



Office of the Superintendent of
Financial Institutions Canada

Bureau du surintendant des
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Office of the Chief Actuary

Bureau de l'actuaire en chef

Actuarial Valuation of the Canada Pension Plan

Modeling Uncertainty and Properly Disclosing the Results



Session 125: Social Insurance Projections – Methods and Models
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Canada

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Canada Pension Plan

- Came into force on 1 January 1966.
- National Career Adjusted Earnings Defined Benefit Plan.
- The CPP includes virtually all members of the labour force in Canada, including both employees and self-employed persons between the ages of 18 and 70 with employment earnings, other than those covered by the Québec Pension Plan (QPP).
- Financed by employees' and employers' contributions (12.5 million contributors in 2009) and in the future, by investment earnings.
- Provides retirement, disability, survivor, child ,and death benefits (5.2 million beneficiaries in 2009).



Cash Flow Formula

Definitions

A_t : Assets at the end of year t .

CF_t : Net Cash Flow in Year t

I_t : Annual investment income in year t

Co_t : Annual contribution income in year t (excluding interest income)

E_t : Annual expenditures in year t (benefits + administrative expenses)

i_t : Rate of Return in year t

Formulas

$$\begin{array}{l} A_t = A_{t-1} + Co_t + I_t - E_t \\ CF_t = Co_t - E_t \end{array} \quad \Rightarrow \quad A_t = A_{t-1} + CF_t + I_t$$

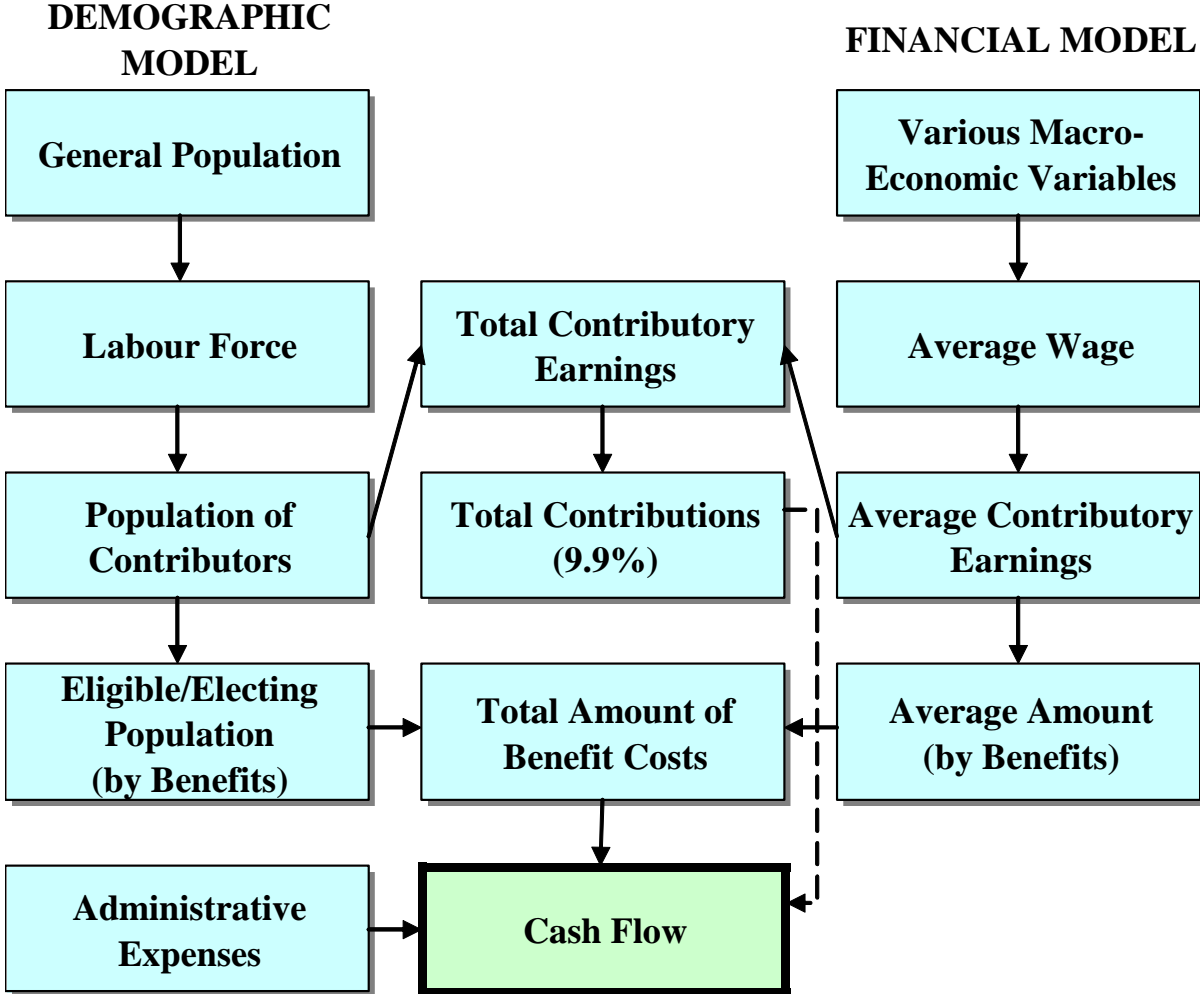
$$I_t = i_t A_{t-1} + [(1 + i_t)^{1/2} - 1] Co_t - [(1 + i_t)^{1/2} - 1] E_t$$

$$A_t = (1 + i_t) A_{t-1} + [(1 + i_t)^{1/2}] (Co_t - E_t) = (1 + i_t) A_{t-1} + [(1 + i_t)^{1/2}] CF_t$$

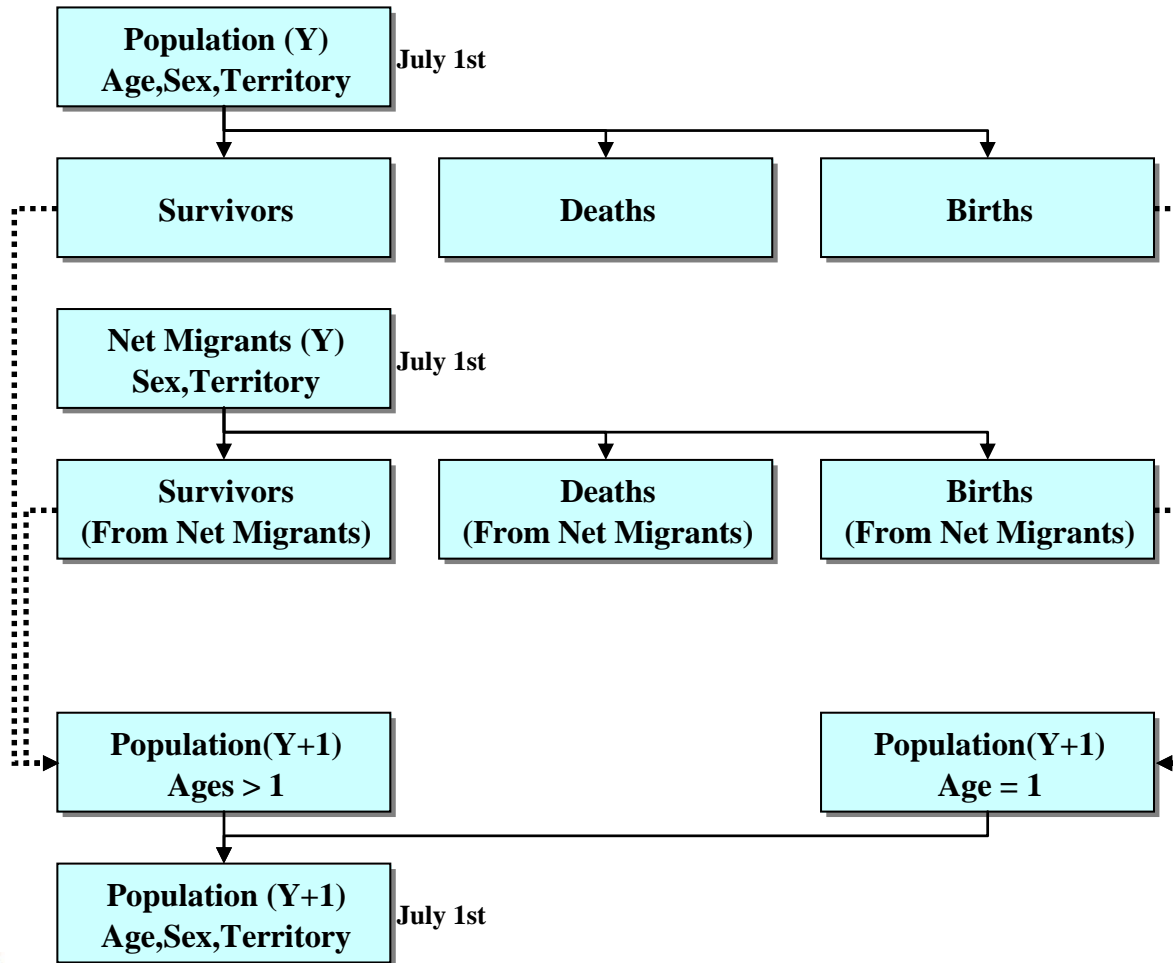


Cash Flow: The Big Picture

PROJECTIONS



Demographic Model



Major Assumptions

- Mortality
- Migration
- Fertility



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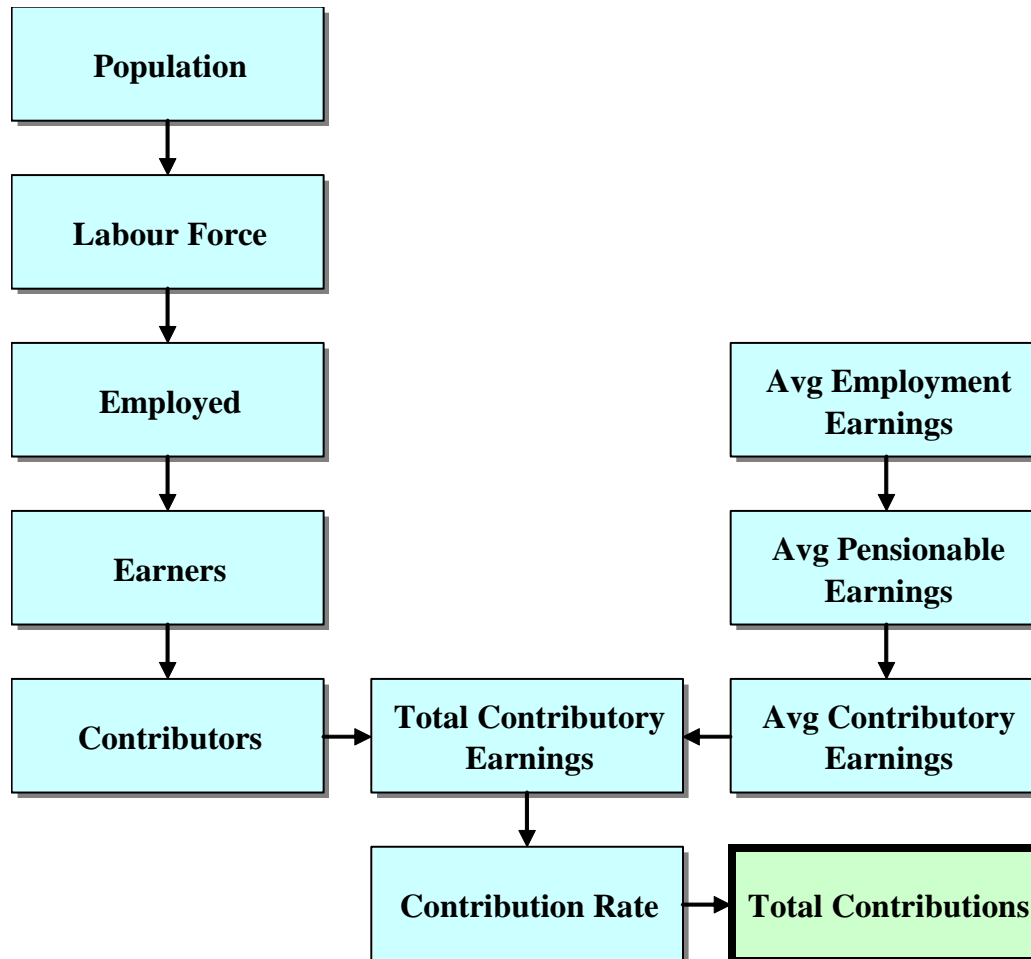
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Contributions

- CPP contribution rate is applicable to annual earnings between
 - a minimum amount called the “Year’s Basic Exemption” (YBE)
 - and a maximum amount called the “Year’s Maximum Pensionable Earnings” (YMPE).
- Contributions are based on
 - Employment earnings from salary or wages; and
 - Self-employment earnings.
- The employer matches each employee’s contributions (4.95%).
- Those who are self-employed pay both shares (9.9%)



Contributions Model



Major Assumptions

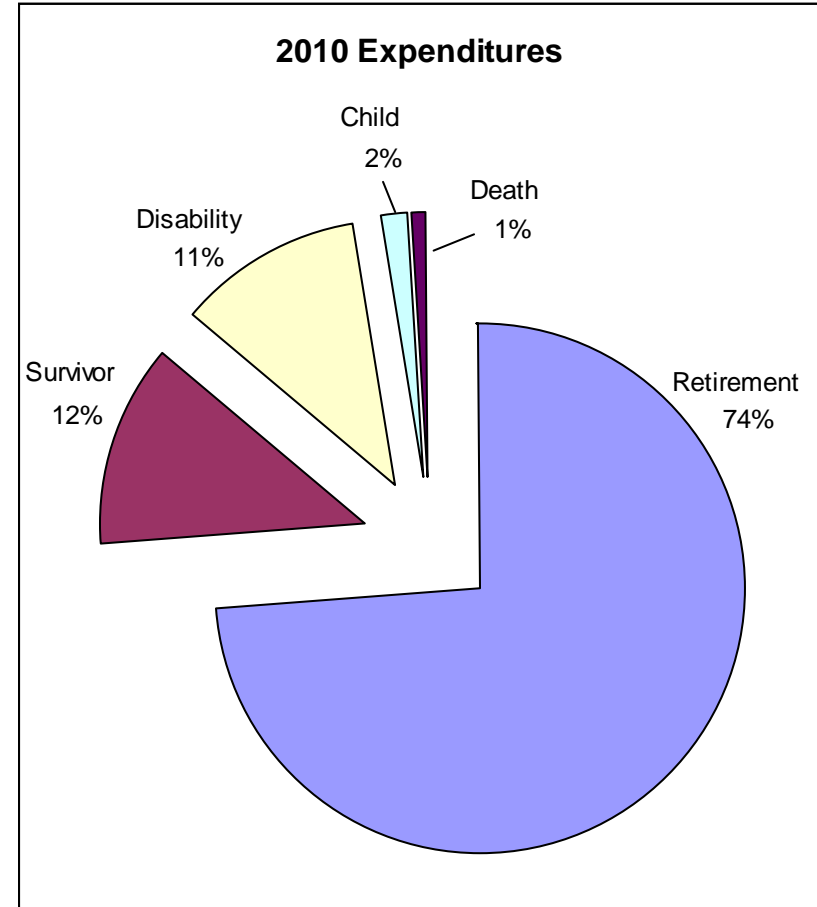
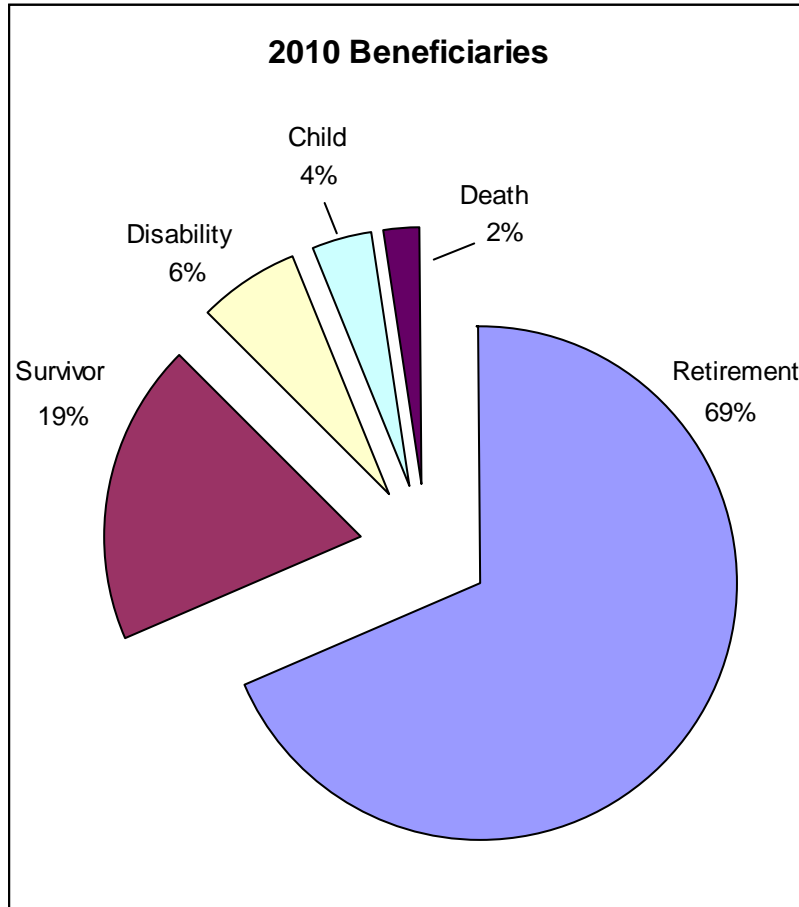
- Labour Force Participation Rates
- Unemployment Rates
- Employment Rates
- Proportion of Earners
- Proportion of Contributors
- Average and Total Employment Earnings
- Average and Total Pensionable Earnings
- Average and Total Contributory Earnings
- Earners and Earnings Distributions (%)



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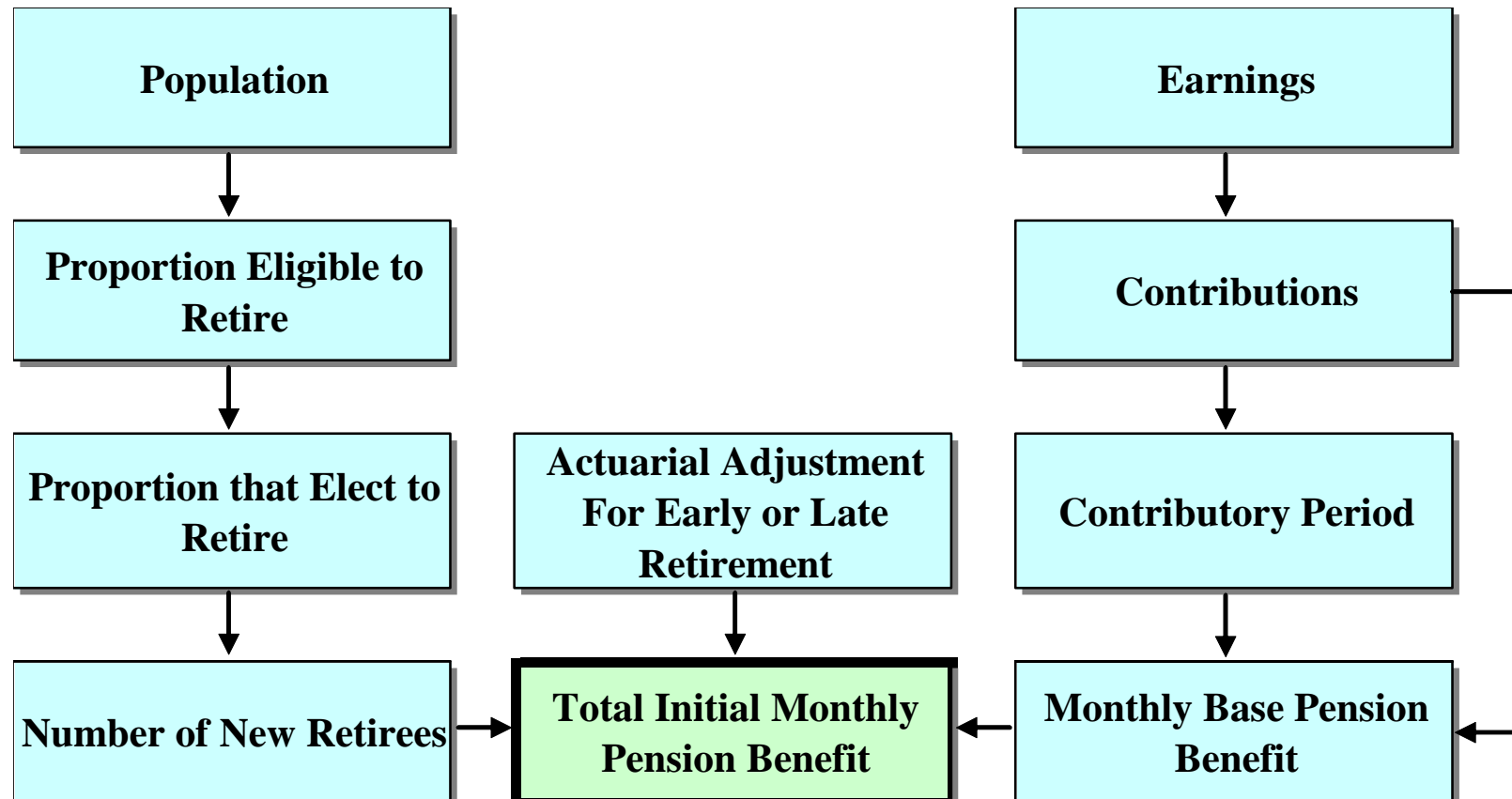
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Expenditures



Source: Actuarial Report on the CPP as at 31 December 2006

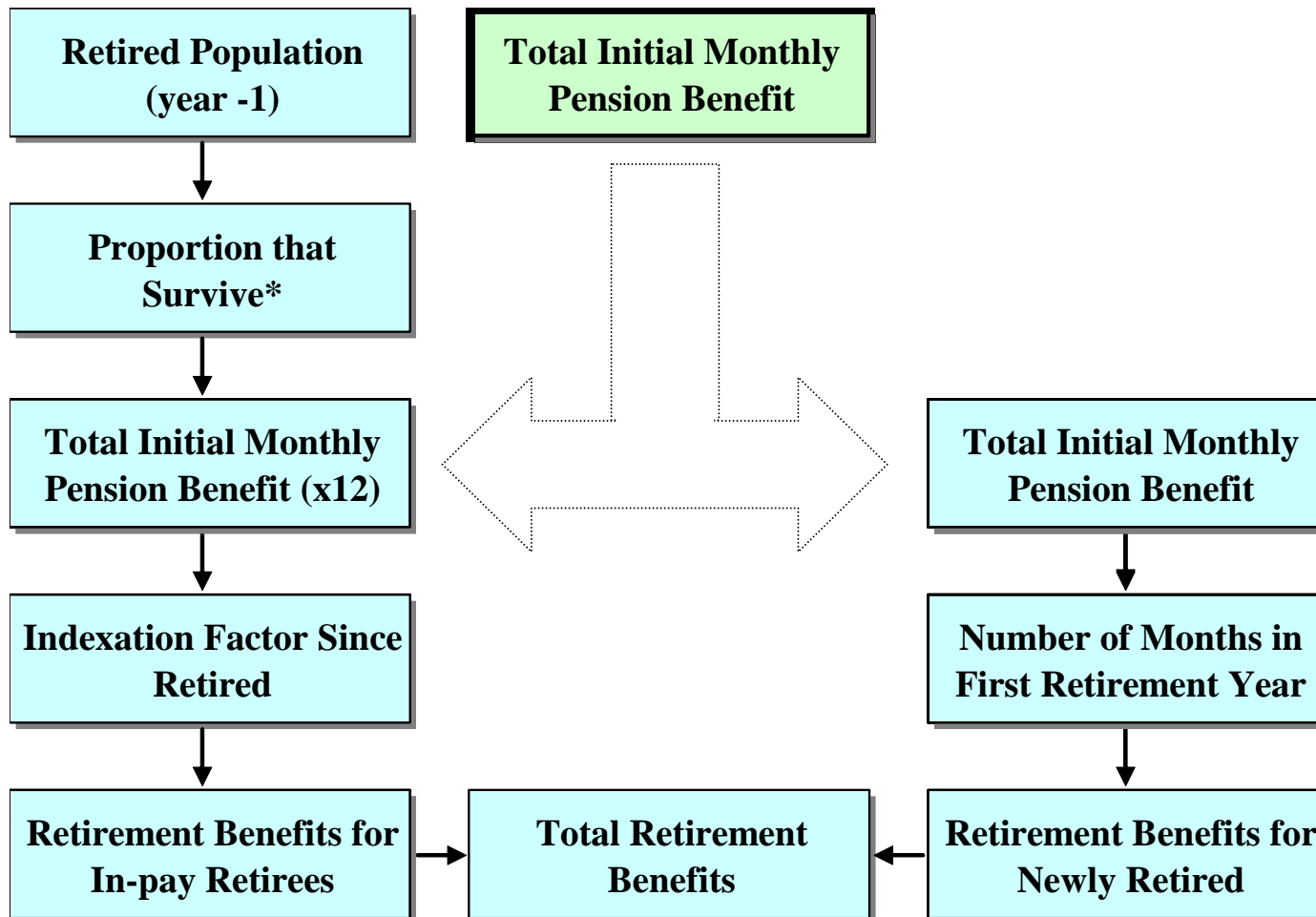
Retirement Benefit Calculation



Calculation done for each year, age and sex



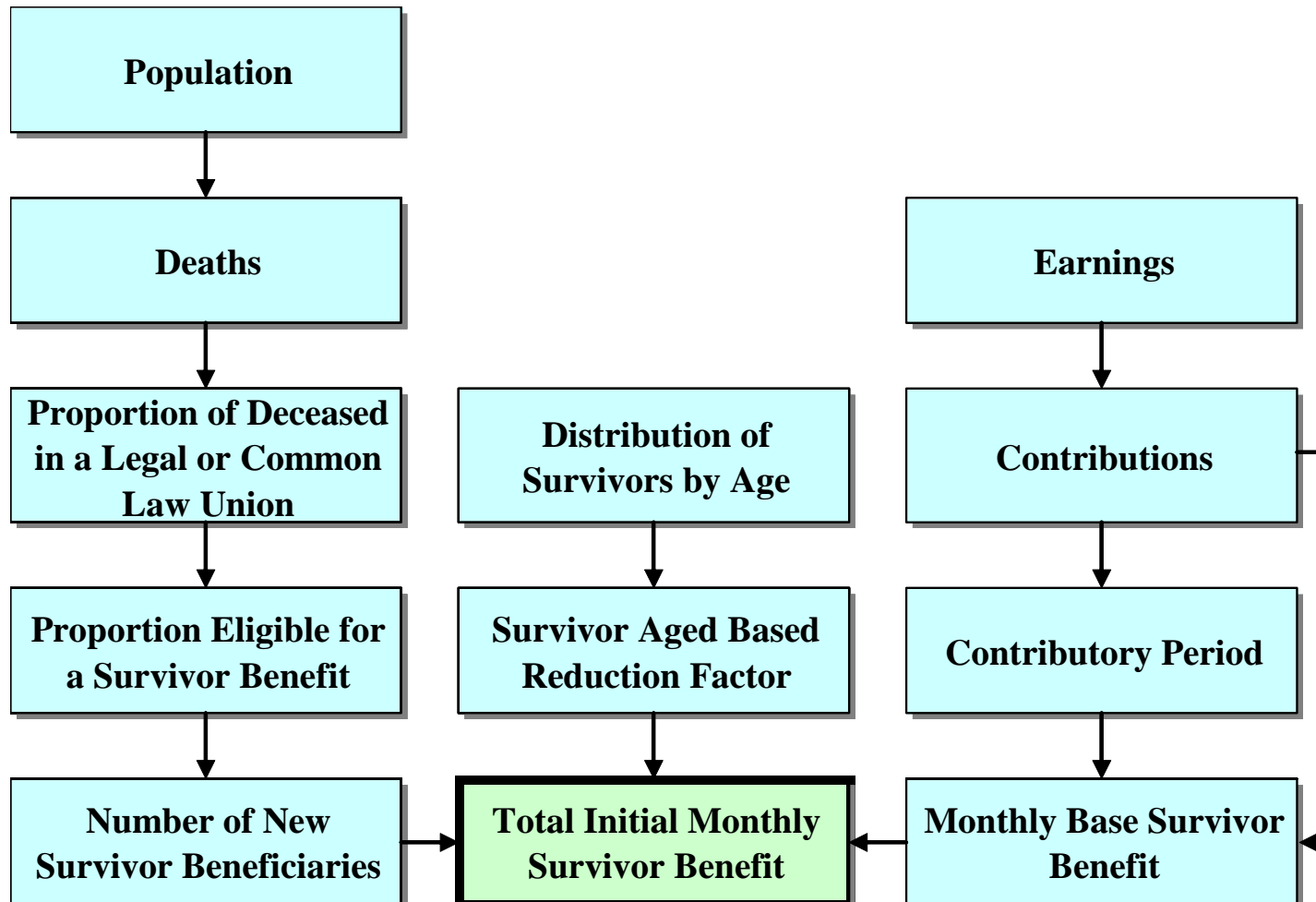
Total Retirement Expenditures



* Specific CPP Beneficiaries Mortality



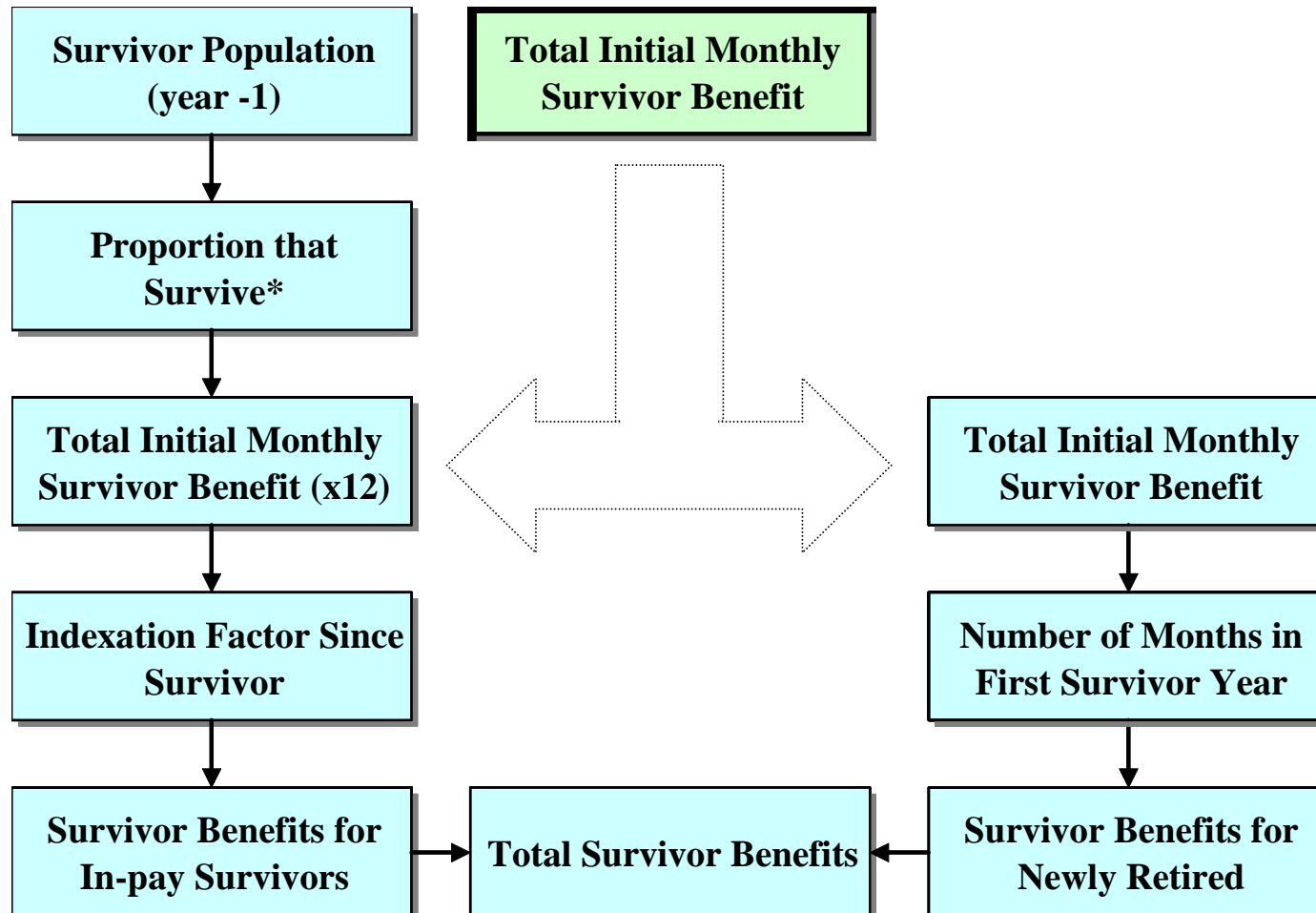
Survivor Benefit Calculation



Calculation done for each year, age and sex



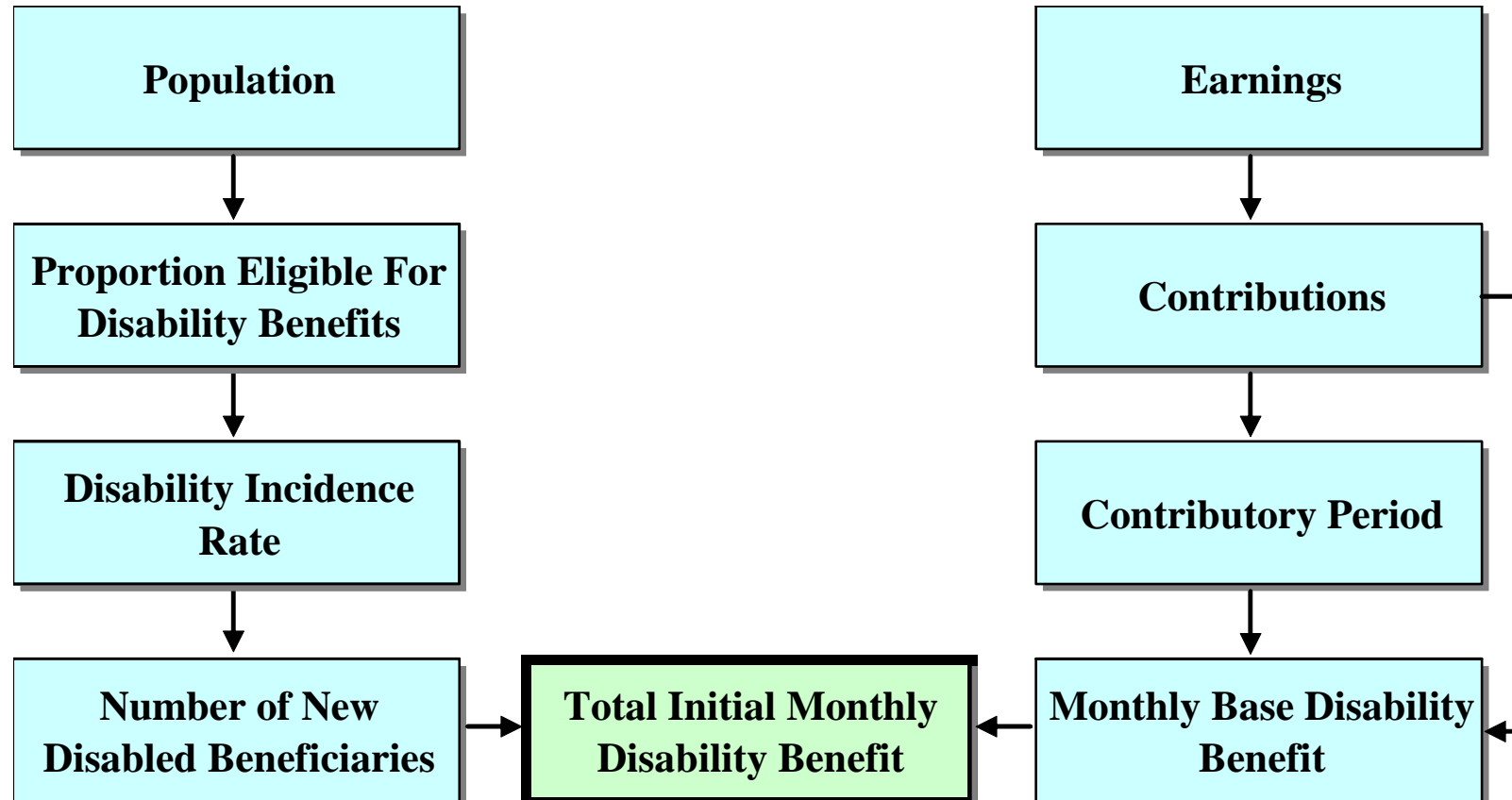
Total Survivor Expenditures



* Specific CPP Beneficiaries Mortality



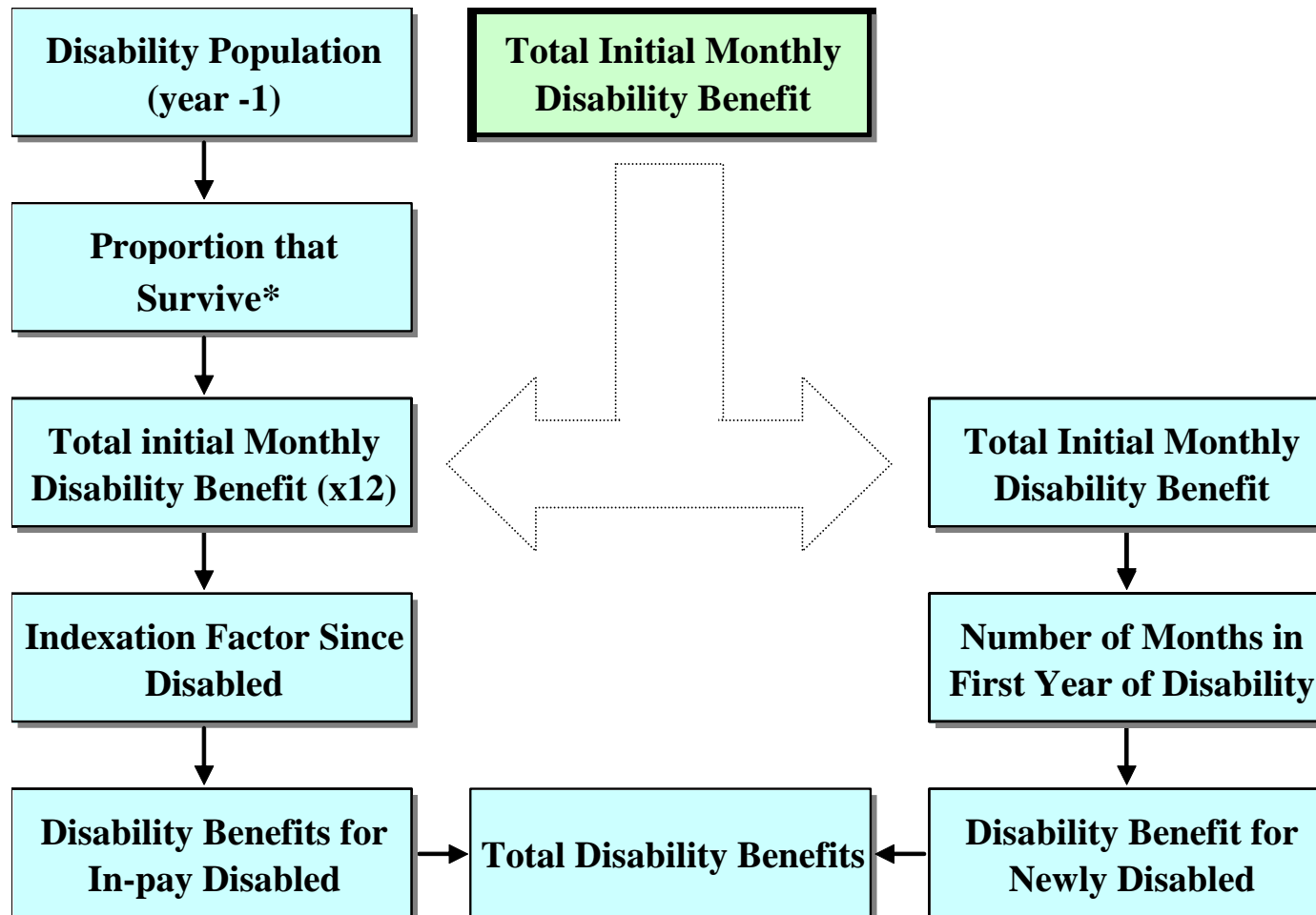
Disability Benefit Calculation



Calculation done for each year, age and sex



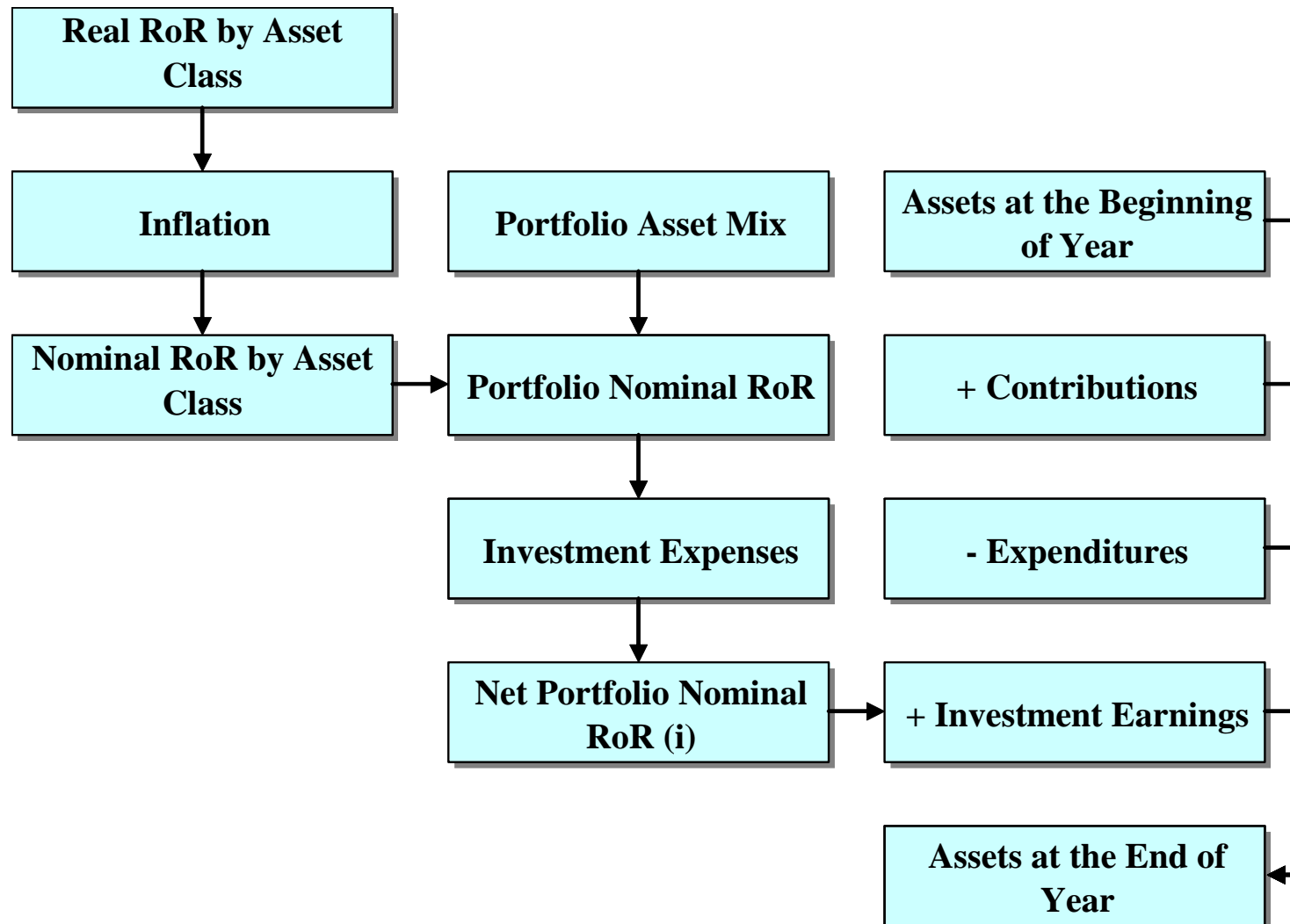
Total Disability Expenditures



* Specific CPP Disabled Termination Rates (Mortality and Recovery)



Assets Projection



Reporting the Results

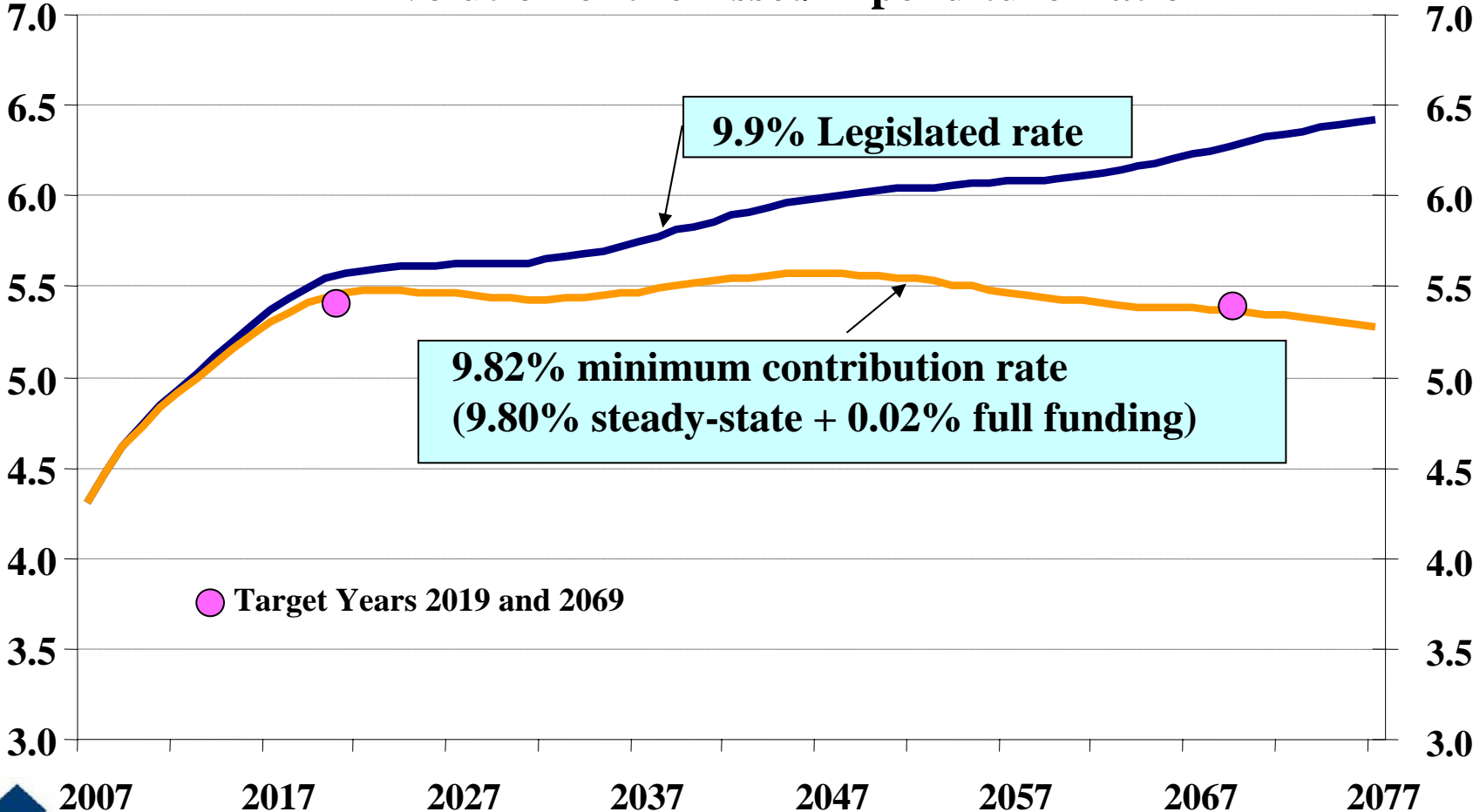
(Purpose of the Actuarial Report)

- Prepared in compliance with the timing and information requirements of the *Canada Pension Plan*.
 - Must be prepared every three years (Section 115).
 - 2008 amendments (Bill C-36) highlight that the Plan is subject to two financing objectives:
 - **Steady-state funding** which replaces the original pay-as-you-go financing to build a reserve of assets and stabilize the ratio of assets to expenditures over time.
 - **Incremental full funding** which requires that changes to the CPP that increase benefits or add new benefits be fully funded.
- To inform contributors and beneficiaries of the current and projected financial status of the Plan.



Projected Asset/Expenditure Ratio

Evolution of the Asset/Expenditure Ratio



Source: Actuarial Report on the CPP as at 31 December 2006

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International Actuarial Standards of Practice (IASP 1) of the International Actuarial Association (IAA)

1. Executive Summary
2. Introduction
3. Program Provisions
4. Data
5. Assumptions
6. Methodology
7. Results
8. Analysis of projection results
9. Conclusions
10. Attestations
11. Actuary's name, position and date

IASP 1 – Guidelines of Actuarial Practice for Social Security Programs

http://www.actuaries.org/STANDARDS/Current/IASP1_EN.pdf



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IAA Guidelines:

Information to be Included in Actuarial Reports

1. Executive Summary

- Purpose of the report and identification of the program
- Identification of key assumptions
- Main results of financial projections and main conclusions



2. Introduction

- To whom the report is addressed
- Starting and ending dates of the projection period
- Reference to the relevant preceding reports
- Contemplated date of next report



3. Description of the provisions of the SSP concerned

- Include a description of the provisions of the program materially relevant to the projections:
 - Coverage, Financing and Benefits



IAA Guidelines

Information to be Included in Actuarial Reports

4. Data

- Obtain reliable and sufficiently complete data:
- Assess and comment on accuracy of data, and any limitations

5. Assumptions

- The actuary should describe in the report the rationale used for the determination of all assumptions used for the projections.

6. Methodology

- Described in a manner that provides sufficient information for an actuary or other person with relevant expertise to assess the results of the report.



IAA Guidelines

Information to be Included in Actuarial Reports

7. Results

– **Sections on data, methodology and assumptions**

- (a) Population by age groups and sex and in total
- (b) Dependency ratios
- (c) Employment earnings by age groups, sex, and averages
- (d) Contributory earnings by age groups, sex, and averages
- (e) Pensionable earnings by age groups, sex, and averages
- (f) Covered payroll and workforce by sector of economic activity



– **Section on cash flow financial projections**

- (g) Contribution rate
- (h) Pay-as-you-go rate
- (i) Contributions
- (j) Investment earnings
- (k) Other income
- (l) Total income
- (m) Benefits
- (n) Administrative expenses
- (o) Total expenditures
- (p) Assets



IAA Guidelines

Information to be Included in Actuarial Reports

8. Analysis of projection results



– Report should present:

- Sensitivity analyses, showing the effects on the main projection results of variations in key assumptions
- Reconciliation with the previous report
- Explanations of the pattern of financial projections, e.g., ageing of the population, maturing of the program, recent changes in the program financing or benefit provisions
- Effect on the financial projections of events subsequent to the beginning of the projection period



IAA Guidelines:

Information to be Included in Actuarial Reports

9. Conclusion

- Main objective of an actuarial report:
 - estimate of the costs and projected financial status of the existing program and/or proposed changes therein
- Ensure readers will have a sound understanding of the future financial prospects for the Program concerned, and the inevitable uncertainties in making projections
- Provide an indication of eroding effect of inflation

10. Attestations / Actuarial Opinion

- In the report, the actuary should provide an opinion regarding the:
- Sufficiency and reliability of data.
- Reasonableness of assumptions.
- Appropriateness of the methodology and its consistency with sound actuarial principles.
- Report's compliance with, and departures from, any local standards and guidelines and the IAA Guidelines of Actuarial Practice.

11. Actuary's Name, Signature, Position Held and Date



Peer Review Process

- Internal peer review (before tabling of the report)
- External Peer Review (after tabling of the report)
 - OCA commissions external peer review
 - Federal, provincial, and territorial finance ministers endorsed peer review of CPP reports
 - External peer reviewers: 3 actuaries enrolled with the CIA and Fellows of the Society of Actuaries
 - UK Government Actuary's Department (GAD)
 - Selects independent Canadian actuaries
 - Provides an opinion on the work done by peer reviewers



Peer Review Process

- External Peer Review
 - Provides opinions on:
 - Professional experience of Chief Actuary and staff
 - Compliance with professional standards and statutory requirements
 - Accessibility to information required to perform valuation
 - Reasonableness of actuarial methods and assumptions
 - Communication of results through Actuarial Report
 - Also provide recommendations for future reports



Annex

- Reporting System in Excel
- Other Uses of CPP Model
- Child Benefits
- Death Benefits
- Best-Estimate Assumptions



Reporting System in Excel

- The Actucan Data Reporting System (ADRS) produces about two hundred files that can be imported into Excel
- Comma Separated Files (.CSV)
- Converted into Pivot tables for ease of viewing
- CD-Rom Distributed to Stakeholders



Reporting in Excel

Actucan Variable [AdrsTable02]

Workbook Name [AdrsCPP23_Cpp23Table02.xls]

Table 02 Population by Year, Age Group, Sex and Territory (Canada, Quebec and Canada less Quebec)

in (thousands)

Import the Report

Go to the Input File Menu

Go to the CDROM Main Menu

ReportList

[CPP-23] Table 02 Population (thousands)

[CPP-23] Table 03 Economic and Investment Assumptions

[CPP-23] Table 04 Contributions

[CPP-23] Table 05 Beneficiaries (thousands)

[CPP-23] Table 06 Beneficiaries by Sex (thousands)

[CPP-23] Table 07 Expenditures (\$ million)

[CPP-23] Table 08 Expenditures (millions of 2007 constant dollars)

[CPP-23] Table 09 Expenditures as Percentage of Contributory Earnings (pay-as-you-go rates)

[CPP-23] Table 10 Historical Results (\$ million)

[CPP-23] Table 11 Financial Status (\$ million)

[CPP-23] Table 12 Financial Status (millions of 2007 constant dollars)

[CPP-23] Table 13 Sources of Revenue and Funding of Expenditures (\$ billion)

[CPP-23] Table 38 Total Fertility Rates

[CPP-23] Table 39 Annual Mortality Improvement Rates

[CPP-23] Table 40 Mortality Rates (annual deaths per 1,000 people)

[CPP-23] Table 41 Life Expectancies, without improvements after the year shown

[CPP-23] Table 42 Life Expectancies, with improvements

Cpp23Table02

Cpp23Table03

Cpp23Table04

Cpp23Table05

Cpp23Table06

Cpp23Table07

Cpp23Table08

Cpp23Table09

Cpp23Table10

Cpp23Table11

Cpp23Table12

Cpp23Table13

Cpp23Table38

Cpp23Table39

Cpp23Table40

Cpp23Table41

Cpp23Table42



InputMenu ReportMenu

Reporting in Excel

Actuarial Tables 23rd CPP Report as at 31/12/2006
 (Step Number: CPP23-11E)
Table 02 Population
 (thousands)

Year	3 Age 20-64	4 Age 65 and Over	5 Ratio of 20-64 to 65 and Over
2007	10,376	1,936	5.4
2008	10,468	1,999	5.2
2009	10,562	2,063	5.1
2010	10,660	2,129	5.0
2011	10,747	2,204	4.9
2012	17,033	3,926	4.7
2013	17,180	3,922	4.5
2014	17,327	3,922	4.4
2015	17,473	3,923	4.2
2016	17,619	3,928	4.1
2017	17,766	3,941	4.0
2018	17,912	3,961	3.8

The (All) option for GENDER is an automatic sum
 The (All) option for TERRITORY is an automatic



Other Uses of CPP Model

- The CPP model is primarily used to project cash flows, but it can also be used to determine the:
 - Unfunded obligation
 - Balance sheet
 - Funded ratio

(Actuarial Study #8 Technical Aspects of the Financing of the Canada Pension Plan

http://www.osfi-bsif.gc.ca/app/DocRepository/1/eng/oca/studies/actetd8_e.pdf)



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Unfunded Obligations of the CPP

- Unfunded Obligation = Liabilities - Assets
- Related measure: Funded Ratio = Assets/Liabilities
- Different approaches to valuing measures based on:
 - Participant Group: Closed versus Open
 - Future Benefit Accruals: With or Without
- Closed group → current participants only, no new entrants permitted
- Open group → current and all future participants



Unfunded Obligations of the CPP (cont.)

- Future benefit accruals
 - ➔ participants continue to contribute and accrue benefits
 - ➔ can apply to either a closed or open group.
- No future benefit accruals
 - ➔ participants do not continue to contribute and accrue benefits
 - ➔ can only apply to a closed group.

Current CPP methodology to value its liabilities:
closed group without future benefit accruals



CPP Groups With or Without Future Benefit Accruals – Balance Sheet at 31 December 2006 (9.9% contribution rate)

Present Value as at 31 Dec. (in \$ billion)*	Excluding Future Benefit Accruals	Including Future Benefit Accruals	
	Current CPP (closed group)	Closed Group	Open Group
Assets and Contributions			
Current Assets	114	114	114
Future Contributions	0	590	1,418
Total Assets (a)	114	704	1,532
Liabilities			
Current Benefits	250	250	250
Future Benefits	484	815	1,279
Total Liabilities (b)	734	1,065	1,529
Unfunded Obligation (b) – (a)	620	361	-3
Funded Ratio (a)/(b)	15%	66%	100%



* Benefit values shown include associated administrative expenses.

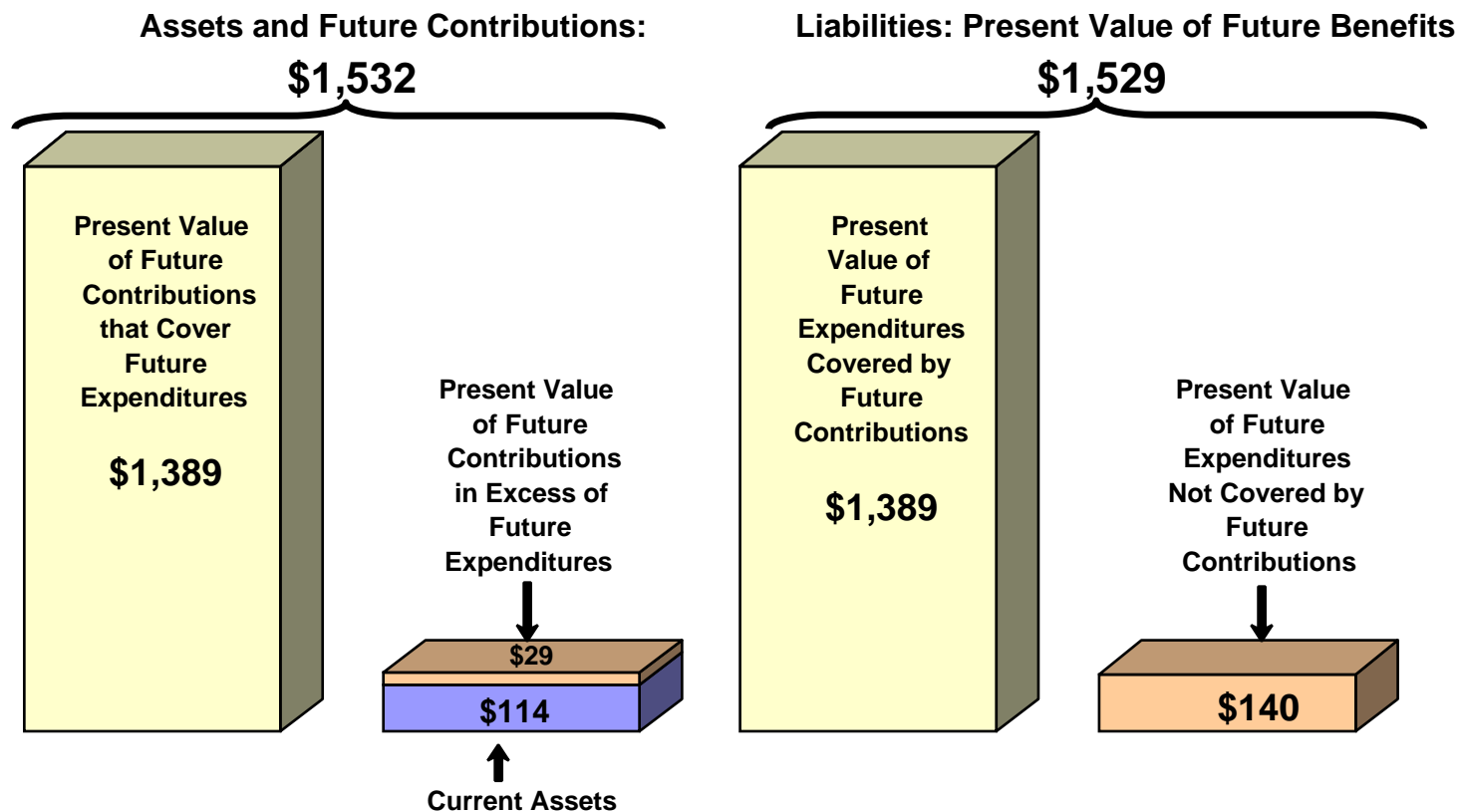
Open Group Modified Balance Sheet – Description and Purpose

- Open group balance sheet may be presented in alternative format: split out into pay-as-you-go and funded components of the Plan
- Modified balance sheet emphasizes hybrid nature of partial (steady-state) funding of the Plan and thus allows for better understanding of how future expenditures are financed



Open Group Modified Balance Sheet – Formation: Step 1

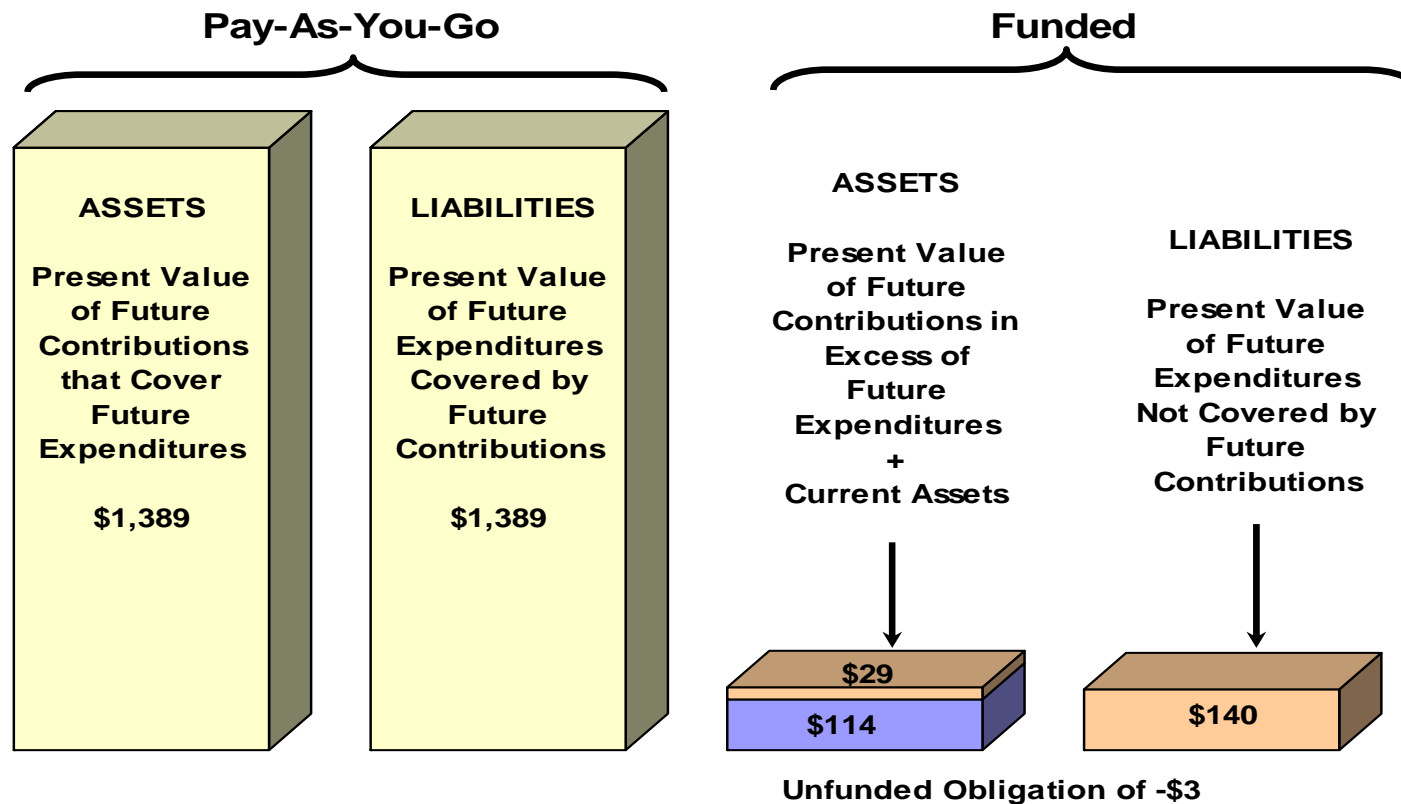
- Separate out present values of contributions and expenditures on assets and liabilities sides of balance sheet
- As at 31 December 2006, 9.9% contribution rate, \$ billion:



Open Group Modified Balance Sheet – Formation: Step 2

- Regroup present values into pay-as-you-go and funded components

As at 31 December 2006, 9.9% contribution rate, \$ billion:

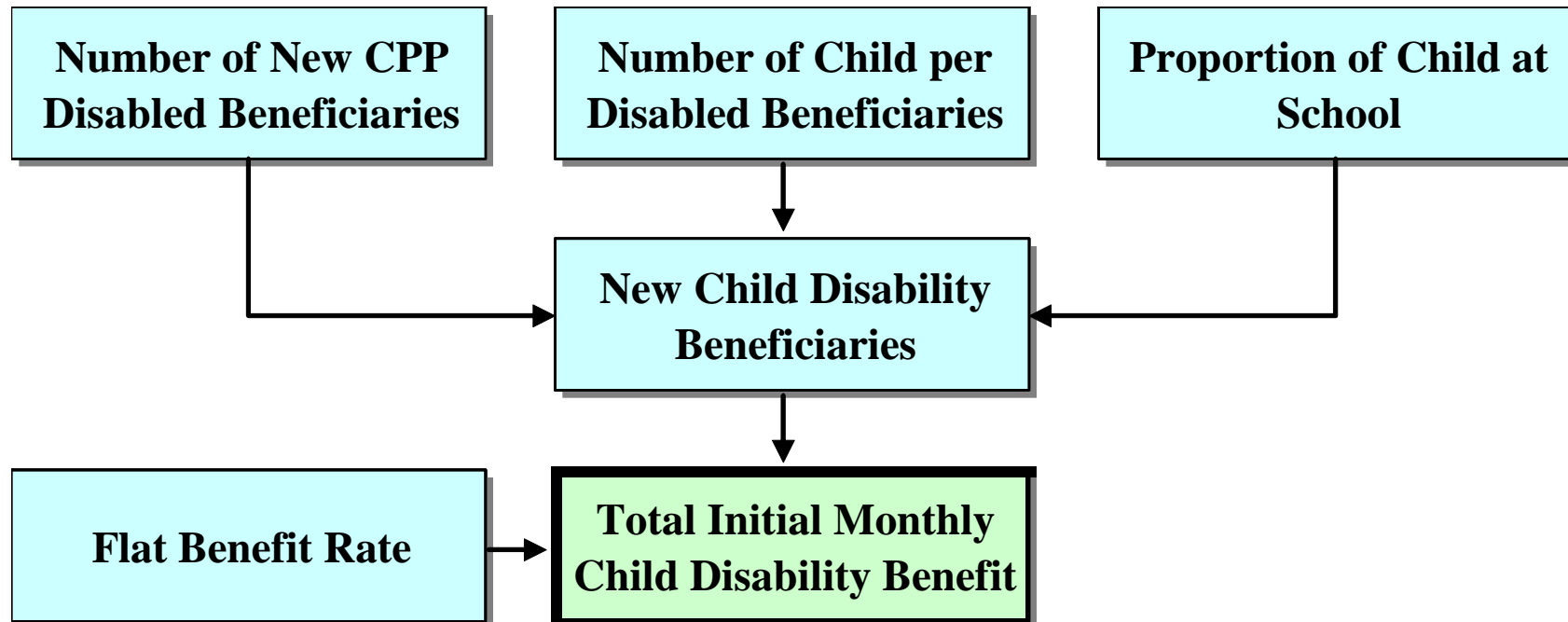


Child Benefits

- Two types of child benefits
 - Disability
 - Survivor
- Monthly flat-rate payable until
 - age 18 (assumed at school full time), or
 - age 25 if at school full time
- Data aggregated on year, age and sex



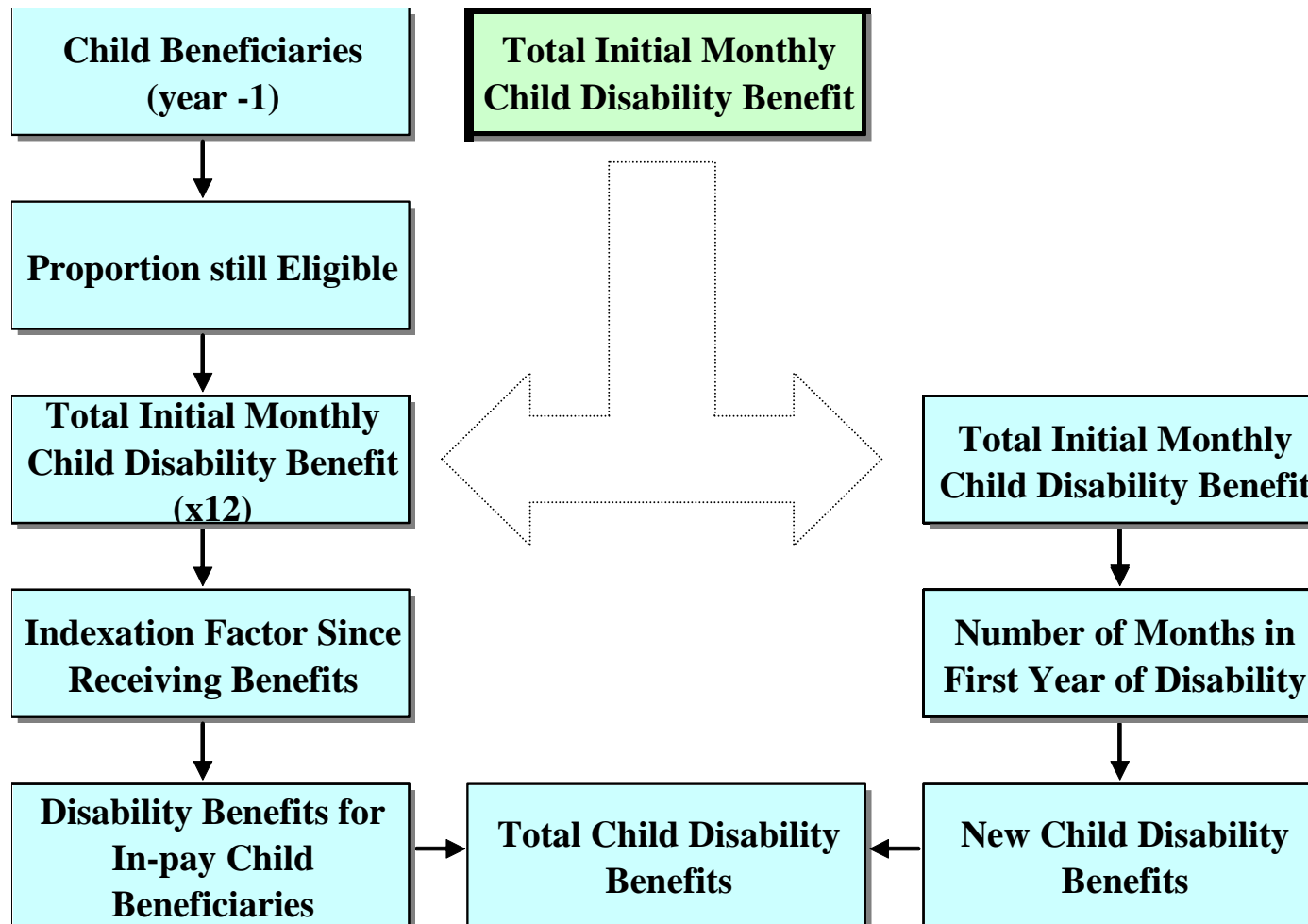
Child benefit Calculation



Also applies for child survivor benefits



Total Child Benefit Expenditures

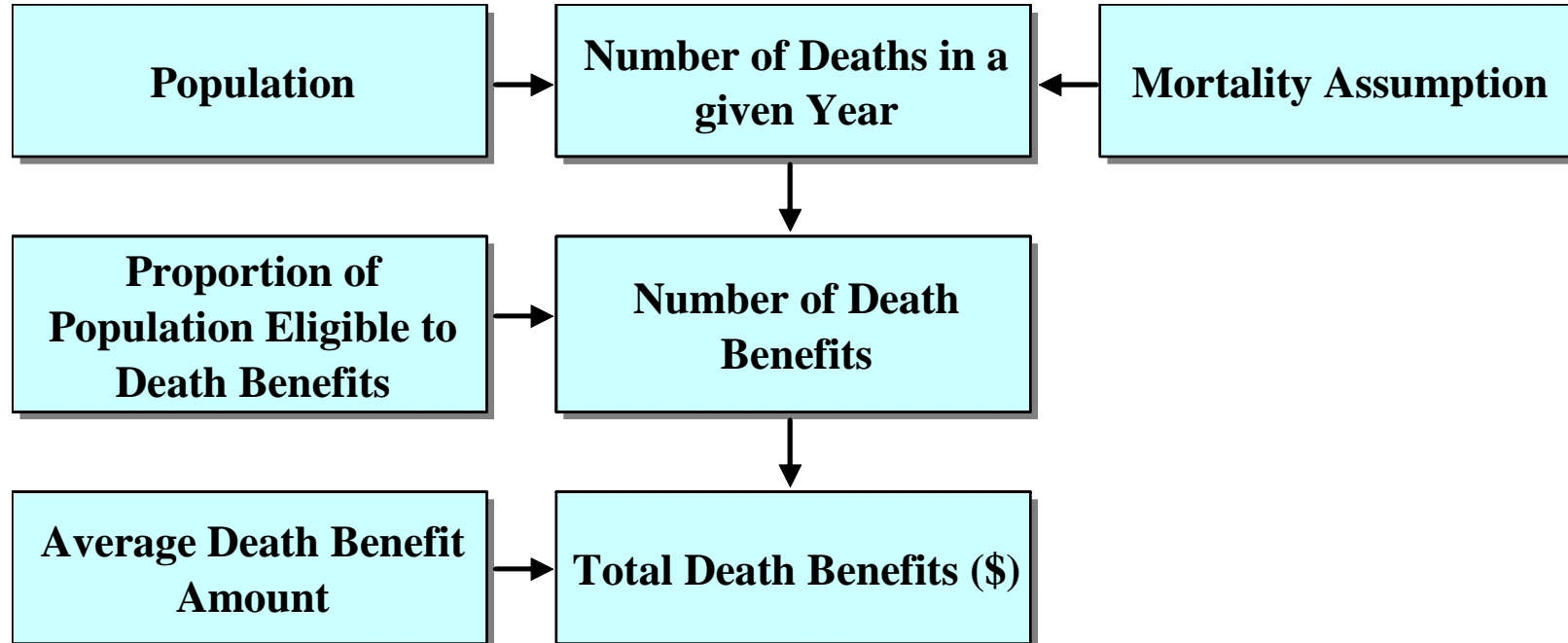


Death Benefits – Basic Principles

- Deceased contributor who meets the contributory requirements is entitled to lump sum death benefit:
 - Minimum of \$2,500 and 6 times the basic monthly pension
- To be eligible, the deceased contributor must have contributed for the lesser of 10 calendar years, or one-third of the number of years in the member's contributory period, but not for less than 3 years.



Total Death Benefit Expenditures



Best-Estimate Demographic and Economic Assumptions

23rd Report		
Canada	(as at 31 December 2006)	
Total fertility rate	1.6 (2010+)	
Mortality	2000-02 Life Tables for Canada with future improvements	
Canadian life expectancy at birth in 2007	Males 84.5 years	Females 87.7 years
at age 65 in 2007	19.3 years	22.0 years
Net migration rate	0.50% of population to 2015 0.54% of population for 2020+	
Participation rate (aged 15-69)	74.2% (2030)	
Employment rate (aged 15-69)	69.9% (2030)	
Unemployment rate	6.3% (2006+)	
Rate of increase in prices	2.5% (2016+)	
Real-wage differential	1.3% (2015+)	
Real rates of return	4.2% (2016+)	
Retirement rates for cohort at age 60	Males 40.0% (2009+)	Females 45.0% (2009+)
CPP disability incidence rates (per 1,000 eligible)	Males 3.1 (2011+)	Females 3.5 (2011+)

