada has to these beneficiaries are paid out of general revenues rather than from a separate fund to which contributions have been made over time. The pension obligations that are mentioned are essentially the cost or liability that the federal government has to pay these future pensioners. These future liabilities are then present value discounted to determine the outstanding liability. If these unfunded pension obligations were to be somehow funded, then it would require a discussion regarding how it would impact the federal budget, how it would be recorded in the Public Accounts of Canada, and most importantly, whether or not it is useful to fund these obligations.

In the Spring 2014 Report of the Auditor General of Canada, there is a discussion regarding what discount rate to use for the unfunded pension obligations. The discussion looks at various arguments presented by different viewpoints. If looking at it from a strict finance theory perspective, then the discount rate has to reflect the riskiness of the pension obligations. However, it is clear that the Government of Canada enjoys certain liberties that others do not. The federal government has the ability to raise tax rates to pay for any necessary expenses. This is why some people believe that it would be better if the discount rate was set in line with the nominal Gross Domestic Product (GDP) growth rate since that would indicate that unfunded pension obligations will be paid for out of future tax revenues. This reflects the fact that long term rate of nominal GDP growth is a good indicator of the growth rate of tax revenues, as nominal GDP is the broadest measure of the tax base.

It is key to note that the decision of what the discount rate is will have significant effects on the size of the unfunded pension obligations, resulting in increasing or decreasing it by tens of millions of dollars.

## **CREATION OF THE PSPIB**

The PSPIB was created on September 14, 1999, under the act titled, “Public Sector Pension Investment Board Act” (PSPIB Act)<sup>3</sup>. The objectives of the board are: to manage the amounts that are transferred to it; to act in the best interests of contributors and beneficiaries; and, to invest its assets with a view to achieving a maximum rate of return without undue risk of loss.

The contributors, and subsequent beneficiaries of the PSPIB are individuals’ who are entitled to receive benefits under the: Canadian Forces Superannuation Act, Public Service Superannuation Act, and the Royal Canadian Mounted Police Superannuation Act.

The PSPIB has several restrictions imposed on it by the PSPIB Act, such as picking investments with regard to the overall portfolio of investments and ensuring that the risks are mitigated. Another restriction on the PSPIB is that it cannot directly or indirectly invest more than 10% of its total

book value on a single individual, two or more associated persons, and two or more affiliated corporations. For this particular restriction there are some exceptions like the subsidiaries of the PSPIB or any security that is backed fully by the Government of Canada or the governments of any of the provinces.

One of the main tasks of the PSPIB is to create an investment strategy that follows the strict guidelines imposed on it. With the goal of achieving the maximum rate of return without undue risk of loss, the PSPIB has created an investment strategy that will deliver, at a minimum, a long-term real rate of return of 4.1%. The Chief Actuary believes that a real rate of return of 4.1% is suitable to cover the pension promises of the Government of Canada. It is key to note that the Chief Actuary's assessment takes as given the current level of contributions and that no other factors affect the funding of the pension plans.<sup>4</sup> The costs of running the PSPIB are taken out of the funds<sup>5</sup>. The PSPIB has 11 Directors, including the chairperson, and has two independent committees that provide it with advice. These two committees are the Audit Committee and Investment Committee.

A key point of the PSPIB regulations is that it has to show the value of common shares it owns through investments by the formula:

$$\text{Value of Common shares (owned by the Board)} = \{A - (L + PCS)\} * \{(C / TOC)\}$$

where,  $A$  = assets,  $L$  = liabilities,  $PCS$  = preferred capital stock,  
 $C$  = number of common shares of the corp. held by the fund,  
 $TOC$  = total number of issued & outstanding common shares of the corp.

if the Board holds more than 30% of any corporations votes such that it can elect the board of directors.<sup>6</sup>

## **WHERE CONTRIBUTIONS ARE GOING AFTER APRIL 1, 2000**

After April 1, 2000, public sector pension contributions go into the Pension Fund account. Total contribution amounts that exceed benefits paid out minus administrative expenses are transferred from the pension fund accounts to the PSPIB to invest in capital markets.

The pension plans mentioned above - Canadian Forces Superannuation Act, Public Service Superannuation Act, and the Royal Canadian Mounted Police Superannuation Act - use a discount rate linked to long-term interest rates applied to future cash flows in order to determine their obligations. These obligations are not fixed but rather move up or down depending on how the discount rate is calculated and whether or not the long-term interest rate increases or decreases.

Obligations that relate to the period after April 1, 2000 are relatively small compared to the total pension contributions that the PSPIB has. Put differently, the net contributions that are currently being made to the pension fund account far outpace the amount that is being paid to pensioners. However, this will likely change in the future, resulting in a smaller share of the pension fund account's revenue coming from contributions and a higher portion will be accredited to investment income that is derived from the return rates that the PSPIB earns. Clearly, if investment income represents a higher share of the pension plan's revenue then the income (revenue) of the pension plan will be more volatile than if a small share of the plan's revenue came from investments. How much volatility is acceptable has not yet been determined by the plan sponsor (Government of Canada) due to the fact that it has not laid out the risk tolerance levels that it finds acceptable to the PSPIB.

### III. ASSUMPTIONS AND METHODS

The assumptions and methods involved in forecasting the Pension Fund Account - consisting of contributions, retirement benefits, investments earnings and opening balance - is described below.

For comparison purposes, the results found in this report are compared with findings of the Chief Actuary in Office of the Superintendent of Financial Institutions (OSFI) 2014 Actuarial Report on Pension plans for the Public Service.<sup>7</sup> The differences are discussed in Section 4.

#### Contributions

Projecting contributions—from present day until 2060—is achieved by imposing various assumptions upon three factors: population of the contributing workforce relative to the total Canadian population, the age band that is present each year, and the dollar value of contributions going towards the pension fund account opening balance.

Based on data from 1983 to 2017 there is a clear decline in the proportion of the public service relative to the total Canadian population. In 1983, the federal workforce accounted for roughly 1% of the total Canadian population, this was lowered to 0.72% in 2017.<sup>8</sup> On this basis, it was assumed that the proportion of the federal workforce to total population will continue to decline slowly over the projection horizon.

A median population projection was taken from Statistics Canada data for the years 2015 to 2060. This was used to determine the total number of contributing members that is projected to be in the public service from years 2017 to 2060. At years 2017-2020 the total number of contributing members is deemed to be 0.70% of the total Canadian population, and from 2021-2025 a decline of 0.01% is assumed to occur in order to follow the general path of the declining public service workforce relative to the total population. This trend is continued until 2060.

Using age band statistics from the Treasury Board Secretariat spanning 2005 to 2015<sup>9</sup>, an assumption was made based on trends seen within each age band. When a certain age band is seen to be increasing or staying stable, we assume the trend to continue. For example, if the proportion of 35-year olds is staying relatively constant at 12% then it is projected to stay at 12% for the duration of the projection horizon. This projected distribution within each age band was multiplied by the total number of contributing members to isolate the number of contributory members within each age band. Please see appendix A for age band distribution chart.

In order to determine the dollar value that is going towards the pension fund account, we must first find an expected salary for each age band and then use the formula provided by the public service on how contribution amounts are determined.

It can be reasonably assumed that a 25-year-old is going to have a salary that is lower than a 60-year-old that is working in the public service. Using the 4 knowledge intensive positions ( EC, AS, CS, PM) that make up 40% of the public workforce<sup>10</sup> an expected salary was determined for each age band between 20 to 65+. The expected salary was determined such that the number of echelons (i.e rates of pay) in each position was matched with a particular age band. Higher echelons were matched with higher ages and lower echelons with lower ages. The number of echelons for each occupational

group/position can be found on the treasury board website. Then for each age band, the expected salary was a weighted average of the rate of pay expected in that age band multiplied by the proportion of public servants in that knowledge intensive position. This expected salary for each age band was then multiplied by the estimated inflation rate—provided by the IFSD—to allow the salary to grow by inflation over the years. See appendix B for information on echelons and salaries.

Once we determine the number of contributory members within each age band and the associated salary, we apply the formula and steps that are used by the federal government to determine that year's contribution towards the pension fund by public servants. Step 1 was multiplying the public servants compensation by the member contribution rate (if compensation is below the yearly maximum pensionable earnings (YMPE)). Step 2 is multiplying the excess amount (Compensation - YMPE) by the member contribution rate above YMPE, if compensation is above YMPE. Step 3 is adding step 1 and 2 together. Finally, step 4 is multiplying the value found in 3 by the number of workers or contributing members of that age band in that specific year. This provides us with the average contribution going towards the pension fund by a specific age band of contributing members in a certain year.<sup>11</sup> We then multiply this number by 2, to account for the government's contribution to the pension fund. (See appendix C for the equations we used.)

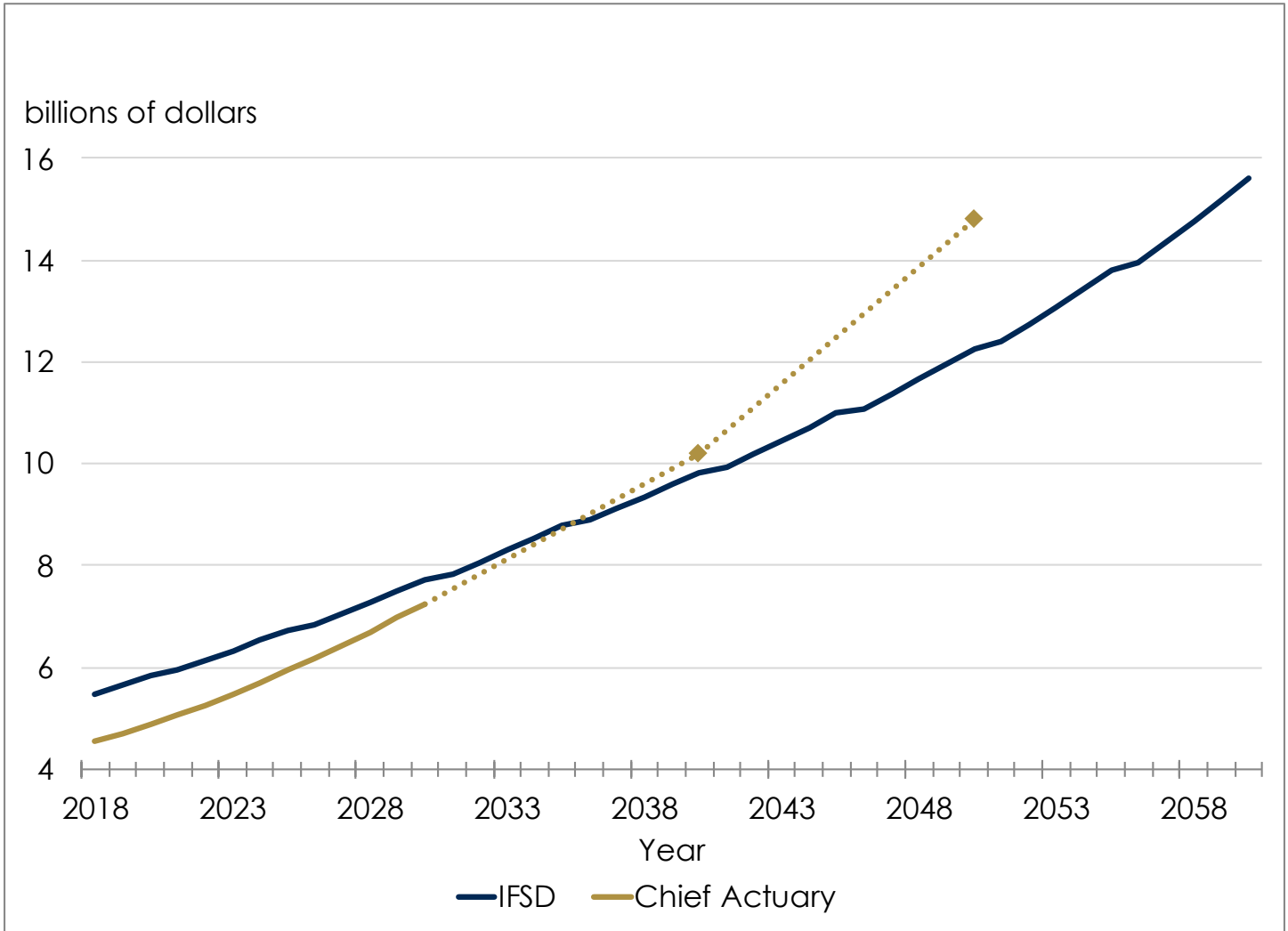
One key aspect of the contribution amount is the member contribution rate. It is clear that the member contribution rate has been increasing in the past. However, for projection purposes the member contribution rate (and member contribution rate above YMPE) is assumed to stay constant at the 2018 level. The contribution rate is affected by several factors that may push it up or pull it down. There is no reason to believe that the contribution rate would change on average.

Lastly, the yearly maximum pensionable earnings (YMPE), growth is defined by the Chief Actuary as “assumed real increase in the average weekly earnings plus assumed increases in the CPI”.<sup>12</sup>

For this study we used the rate of growth of personal household income (from IFSD's long-term forecast ) to forecast changes in YMPE.

For details on equations used, please refer to the appendix.

# Chart 1: Projected Contributions



## Retirement Benefits

There are two main components to projecting retirement benefits, the first one is being able to capture the benefits being paid out to existing retirees and then to include the value of benefits being paid out to new retirees.

Based on the total workforce numbers determined in contributions assumptions presented above and using treasury board statistics from the demographic snapshot of the federal public service, the percentage of new retired members relative to the total workforce has increased by roughly 0.1% in each decade. Therefore, an assumption was made that every ten years the percentage of newly retired individuals—to total workforce—increases by 0.1% in the future as well. For the years 2020-2030 the number of new retirees is forecasted to be 3.30% of the total workforce, and every ten years an addition of 0.1% to the previous decade's value is assumed.

This can be justified by the fact that overall, baby boomers are expected to retire out of the workforce soon so the number of retirees in Canada will definitely increase, a similar increase can be anticipated in the number of public servants retiring which is reflected in the 0.1% increase in the forecasted number of retirees.

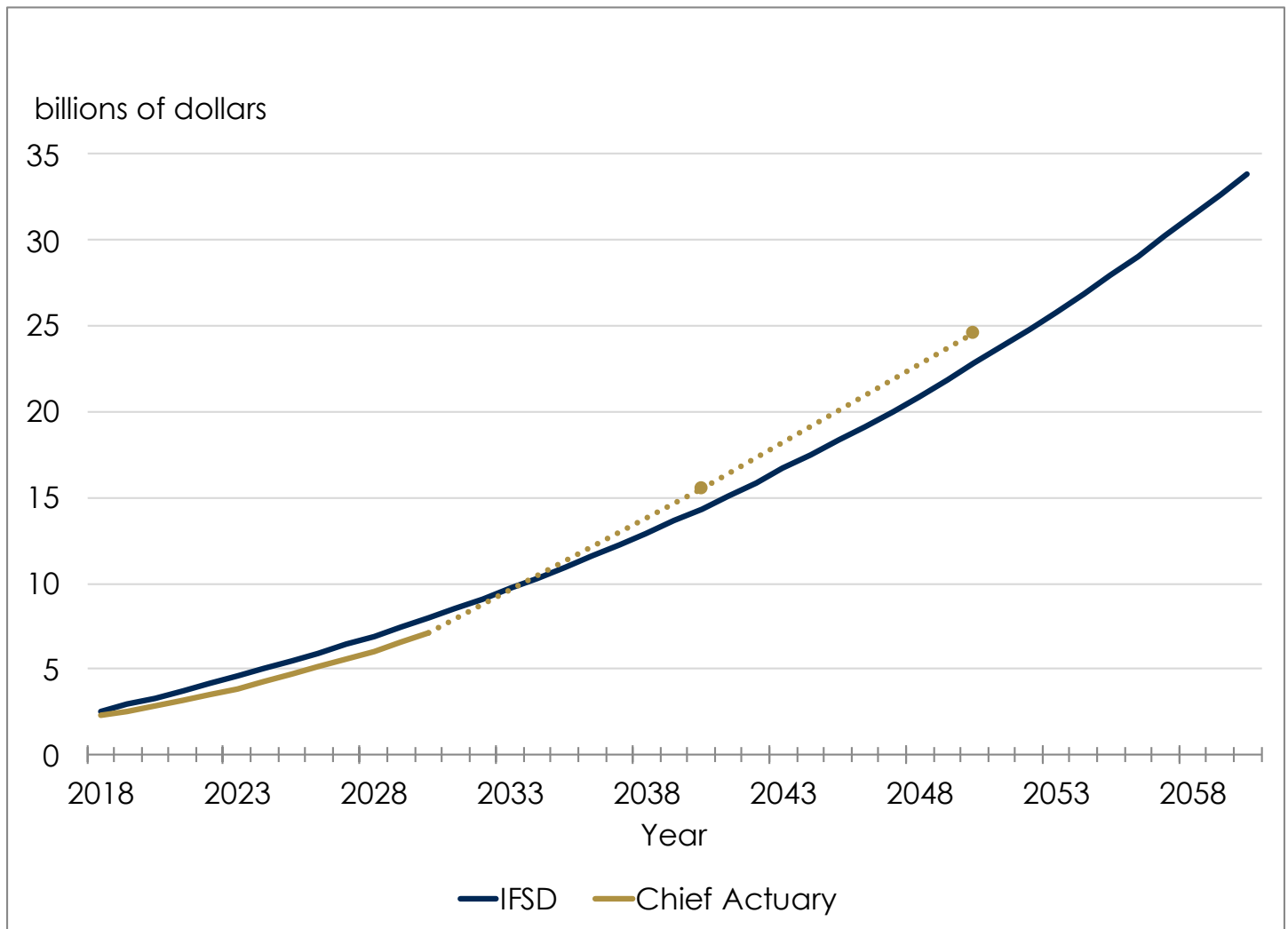


Using the latest value from the treasury board secretariat on the pension fund, (available at time of writing) it is stated that the average pension given to retirees who retired in 2017 was \$37,785.<sup>13</sup> This value was taken and then assumed to grow by inflation over the years in the projection.

In order to capture the existing retirees burden on the opening balance, the previous years dollar value of retirement benefits was used and added to new retirees benefits that are projected to be paid out. The new benefits being paid out are calculated as the average pension paid out to each member multiplied by the number of new retirees. The value from this calculation is then added to the previous years total retirement benefits paid out. This ensures that both the dollar burden of the old retirees and new retirees is captured in the projection.

A mortality factor has not been explicitly included in the equations to calculate the value of projected retirement benefits. Therefore, as a result, we are likely overestimating the number of pensioners alive during the projection horizon and clearly overestimating the dollar value of retirement benefits that are expected to be paid out. Nevertheless, with respect to the sustainability of the pension fund—which is the question we are trying to answer here—even though we are overestimating the value of pension benefits we are able to show that it is sustainable. As contributions and investments earnings are greater than retirement benefits.

## Chart 2: Projected Retirement Benefits



This goes to further reinforce our conclusion that the public service pension fund is sustainable.

If we were to include a mortality factor thereby reducing the dollar value of expected retirement benefits paid out in the future then evidently the pension fund would still be sustainable. Overall, by performing the calculations mentioned above, we can project the value of retirement benefits being given out - till 2060. For details see appendix C.

## **Investment Earnings**

Investment earnings are largely dependent upon the rate of return of each asset class and the asset mix. Therefore, this section is split into two parts and the assumptions imposed and relevant to each one is explained in detail.

### **Asset Rate of Return**

Six asset classes are examined for the purposes of this report and an individual rate of return is projected for each asset class. The asset classes are: cash & equivalents, government and corporate bonds, inflation linked bonds, canadian equity, foreign equity, and real assets.

Cash & cash equivalents are assumed to have a constant long run real rate of return of 1%. This is in line with the long-term projection in the 2014 actuarial report.

Government and corporate bonds' rates of return are assumed to stay constant at 2.7% over the projection horizon. This is based on the understanding that attempting to project the rate on corporate bonds over the long run is difficult and the end result would not change the total value of investment earnings by a significant margin. Therefore, in following the same long run projections as OSFI, a 2.7% long run real rate of return is given to government and corporate bonds.

For inflation linked bonds the spread between inflation linked bonds and the ten year government of Canada bond (real) yield is usually around -0.20% therefore the inflation linked bonds are taken as the ten year government bond (real) yield minus 0.20%. This is taken to be in line with long run expectations found by OSFI.

Canadian equity carries with it a historical long run equity risk premium of 5.37%. This value was taken from Damodaran's website. Adding the equity risk premium to the ten year government of Canada bond real rate of return provides us the real rate of return for Canadian equities in each year of the projection horizon.<sup>14</sup>

Foreign equity carries with it a higher equity risk premium than Canadian equity. This is due to the fact that investors want to be compensated for the higher risk that comes with investing in foreign markets. As a result, foreign equity risk premium is taken as roughly 1% higher than Canadian equity risk premium. Therefore long run foreign equity risk premium is 6.47%. This value is again taken from Damodaran's website, in particular, this is the GDP weighted total equity risk premium value for Western Europe. Excluding North America, Europe and in particular Western Europe carries the most weight in the portfolio. The 6.47% equity risk premium is a good proxy for a middle ground between North American equity risk premium (5.37%), Asia's equity risk premium (6.81%), and Central and South American equity risk premium (10.13%).

Real assets were assumed to provide consistent returns of 4%. This is due to the fact that real assets are not very volatile in nature and can be relied upon for consistent positive returns. The value of 4%

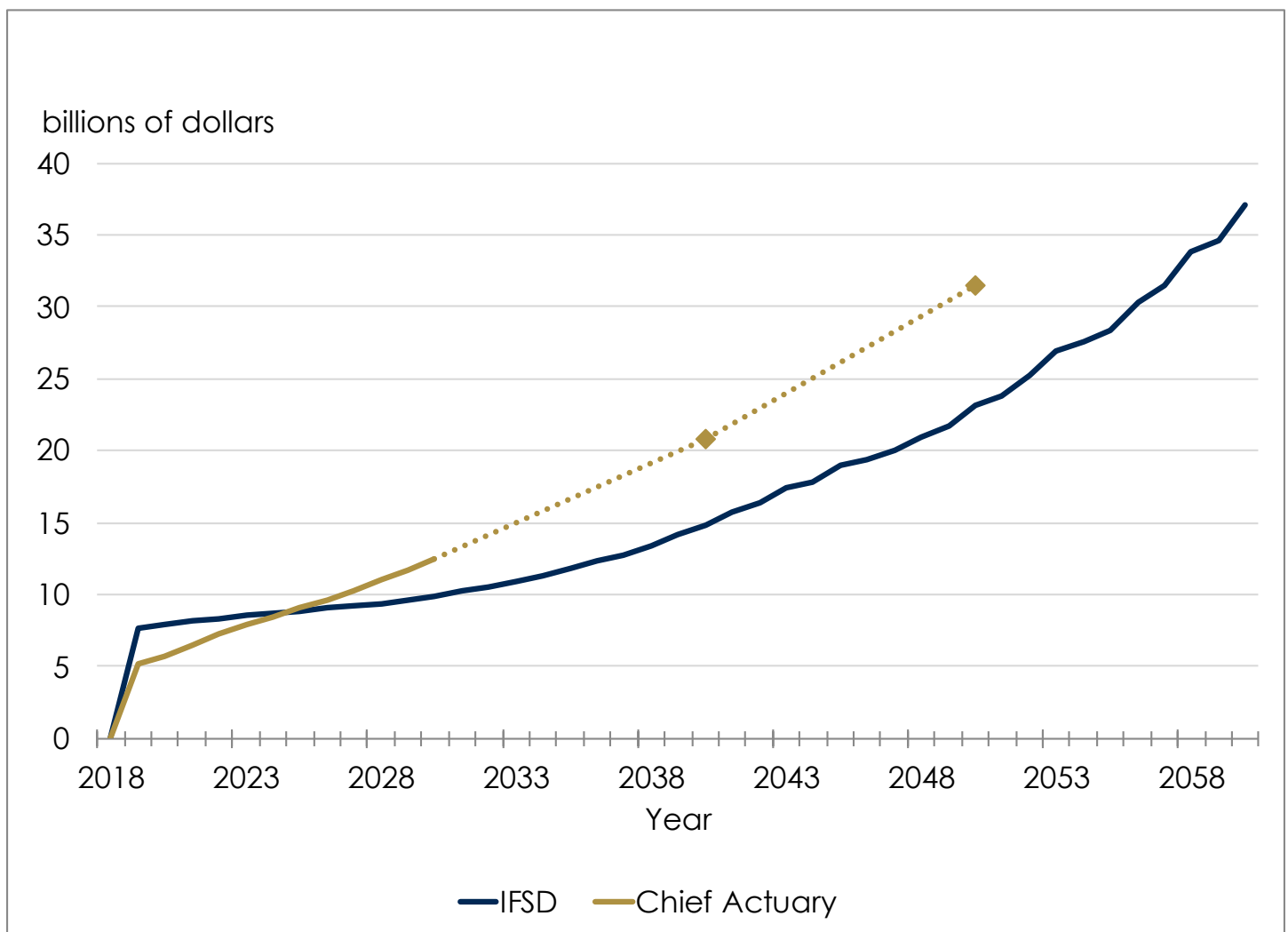
is based on the Credit Suisse 2018 Investment Outlook which shows that global real estate yields are staying fairly consistent around 4%. This is slightly higher than the one in Actuarial reports which deemed real assets to grow by 3.9% consistently over the long run.

### Asset Mix

The target asset allocation presented in PSPIB’s 2018 Annual report is taken to be the long-term optimal asset mix for this report. The target asset allocation, by PSPIB, is 43% equity, 30% real assets, 20% government fixed income, and 7% credit. Taking initial values regarding investments in each bucket (equity, real assets, government fixed income and credit) for 2018 from PSPIB’s financial statements on the Public Service Pension Fund, the current asset mix is not at the optimal level. So the investments are allowed to grow and slowly converge towards the optimal asset mix. Up to year 2040, no adjustments are made as the asset mix is slowly converging to the target asset mix.

After 2040, as the share of each bucket starts to deviate from the target asset mix an adjustment is made to ensure it stays within plus/minus 3% of its target and converges towards the optimal asset mix.

## Chart 3: Projected Investment Earnings

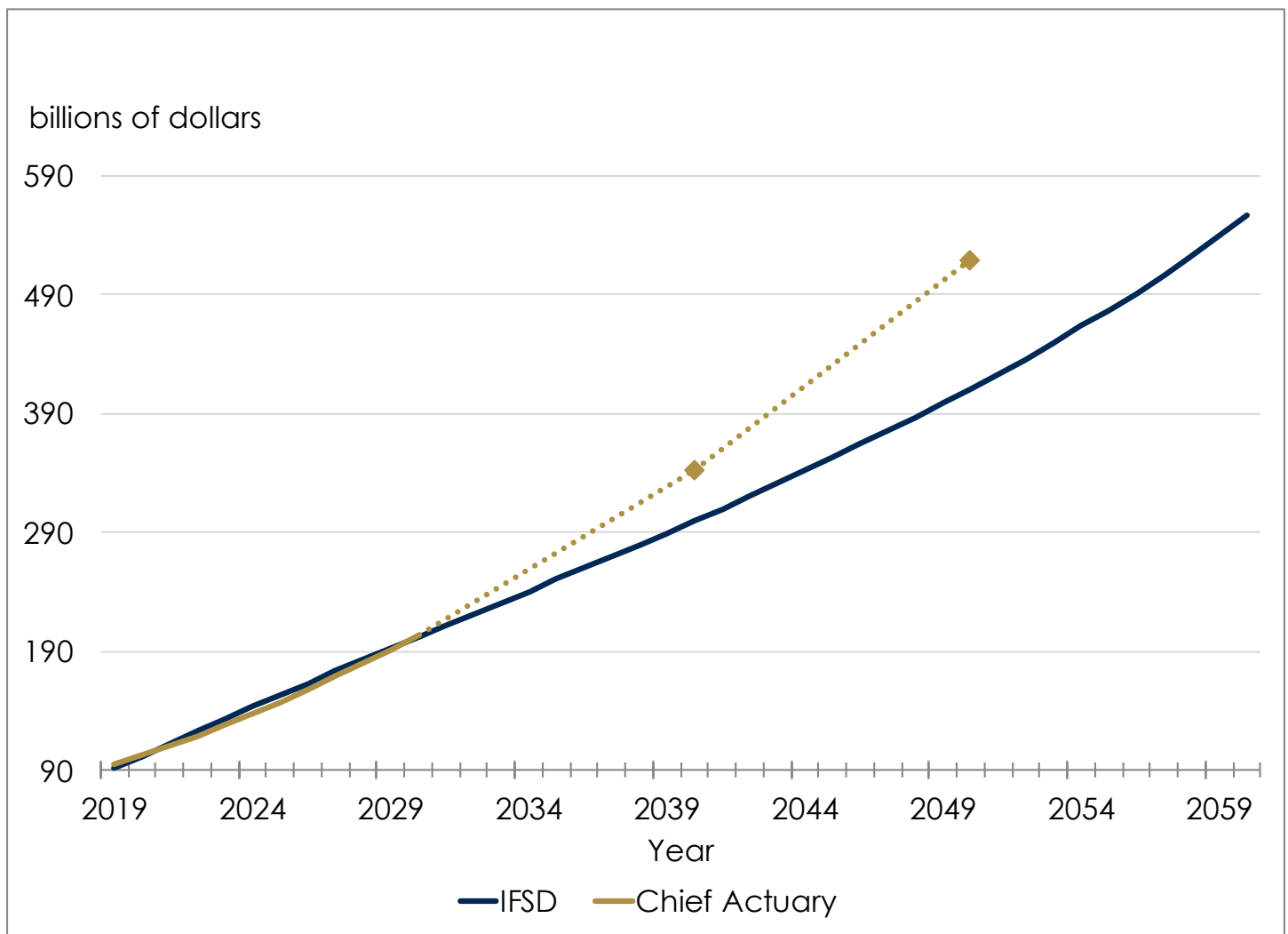


We have chosen to maintain a 3% window rather than a fixed asset mix for the duration of the projection in order to better reflect the reality that PSPIB faces with regards to investments. Maintaining a fixed asset mix is extremely difficult in reality. (For a table of the asset mix over the projection period see appendix C.)

### Opening Balance

The opening balance is determined by taking the previous years opening balance and adding the income generated in the current period (contributions and investment earnings) and subtracting it from the retirement benefits given out in the current period.

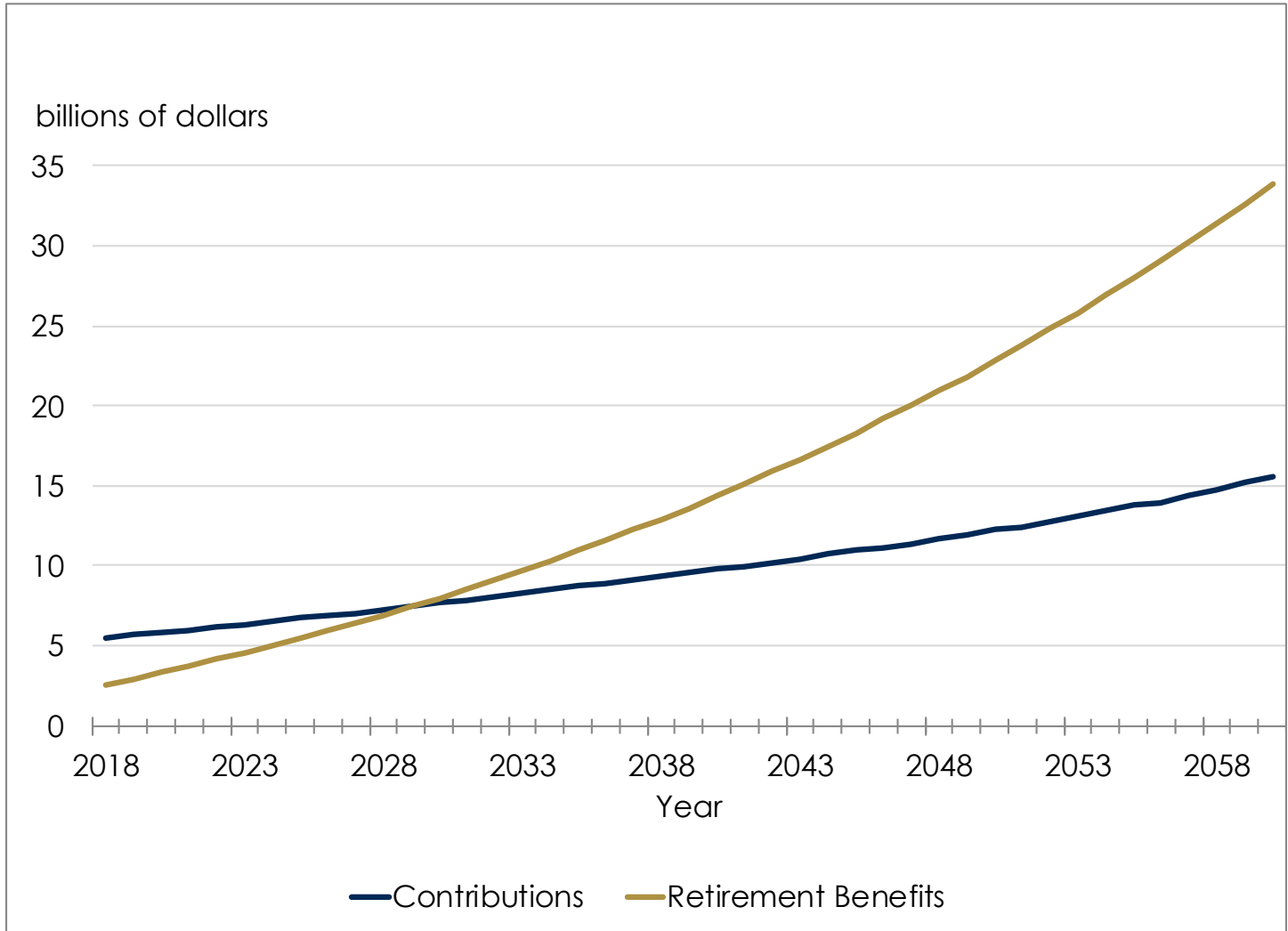
## Chart 4: Projected Opening Balance



## IV. DISCUSSION

The projections show a sustainable pension fund account well into the future. Projections up to 2060 show that the income generated from the pension fund (i.e contributions and investment earnings) are far greater than the retirement benefit obligations that the government has towards the future pensioners.

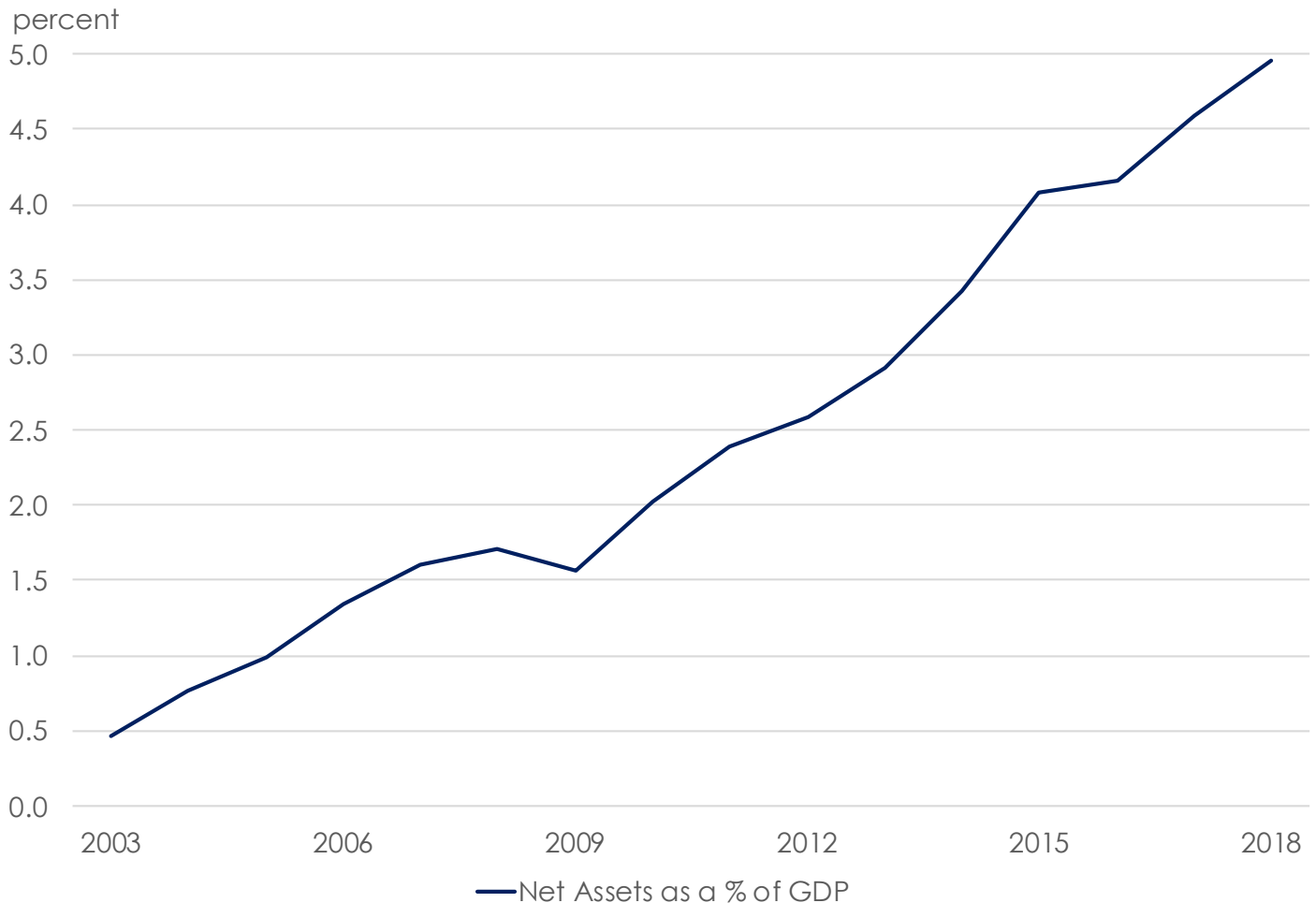
## Chart 5: Comparison I



Until 2030 annual contributions from public servants is larger than the annual retirement benefit obligations. Around 2030 and after, retirement benefits outpace contributions. So what this implies for the pension fund is that up to 2030, they are in a comfortable position since all contributions in excess of retirement benefits can be used for investing in capital markets. After 2030, the pension fund's investment earnings will become a greater source for income in paying out retirement benefits. This should not pose a problem for PSPIB, since they can easily cover the difference between contributions and retirement benefits and will still be able to grow their net asset base. In other words, since their net assets are essentially growing over time, the PSPIB is in a healthy financial position.

The graph below depicts PSPIB's net asset position relative to GDP, from the years 2003 to 2018. Data for the value of PSPIB's net assets was taken from the financial statements in their annual reports and GDP data was provided by the IFSD.

## Chart 6: Net Assets as a Percentage of GDP



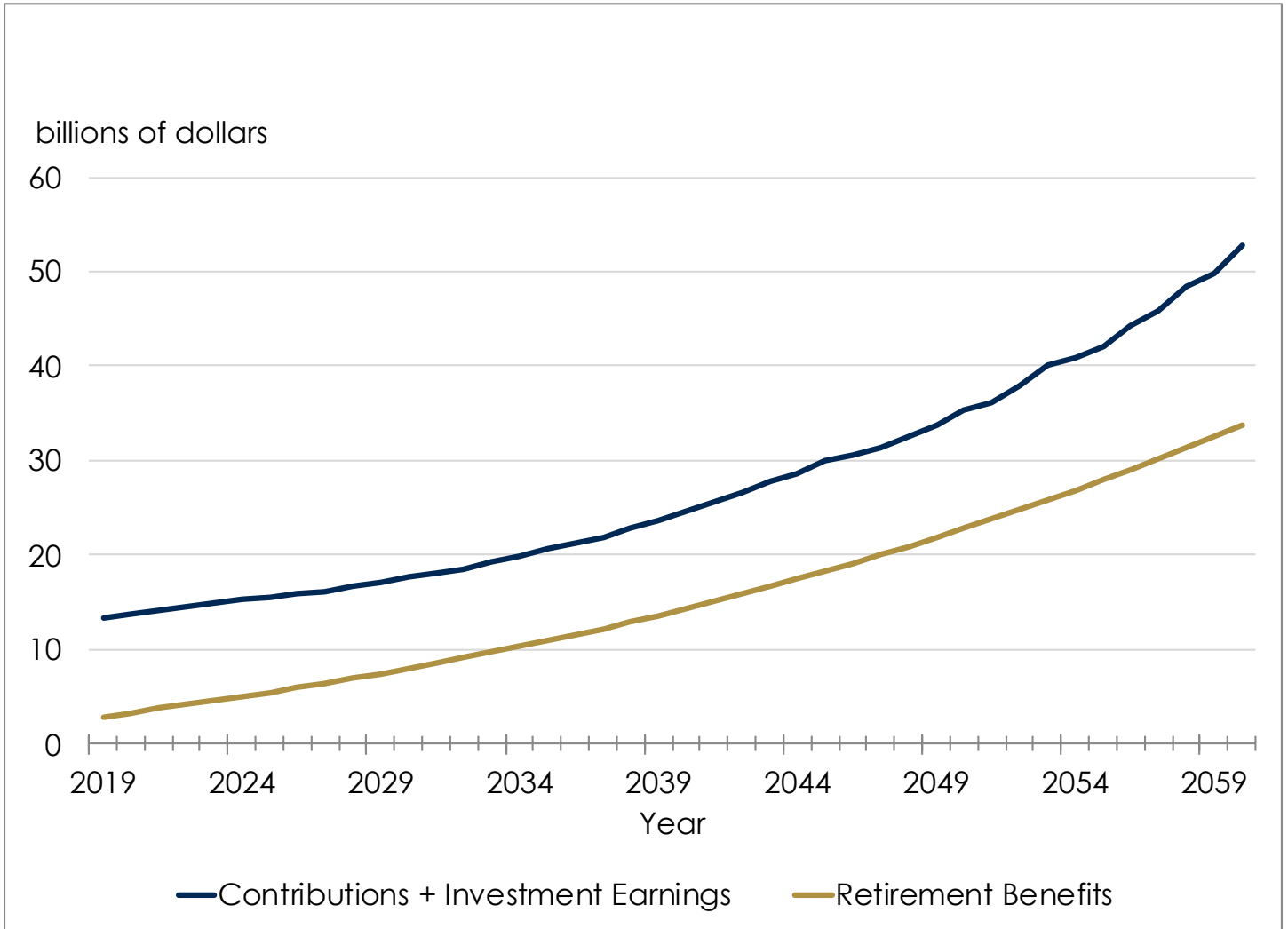
By PSPIB’s own estimates in their 2018 annual report, they state; “the proportion of assets coming from investment returns is expected to reach about 70% over the long term”.<sup>15</sup>

Based on our projections, assuming that the assumptions mentioned above for each asset class is realized, we believe that PSPIB should have no problem reaching its return objective and being in a healthy position to fund pension obligations.

Clearly, over the projection period, investment earnings and contributions are comfortably above retirement benefits. The pension fund is without a doubt in a financially healthy position.

Now, let’s examine some differences between the projections we found and the projections that were presented by the Chief Actuary in the 2014 triennial actuarial report on the public service pension plans. For contributions, both our estimate and the Chief Actuary’s projections are similar up to 2040. After 2040, both project an upward trend, however, the Chief Actuary’s projection is higher than our projection by about \$2 billion in 2050. This can be attributed to several factors. We suspect the main difference is in the number of contributing members in the public service in the future, and their average salaries.

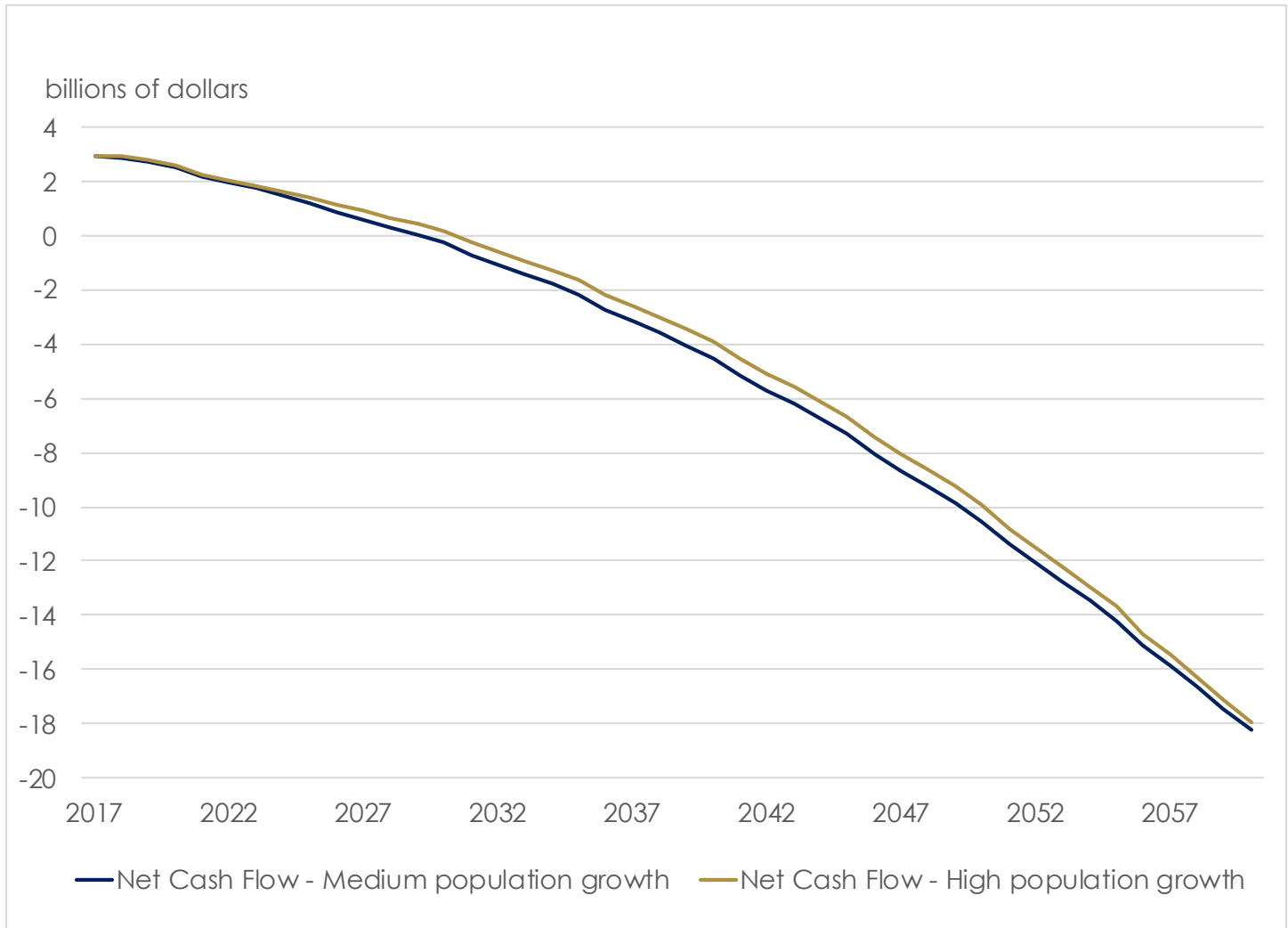
## Chart 7: Comparison II



We believe that the median growth scenario used in the population projections is adequate. However, to demonstrate that if another population projection scenario is used the end result and conclusions found will not be substantially different - we estimate an alternative scenario where retirement benefits are calculated using a high population growth scenario.

Clearly, if a high population growth scenario is applied both contributions and retirement benefits will be higher than if a medium population growth scenario is used. In pure dollar terms there is a clear difference, however, when examining the net cash flows - defined as difference between contributions and retirement benefits - the two scenarios lead to the same conclusion. The conclusion being that net cash flows are positive up to 2030 and negative afterwards. In either scenario, the pension fund is deemed sustainable. Since the negative net cash flows seen in both scenarios are not large to offset investment earnings over time.

## Chart 8: Net Cash Flow Comparison in \$ Billions



For retirement benefits, both our estimate and the Chief Actuary's projections are very similar. The slight difference between the two projections is that we project a slower growth in retirement benefits while the Chief Actuary's projection grows slightly faster.

The largest difference between our projection and the Chief Actuary's projections can be seen in investment earnings. With respect to rates of return, our rates of return are equal for some asset classes and higher for others. However, when it comes to asset mix, there are two key and significant differences.

Primarily, we have chosen to place our asset classes in slightly different buckets than the Actuary's office. Also, and more importantly, they have maintained a fixed asset mix for the projection while we have chosen to have a window within which our asset mix can fluctuate. It is important to note that we are comparing our findings to the 2014 Actuarial Report on the Public Service Pension Plan.



## V CONCLUSION

In conclusion, the main question of this report which was to determine whether or not the pension fund is sustainable has been answered. The pension fund for the federal public service of Canada is sustainable. There is enough income coming in such that all retirement benefit obligations can be satisfied over the projection horizon.

# Endnotes

- 1 Treasury Board Secretariat: “Public Service Pension Plan History”.
- 2 Treasury Board Secretariat: “Review of Methodologies to Determine Discount Rate”.
- 3 Public Sector Pension Investment Board Act
- 4 2014 Spring Report of the Auditor General of Canada, Chapter 1 - Public Sector Pension Plans Section Subsection 1.28. Under these assumptions, in 2012, the PSPIB, projected that over 10 years there is 35% probability that its investment strategy will not achieve its set target, of 4.1%. It is noted in the AG’s report that this probability could increase or decrease over the years. We do not believe 35% is a significant amount of uncertainty given that any investments made by any type of investor - individual or institutional - comes with a certain degree of risk of not meeting expectations.
- 5 Public Sector Pension Investment Board Regulations - Objects of Power, subsection 4(2), 4(3).The costs of running the PSPIB are largely taken out of the Public Service Pension Fund. If money were to be taken out of the Canadian Forces or RCMP funds, then the respective ministers of each would have to be notified. The President of the Treasury Board Secretariat decides which funds the costs of operations are taken out of.
- 6 Public Sector Pension Investment Board Regulations - Quantitative Limits, subsection 13.1 (1).
- 7 The 2014 Actuarial report - Appendix 10, Table 68 - contains a detailed table with investment, contributions and payments projections. However the 2017 Actuarial report - Appendix 10 - simply has graphs of the liabilities and cash flows of the Public Service Pension Fund. A request to have a similar table for the 2017 report is still pending.
- 8 Treasury Board Secretariat: Demographic Snapshot of Canada’s Federal Public Service
- 9 Treasury Board Secretariat: Graphic’s Data Tables
- 10 Treasury Board Secretariat: Demographic Snapshot of Canada’s Federal Public Service
- 11 Public Service Pension Plan - Pension Contributions
- 12 Actuarial Report on the Pension Plan for the Public Service of Canada as at 31 March 2017 - Appendix 6 page 54.
- 13 Treasury Board Secretariat: Report on the Public Service Pension Plan for the Fiscal Year ended March 31, 2017.
- 14 Following the CAPM model. Equity Risk Premium =  $R_a - R_f = \beta a (R_m - R_f)$  and the ten year government of Canada bond real rate of return is taken as a proxy for the risk free rate of return.
- 15 Public Sector Pension Investment Board - Annual Report 2018: page 35.

# Appendix A

Age Band	2005	2010	2015	2017	Projected
~20	0.2	0.3	0.2	0.2	0.2
20-24	3.1	4.2	3.2	3.8	4
25-29	8	8.9	6.6	6.6	6.9
30-34	9.8	11.4	10.7	10.2	10
35-39	11.7	12	13.7	13.6	14
40-44	16.2	13.2	14.1	14.6	15
45-49	18.6	16.4	14.7	14.6	14.5
50-54	18	16.7	17.2	16.1	15
55-59	10.6	11.1	12.2	12.5	12.6
60-64	3.1	4.4	5.4	5.6	5.8
65+	0.9	1.3	2	2.2	2

# Appendix B

Age Band	Expected Salary	EC	CS	AS	PM
~20	\$32,724.00			\$32,724.00	\$32,724.00
20-24	\$58,145.14	\$63,428.00	\$56,907.00	\$61,588.00	\$51,538.00
25-29	\$63,134.22	\$63,428.00	\$56,907.00	\$67,241.00	\$61,558.00
30-34	\$78,877.74	\$81,858.00	\$70,439.00	\$80,274.00	\$80,272.00
35-39	\$78,877.74	\$81,858.00	\$70,439.00	\$80,274.00	\$80,274.00
40-44	\$90,271.02	\$92,483.00	\$83,147.00	\$89,415.00	\$94,121.00
45-49	\$90,271.02	\$92,483.00	\$83,147.00	\$89,415.00	\$94,121.00
50-54	\$97,032.81	\$104,494.00	\$95,201.00	\$94,121.00	\$97,186.00
55-59	\$97,032.81	\$104,494.00	\$95,201.00	\$94,121.00	\$97,186.00
60-64	\$107,070.30	\$113,608.00	\$108,528.00	\$97,186.00	\$114,392.00
65+	\$107,070.30	\$113,608.00	\$108,528.00	\$97,186.00	\$114,392.00

# Appendix C

## Contributions

Age bands:  $y_i$ , where  $i = 1, \dots, 11$

$y_1 = 20-24, y_2 = 25-29, y_3 = 30-34, y_4 = 35-39, y_5 = 40-44, y_6 = 45-49, y_7 = 50-54$

$y_8 = 55-59, y_9 = 60-64, y_{10} = 65+, y_{11} = \text{under } 20$

$j = \text{year}, 2017-2060$

$T_j = \text{total workforce in year } j, \text{ people in the workforce are by definition contributing members}$

$p_i = \text{proportion of contributing members within each age band}$

$w_j = T_j * p_i = \text{number of contributing members within each age band for year } j$

$S_i = \text{salary of public servant in group (EC, PM, AS, CS) in age band } i$

$p_2 = \text{proportion of public servants in a particular group (EC, PM, AS, CS)}$

$ES_{i,j} = S_i * p_2 = \text{Expected Salary of age band } i \text{ in year } j$

$MCR = \text{Member contribution rate}, MCRA = \text{member contribution rate above YMPE}$

$YMPE = \text{yearly maximum pensionable earnings}$

Step 1:  $ES_{i,j} * MCR_j$  Step 2:  $ES_{i,j} * MCRA_j$

Step 3: Step 1 + Step 2 =  $q_j * 2$ , Step 4:  $(q_j * 2) * w_j = \text{average contribution going towards the pension fund by age band } i \text{ in year } j$

## Equations for Retirement Benefits

$NR_j = \text{new retirees in year } j = p_3 * T_j, p_3 = \text{proportion of new retirees relative to total workforce of that year } (j).$

$NB_j = \text{new benefits given out in year } j = (\text{avg. pension}) * NR_j$

$TB_j = \text{total benefits paid out in year } j = TB_{j-1} + NB_j$

## Equations for Investment Earnings

$IE_j = \text{Inv}_j - \text{Inv}_{j-1}, \text{total investments from current year minus investments from previous year}$

$IE = \text{investment earnings in year } j$

$\text{Inv}_j = \sum q, \text{sum of annual investments in year } j \text{ from asset classes}$

$q_j (1+r_j) = q_{j+1}$

asset class  $q$  in year  $j$  multiplied by 1 plus real rate of return in year  $j$

gives value of investments in asset class  $q$  in year  $j + 1$ .

$r_j = \alpha_j + ERP_q,$

$\alpha = \text{ten year government of Canada bond real rate of return in year } j, r = \text{real rate of return in year } j \text{ of asset}$

$ERP = \text{equity risk premium of asset class } q \rightarrow \text{Equity Risk Premium} = R_a - R_f = \beta_a (R_m - R_f)$

## Equation for Opening Balance

$OB_t = OB_{t-1} + C_t + I_t - RB_t$

where  $C = \text{Contributions}, I = \text{Investment earnings}, RB = \text{Retirement Benefits}, t = \text{time}$

## Appendix D

Year	Equity	Real Assets	Government Fixed Income	Credit
2018	22.33%	37.95%	26.58%	13.14%
2019	22.52%	37.21%	27.64%	12.64%
2020	22.81%	36.55%	28.46%	12.17%
2021	23.23%	35.95%	29.07%	11.74%
2022	23.79%	35.43%	29.44%	11.35%
2023	24.42%	34.97%	29.62%	10.99%
2024	25.13%	34.56%	29.65%	10.65%
2025	29.51%	34.22%	29.54%	10.34%
2026	26.73%	33.92%	29.29%	10.05%
2027	27.63%	33.69%	28.89%	9.79%
2028	28.59%	33.49%	28.38%	9.55%
2029	29.60%	33.32%	27.77%	9.32%
2030	30.68%	33.17%	27.06%	9.10%
2031	31.80%	33.00%	26.33%	8.87%
2032	32.94%	32.80%	25.61%	8.65%
2033	34.10%	32.58%	24.89%	8.43%
2034	35.29%	32.33%	24.17%	8.20%
2035	36.51%	32.06%	23.46%	7.98%
2036	37.74%	31.76%	22.75%	7.75%
2037	38.99%	31.44%	22.05%	7.53%
2038	40.25%	31.10%	21.35%	7.30%
2039	41.53%	30.73%	20.66%	7.08%
2040	42.81%	30.35%	19.98%	6.85%
2041	44.11%	29.95%	19.31%	6.63%
2042	45.41%	29.53%	18.64%	6.42%
2043	44.59%	29.10%	17.99%	8.32%
2044	45.88%	28.69%	17.37%	8.05%
2045	45.25%	27.00%	19.97%	7.78%
2046	44.52%	28.67%	19.30%	7.52%
2047	44.08%	30.00%	18.65%	7.28%
2048	43.81%	29.59%	19.56%	7.04%
2049	45.07%	29.20%	18.92%	6.81%
2050	44.38%	28.79%	20.24%	6.59%
2051	45.64%	28.42%	19.56%	6.38%
2052	46.90%	28.03%	18.90%	6.17%
2053	45.40%	27.63%	18.25%	8.72%

Year	Equity	Real Assets	Government Fixed Income	Credit
2054	44.58%	27.26%	19.72%	8.44%
2055	45.84%	26.93%	19.06%	8.17%
2056	44.83%	28.84%	18.42%	7.91%
2057	46.07%	28.47%	17.80%	7.66%
2058	44.95%	28.10%	19.54%	7.41%
2059	46.18%	27.76%	18.88%	7.18%
2060	45.02%	29.79%	18.23%	6.96%

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