Master Thesis

Reforms to the Canadian Pension Plan: A Generational Account Perspective

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Abstract

This thesis analyzes the impact of the recent reforms to the Canadian Pension Plan through the lens of generational accounts. I developed a simulation using Python to model the Canadian Pension Plan, and its reforms, and then analyzed the changes to the generational accounts for the cohorts born between 1955 and 2019. I find that the reforms increase the generational accounts of both the male and female cohorts proportional to the number of years each cohort works in the reformed system. The result is that the internal rate of return for both cohorts increases by as much as 0.27 percentage points. This represents an increase in the intergenerational transfer from the young to the old. And due to the structure of the reforms, the short-term financial position of the CPP improves.

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1. Introduction

There is a transformation taking place in the second pillar of the Canadian pension system. The defined benefit workplace pension is in decline. In the 1970s 55% of the labor force had a defined benefit workplace pension, but today it is just 25% (Committee on the Status of Persons with Disabilities, 2010). Less generous, defined contribution pensions are taking their place. As a result, the total replacement rate provided by the second pillar has declined by 10 percentage points in this period (Canada G. o., 2019). These trends compelled the federal government of Canada, and its provincial counterparts, to come together and agree on the largest reforms to the government run pension plan, called the Canadian Pension Plan, in 25 years. These changes included increasing the replacement rate, increasing the amount of income covered, and raising contribution rates.

The aim of this paper is to analyze the impact of the 2016 reforms to the Canadian Pension Plan through the lens of *generational accounts*. I developed a simulation using Python to model the Canadian Pension Plan, and its reforms, and I then analyzed the changes to the generational accounts. The research question is thus 'How do the reforms to the Canadian Pension Plan affect the generational accounts of current and future generations?' I find that the reforms increase the generational accounts of both the male and female cohorts. The result is that the internal rate of return for each cohort increases by as much as 0.27 percentage points. And the short-term financial position of the CPP improves.

This paper proceeds as follows, section 2 gives a brief overview of the Canadian Pension Plan, section 3 provides a literature review, section 4 goes over methodology, section 5 reviews the results using the best-estimate assumptions, section 6 conducts sensitivity analysis, section 7 goes over four different economic and demographic scenarios, and section 8 concludes.

2. The History of the Canadian Pension Plan

The Canadian Pension Plan (CPP) was introduced in 1965 to help supplement the retirement income of working Canadians. It was designed to make up one part of the second pillar of the pension system, alongside workplace pensions. Contributing to the CPP is mandatory for all employed Canadians (except those in Quebec)[1] earning more than the minimum eligible income and is funded exclusively through payroll taxes. As of 2005 97% of the labor force was contributing towards or receiving CPP benefits (Canada P. o., 2010).

[1] Except for those working in Quebec since the province runs its own pension system called the Quebec Pension Plan (QPP). It is similar to the CPP but will not be analyzed in this paper.

The CPP is a defined benefit pension plan, aimed at replacing 25% of workers' average income. Contributions are funded through a payroll tax of 9.9% split equally between the employee and employer. It only covers income up to the Canadian average (which is equal to $57,400 in 2019[2]), income above this is not replaced nor do participants pay contributions on it[3]. The benefits a contributor receives are determined based on the amount of contributions paid and the number of years worked. For example, if a contributor earned the maximum eligible income for at least 40 years, they will receive the maximum benefit (equal to $1,154.58 per month in 2019), which is then indexed to inflation. The average benefit received in 2019 was $664.41 per month (Canada G. o., 2019). Benefits can be claimed at age 65, but early, and late, retirement options do exist.

2.1 The 1997 Reforms to the Canadian Pension Plan

In Canada, responsibility for many government programs are shared jointly between the federal and provincial governments. The CPP is one such program. Any major changes to the program, such as to the contribution rate, must be approved by at least seven of the ten provinces representing at least two-thirds of the population. For this reason, between the years 1966 and 1996, the only change to the CPP was to the contribution rate, which gradually rose from a combined rate of 3.6% to 6% (Mernard, Jean-Claude, 2015).

By the mid-1990s it was clear that the CPP was not financially sustainable. Even with the increase in contribution rates the system had been in deficit since 1985 (Actuarial Study No., 2014). In addition, the Canadian population was aging, the fertility rate declining, and productivity growth rates were stagnant. The 15th Actuarial Report on the CPP released in 1993 projected that if the system was not reformed, the pay-as-you-go (PAYG) rate would rise to 14.2% by 2030 and the reserve fund would be exhausted by 2015.

To deal with the impending crisis, in 1996 the federal government outlined the largest reforms to the CPP since its creation. The main aspect of the reforms entailed raising the contribution rate to 9.9% by 2003. This increase would put the system into financial surplus, where it would build up financial reserves in an investment fund, and eventually use the income generated by this fund to help pay for benefits. A new

[2] All dollar figures are in Canadian Dollars (CAD)
[3] Stats Canada uses the average weekly industrial wage to calculate average income

crown-corporation, called the Canadian Pension Plan Investment Board (CPPIB[4]) was created to manage this new fund.

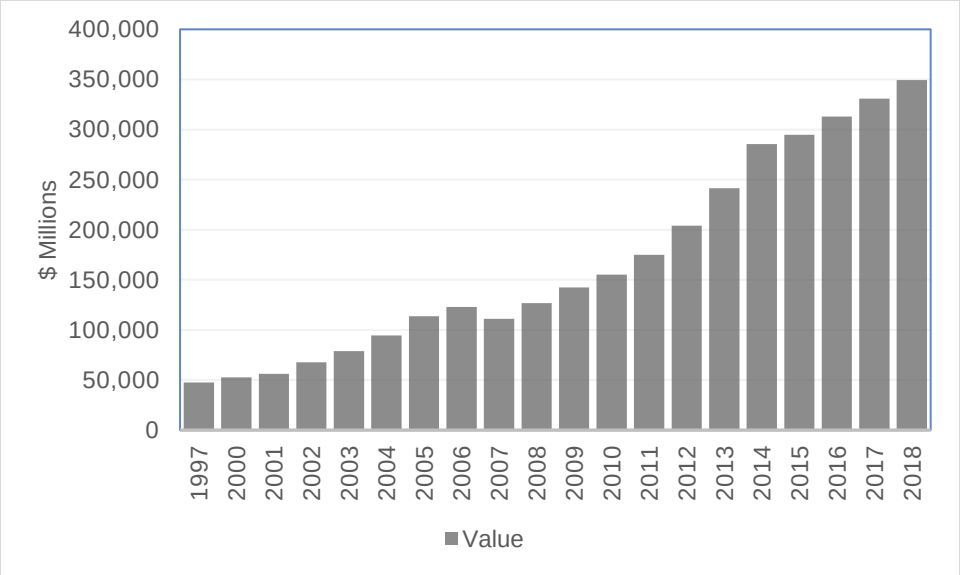
The reforms changed the CPP from being a purely PAYG system, to a hybrid PAYG and funded system. This new funding mechanism was called 'steady-state funding', due to how the system is expected to remain in balance. The main parameter that shows the financial position of the CPP is called the *minimum contribution rate*, or sometimes called the *steady-state contribution rate,* which is defined as the minimum contribution rate that allows the ratio of assets to expenditures (A/E ratio) to remain stable in the 10th year, and 60th year of the publication of the tri-annual actuary's report. If the report showed the minimum contribution rate is above the current contribution rate (9.9%), then a semi-automatic balancing mechanism is engaged.

This semi-automatic balancing mechanism requires the federal parliament to act to restore the financial position of the CPP. While the legislation recommends raising the contribution rates to cover 50% of the actuarial deficit and reducing benefits to cover the other 50%, the parliament has final say. These reforms would stay in place for three years, until a new actuarial report is released, where the process would be repeated.

This CPPIB fund is substantially different from the previous reserve fund. While the reserve fund primarily invested in government bonds (Actuarial Study, 2014), the mandate of the CPPIB was to *'to maximize long-term investment returns without undue risk, taking into account the factors that may affect the funding of the Canada Pension Plan and its ability to meet its financial obligations.'* (Mernard, Jean-Claude, 2015). This let the fund pursue higher returns, without political interference. As of 2019, the fund averaged a net nominal return of 10.1% per year for the last 10 years and was worth $392 Billion ($265 Billion Euros), making it one of the largest sovereign wealth funds in the world.

[4] The CPPIB also publish the actuary's report. I refer to the agency as the CPPIB, and the fund they manage as the CPPIB fund.

Chart 1: CPPIB Fund Value



The CPP is projected to remain in surplus until 2021, whereupon the deficit will be financed through income generated by the CPPIB fund. The A/E ratio is projected to stabilize at about 6.6, and income from the CPPIB fund is expected to pay for about one-third of future benefits.

The final aspect of the 1997 reforms was to change how future reforms to the CPP were conducted. If any future government wanted to increase benefits, or extend the scope of the system, these changes would have to be financed in advance. Specifically, any increase in benefits must be accompanied by a permanent increase in the contribution rate to pay for the unfunded liability. This stringent requirement ensures intergenerational balance and lays out the boundaries of any future reforms.

The main result of the 1996 reforms were that the CPP was able to manage the demographic changes of the Canadian population and the changes to the economy without raising contribution rates above 9.9% or reducing benefits. This restored the financial position of the CPP for the foreseeable future.

2.2 The 2016 Reforms to the Canadian Pension Plan

While the CPP may be financially stable due to the transition to steady-state funding, other changes were happening in the Canadian pension system. Namely, the decline in defined benefit workplace pensions. The CPP is meant to supplement a workplace pension, but since 1977, workplace pension plans have declined from providing coverage to 55% of the labor force, to less than 25% today (Canada P. o., 2010). In addition, the government estimates that only 24% of Canadians near retirement have enough income

between the three pillars to replace 60% of their income in retirement (Finance, 2016). And while Canada has several tax-exempt retirement account options in the third pillar, only 65% of Canadians are taking full advantage of them[5] (Finance, 2016). This means that the CPP now represents a larger portion of retirement income for Canadians. This motivated the federal and provincial governments to come to an agreement and expand the coverage of the CPP to better support workers in retirement.

In 2016, the federal government unveiled a set of reforms called the CPP 'enhancement'. The reforms presented three major changes to the CPP, the first was to increase the replacement rate on eligible earnings from 25% to 33%. The second was the raise the maximum income covered by the CPP from 100% of the Canadian average income to 114% (from an estimated $69,700, to $82,700 in 2025). And to pay for these larger benefits, the contribution rate was raised from 9.9% to 11.9% (split equally between the employee and the employer). The reforms will start to be implemented in 2019 and will be phased in over a seven-year period. These changes are projected to increase the pension benefit by 33% to 50%. These reforms do not change the retirement age for participants of the CPP, which will remain at 65.

The reforms are designed to only affect current and future workers, and not current retirees. This is not only prudent public policy, but also because the provision that all future expansion of benefits must be pre-financed. This means that contributions will increase immediately, whereas the maximum benefit will graduatlly incrase over the next 40 years. Although all contributors will see higher benefits as a result of the enhancement, younger workers will see the largest increase in benefits, since they will work in the reformed system for more years. According to government estimates, roughly 70% of workers will have their entire earnings covered by the reformed CPP (Finance, 2016).

3. Literature Review

Auerbach, Gokhale, and Kotlikoff first introduced the concept of generational accounting in 1991 (Auerbach, Gokhale, and Kotlikoff, 1991*)* as an alternative way of analyzing fiscal policy. Traditional fiscal policy focuses on the government budget deficit and debt. While this analysis can be useful from a financial perspective, it falls short in several areas. For example, how exactly should one calculate the budget deficit and government debt, and should it consider the state of the economy, and unfunded liabilities?

[5] The Retirement Saving Plan (RSP) which is a Exempt-Exempt-Tax account and the Tax-Free Savings Accounts (TFSA) which is Tax-Exempt-Exempt are the main two.

In a response to these problems Auerbach, Gokhale, and Kotlikoff outlined a new concept called *generational accounts* to analyze changes in fiscal policy. They are defined as the present value of net taxes (taxes minus transfers) that a generation is expected to pay over their remaining lifetimes. Generational accounting reveals the zero-sum nature of public finances, that is what some generations receive as an increase net benefits must be paid for by other generations, who will experience a decrease in net benefits**.** Additionally**,** net taxes are calculated in a forward-looking manner, and thus we gain a clearer picture of how policy changes affect society in the long run. Specifically, which generation benefits and which ones pay the cost of a change in policy. This is a much more comprehensive approach to analyzing a policy change.

Kotlikoff and Raffelhuschen expanded the concept of generational accounting to 22 countries (Kotlikoff & Raffelhuschen, 1993). They concluded that while many countries have similar social safety nets, the size of their generational transfers vary widely, irrespective of whether a country was in fiscal surplus or deficit. From the countries analyzed, only two stand out for having balanced generational accounts, New Zealand and Canada. This shows that there are not major intergenerational transfers taking place to fund government policy in these countries.

Generational accounting has grown in popularity since its introduction, and has been applied to many policy areas, including pensions. Since analyzing pensions requires long time horizons, and often inter- and intragenerational transfers and risk sharing, generational accounts provide an ideal framework to analyze policy changes. Although, calculating generational accounts in a pension system changes slightly, since they only consider taxes paid (contributions) and pension benefits received, within the pension system, and ignores all other government spending. This then determines the value of the pension contract, or the pension deal, for a specific generation.

Auerbach and Lee analyze unfunded PAYG pension systems through the concept of generational accounts (Auerbach & Lee, 2011). Specifically, they compare the US social security system, the Swedish notional defined contribution system, and the German PAYG system. Using a stochastic simulation, they modeled population dynamics, and the relevant economic variables, to create 1000 different scenarios and ran each scenario for 500 years through each of the systems. They then compared the generational equity of each system, which is defined as the change in generational accounts between generations born close to one another. They found that the Swedish notional defined contribution system has the greatest generational equity, primarily due to how its automatic balancing mechanism smooths stochastic fluctuations, but at the cost of a lower average rate of return.

The concept of generational accounting can also be applied to collective funded pension systems. Ponds and Hoevenaars combine the concept of generational accounts and traditional asset-liability management to create a framework for understanding intergenerational risk sharing in pension funds (Hoevenaars & Ponds, 2008). They point out that collective pension funds face a similar zero-sum game as public finances do, so any change in a pension contract cannot increase the overall economic value of the pension fund, but rather just change the generational balance and intergenerational risk sharing of its participants. To show the relevance of this approach they analyzed the solvency crisis that the Dutch pension funds faced in 2000, specifically how traditional defined benefit plans were being reformed to better deal with solvency risk management and avoid intergenerational transfers while maintaining pension outcomes. This framework allowed them to analyze different pension contracts to better understand the strengths and weaknesses of each reform.

While using generational accounting to analyze pension systems is quite common in countries such as the Netherlands, it is a novel approach in Canada. Little to no literature exists that analyze policy in Canada using generational accounts. This does not mean that generational accounting is not used, but rather it is often not explicitly investigated. For example, the CPPIB actuary's reports an internal rate of return for each generation in the CPP, but not the value, or change in generational accounts. A similar observation can be said about the paper 'The Fair Value of the Canada Pension Plan' which compares the rate of return provided by the CPP to private annuities (James, Pesando, Arnold, & Ilkiw, 2008). And even when intergenerational equity is explicitly investigated, such as in the government report, 'Intergenerational Balance of the Canadian Retirement Income System' written by the chief actuary of Canada, the concept of generational accounts is not even mentioned (Ménard, Jean-Claude & Assia, 2013). This implies that analyzing Canadian public policy through the lens of generational account is still novel.

4. Methodology

To analyze the impact that the 2016 reforms have on generational accounts I will create a stylized version of the CPP and its reforms in Python. The simulation will be built in three parts: the population projection which includes births, immigration, and mortality, the economic parameters, which includes the labor force participation rate, the unemployment rate, productivity, and inflation, and finally the CPP system and its reforms. Whenever possible, I will use data and assumptions found in the 2016 CPPIB actuary's report[6]. The advantage of using this report as a starting point is that I can be confident the assumptions are

[6] This is the latest version of the report. The 2019 report will be released in September 2019

realistic, and more importantly the results from the simulation can be directly compared to projections found in the report (found in section 4.4). The best-estimate assumptions provided by the CPPIB report are found in table 1.

Table 1: Best-Estimate – Assumptions from the CPPIB

Assumptions	Best-Estimate
Inflation	2%
Real Productivity	1.10%
Real Fund Returns	3.90%
Fertility Rate	~1.65
Net Migration	~0.62%
Life Expectancy for 2050 cohort: Female	87.4
Life Expectancy for 2050 cohort: Male	84.2
Labor Force Participation Rate: Female	78%
Labor Force Participation Rate: Male	84%
Average Yearly Increase in the Labor Force Participation Rate	0.10%
Working Age	18
Retirement Age	65

Several simplifications were made to make the model easier to create. The economic model does not include the unemployment rate. Several aspects of the CPP were also not modeled, such as early and late retirement, operating expenses of the system, and behavioral responses to the reforms. And instead of modeling all the different benefits the CPP offers (such as survivor and disability benefits), all benefits are lumped into one. Finally, the transition period is not modeled, which means that instead of gradually raising contribution rate, and pensionable income, the reforms are implemented in their totality in 2019.

4.1 The Canadian Pension Plan Model

The CPP system was modeled in three steps, historic benefits, the old CPP system, and the reformed CPP system (appendix section 3).

Even though the CPP reforms do not affect current retirees, I will need to model their benefits so that the simulation can create accurate financial projections. To calculate these benefits, I will use data provided by the CPP administration. Each year, the CPP publishes the maximum benefits a new retiree could receive in historical dollars. For example, the maximum benefit that a new retiree could receive if they retired in 1985 was $435 per month, which is equivalent to $935 in 2019 dollars. The simulation will take these maximum benefits and inflate them into 2019 dollars using a CPI inflator provided by Statistics

Canada. On average, people do not receive the maximum benefit, but instead they receive some fraction of it (70% of the maximum for males, 65% for females), which is then indexed to inflation. During the first year of the simulation, the expenditure figure will only include historic pensions, so I can fit the first year of expenditures of the simulation to the expenditure figure for 2019 provided by the CPPIB report.

Next I will model the old, and reformed CPP systems. The functions for the old and the reformed CPP work in similar ways, just with different contribution rates, and pensionable income figures (appendix section 3.2). For example, contributions in year *t* for cohort *i* are determined by the number of people in the cohort in year *t*, labor force participation rate in year *t*, normalized income, productivity level in year *t* (which determines the wage level), and the contribution rate. Benefits are determined by the number of people in cohort *i* in year *t* subtracted by the number of immigrants who are added to that cohort in year *t*, inflation level in year *t*, average productivity level between the year of retirement and the previous five years, average income between the ages of 20 and 65, the maximum labor force participation rate for this cohort, benefit rate, and the benefit accelerator (see below) [7].

As mentioned previously, the CPP provides several different types of benefits such as the standard retirement pension, the survivor pension, and disability pension. These, as well as the operating costs of the CPP, have all been lumped into one benefit for the purposes of this simulation. In an attempt to naively model these additional benefits, I add a benefit accelerator to the model. This accelerator slowly increases the size of the benefit, in addition to inflation. Since females receive these additional benefits at a ratio of 3:1 to males, their benefit accelerator is 3x larger (Mernard, Jean-Claude, 2015). The size of the accelerator was determined by fitting the financial data of the simulation, to that of the data provided by the CPPIB report. For a male who lives until the maximum age of 110, their benefit increases 10% above inflation, and for females its 30%.

4.2 The Population Model

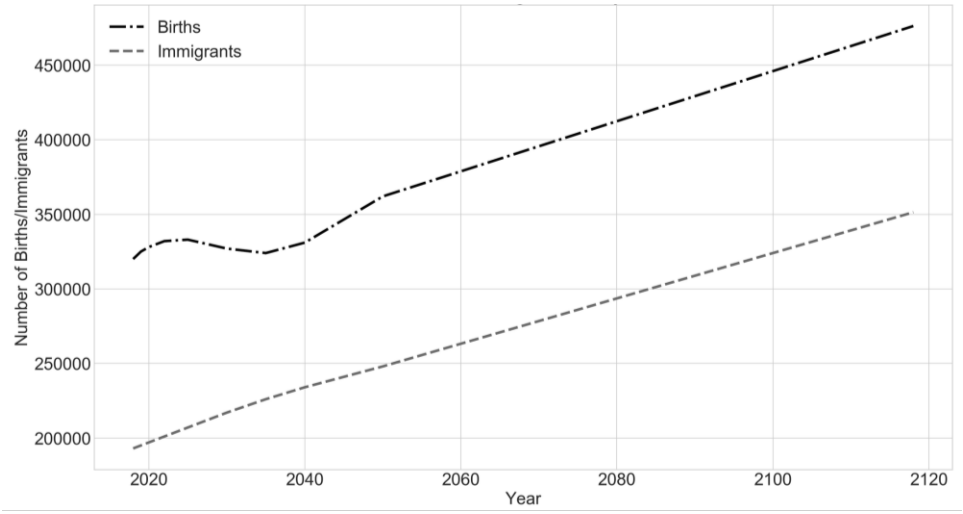
To accurately calculate the generational accounts, we need to know the number of people in each generation in any particular year (appendix section 1). This means that detailed population accounting is needed. To start the simulation, I used the 2018 Canadian population from data provided by Statistics Canada, which included the number of people in each age group. There were 101 age groups, starting at age 0, and ending at age 100. A generational cohort is represented by the year they were born, which

[7] Immigrants who arrive over the age of 65 do not receive benefits

means that in 2018 the initial population had cohorts going back to 1918. I then project the population forward 100 years until the year 2118 accounting for births, immigration, and deaths in each generation.

Instead of using an endogenous birth model, where births are determined each year by the number adult females and the average fertility rate for each age group, they were modeled exogenously[8]. The initial projections for the number of births each year was taken from the CPPIB report, and then this trend is projected until 2118. This means that the actual fertility rate varies over time, but on average is equal to about 1.65.

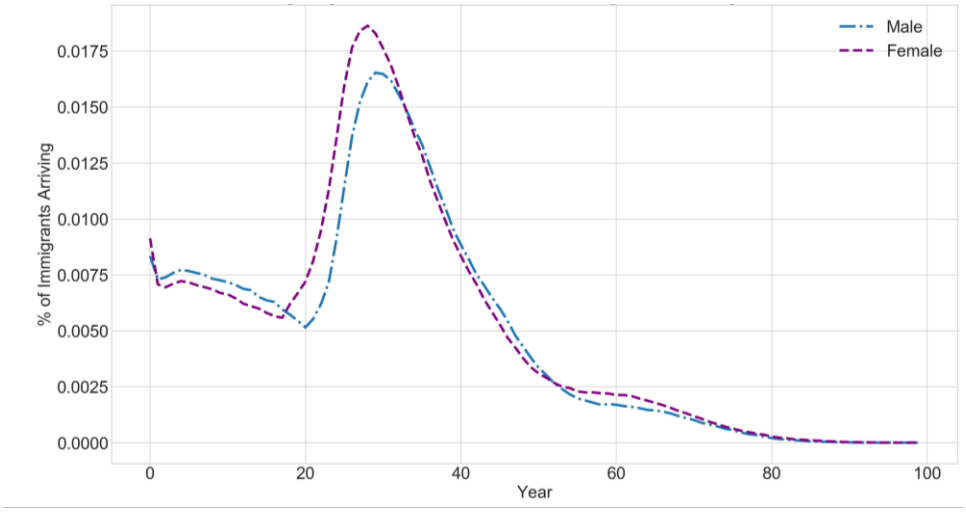
Chart 2: Number of Births and Immigrants per Year



The other aspect that I must account for in the Canadian context is immigration. On average, net migration each year is equivalent to about 80% of births. This means that I cannot ignore immigration in the population projection. Immigration is harder to account for than births since before I can add them to the correct cohort, I must know an immigrant's age and sex. For example, an immigrant arriving in 2019, who is 20 years old, must be added to the cohort born in 1999. To create a realistic age and sex distribution, I use immigration data from Statistics Canada. A minor assumption used in this simulation is that this distribution stays constant over time. Also, immigrants arriving before the age of 65 participate in the CPP system, while immigrants arriving after the age of 65 do not. On average 52% of immigrants arriving to Canada are females, and the average age for both male and female immigrants is 28.

[8]This made the simulation easier to program but it essentially means that the number of babies born each year is not related to the number of adults in the population. It is the first area of the simulation I would like to improve.

Chart 3: Age Distribution of Immigrants Arriving to Canada



I will project mortality using historical lifetables, and a modified Lee-Carter method (Lee & Carter, 1992). This is a purely statistical method of projecting mortality, which summarizes historical lifetables into three variables: the average-age profile of mortality, how each age group changes with time, and how overall mortality changes over time (appendix section 1.3)[9]. While Lee-Carter used a stochastic approach to project mortality, I will modify their approach to fit the simulation's mortality projections to those provided by the CPPIB report. This means that the simulation will be able to produce lifetables, based on historic Canadian data, with expected life characteristics that match those provided by the CPPIB. In other words, the simulation can produce a lifetable with a life expectancy of 80.7 in 2025, and 84.2 in 2050, and then project this trend to 2118, creating a lifetable for each year in between[11]. Mortality each year will then be calculated using a period-based lifetable, meaning that each year the lifetable is updated for the entire population, rather than using the lifetable from the year the cohort was born.[12]

[9] Meaning it does not take into account any biological aspects of mortality

[11] To check the accuracy of the projection, the model was given data for 2025, and 2050, and then projected this trend to 2075. This way I was able to directly able to compare the simulations mortality projection in 2075, to that of the simulation. My projections matched.

[12] This is the area of the simulation where I am uncertain about. Since the CPPIB does not specify how the project mortality. When I calculate total population using cohort lifetables (where a cohort's lifetable is assigned at birth, and not updated over time), the simulation dramatically underestimates population over time.

Chart 4: Life Expectancy at Birth and at age 65

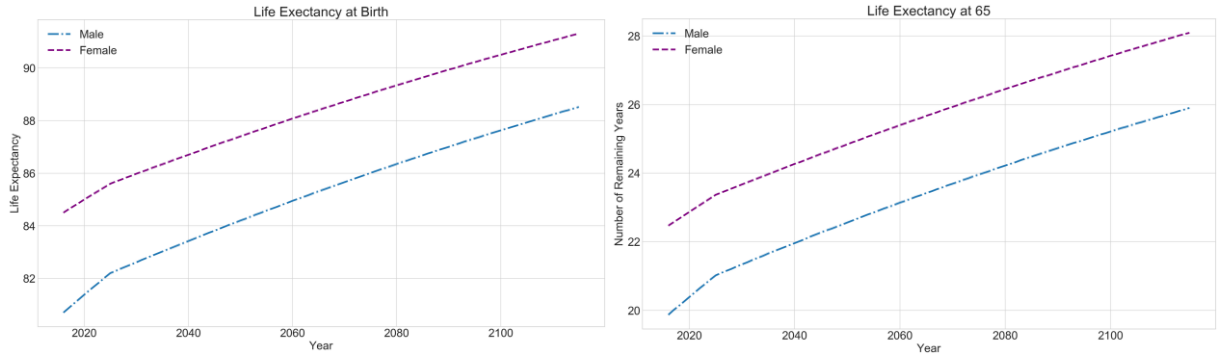
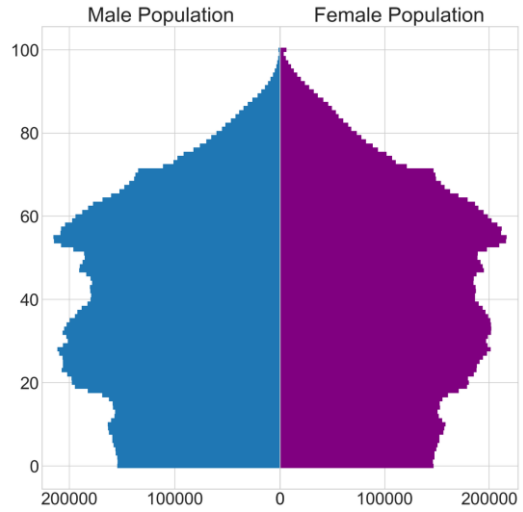
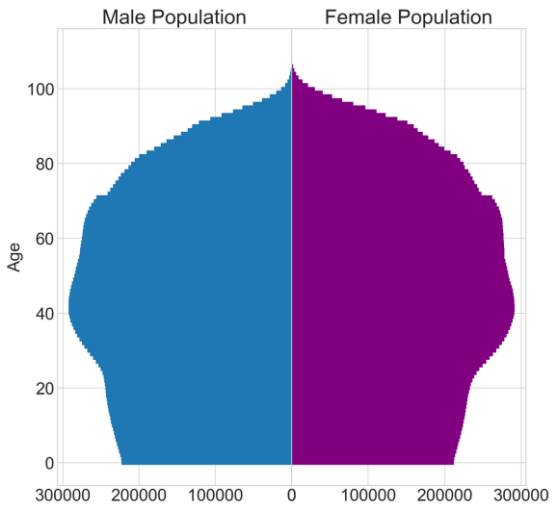


Chart 5: Population Pyramids in 2018 and 2090

Population Pyramid in 2018



Population Pyramid in 2090[13]



4.3 The Economic Model

To analyze the CPP I will need to model some economic variables, but not the entire economy. Following the approach of the CPPIB, the economic parameters I will need are inflation, productivity, labor force participation rate, income distribution, and average pensionable income (appendix section 2). Unlike the population model, the economic model will be built exclusively on data and assumptions provided in the CPPIB report. Inflation and productivity are modeled using deterministic trends. Labor force participation rates are assumed to increase by about 0.1 percentage points each year. The CPPIB report provides the age and sex distributions for the labor force participation rate for the year 2016, and 2075, the simulation

[13] The best demographic statistic to compare between the simulation and the CPPIB projection is the dependency ratio, which is presented in chart 7.

calculates the average change per year and projects this forward until 2118 (appendix section 2.1). The age distribution of income is assumed not to change over time, but the gender pay gap is assumed to narrow over time. This is done by assuming that female productivity growth is 0.1 percentage points higher than males. Since productivity determines wage increases, this means that female income rises slightly faster than male income.

Another area that needs to be treated carefully is the difference between average income, and average *pensionable* income. Participants only contribute to the CPP on income up to the *yearly maximum pensionable earnings* (YMPE) cutoff, which is about equal to the average Canadian income[14]. Participants do not pay contributions on income above this cutoff, as well as below the minimum income exemption (which has been fixed at $3500 since 1997). This means that there is a difference between average income, and average *pensionable* income. Average income will include income above, and below the cutoff values, while the average pensionable income will not. For example, if someone earned $2000 in 2019, this is not counted in the average pensionable income figures, but it will be in the average income figure. Whereas if someone earns $100,000, which is above the YMPE, then this income is only counted as equal to the YMPE when calculating the average pensionable income figures. What this means is that average pensionable income tends to be lower than average income.

The CPP reforms increase the YMPE to 1.14x the average income. While this will not change average income, it will increase the average *pensionable* income figures. The CPPIB report does not provide data on the underlying distribution of income in Canada, so I assume that the new average pensionable income falls somewhere in between average income, and the old average pensionable income[15] (appendix section 2.2).

4.4 Comparing the simulation to the CPPIB report

By modeling the simulation on data and assumptions found in the CPPIB report, I can directly compare the simulation results, to those found in the report. Table 2 summarizes six statistics generated by the simulation and compares them to those in the report.

[14] Stats Canada uses the average weekly industrial wage to calculate the YMPE

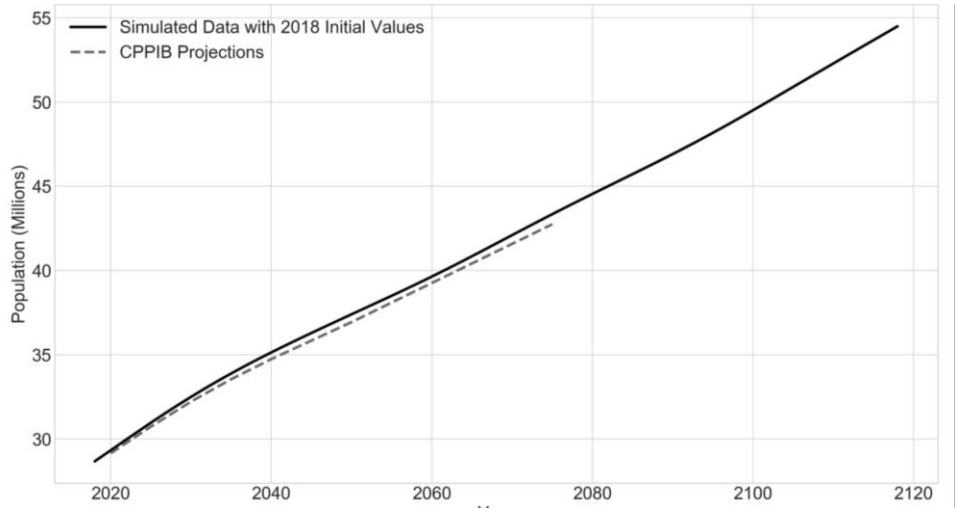
[15] This is the second major area of the simulation that I would like to improve. For example, I could have found more data on the income distribution in Canada and calculated how the change in the YMPE change the distribution of pensionable income.

Table 2: Simulation vs CPPIB Comparison

	Simulation	CPPIB
Population in 2075 (Million)	43.34	42.74
Dependency Ratio 2075	1.91	2
First Year of Deficit	2021	2021
Average Expenditure / Contribution Ratio	1.136	1.135
Minimum Contribution Rate	9.70%	9.79%
Internal Rate of Return for 2019 Generation	2.35%	2.30%

The first metric is total population. Overall, the simulation slightly overestimates total population by around 2% in 2075. Chart 6 visualizes this discrepancy with the dotted grey line is the projection provided by the CPPIB report, and the solid dashed line is the simulations projection[16]. Even the initial 2018 population seems to be overestimated in the simulation, and the gap seems to be slowly increasing with time.

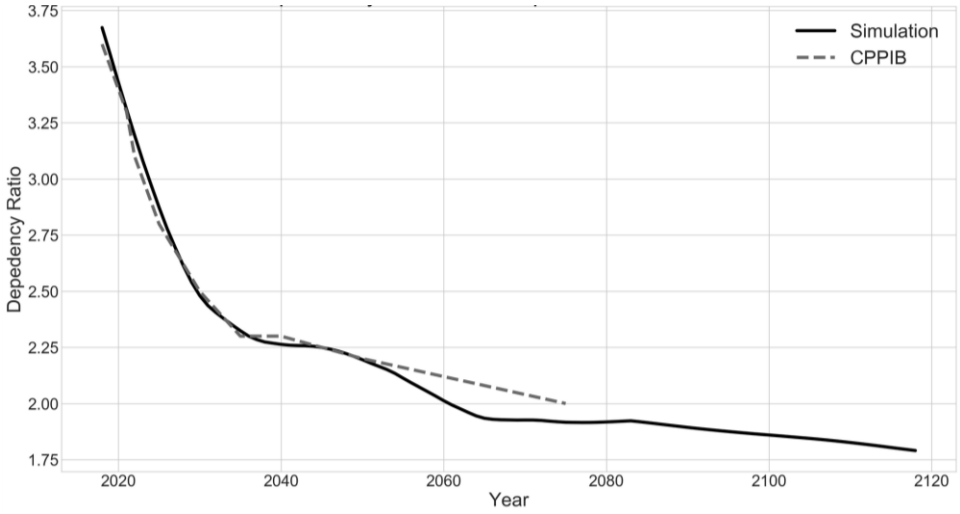
Chart 6: CPPIB vs Simulation – Canadian Population (minus Quebec)



More important than total population is the underlying population demographics, specifically the dependency ratio. Chart 7 compares the dependency ratio provided by the simulation to that of the CPPIB report. It seems like the shape, and size, of the curves match, with the simulation projecting a dependency ratio of 1.91 in 2075, and the CPPIB report projecting 2.0[17].

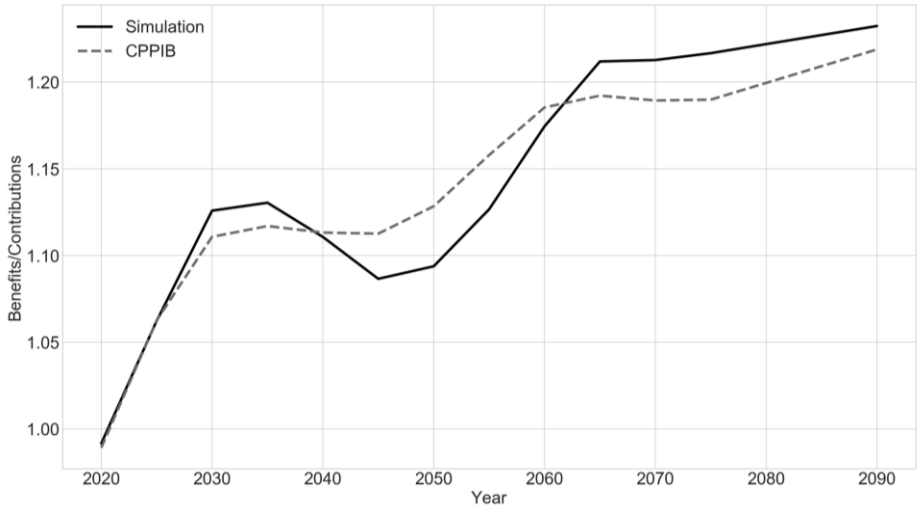
[16] The CPPIB projections only go to 2075
[17] The CPPIB provides data a select number of years. So, their curves look more linear than they should.

Chart 7: CPPIB vs Simulation – Dependency Ratio



Next, I compare some financial data generated by the simulation for the old CPP. Chart 8 compares total expenditures (benefit payments) divided by the contributions over time. Numbers greater than one mean that benefits exceed contributions in that year. The simulation follows a similar trend to the CPPIB report, but it overestimates the degree in which benefits are greater than contributions between 2030 to 2040, and then underestimates them between 2040 to 2055. All deviations are within 3% of the CPPIB data. The CPPIB report predicts that on average, benefits will be 1.135x larger than contributions between 2018, and 2090, while the simulation projects that benefits will be 1.136x larger.

Chart 8: CPPIB vs Simulation - Benefits/Contributions



Three other metrics that the CPPIB uses to measure the financial state of the CPP is the first year the system is projected to go into deficit, the minimum contribution rate, and the internal rate of return (defined as the rate of return when the net present value of contributions paid, and benefits received, by a

generation is equal to zero (appendix section 3.3)). The simulation comes close to matching the CPPIB report on all three accounts, it shows the system going into deficit in 2021, the minimum PAYGO rate being 9.70% compared to 9.79%, and the real internal rate of return for the average cohort being 2.35% compared to 2.3%.

There are several explanations for the discrepancies between the simulation and the CPPIB. Regarding the population model, one explanation is that the CPPIB report was published in 2016 which implies that they used the 2015 population as their starting point. Between 2016 and 2018 the CPPIB underestimated births and immigration[18], and therefore the 2018 population obtained from Statistics Canada was already larger than that projected by the CPPIB. Another explanation could be the differences in mortality projections. The CPPIB report does not specify how exactly they model mortality, and while the modified Lee-Carter approach seems adequate I cannot know for sure. Finally, the CPPIB report does not specify an immigration age distribution, so they could be assuming that immigrants have different characteristics than I assume.

Regarding the CPP model, the differences could stem from several areas. First, we must acknowledge that the discrepancies in the population model will also be reflected in the CPP model. More importantly though are the simplifications made to the CPP benefits (where the simulation lumps all benefits into one), mentioned previously. Finally, it could also be due to other simplifications made to the simulation, such as the lack of early and late retirement options.

The question one must ask is whether the model fits the CPPIB data *on average*, and whether these differences would affect the changes in generational accounts. Without knowing all the underlying assumptions, methods, and calculations made by the CPPIB, fitting the data perfectly is difficult, as well as beyond the scope of this thesis. While more can be done to better fit the model, I believe one can conclude that for the purposes of this paper, the model is adequate to calculate the change in generational accounts associated with the CPP reforms.

[18] There was a change in government in 2015, and immigration increased from about 200k per year in 2015, to 300k by 2018.

5. Best-Estimate Results

The results are presented in three parts: section 5 compares the generational accounts from the old CPP system, and the reformed CPP system, using the best-estimate assumptions. Section 6 conducts individual sensitivity analysis, as well as finds the high-cost boundaries for each system. And section 7 compares four different economic and demographic scenarios.

5.1 Best-Estimate Results: Generational Accounts

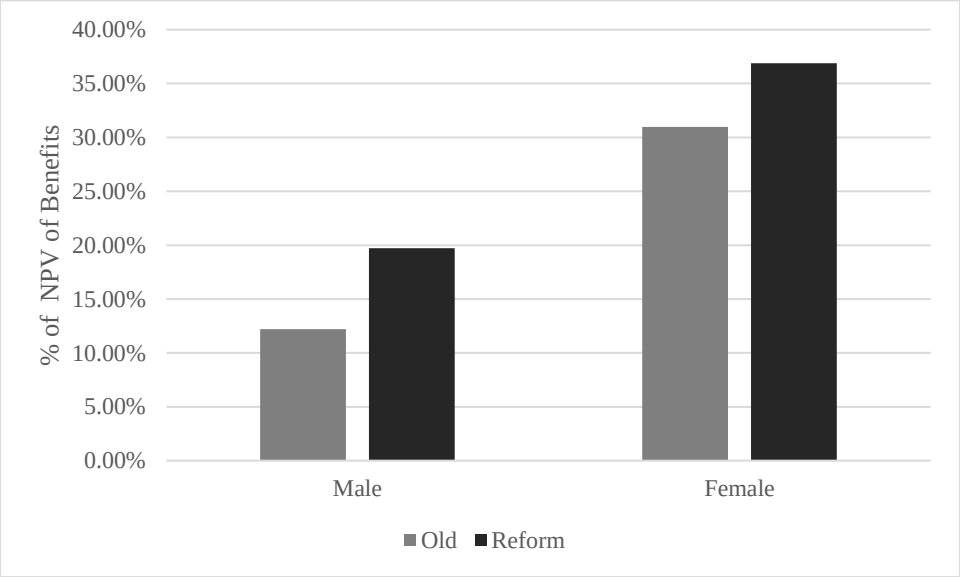
The main question of this paper is how the generational accounts of current and future cohorts change due to the CPP reforms. The best place to start is by looking at the 2001 cohort. Unlike older cohorts, the 2001 cohort works entirely in the old system or the reformed system. This means that the full effect of the reforms will be reflected in their generational accounts. Table 3 shows the generational accounts for the entire cohort, for both the old system, and the reformed system, as well as the internal rate of return (appendix section 3.3). To make the generational account figures easier to compare, they are divided by the net present value of their received benefits (appendix section 3.3). A real risk-free rate of 1.61% was used, which equals the yield of Canadian treasury bonds in July 2019[19]. Finally, the accounts are calculated in 2019 which is the first year of the simulation.

Table 3: Best-Estimate - Generational Account for the 2001 Cohort

Account	Old	Reform	Change
Male	12.19%	19.73%	7.54%
Female	30.98%	36.88%	5.90%
Internal Rate of Return	2.35%	2.62%	0.27%

[19] https://www.bankofcanada.ca/rates/interest-rates/canadian-bonds/

Chart 9: Best-Estimate - Generational Account for the 2001 Cohort



For both the entire male, and female cohorts, the reforms increase the value of their generational accounts by 5.9 – 7.5 percentage points. This represents the period when the generational accounts are at their smallest, since this is the first year this cohort begins contributing, and where benefits are furthest into the future. The increase in generational accounts results in an increase in the internal rate of return of 0.27 percentage points. As expected, the generational account is larger for females then for males, in both the old and reformed system. This is due to differences in mortality as well as how the additional CPP benefits were modeled[20]. Overall this represents a transfer from the male cohort to the female cohort.

This increase in the real internal rate of return represents an increase in the intergenerational transfer from the young to the old. This transfer has always been present in the CPP, as the average real rate of return since the creation of the program has been 2.3 percent (Mernard, Jean-Claude, 2015), with the older cohorts receiving an internal rate of return as high as 5 percent. But since the move to steady-state funding this does not represent a pure intergenerational transfer, it could also reflect the fact that part of each generation's contributions are being invested in the CPPIB fund and generating a financial return. Since this fund has historically generated returns much higher than 2.3%, this increase in the internal rate of return can partly be funded by these financial returns.

Chart 10 shows how the value of a generational account changes over time. The value of the generational account increases each year until it peaks at age 65, the year the cohort retires. At this point, the

[20] Since females receive the additional CPP benefits (specifically survivor benefits) more often than males

generational account under the reformed system is approximately 50% larger. This is due to the increase in the replacement rate and the increase in pensionable earnings.

Chart 10: Best-Estimate - Generational Account over Time for the Entire 2001 Male Cohort

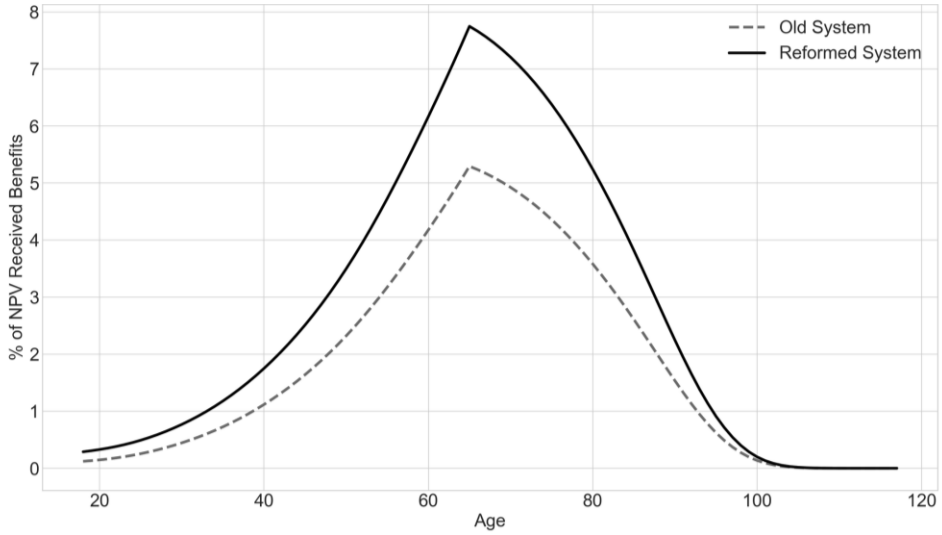
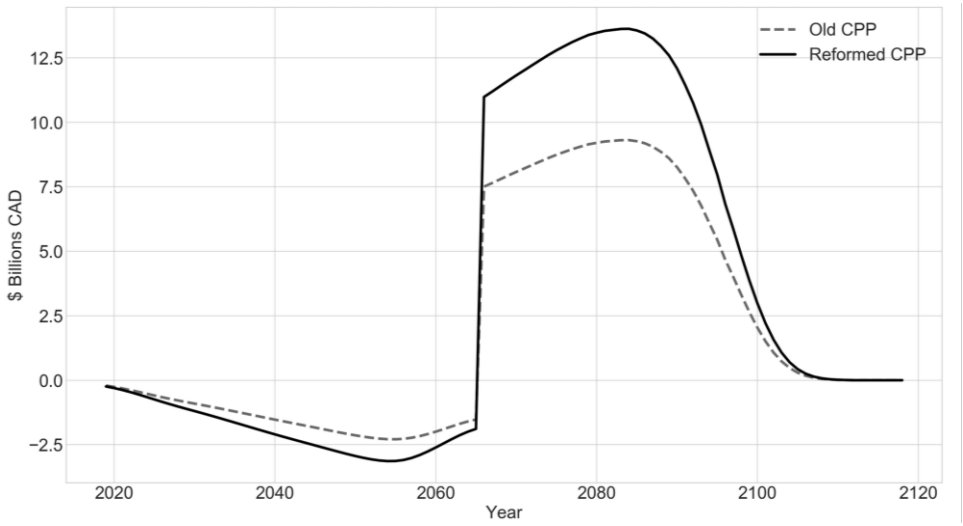


Chart 11 shows the financial projections in nominal terms for the entire male cohort born in 2001[21]. As expected, both contributions and benefits increase. Contributions peak around age 45-50, when income is the highest. This means that for those earning more than the YMPE (like males between the ages of 45 and 55), both the contribution rate, and the amount of income they must pay contributions on, increases. Total benefits paid to this cohort increases faster than the mortality rate for about 20 years, with benefits peaking when the cohort is in their 80s. This is primarily because of inflation, but also due to the additional pension benefits, which increase the pension benefit later in life in addition to inflation.

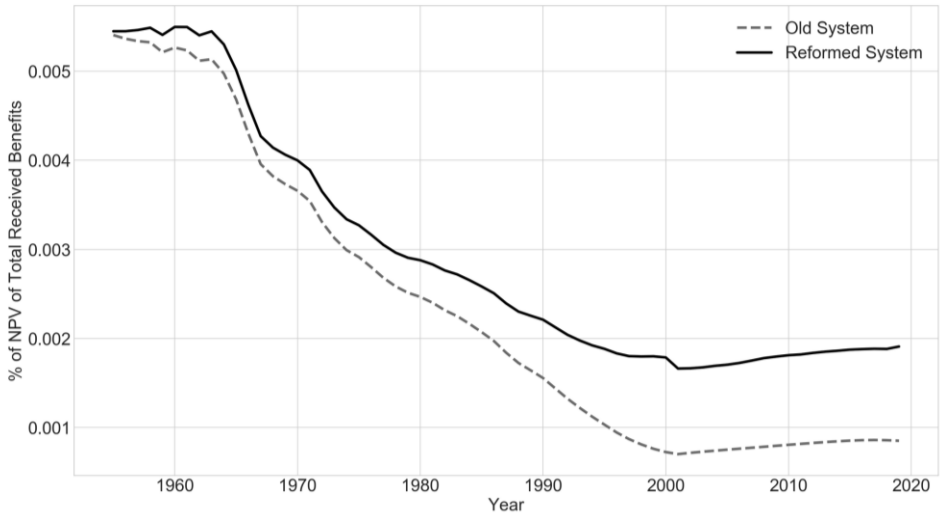
[21] I only show the male payments since males earn more than females, and therefore the differences between payments will be largest.

Chart 11: Best-Estimate - Nominal Net Payments for the 2001 Male Cohort



To expand upon this analysis, let us see how the reforms affect all working generations. Chart 12 shows how the change in generational accounts for the cohorts born between 1955 and 2019. The cohorts born before 1955 are not represented since they have already retired, and their benefits are not affected by the reforms. For those that contributed to both systems, their retirement benefit is calculated based on the number of years they worked in each system. Note that the older the generation, the closer they are to retiring, which makes the absolute size of the generational account larger. What is of interest is the change in generational accounts, and not the absolute size. As expected, the reforms have increased the generational accounts of every generation, in proportion to the number of years they worked in each system, with the largest increases going to those who worked in the reformed system longest.

Chart 12: Best-Estimate - Generational Accounts for Male Cohorts 1955 to 2019



To summarize, the generational accounts, for both male and female cohorts, increase. The male cohorts see the largest change in their generational accounts of 7.5 percentage points for the 2001 cohort. Whereas the generational account for the female cohort increases by 5.9 percentage points. Overall, the reforms increase the intergenerational transfers from the young to the old which results in an increase in the internal rate of return of 0.27 percentage points. This increase in generational accounts is present for all generations but is largest for those who work in the reformed system for more years.

5.2 Best-Estimate - Minimum Contribution Rates, PAYG rates, and A/E Ratios

The CPPIB uses several metrics when measuring the financial position of the CPP, such as the minimum contribution rate, the first year the system goes into deficit, and the asset-to-expenditure ratio (A/E ratio)[22]. These calculations are found in section 3.4 of the appendix. Table 4 and 5 summarize these results.

Table 4: Best-Estimate - Minimum Contribution Rates

	Minimum Contribution Rate		PAYG Rates 2025		PAYG Rates 2100	
Scenario	**Old**	**Reform**	**Old**	**Reform**	**Old**	**Reform**
Best-estimate	9.70%	10.60%	10.50%	9.30%	12.40%	16.30%

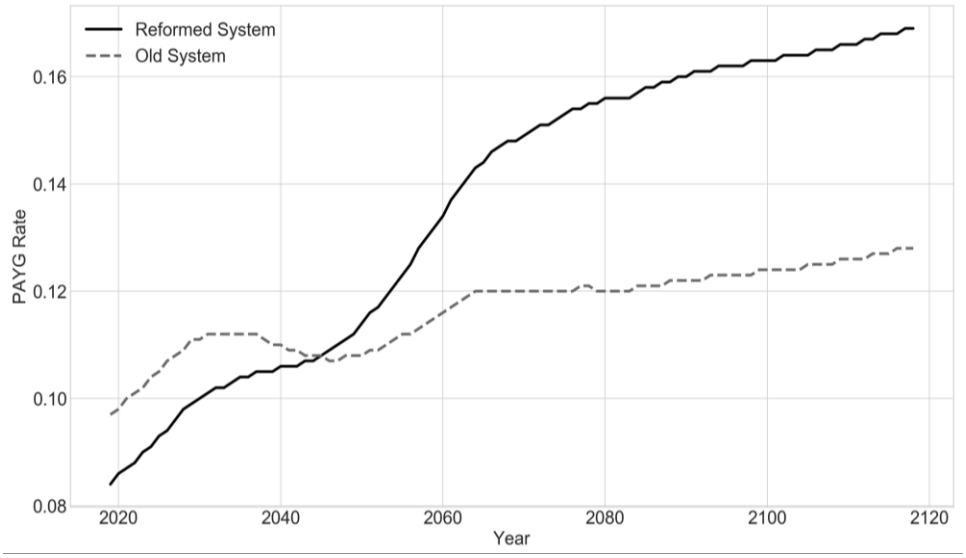
As described in section 2, the minimum contribution rate is defined as the contribution rate that allows the A/E ratio to remain stable in the 10th, and the 60th year of the analysis. As of 2019 the minimum contribution rate for the old system was 9.7% compared to 10.6% for the reformed system. As expected, the reforms push this minimum contribution rate up, due to the expansion of benefits. But notice how close each minimum contribution rate is to their respective statutory contribution rate. The old system only has 0.3 percentage points to rise before the minimum contribution rate exceeds the contribution rate of 9.9%, while the new minimum contribution rate has 1.4 percentage points to rise before it exceeds the contribution rate of 11.9%. This shows that the reformed system has more space to expand before the balancing mechanism is triggered.

An interesting result is how the reforms initially push the PAYG rate down below that of the old system. This is driven by the increase in pensionable earnings. Even though expenditures do not rise much in the short term, the amount of income that participants are paying contributions on increases, which thus pushes down the PAYG rate. That is, until the new enhanced benefits start to be paid out, and the full

[22] Value of the CPPIB fund divided by the expenditures (benefits paid) for a particular year

effect of the reforms are reflected. Then the PAYG rate for the reformed system rises above the old rate, as displayed in chart 13.

Chart 13: Best-Estimate - PAYG Rates



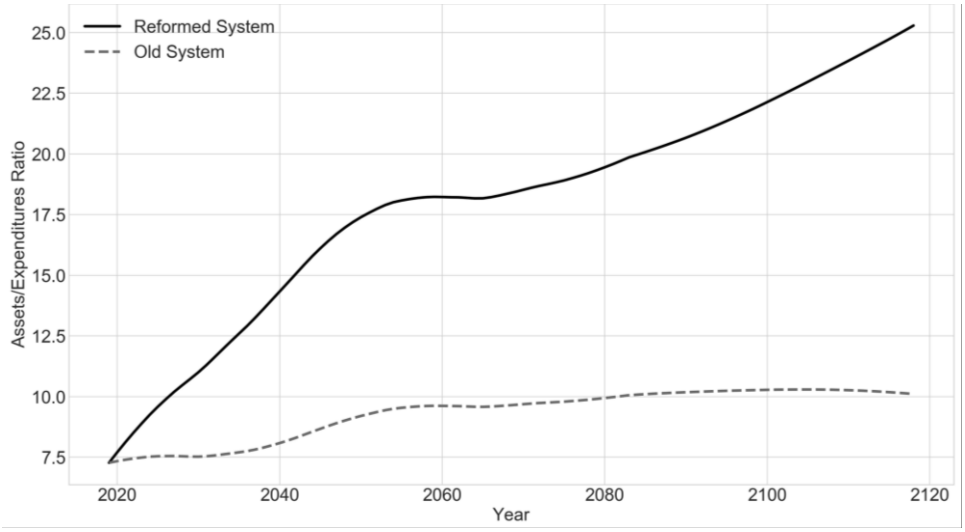
Under the old CPP system, the first projected year of deficit is 2021, while the reforms push this date back until 2055. These additional years in surplus allow the CPPIB fund to grow faster. Due to the additional investments, and the additional time the fund is not in deficit, the fund is projected to be 21.1x expenditures by 2100 for the reformed system, whereas it's only projected to be 10.3x times for the current system.[23] Full financial projections are found in section 3.4 of the appendix.

Table 5: Best-Estimate - Deficit and A/E Ratios

	First Year of Deficit		A/E 2025		A/E 2100	
Scenario	**Old**	**Reform**	**Old**	**Reform**	**Old**	**Reform**
Best-estimate	2021	2053	7.54	9.58	10.28	22.14

[23] These results are likely to change with further improvements to the simulation. Also note that the simulation was already overestimating the size of the CPPIB fund compared to the report. This is only a minor concern since the CPPIB fund does not directly affect generational accounts.

Chart 14: Best-Estimate - Asset/Expenditure Ratio



6. Sensitivity Analysis

To investigate the robustness of these results, sensitivity analysis was conducted using high-cost and low-estimates on six parameters: inflation, productivity, returns to the CPPIB fund, population growth, immigration, and life expectancy. The CPPIB report provided the initial values for the low-cost, and high-cost parameters but some had to be changed to meet the needs of this thesis. Unlike the actuary's report, the main interest of this thesis is the change in generational accounts, therefore to accurately compare these changes the balancing mechanism must not be engaged. If it were engaged, then the value of the generational accounts may change, but until we know how parliament would restore the financial position of the CPP, we do not know which cohorts will be affected and by how much. Therefore, the high-cost parameters were changed from those provided by the CPPIB to values where both systems were sustainable. But to shed light on the sensitivity of each system, high-cost boundaries were found for each system, and are reported in table 9.

Table 6: Sensitivity Analysis - Parameters

Assumption	Low-Cost	Best-Estimate	High-Cost
Inflation	2.50%	2%	1.50%
Real Productivity Growth	1.80%	1.10%	0.05%
Real Fund Returns	5.60%	3.90%	3.60%
Population Growth	~2.0	~1.65	~1.3
Net Migration	~0.74%	~0.62%	~0.49%
Life Expectancy in 2050: Female	85.8	87.4	88.5
Life Expectancy in 2050: Male	82.2	84.2	85.5

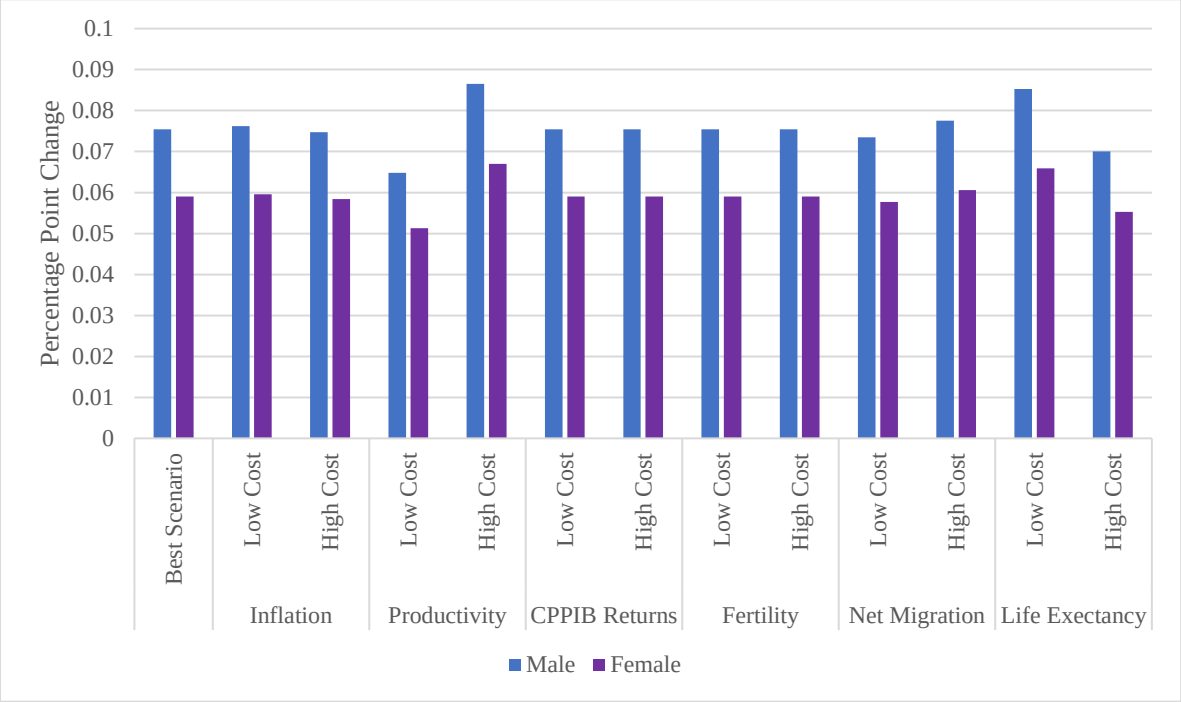
Table 7 presents the change in generational accounts for the 2001 cohort between the low-cost and high-cost parameters. While the absolute value of the generational accounts varies widely (between 0.4% to up to 44.9%), the change in generational accounts remained similar to those for the best estimate – on average between 5.9 percentage points for females – and 7.5 for males. These changes resulted in an almost uniform increase in the internal rate of return of 0.27%. This implies that regardless of economic, or demographic changes, the reforms increase the generational accounts, and intergenerational transfers. The two parameters that drive the largest changes in generational accounts are productivity and mortality.

Table 7: Sensitivity Analysis - Generational Accounts

		Male			Female			IRR		
Assumption	**Scenario**	**Old**	**Reform**	**Change**	**Old**	**Reform**	**Change**	**Old**	**Reform**	**Change**
	Best Scenario	12.2%	19.7%	7.54%	31.0%	36.9%	5.90%	2.4%	2.6%	0.27%
Inflation	Low-Cost	11.3%	18.9%	7.62%	30.3%	36.2%	5.96%	2.3%	2.6%	0.27%
	High-Cost	13.1%	20.6%	7.47%	31.7%	37.5%	5.84%	2.4%	2.6%	0.27%
Productivity	Low-Cost	23.7%	30.1%	6.48%	39.8%	44.9%	5.13%	2.8%	3.0%	0.27%
	High-Cost	0.4%	9.1%	8.65%	22.0%	28.7%	6.70%	2.0%	2.3%	0.27%
CPPIB Returns	Low-Cost	12.2%	19.7%	7.54%	31.0%	36.9%	5.90%	2.4%	2.6%	0.27%
	High-Cost	12.2%	19.7%	7.54%	31.0%	36.9%	5.90%	2.4%	2.6%	0.27%
Fertility	Low-Cost	12.2%	19.7%	7.54%	31.0%	36.9%	5.90%	2.3%	2.6%	0.27%
	High-Cost	12.2%	19.7%	7.54%	31.0%	36.9%	5.90%	2.4%	2.7%	0.27%
Net Migration	Low-Cost	14.0%	21.3%	7.35%	32.3%	38.1%	5.77%	2.4%	2.7%	0.27%
	High-Cost	10.2%	17.9%	7.75%	29.4%	35.5%	6.06%	2.3%	2.6%	0.27%
Life Expectancy	Low-Cost	0.7%	9.3%	8.53%	22.9%	29.5%	6.59%	2.0%	2.3%	0.28%
	High-Cost	18.5%	25.5%	7.00%	35.3%	40.9%	5.53%	2.5%	2.8%	0.26%
Average	**Scenarios**	**11.76%**	**19.34%**	**7.58%**	**30.66%**	**36.59%**	**5.93%**	**2.34%**	**2.61%**	**0.27%**

Table 7 also highlights the fact that CPPIB fund returns do not affect the generational accounts. This is because benefits are only indexed to inflation, and nothing else. Participants do not have a notional claim on the higher returns of the CPPIB fund. The only circumstance where the returns of the CPPIB fund affect generational accounts is when the fund underperforms, reducing the A/E ratio, and triggering the balancing mechanism.

Chart 15: Sensitivity Analysis - Change in Generational Accounts



When looking at the financial results, the most important metric to focus on is the change to the minimum contribution rate. As chart 16 shows, the parameter that affects the minimum contribution rate the most is the CPPIB fund returns, followed by mortality and fertility. Table 8 shows the value of the minimum contribution rate for the old and reformed systems. Notice that in almost every high-cost scenario the old system is on the edge of triggering the balancing mechanism, while the highest value for the reformed system is 11%, which is well below the threshold of 11.9%.

Chart 16: Sensitivity Analysis - Change in Minimum Contribution Rate

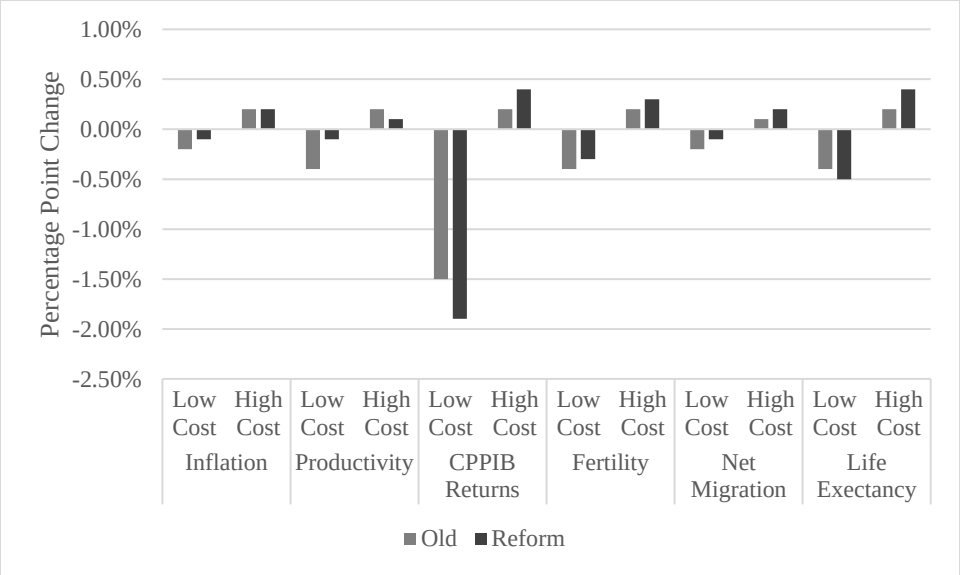


Table 8: Sensitivity Analysis - Minimum Contribution and PAYG Rates

		Minimum Contribution Rate		PAYG Rates 2025		PAYG Rates 2100	
Assumption	**Scenario**	**Old**	**Reform**	**Old**	**Reform**	**Old**	**Reform**
	Best-estimate	9.70%	10.60%	10.50%	9.30%	12.40%	16.30%
Inflation	Low-Cost	9.50%	10.50%	10.30%	9.10%	12.20%	16.10%
	High-Cost	9.90%	10.80%	10.80%	9.50%	12.50%	16.50%
Productivity	Low-Cost	9.30%	10.50%	10.10%	8.90%	11.10%	14.70%
	High-Cost	9.90%	10.70%	10.90%	9.60%	13.60%	17.90%
CPPIB Returns	Low-Cost	8.20%	8.70%	10.50%	9.30%	12.40%	16.30%
	High-Cost	9.90%	11.00%	10.50%	9.30%	12.40%	16.30%
Fertility	Low-Cost	9.30%	10.30%	10.50%	9.30%	11.70%	15.50%
	High-Cost	9.90%	10.90%	10.50%	9.30%	12.90%	17.10%
Net Migration	Low-Cost	9.50%	10.50%	10.40%	9.20%	12.50%	16.50%
	High-Cost	9.80%	10.80%	10.60%	9.40%	12.20%	16.10%
Life Expectancy	Low-Cost	9.30%	10.10%	10.50%	9.30%	10.90%	14.30%
	High-Cost	9.90%	11.00%	10.50%	9.30%	13.30%	17.50%

Table 9 summarizes the first year each system goes into deficit, and the A/E ratios in 2025, and 2100. The first year of deficit for the reformed system varies widely, with the largest variations due to productivity. The high-cost productivity parameter pushes the first year of deficit forward to 2047, which is six years earlier than the best-estimate, while the low-cost pushes it back until 2059. The A/E ratio does not change much in 2025 but varies widely in 2100. As expected, the largest variation is in the CPPIB fund returns.

They can be anywhere between 6x larger than expenditures, or 100x larger than expenditures depending on the return of the fund. This highlights the importance of generating steady returns to the CPP.

Table 9: Sensitivity Analysis - Deficit and A/E Ratios

		First Year of Deficit		A/E 2025		A/E 2100	
Assumption	Scenario	**Old**	**Reform**	**Old**	**Reform**	**Old**	**Reform**
	Best-estimate	2021	2053	7.54	9.58	10.28	22.14
Inflation	Low-Cost	2022	2054	7.77	9.84	13.57	24.51
	High-Cost	2021	2053	7.31	9.32	6.80	19.64
Productivity	Low-Cost	2022	2059	7.60	9.67	13.74	20.28
	High-Cost	2021	2047	7.49	9.51	5.40	24.04
CPPIB Returns	Low-Cost	2021	2053	8.30	10.43	70.50	100.03
	High-Cost	2021	2053	7.41	9.44	6.14	16.10
Fertility	Low-Cost	2021	2057	7.54	9.58	15.42	25.79
	High-Cost	2021	2051	7.54	9.58	6.10	19.17
Net Migration	Low-Cost	2021	2056	7.56	9.61	11.72	22.34
	High-Cost	2021	2051	7.52	9.56	8.56	21.90
Life Expectancy	Low-Cost	2021	2056	7.54	9.58	19.27	32.04
	High-Cost	2021	2052	7.54	9.58	5.54	17.04

6.1 Sensitivity Analysis: High-Cost Boundaries

While conducting sensitivity analysis, the high-cost boundaries were calculated for each system and are summarized in table 10. These are defined as the minimum high-cost values that will engage the balancing mechanism. For example, if the CPPIB fund returns are less than 3.5% per year then the balancing system will be triggered, but values higher than this are sustainable.

Table 10: Sensitivity Analysis - High-Cost Boundaries

	High-Cost Boundary	
Assumption	**Old**	**Reform**
Inflation	1.30%	0.00%[24]
Real Productivity Growth	0.40%	0.00%[25]
Real Fund Returns	3.50%	3.00%
Fertility	~1.15	~0.66
Net Migration	0.45%	0.00%
Life Expectancy in 2050: Female	89	91.7
Life Expectancy in 2050: Male	86	89.5

[24] The simulation was not designed for deflation, so zero is the lowest value analyzed
[25] The simulation was not designed for negative productivity growth, so zero is the lowest value analyzed

By comparing the boundaries for each system, we can directly compare how financially robust each is. At initial inspection, the reformed system seems more robust than the old system, since the boundaries are much lower. This implies that it has much more scope to absorb a shock in any one of these parameters then the old system. Although, this is slightly misleading since each system is in a different stage of maturity. The old system is about to fully reflect the reforms from 1997, with the PAYG rate rising above the contribution rate, and investment income beginning to cover the deficit in 2021. Whereas the reformed system is now entering a period where it is accumulating assets and will be in surplus until 2053. It would be more accurate to compare the old system with the reformed system in 2050, right before it is projected to go into deficit. While this analysis suggests that in the short term, the reformed system is more robust then the old system, we cannot draw long term conclusions about this.

7. Scenario Analysis

To further understand the effect of the reforms, four scenarios are created which combine high and low population and economic growth parameters. This can be thought as four different types of economies, with a high population and high economic growth economy similar to that of the 1950s, a high population and low economic growth economy similar to the 1970s, a low population and high economic growth economy similar to the 1990s and the low population and low economic growth economy similar to the economy today. [26] The scenarios are summarized in table 11.

Table 11: Scenario Analysis - Parameters

Assumption	Best-estimate	High Population and High Economic Growth	High Population and Low Economic Growth	Low Population and High Economic Growth	Low Population and Low Economic Growth
Inflation	2%	2.50%	1.50%	2.50%	1.50%
Productivity	1.10%	2.00%	0.80%	2.00%	0.80%
Returns	3.90%	6.50%	3.60%	6.50%	3.60%
Fertility Rate	~1.65	~2.0	~2.0	~1.3	~1.3
Net Migration	~0.62%	~0.74%	~0.74%	~0.49%	~0.49%
Life Expectancy 2050: Female	87.4	88.5	88.5	86	86
Life Expectancy 2050: Male	84.2	85.5	85.5	83	83

[26] When choosing parameters, the high-cost boundaries were avoided since these are known to trigger the balancing mechanism.

These different scenarios can lead to very different population and economic figures. For example, using the best-estimate assumptions, the population is projected to be 50 million in 2100, but in the low-population growth scenario its only projected to be 35 million, whereas in the high-population growth scenario its projected to be 60 million. The difference between inflation, and productivity, also leads to a wide variation. In the best-estimate assumption, between 2018 and 2100, prices rise 5x, whereas for the low-economic growth scenario they rise only 3.4x and for the high-economic growth scenario its 7.5x. These variations will help us better understand the changes to the generational accounts in different economies, as well as how robust each system is to different population and economic circumstances.

Chart 17: Scenario Analysis – Population Projections

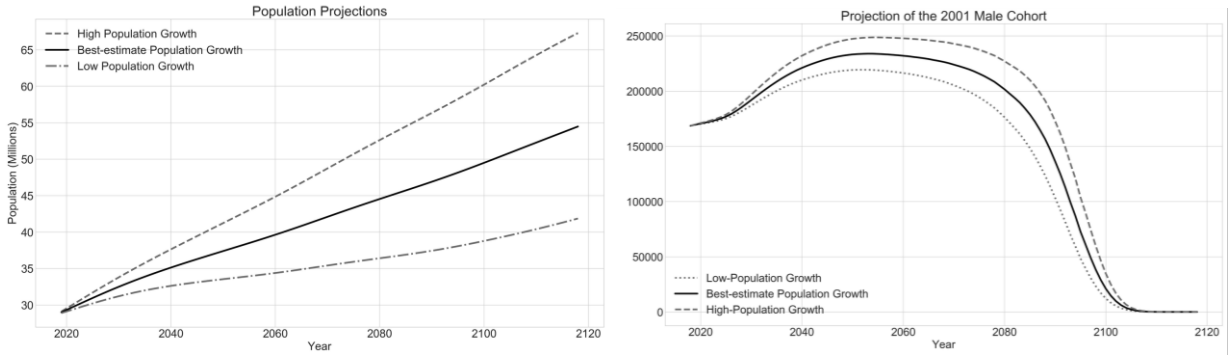


Table 12 summarizes the changes in the generational accounts. Upon first inspection, the results are as expected, with the reformed system increasing the size of the generational accounts between 5.9 to 7.5 percentage points, similar to the results using the best-estimate assumptions. But analyzing these changes is made more difficult by the fact that the balancing mechanism was engaged in both the low economic growth scenarios but only for the old system (as showed in table 13). Therefore, we cannot be sure what the generational accounts are for the old system, but we can assume that these figures represent the most optimistic figures for this cohort. This is because any act by parliament to restore the financial position of the CPP will either raise contribution rates, or lower benefits, on some or all generations. We can think of this generational account figure as being accurate only if we assume that what parliament does will not affect this generation (or in other words the entire burden will fall on other generations). Therefore, the change in generational accounts of 7.24, and 8.63 percentage points for the male, and 5.79 and 6.89 percentage points for the female cohort probably underestimates the true change, since it assumes that the balancing mechanism does not affect this generation.

Table 12: Scenario Analysis - Generational Accounts

	Male			Female		
	Old	**Reform**	**Change**	**Old**	**Reform**	**Change**
Best-estimate	**12.20%**	**19.74%**	**7.54%**	**31.0%**	**36.9%**	**5.90%**
High Population and High Economic Growth	26.67%	32.93%	6.26%	40.7%	45.8%	5.06%
High Population and Low Economic Growth	16.32%	23.56%	7.24%	32.7%	38.5%	5.79%
Low Population and High Economic Growth	12.59%	20.05%	7.46%	29.4%	35.4%	6.02%
Low Population and Low Economic Growth	0.26%	8.89%	8.63%	19.8%	26.7%	6.89%

While the balancing mechanism will affect the generational accounts and the A/E ratios, it will have little effect on the future PAYG rates. The two scenarios that cause the largest variation in the minimum contribution rate, as well as the PAYG rates are the low economic growth scenarios. Interestingly though, in 2100, only one PAYG rate is above the best-estimate rate, that is for the high population growth and low economic growth scenario. As chart 18 shows, up until 2080, the low population and economic growth PAYG rate was above that of the best estimate, but eventually declines once the size of the older generations declines.

Table 13: Scenario Analysis - Minimum Contribution Rates

	Minimum Contribution Rate		PAYG Rates 2025		PAYG Rates 2100	
	Old	**Reform**	**Old**	**Reform**	**Old**	**Reform**
Best-estimate	9.70%	10.60%	10.50%	9.30%	12.40%	16.30%
High Population and High Economic Growth	7.00%	7.50%	9.70%	8.60%	11.00%	14.50%
High Population and Low Economic Growth	10.10%[27]	11.20%	10.80%	9.50%	13.50%	17.90%
Low Population and High Economic Growth	7.20%	7.60%	9.90%	8.70%	10.20%	13.40%
Low Population and Low Economic Growth	10.50%[28]	11.40%	11.00%	9.70%	12.40%	16.40%

[27] Balancing mechanism triggered
[28] Balancing mechanism triggered

Chart 18: Scenario Analysis – PAYG Rates

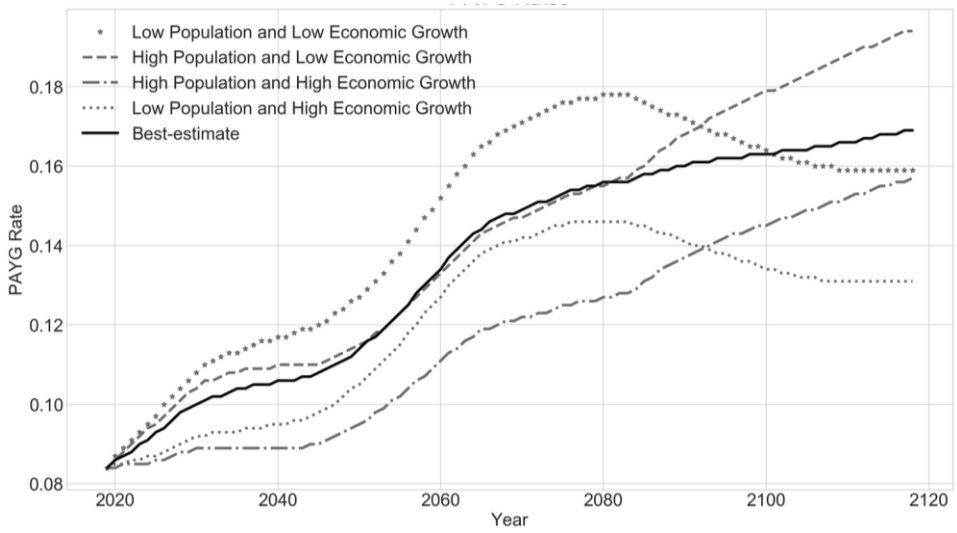


Chart 19 shows the change in nominal net payments for the 2001 male cohort. The solid black line is the reformed system under the best-estimate assumptions. As we can see the nominal size of the CPP can vary widely, with max benefits paid out to a cohort anywhere from $8 billion for the low population and economic growth scenario to $32 billion for the high population and economic growth scenario. Also, the degree at which benefits increase over time changes (as shown by the year in which total benefits paid peaks). This is due to the difference between inflation (which increases benefits) and mortality (which reduces the number of beneficiaries). As expected, benefits peak at the latest for the high economic and population growth scenario due to the higher inflation rate, and lower mortality rate.

Chart 19: Scenario Analysis – Nominal Net Payments 2001 Male Cohort

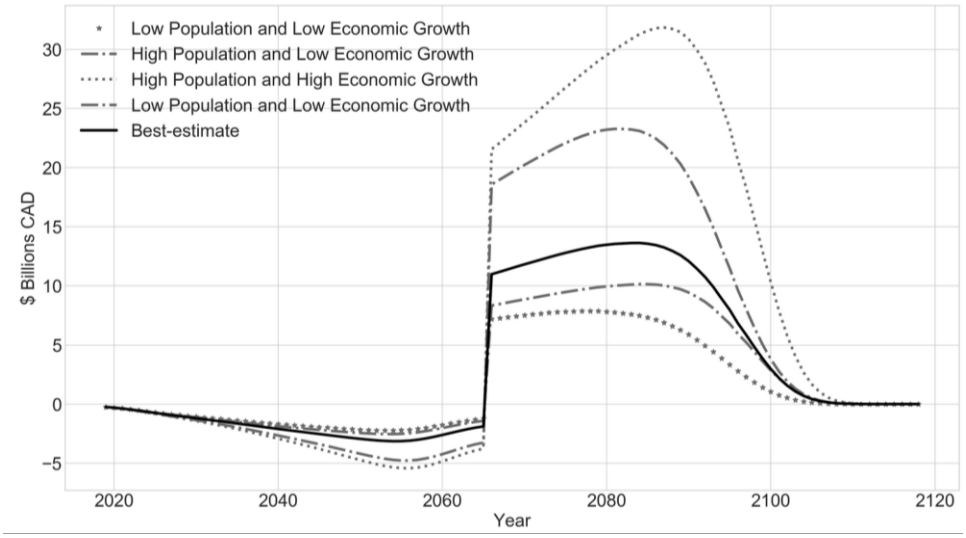


Table 14 shows the first year of deficit and A/E ratios for each scenario. There are several interesting things about this chart. First, what is not surprising is that the high population and economic growth scenario pushes the first year of deficit back the furthest, but what is surprising is the number of years it pushes it back by – by 63 years for the old system, and 13 years for the reformed system. This is also reflected in the A/E ratio of over 100 for both systems.

Table 14: Scenario Analysis - Deficit and A/E Ratios

	First Year of Deficit		A/E 2025		A/E 2100	
	Old	**Reform**	**Old**	**Reform**	**Old**	**Reform**
Best-estimate	2021	2053	7.54	9.58	10.28	22.14
High Population and High Economic Growth	2084	2066	9.078	11.319	111.378	127.323
High Population and Low Economic Growth	2021	2053	7.179	9.17	2.766	13.386
Low Population and High Economic Growth	2025	2057	9.04	11.266	149.649	178.443
Low Population and Low Economic Growth	2020	2044	7.144	9.12	N/A[29]	14.835

The scenario analysis highlights how economic growth seems to be more important than population growth. There is a lot of discussion about the necessity of increasing population growth figures, but even with a 20% increase in birth rates, and immigration, the dependency ratio is still projected to decline to around 2 (appendix section 4.3). It is much harder to change demographics than it is economic conditions. While having higher population growth could ease some of the stress on the CPP, economic growth is more important.

8. Conclusions and Future Research

In conclusion the CPP reforms increase the generational accounts by an average of 5.9 percentage points for females, and 7.4 percentage points for males. All generations working in the reformed system see an increase in their generational account, proportional to the number of years they worked in each system. The increase in generational accounts results in an increase in the internal rate of return by 0.27 percentage points. This represents an increase in the intergenerational transfer from the young to the old, but because the CPP is not a pure PAYG system, it does not represent a pure intergenerational transfer. Instead, part of this transfer comes from the returns of the CPPIB fund. These changes to the generational accounts, and the internal rate of return, remain stable when conducting sensitivity, and scenario analysis.

[29] Fund depleted before 2100

This implies that these results are robust – but more work can be done to further verify these figures as described below.

Since the reforms increase contribution rates, and pensionable earnings, while pushing benefit increases into the future, the financial position of the CPP improves for the next 35 years, with the first deficit not scheduled until 2053. That does not mean that the system is less risky, but only that the type of risk is shifted over time. Demographic risk was pushed into the future and will be at its highest when the full increase in benefits start to be paid out. But the reformed CPP faces more financial risk in the present. The CPPIB fund is already one of the largest sovereign wealth funds in the world, and it will inevitably increase over the next 35 years while the system continues to invest its financial surpluses. Can it continue to grow at a nominal rate of 5.9% over the long run? If it does not the consequences are higher contribution rates, or lower benefits for participants.

What is more surprising was how comparatively frail the old CPP system was. Under the best-estimate the minimum contribution rate is already 9.7%, with not much room to rise before the balancing mechanism is engaged. While the government does not mention anywhere that they were motivated to improve the financial position of the system, it is conceivable that this was a secondary motivation.

There are many areas in which this type of research can be expanded. For example, the simulation could be improved by modeling early and late retirement options, different asset mixes for the CPPIB fund, as well as how the CPP is affected by recessions. It could also be interesting to challenge some of the assumptions made by in the CPPIB report and see how this effects their analysis. Additionally, the trends can be made stochastic instead of deterministic – turning the simulation into a Monte Carlo simulation.

While the model is adequate to calculate generational accounts, it is still a simplified version of that used by the CPPIB, especially when attempting to make accurate financial projections. There are many areas that one could improve upon the simulation. On the population side, the largest area of improvement would be to make births endogenous to the population. On the economic side, a more dynamic system for productivity, and job creation could be modeled. Finally, from the pension plan aspect of the simulation, an area of improvement would be to properly model the different pension benefits, and the rates and age that they are taken up.

The 2016 reforms to the Canadian Pension Plan are the largest changes to the Canadian pension system in the last 25 years. More research will be needed to fully understand how they affect the retirement income of working Canadians. Particularly of interest, is the publication of the 2019 actuary's report, which is due to be published in September 2019.

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