

ACTUARIAL TRAINING  
(SOCIAL SECURITY BOARD OF  
MYANMAR)

GENERAL OVERVIEW  
OF ACTUARIAL MODELLING

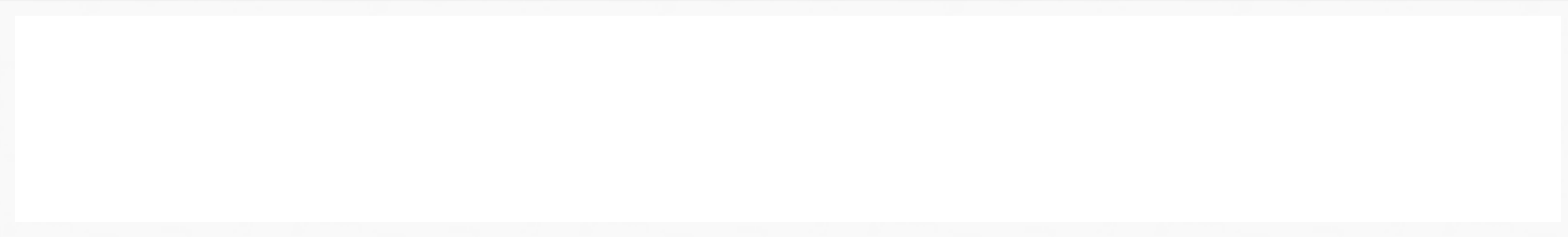
MYANMAR 2014, DECEMBER 15-17

Day  
1

# PLAN OF THE PRESENTATION

- Goal of the assignment
- What is an actuarial model
- Actuarial and Statistical Requirements in Social Security Management
- Financing Methods
- Projections and Model
- Assumptions

# GOAL OF THE ASSIGNMENT



Delivering an actuarial model to  
assess the cost of short term  
branches:

- Health
- Sickness
- Maternity
- Death
- Employment injury

Improve capacities of SSB staff in:

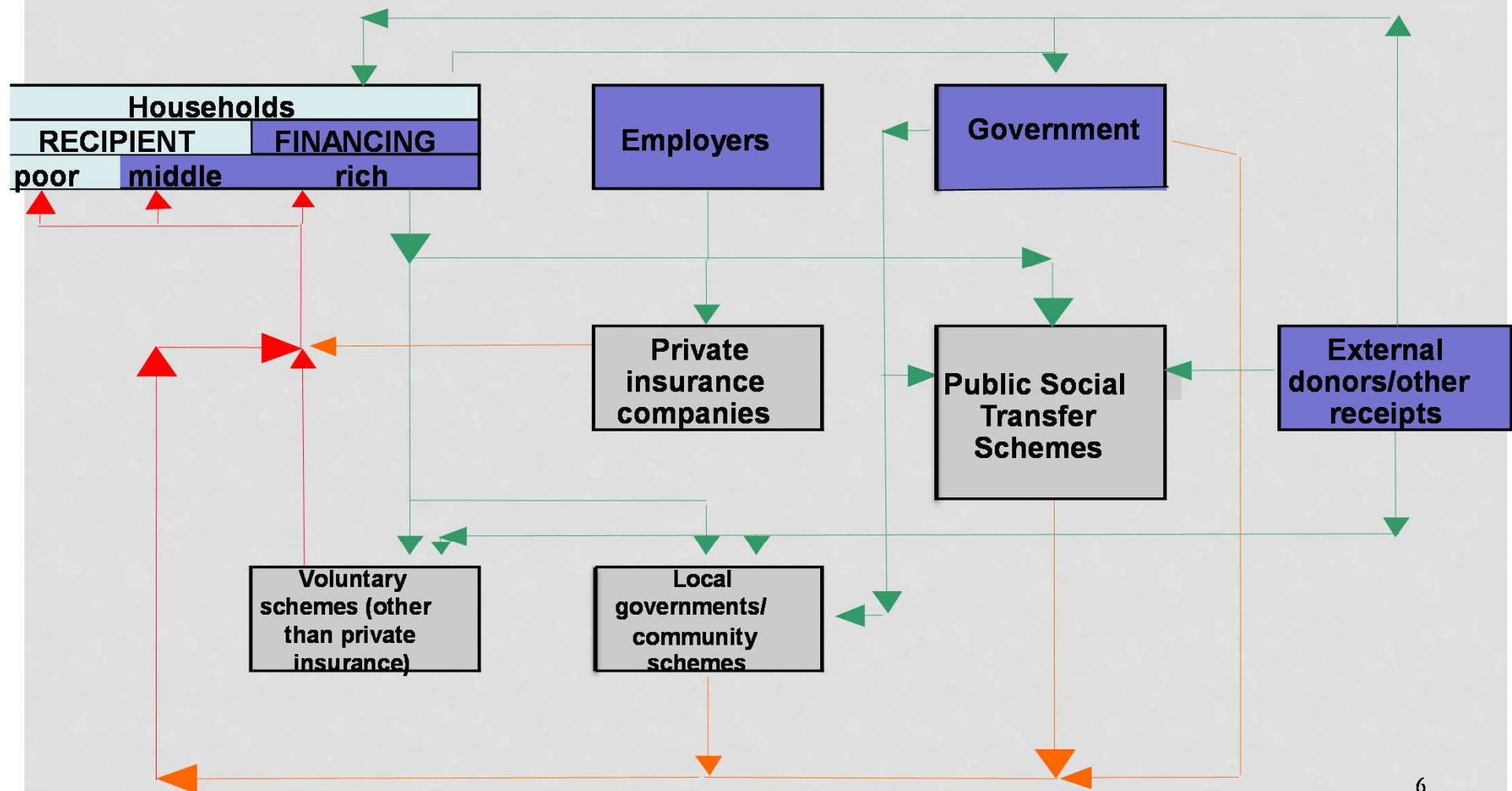
- Data collection
- Financial planning and projections

# WHAT IS AN ACTUARIAL MODEL?

# WHY USING AN ACTUARIAL MODEL?

- Estimate the cost
  - Frequency
  - Severity
  - Time value
- Estimate the risk
- Prerequisite
  - Mathematical, statistical, economic, financial skills...some legal skills too
    - Try to simplify life...in a model
  - Computerized skills

# ESTIMATION IN A SOCIAL SECURITY CONTEXT...



# 5 RULES OF MODELING

# 5 RULES OF MODELLING : # 1

- Use good, reliable and sufficient data
  - Garbage in → garbage out
  - We cannot manage what we don't have
  - Strong analysis of past experience
  - Reconciliation with others sources of info
  - Preferable to have simple model with good data than a complicated model with weak data
  - [Exercise1.doc](#)
  - [Exercise1SQL.pptx](#)

# Quality

*Good data help you to assess risk appropriately*

## READ : ASOP 23

The purpose of this actuarial standard of practice (ASOP) is to give guidance to the actuary in the following:

1. selecting the data that underlie the actuarial work product;
2. relying on data supplied by others;
3. reviewing data;
4. using data; and
5. making appropriate disclosures with regard to data quality.

Data that are completely accurate, appropriate, and comprehensive are frequently not available:

- use available data that, in the actuary's professional judgment, allow the actuary to perform the desired analysis.
- if material data limitations are known, the actuary should disclose those limitations and their implications.

- The validity and comprehensiveness of information are the responsibility of those who supply such information
- The actuary may rely on such information supplied by another, unless it is or becomes apparent that the information contains material errors or is otherwise unreliable.
  - The actuary should disclose reliance on information provided by another in an appropriate actuarial communication.
- The actuary should review the data for reasonableness and consistency the actuary should take into account the extent of any checking, verification, or auditing that has already been performed on the data

## YOU DON'T HAVE COMPLETE DATA AND NO TIMES TO FIX THE PROBLEMS?

- Do sampling
  - Sufficient size
  - Representativeness (sex, age...)
- Do a survey
  - Useful for social security???
- Other scheme's data
  - Research

# SOME EXAMPLES

- Analyze the trends
  - You have to explain deviation
  - Should see behaviour
    - Retirement age
- Reconciliation
  - With prior analysis
    - Reconciliation of population of beneficiaries
  - Other sources
    - Auditors

# SOME EXAMPLES

- Cross checking
  - General population mortality assumptions VS participants' mortality rates
  - Pensions paid in the computerized system VS amounts in the financial statement
  - New amount of pension payable VS past services and average salary used in pension formula
  - Number of contributors and average salary VS amount of contributions

# SOME EXAMPLES

- Ask questions, inquire:
  - Unusual data
    - Someone aged 140
    - Large population with no birth date
    - Contributors aged 5
- Do some checks
  - Review how pensions are calculated
    - You may find errors

# SOME EXAMPLES

- If you administer other programs
  - Do crosscheck
- Insured taken into account twice
  - Merge by :
    - Name
    - Family name
    - Name of the mother

# SOME EXAMPLES

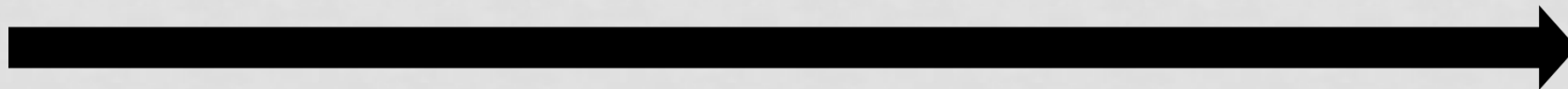
- Check with other ministries
  - For example in Québec:
    - Directeur de l'État Civil
      - Deaths
      - Births
      - Marriages

## 5 RULES OF MODELLING : # 2

- Choose the appropriate model

- Models are approximations of reality
- Different modeling techniques

Increasing complexity, time, data requirements, and computing power



**I**

Closed Form  
Solution

**II**

Regression Type

**III**

Deterministic  
Projection Models

**IV**

Stochastic  
Projection Models

## 5 RULES OF MODELLING : # 2

- STB projections: deterministic model
- Use a cohort (generational) approach
  - If it is possible
- You will see things that otherwise you will not be able to see
  - See example (others slides)

## 5 RULES OF MODELLING : # 3

- Explicit assumptions are preferable than implicit assumptions
- Even the best estimate or most appropriate assumptions will not perfectly mirror emerging reality: it is necessary to reconcile actual results and expected results.

## 5 RULES OF MODELLING : # 4

- Validate your results
  - Do peer reviewing
  - Important to have feedback of others
  - Eliminate errors
  - Share expertise with other professionals
- A common error made by modellers is the assumption that the model will produce quality results

# 5 RULES OF MODELLING : # 5

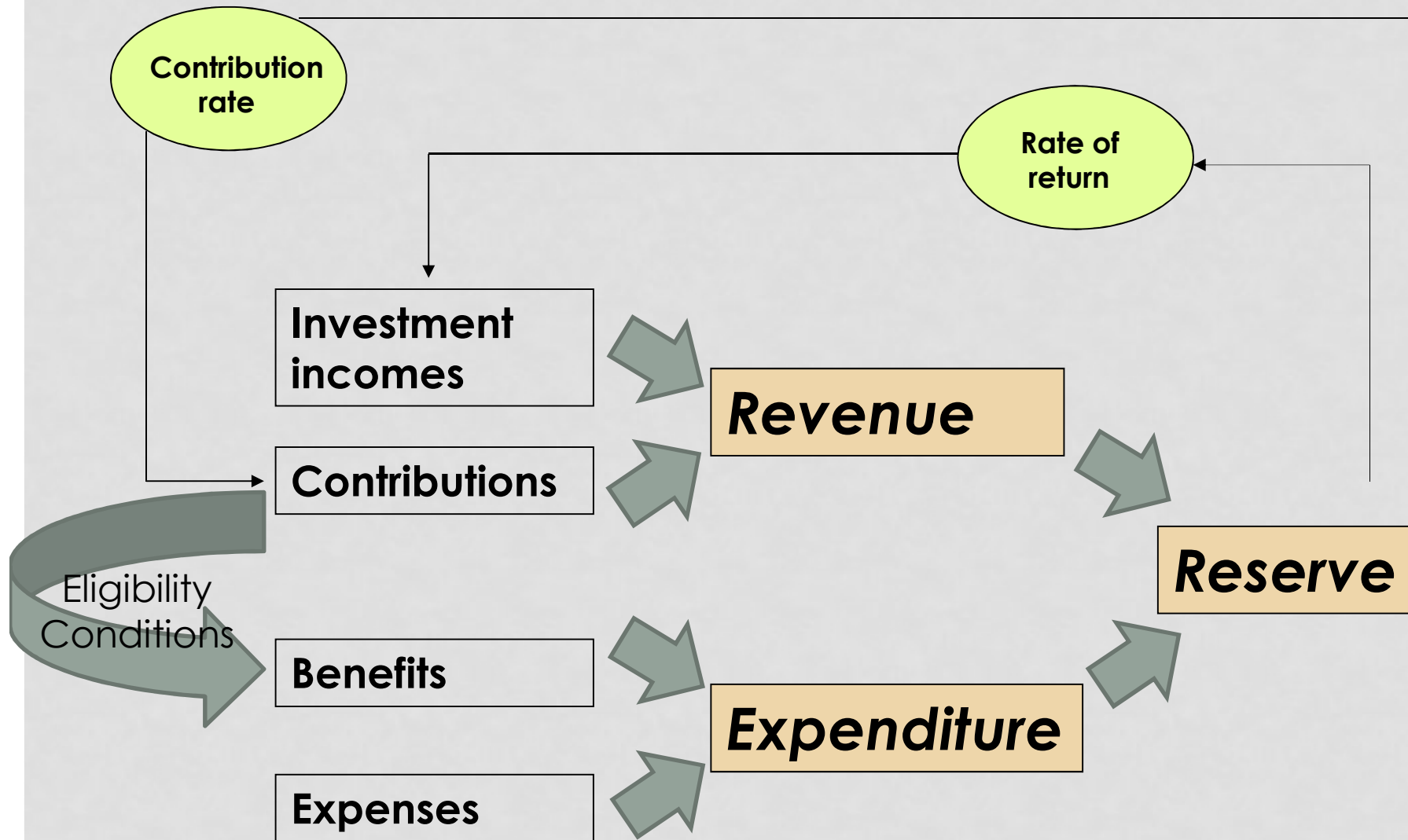
- [illegible]

# PRESENTATION ON THE QUALITY OF DATA



# FINANCING METHODS

# The financing objective : equilibrium



- The financial equilibrium of a system is directly affected by developments in the economic environment of the scheme
- for example (health), if GDP and employment contract
  - number of contributors or taxpayers to shrink
  - not necessarily with an equivalent decrease in the number of covered persons (dependents).
    - in the short term : little or no impact on expenditure levels but a decrease in income
  - Also a lower per capita insurable earnings
    - negative impact on the income.

# THE FINANCING OBJECTIVE

- Always of question of:
  - Who pays?
  - From what?
    - Taxes
    - Contributions
    - Investment
  - How much?
    - Capacity to pay
    - Return on asset
      - Financial assets
      - Human capital assets
  - How long?
    - Equilibrium
    - Depend on the type of benefits offered
    - Short-term benefit projection period normally lower than for pension benefits
      - May adapt more easily

.....conditional to the development of expenditure...

# FACTORS AFFECTING THE FINANCIAL EQUILIBRIUM OF A PENSION SCHEME

## Economic factors

- Growth
- Employment
- Wages
- Inflation
- Interest rates

## Demographic factors

- Initial population structure
- Mortality changes
- Fertility changes
- Migration



## Financial factors

- Investment return
- Stocks
- Real estate
- .....

## Governance factors

- Design
- Adjustment of scheme's parameters
- Administration cost
- Compliance
- Monitoring (investment, funding policy)

## FACTORS AFFECTING THE FINANCIAL EQUILIBRIUM OF A PENSION SCHEME

The importance of each factor on the financial equilibrium depends on the choice of the financing system

# FINANCING SYSTEMS



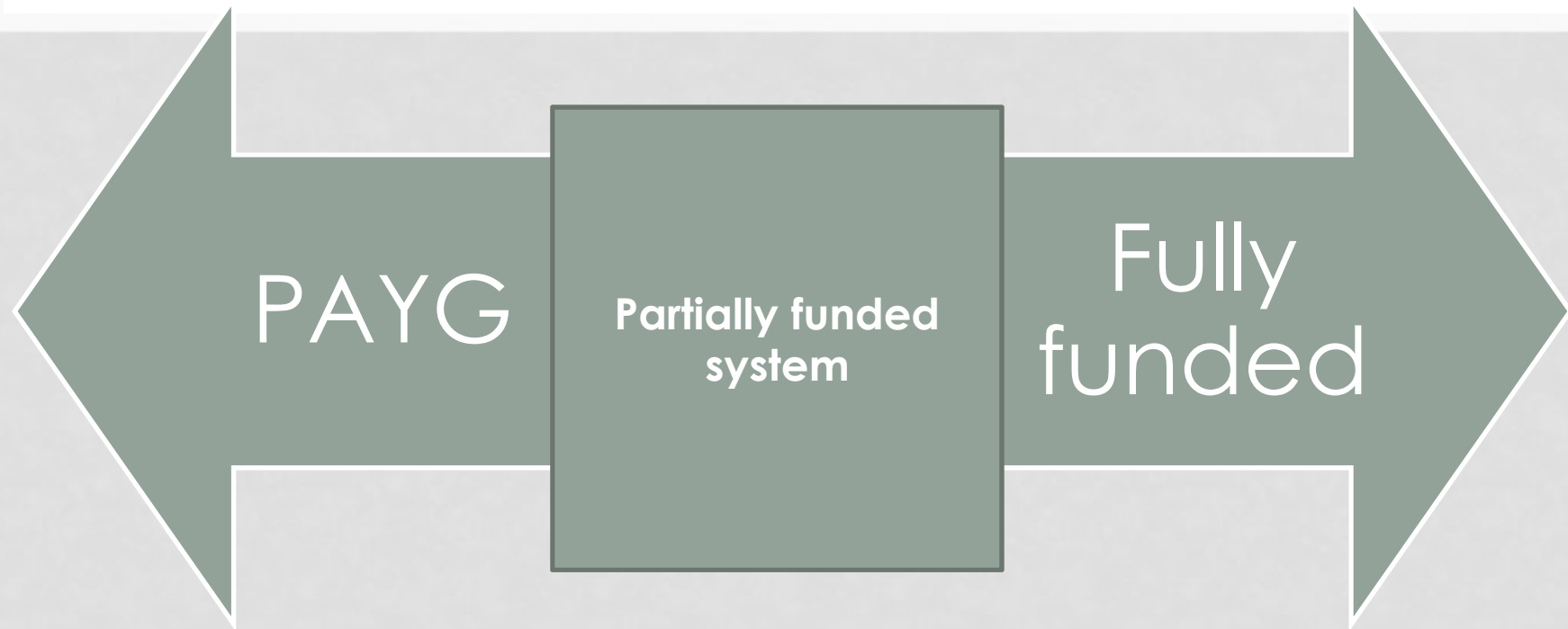
PAYG

The diagram consists of a light gray rectangular background. At the top, a white rectangular box with a thin gray border contains the text 'FINANCING SYSTEMS'. Below this box, there are two large, dark green arrows pointing in opposite directions. The left arrow points to the left and contains the text 'PAYG'. The right arrow points to the right and contains the text 'Fully funded'.

Fully  
funded

PAYG: pay-as-you-go

# FINANCING SYSTEMS



PAYG: pay-as-you-go

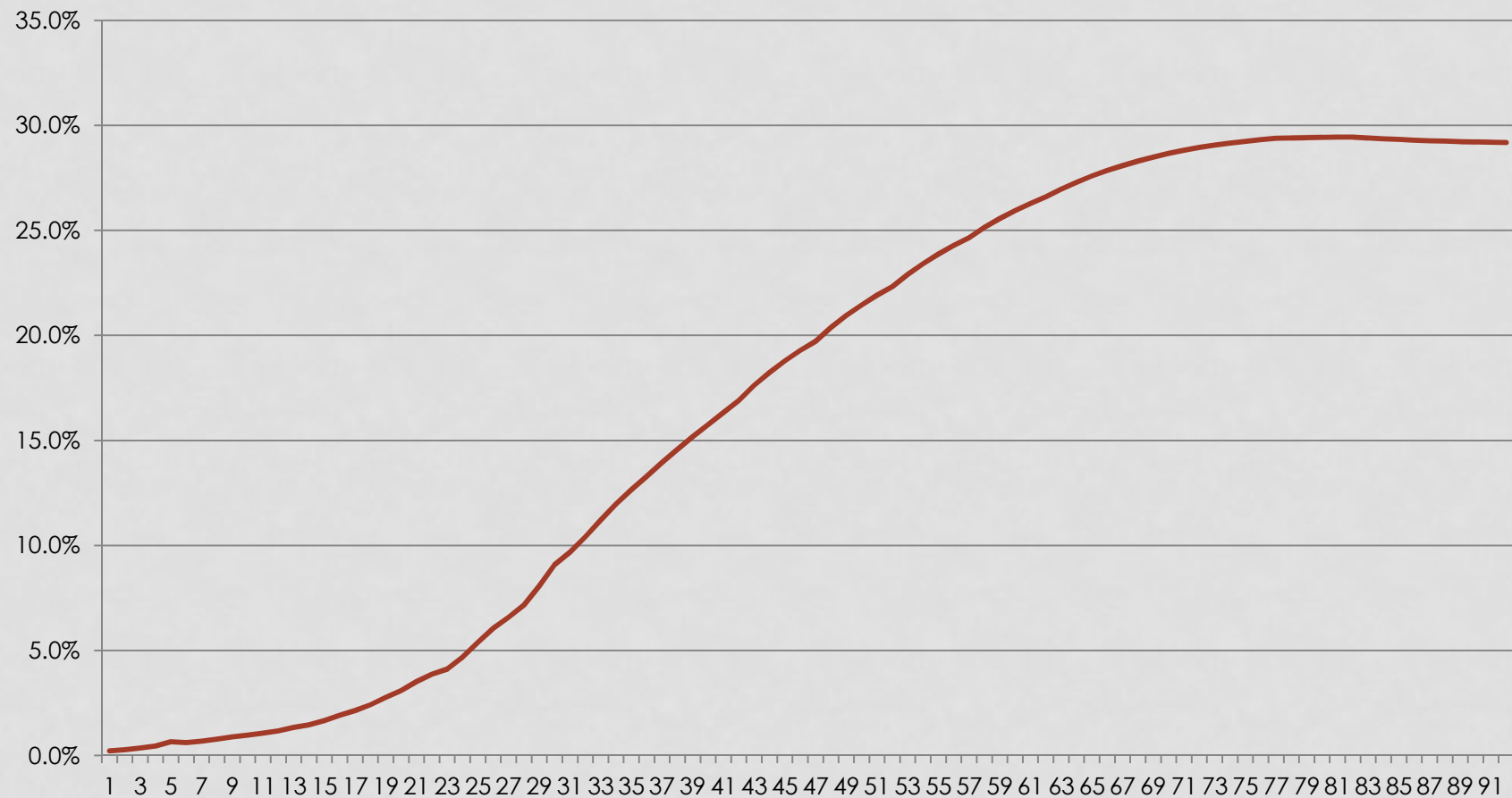
# PAYG

- A generation pays for benefits of another
- The contribution rate, each year, is the ratio of

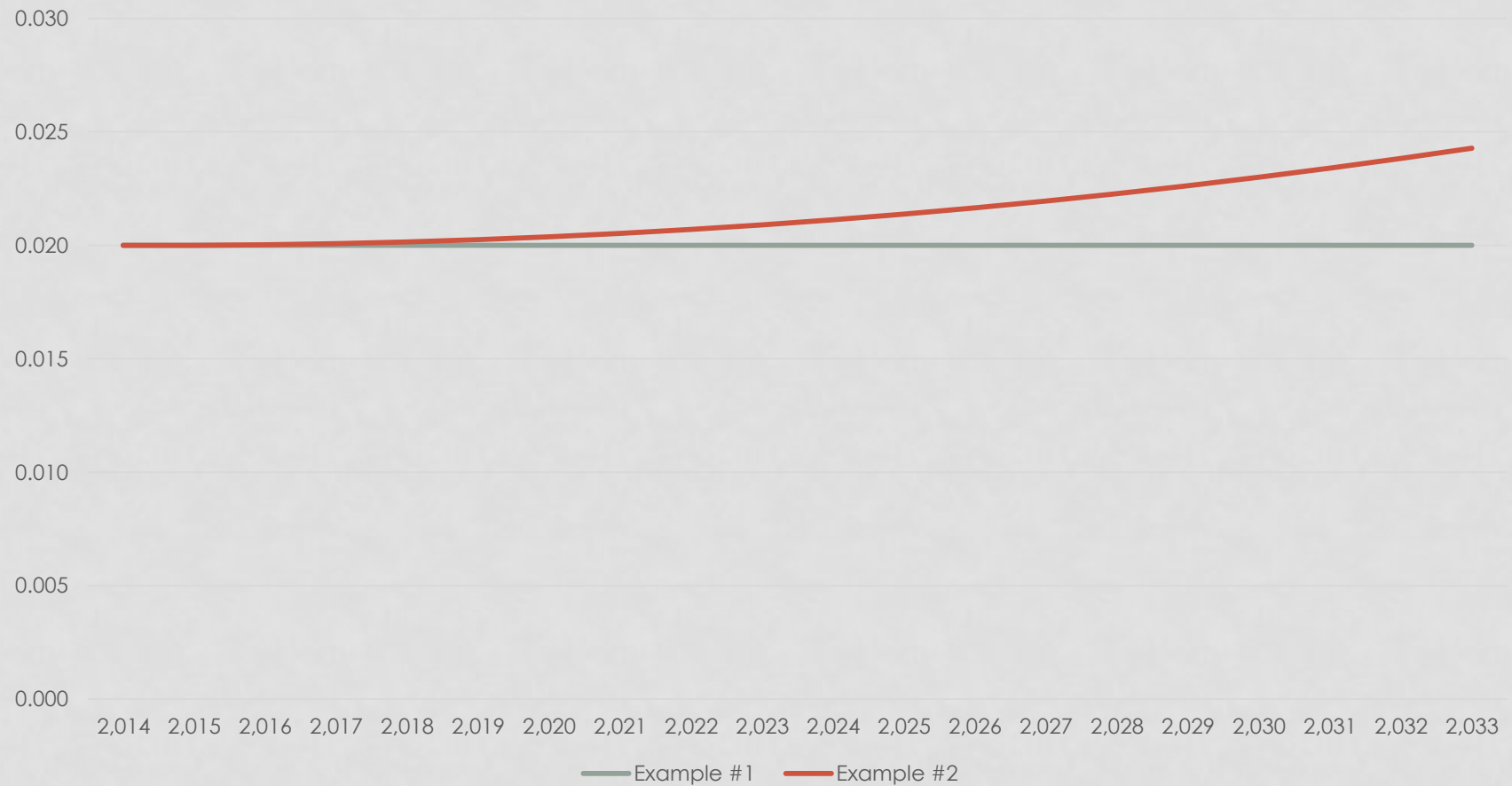
$$\frac{\text{Benefits + other expenses}}{\text{Salary}}$$

- Cost is low at the beginning but increases with time
- No accumulation of financial assets (reserve)
- Link ultimately to the capacity of paying

# EXAMPLE OF PAYG FOR PENSION



# EXAMPLE OF PAYG FOR SHORT TERM BENEFITS

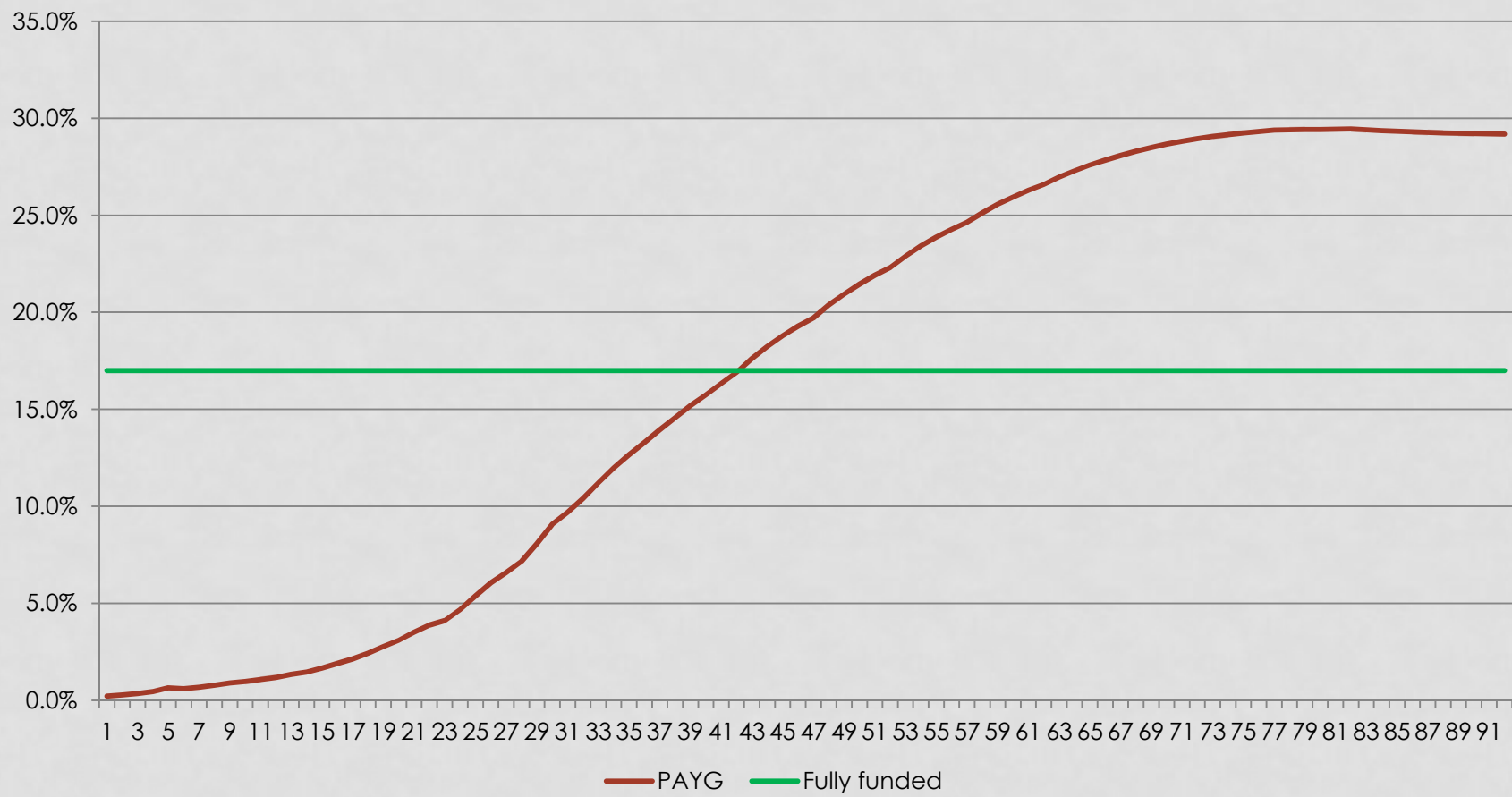


# WHY EXPENDITURE INCREASES

- the number of pensioners increases each year as new cohorts qualify;
  - For example, if the pensioners don't pay a contribution for health coverage
- The number of contributors can decrease;
- Increase in utilization rate
- Health cost are increasing at higher rate than the salary

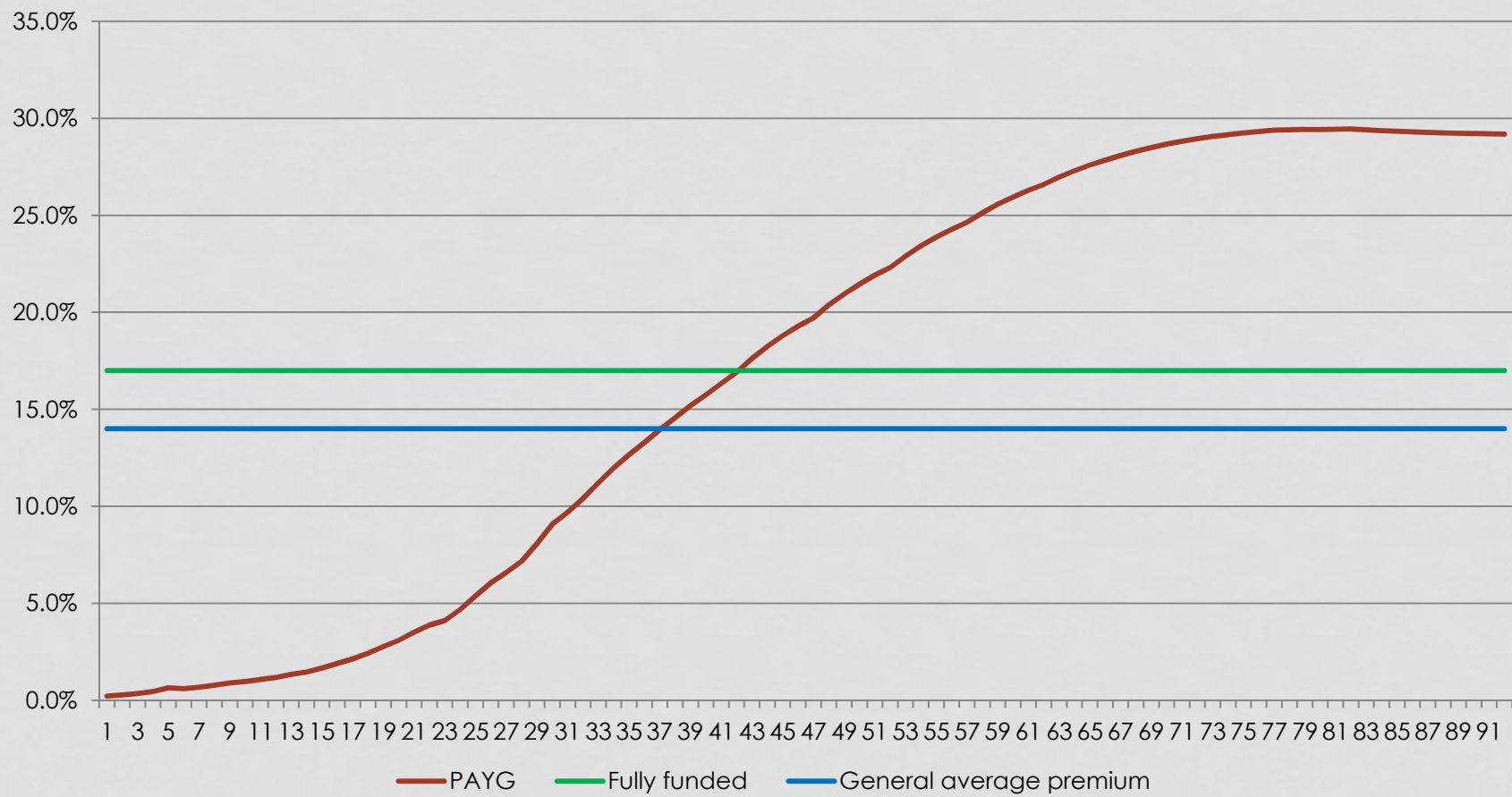
# FULLY FUNDED SYSTEM

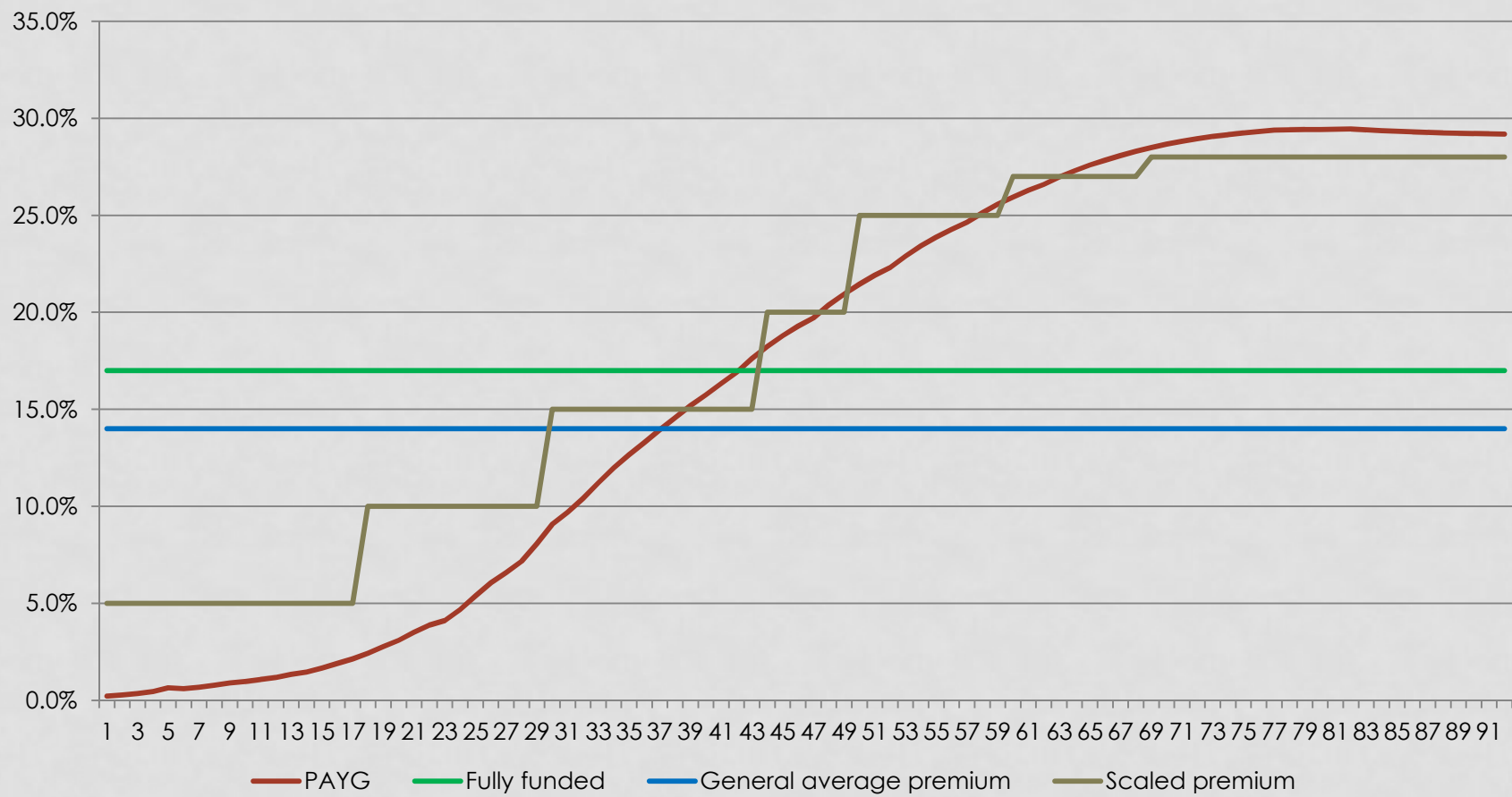
- Each generation pays for its own benefits
  - Accumulation of assets
    - Consequences
      - We have to manage surplus and deficit
        - Funding policy
        - Investment policy
- More equity among generations of contributors and employers
- Normally, the actuarial valuation is on a closed group approach, compared to an open group approach
- Can be the approached for workers injury benefits



# PARTIALLY FUNDED SYSTEM

- Between PAYG and fully funded system
- Biggest question:
  - What level of reserve should we keep
- For some short term benefits
  - All the approach give a contribution rate that are closed
    - Sickness
    - Death
    - ....







# ACTUARIAL PROJECTIONS AND MODEL

# CLOSED GROUP

- Consider only those who participate on the actuarial valuation date
- Private pension
- Not really used for a social security system...but
  - It is not impossible to think that a pension plan for all workers is evaluated like a private scheme
    - Want 100% funded
    - Surplus / deficits
- More than one method
  - Projected unit credit
  - Attained age
  - Aggregate method
  - .....Financial economics

# OPEN GROUP

- Have to consider those in the scheme as well as new one
- Use for social security system
- Also for projection of private pension plan
  - Stochastic valuation
  - Impact on business

# OPEN GROUP FOR A SOCIAL SECURITY SYSTEM

General population projection



Labour force



Employed population

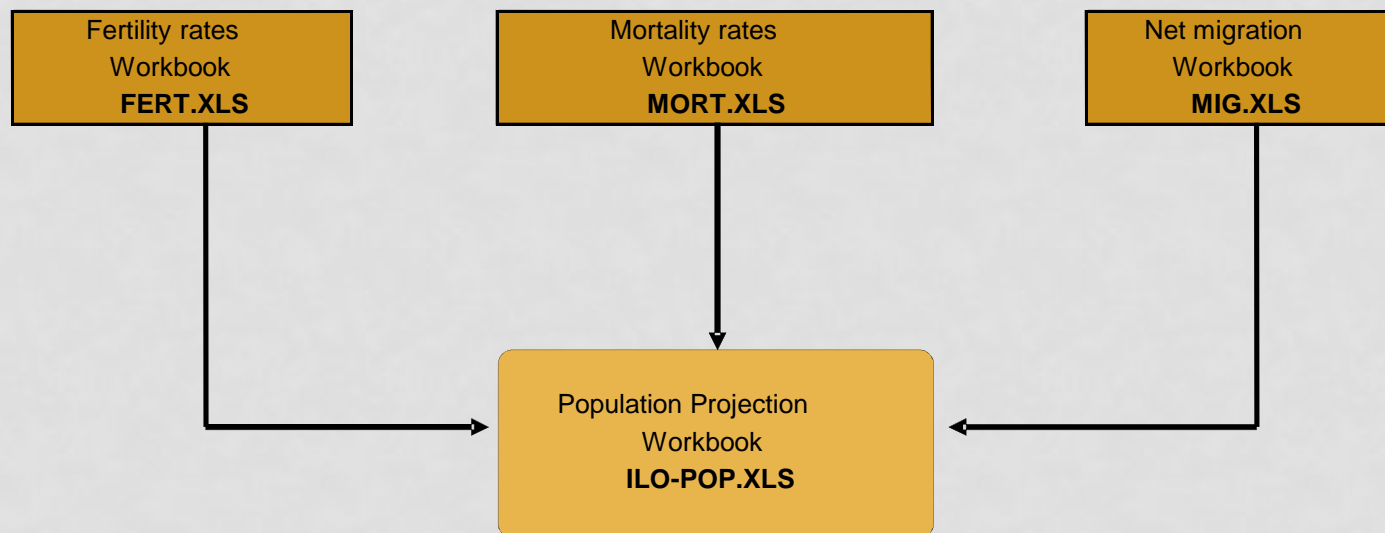


Contributors



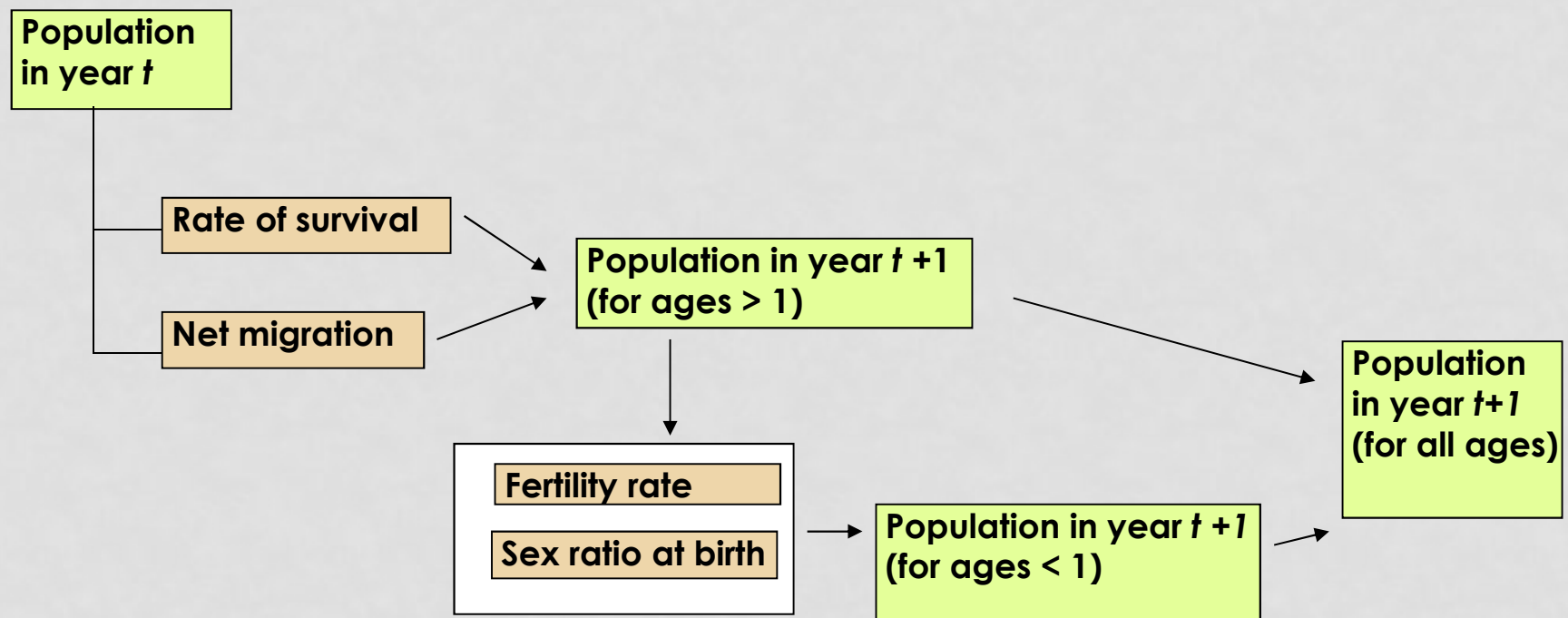
# GENERAL POPULATION PROJECTION

# COMPONENTS OF THE DEMOGRAPHIC PROJECTION MODEL



# DEMOGRAPHIC PROJECTIONS

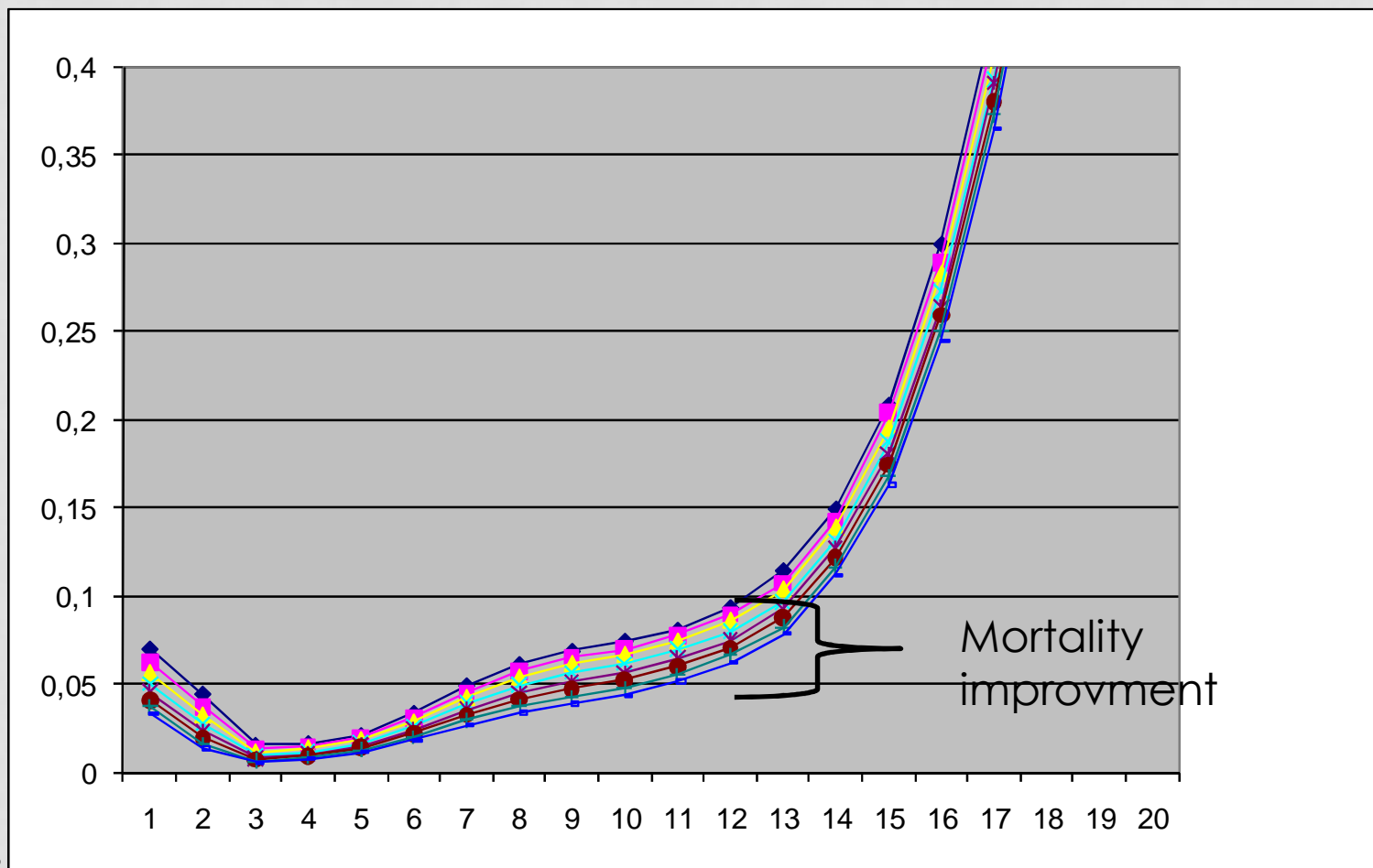
## COHORT APPROACH



# WHERE THE INFORMATION COME FROM?

- UN methodology
  - Life expectancy at birth projected
  - Model life tables
- Impact of AIDS in certain countries
- National Statistical Office

# A MORTALITY TABLE



# THE MODEL OF SSB – GENERAL POPULATION (1)

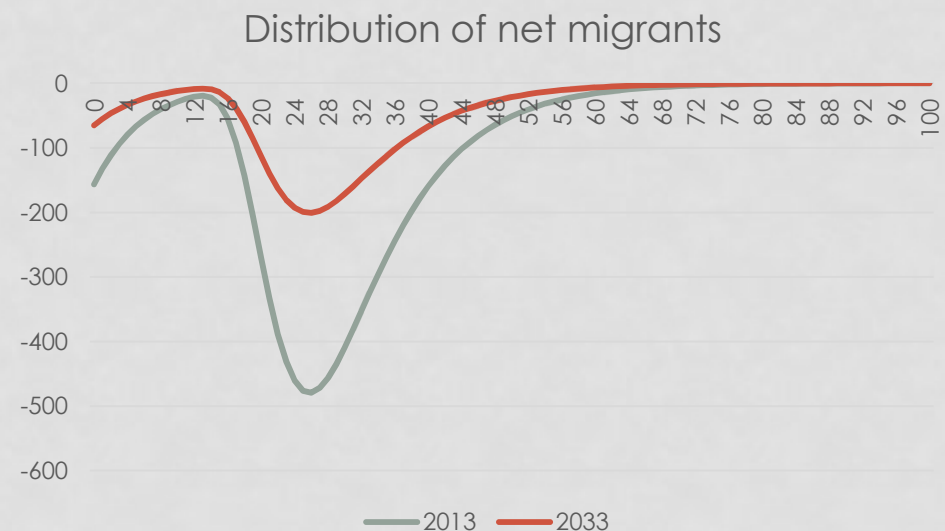
- Mortality
  - Life expectancy at birth

	Men			Women		
Year						
	At 0	At 20	At 60	At 0	At 20	At 60
2013	63.2	49.2	15.7	67.4	52.2	17.6
2033	66.1	50.6	16.2	70.7	54.0	18.2

- Fertility
  - Decrease from 1,95 in 2013 to 1,75 in 2033

# THE MODEL OF SSB – GENERAL POPULATION (2)

- Migration
  - Affect more pension than Short-term benefits
  - Usually at at 0...but it is a training!
  - Assumptions based on UN
    - Net migration = -20 000 in 2013 going up to 8 375 in 2033
    - 50% / 50 % male and female



## EXERCISE #2

- [Exercise # 2.xls](#)
- [Exercise # 2 Solution.xls](#)

# FERTILITY RATES

- Use age pattern of mother (may evolve over time)
  - 15 to 49
  - Important assumptions
- Ultimate fertility rate (critical assumption)
- Can be used for maternity benefits

## Fertility rate by group age of 1000 women

Group of age	1995	2000	2005	2010	Child bearing schedule (%)
15-19	186	164	142	138	13,9
20-24	295	282	237	236	23,7
25-29	276	260	244	231	23,2
30-34	220	228	189	194	19,5
35-39	155	149	136	126	12,7
40-44	106	62	63	53	5,3
45-49	36	20	20	16	1,6
<b>TFR 15-49</b>	<b>6,4</b>	<b>5,8</b>	<b>5,2</b>	<b>5,0</b>	100,0

# EXERCISE #3

- [Exercise # 3.xls](#)
- [Exercise #3 Solution.xls](#)

# MIGRATION

- Look at past data
- Volatile factor
- Important to isolate non-recurrent events (political turmoil)
- Rely (for short-term) to government policy
- Immigrants may be subject to different rates of mortality, fertility, and disability.

# MIGRATION

- In some cases allowance may also have to be made for internal migration within a country
  - Québec and others provinces
- A tough one if data don't exist
  - Simplicity
- Normally, if net migration is low compared to total population, we can ignore migration

# EXERCISE #4

- [Exercise # 4.xls](#)
- [Exercise #4 Solution.xls](#)

# THE MODEL OF SSB – GENERAL POPULATION

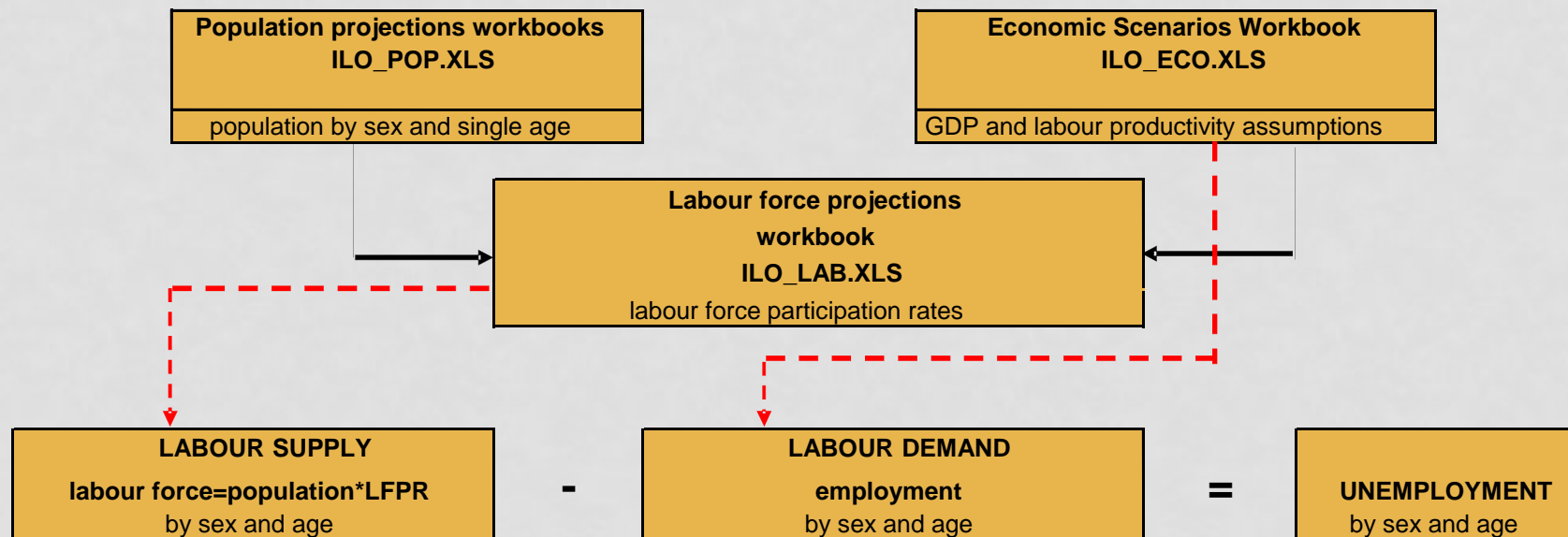
- Mortality
  - Life expectancy at birth

	Men			Women		
Year						
	At 0	At 20	At 60	At 0	At 20	At 60
2013	63.2	49.2	15.7	67.4	52.2	17.6
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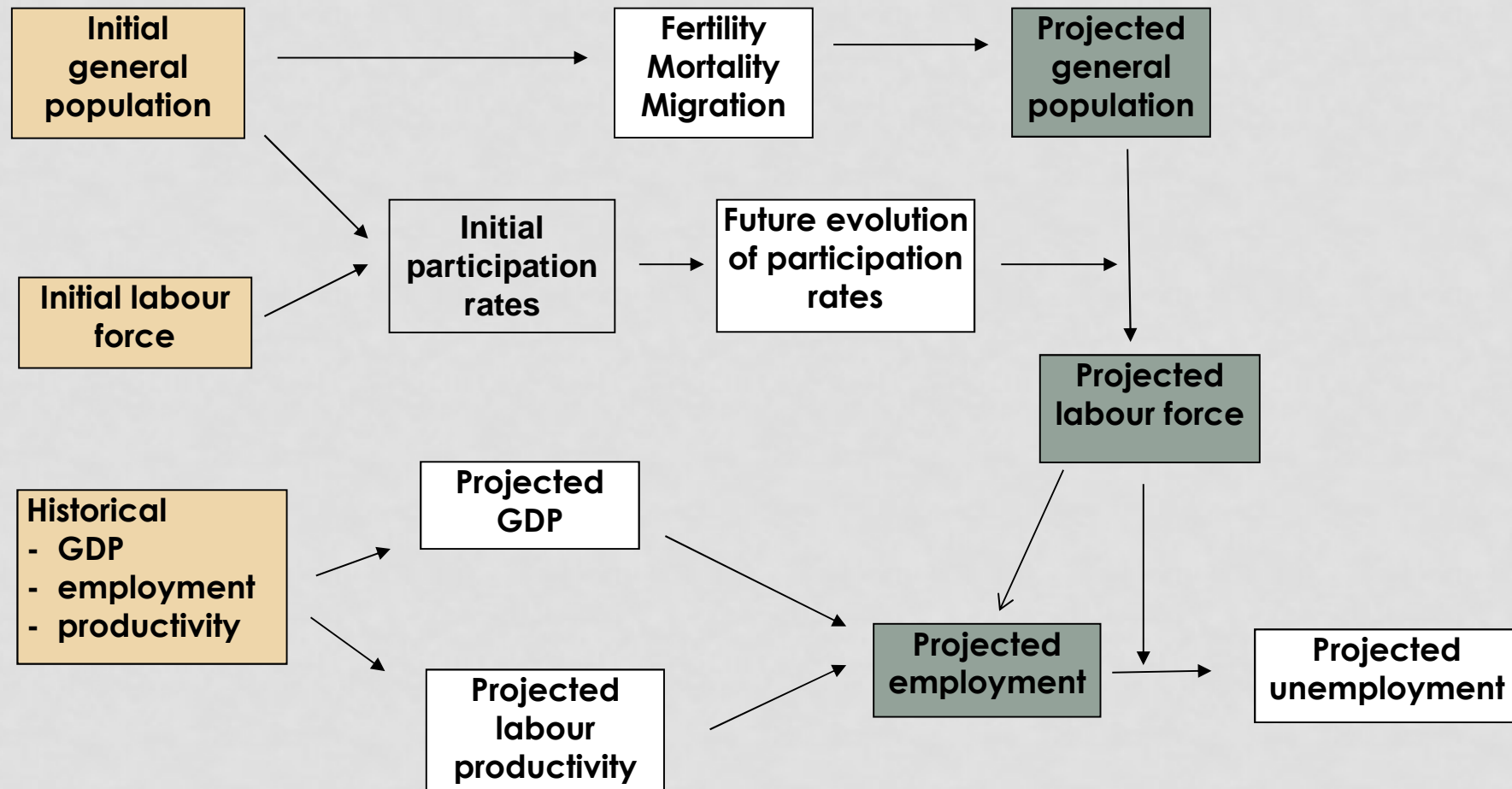
- Fertility
  - Decrease from 1,95 in 2013 to xx in 2033
- Migration
  - 0

Going through the  
ILO-POP model!

# LABOUR FORCE PROJECTION



# LABOUR MARKET PROJECTIONS



# LABOUR FORCE MODULE

## Requirements: Data and Assumptions

- Data (Labour Force Survey)
  - Initial participation rates
    - Single age cohort obtained by linear interpolation
  - Initial employment
    - Single age cohort obtained by linear interpolation
  - The more detailed and accurate the better
- Assumptions
  - Labour force participation rates
  - Employment distribution (by status, by age)
  - Employment growth (Economic module)

# LABOUR FORCE AND LABOUR FORCE PARTICIPATION RATE

$$TLF_t = \sum_{x,s} (POP_{t,x,s} * LFPR_{t,x,s})$$

where

$TLF_t$  = total labour force in year  $t$

$POP_{t,x,s}$  = population of sex  $s$  and age  $x$  in year  $t$

$LFPR_{t,x,s}$  = **labour force participation rates** of sex  $s$  and age  $x$  in year  $t$  (exogenous)

$t$  = 1, ...,  $T$  ( $T$  = end year of projection)

$x$  = Age 0, ..., 100

$s$  = male (0), female (1)

# EMPLOYMENT POPULATION

$$Empl_t = \sum_{x,s} (LFPR_{t,x,s} * (1 - Unemp_{t,x,s}))$$

where

$Empl_t$  = total employed population in year  $t$

$LFPR_{t,x,s}$  = labour force population of sex  $s$  and age  $x$  in year  $t$

$Unemp_{t,x,s}$  = **Unemployment rates** of sex  $s$  and age  $x$  in year  $t$  (exogenous)

$t$  = 1, ...,  $T$  ( $T$  = end year of projection)

$x$  = Age 0, ..., 100

$s$  = male (0), female (1)

# SOURCES

- National Statistical Office
- Labour market survey
- Social Security database  
(often the most reliable source even if incomplete)
- Central Bank
- International organisations  
Ex. ILOSTAT Database (LABORSTA up to 2008),  
ILO Key Indicators of the Labour Market (KILM)

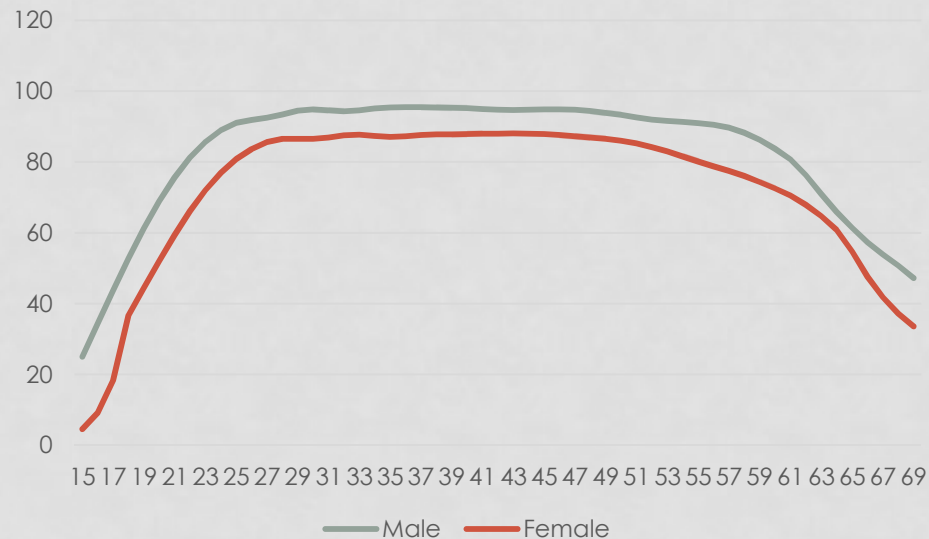
# EXERCISE #5

- [Exercise # 5.xls](#)
- [Exercise #5 Solution.xls](#)

# THE MODEL OF SSB – LABOUR

- Labour force participation rate

- Source: ILO labour-stat



- Unemployment rate: male 3,66% / female 4,5%
- Source: World Bank and ILO

# ECONOMIC MODULE

# ECONOMIC MODULE

## Objective

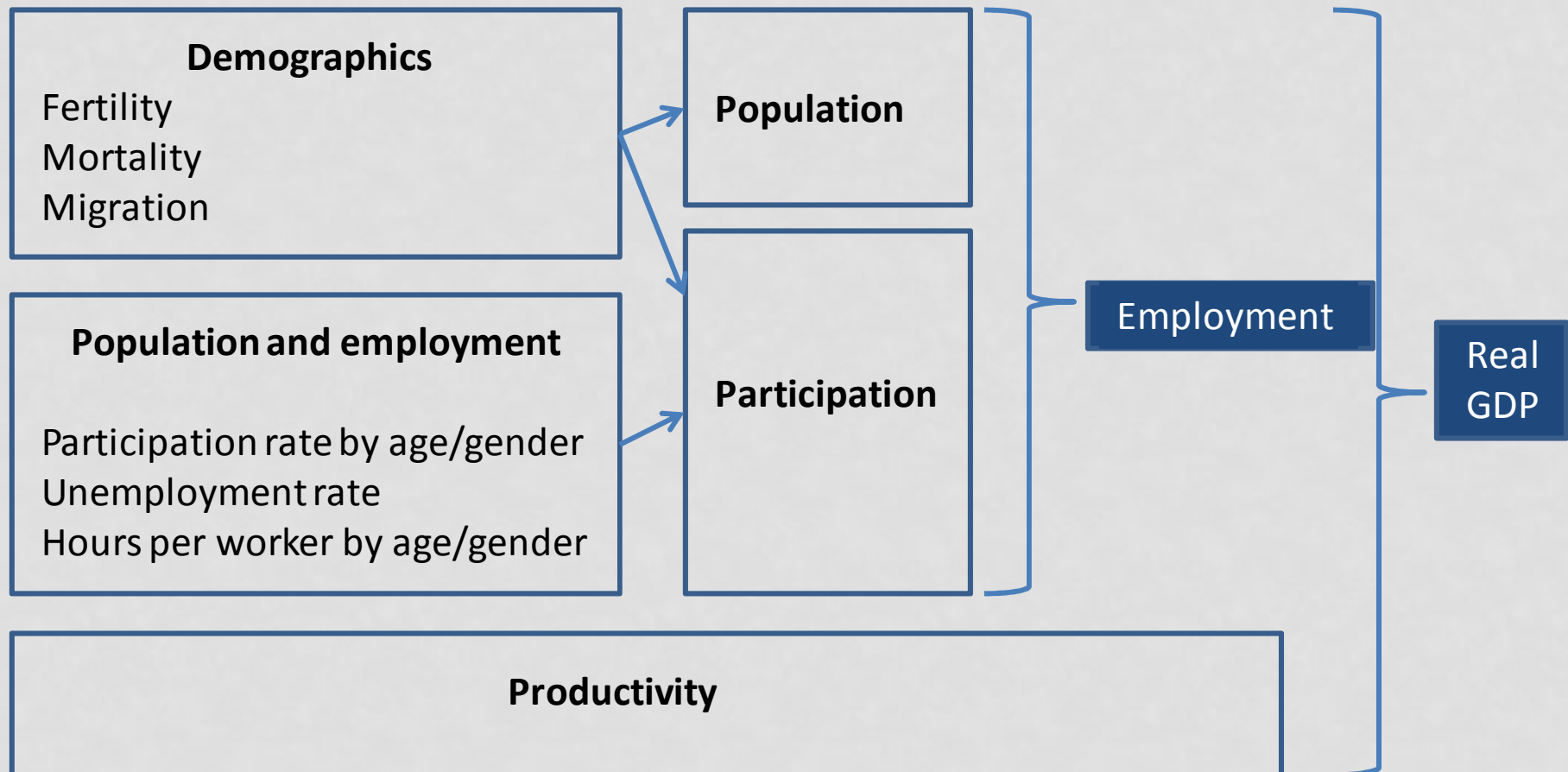
- Project different macroeconomic scenarios

# ECONOMIC MODULE

## MACROECONOMIC SERIES

- GDP (BoM, IMF)
  - Nominal, real, per capita
  - GDP growth rate
- Inflation (BoM, NSO, IMF)
- Exchange rate (BoM, IMF)
- Interest rate (BoM, IMF)
  - Nominal, real
- Average wage
  - Pension schemes
  - National average wage

# POPULATION, PARTICIPATION, PRODUCTIVITY AND REAL GDP



# GDP<sup>R</sup> : REAL GDP GROWTH

$$\text{GDP}_t^r = \text{Empl}_t \times \text{Labprod}_t$$

where

$\text{Empl}_t$  = total employed population in year  $t$

$\text{Labprod}_t$  = labour productivity in year  $t$   
(exogenous)

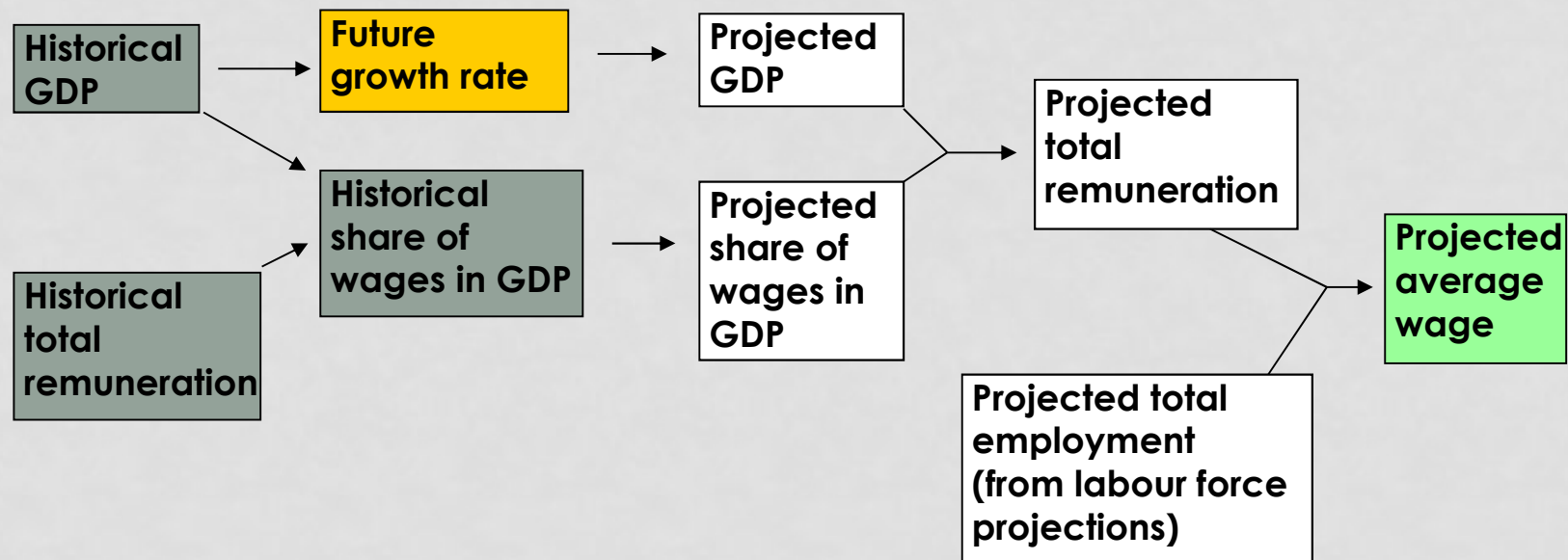
*included in Labprod<sub>t</sub>* : Work intensity (Average number of hours worked)

GDP per hour worked  
(increase in capital intensity  
and technological  
improvement)

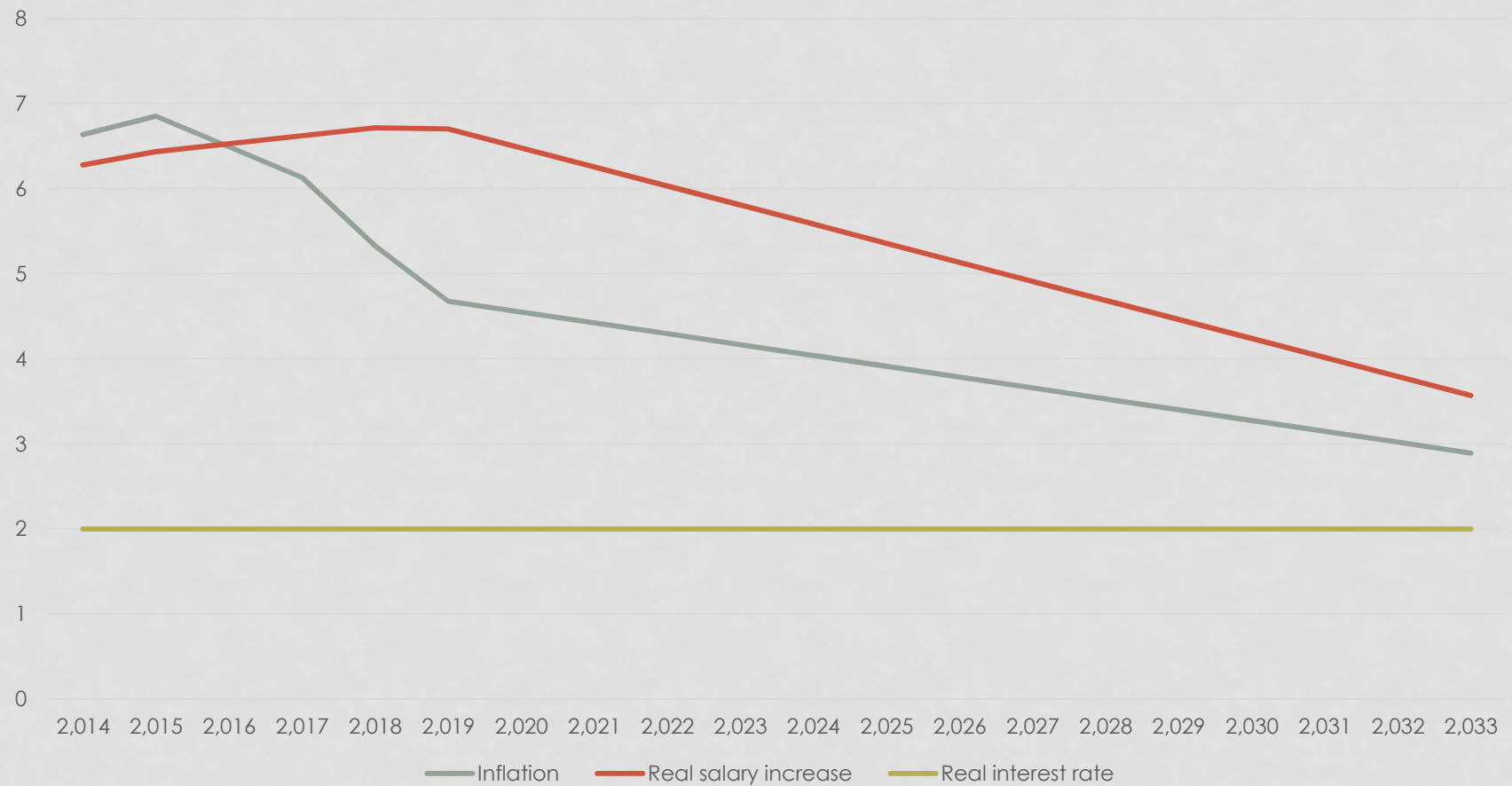
# OTHER ECONOMIC VARIABLES

- $GDP^n_t = GDP^r_t \times DEFLGDP_T$ 
  - $DEFLGDP_T$  = GDP deflator in t
- Inflation (exogenous)
  - Crucial or not
    - depends on pension adjustment
- Interest rates (exogenous)
  - Real interest rate
  - Spread analysis
- Salary growth
  - In long term reach labour productivity

# ANOTHER WAY FOR SALARY GROWTH ASSUMPTIONS

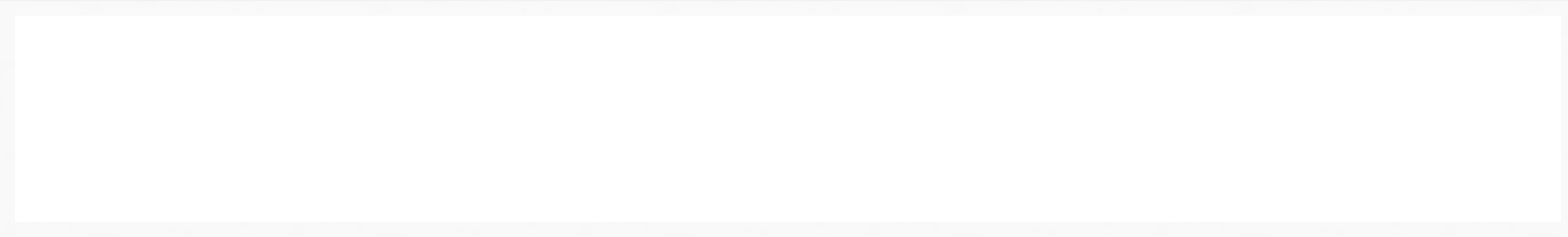


# THE SSB MODEL – ECONOMIC VARIABLE





# ASSUMPTIONS



“ There are known knowns; there are things we know we know.

We also know there are known unknowns; that is to say we know there are some things we do not know.

But there are also unknown unknowns – the ones we don't know we don't know. ”

Former United States Secretary of Defense Donald Rumsfeld

# SCHEME-SPECIFIC PAST EXPERIENCE REVIEW

- Analysis of past experience as a basis for determining the assumptions used for the financial projections
- Important to understand past experience before understanding where the scheme is going
  - Help in the calibration process
- Look at financial statement
  - summary of the income, expenditure and assets
- Modifications since last projection
  - Provisions, administration...
    - Explain how they affect results

# RECONCILIATION

- Important and necessary to link the results between two projections
  - Reconciliation should take into account the «financial indicators» of the actuarial valuation
    - Liabilities (fully funded scheme)
    - Contribution rates
      - PAYG rates
  - Reconciliation should be done for main assumptions
- Explain the differences with the expectation and the experience
  - Income, expenditure and assets
  - # of contributors and # beneficiaries
  - Main actuarial assumptions
    - Salary increase, rate of return on assets, inflation...

# *ASSUMPTIONS*

- A realistic basis, as opposed to a conservative or a liberal basis
  - Each assumption should be individually realistic
  - An explicit assumption, as opposed to an implicit one
  - Internal consistency (all assumptions should be mutually consistent (correlation or interrelationship))
  - Overall consistency : the economic and demographic assumptions used should be consistent with the long-term experience and the outlook for the economy

## *WHEN YOU DO A REPORT*

- Reminder that the results of the valuation are based on assumptions concerning uncertain future events and outcomes and that the eventual experience will most likely differ, possibly materially, from that indicated in the projections
  - Valuations are not predictions

## MORE ON ASSUMPTIONS.....

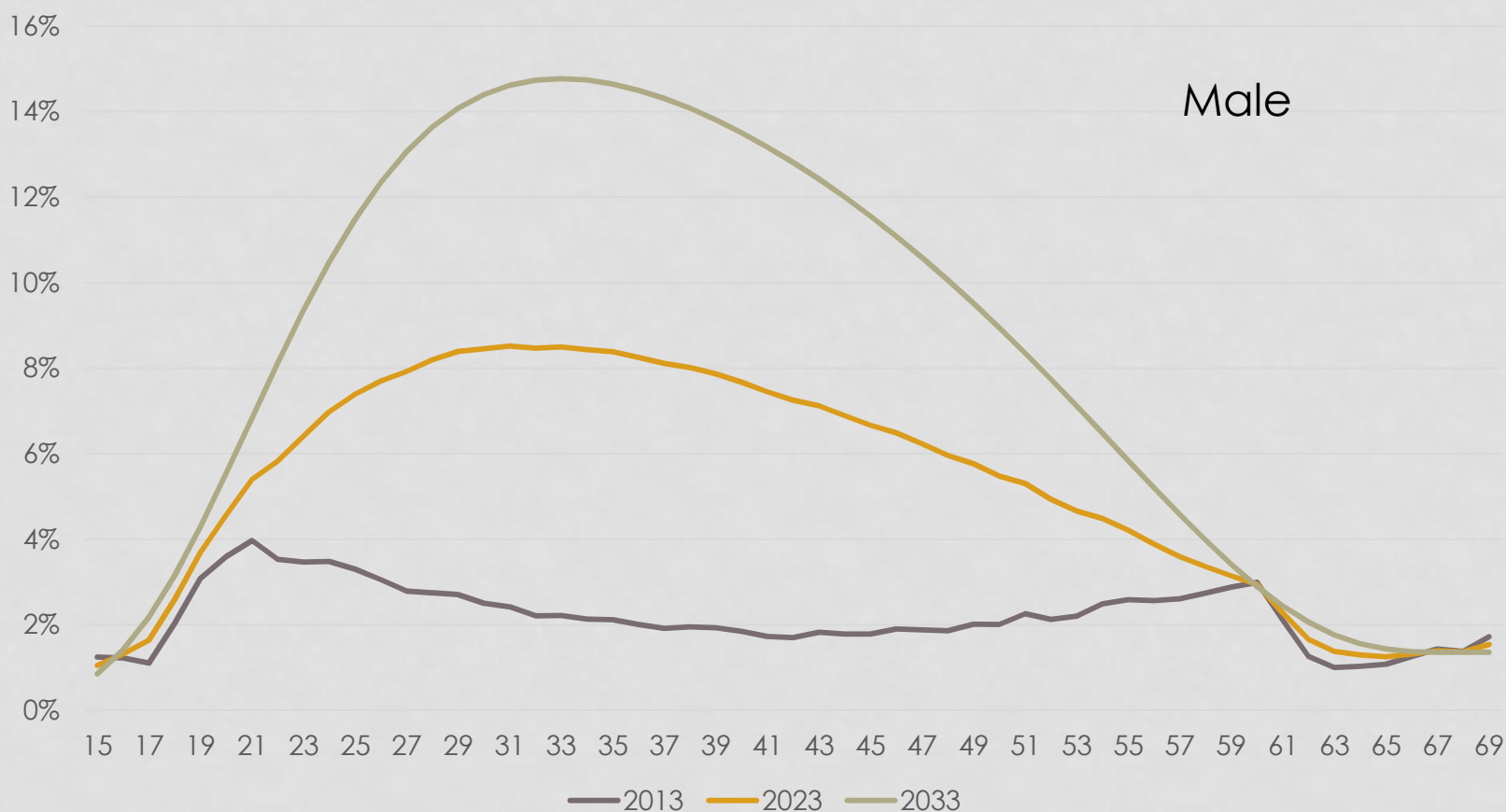
- It is important to document your assumptions
- Keep in mind materiality
  - More efforts on crucial assumptions
- Because there is a lot of uncertainty:
  - Important to know the risk
  - Do sensitivity analysis
  - Worst case and best case scenarios
  - Stochastic analysis

# FUTURE DEVELOPMENT OF THE INSURED POPULATION

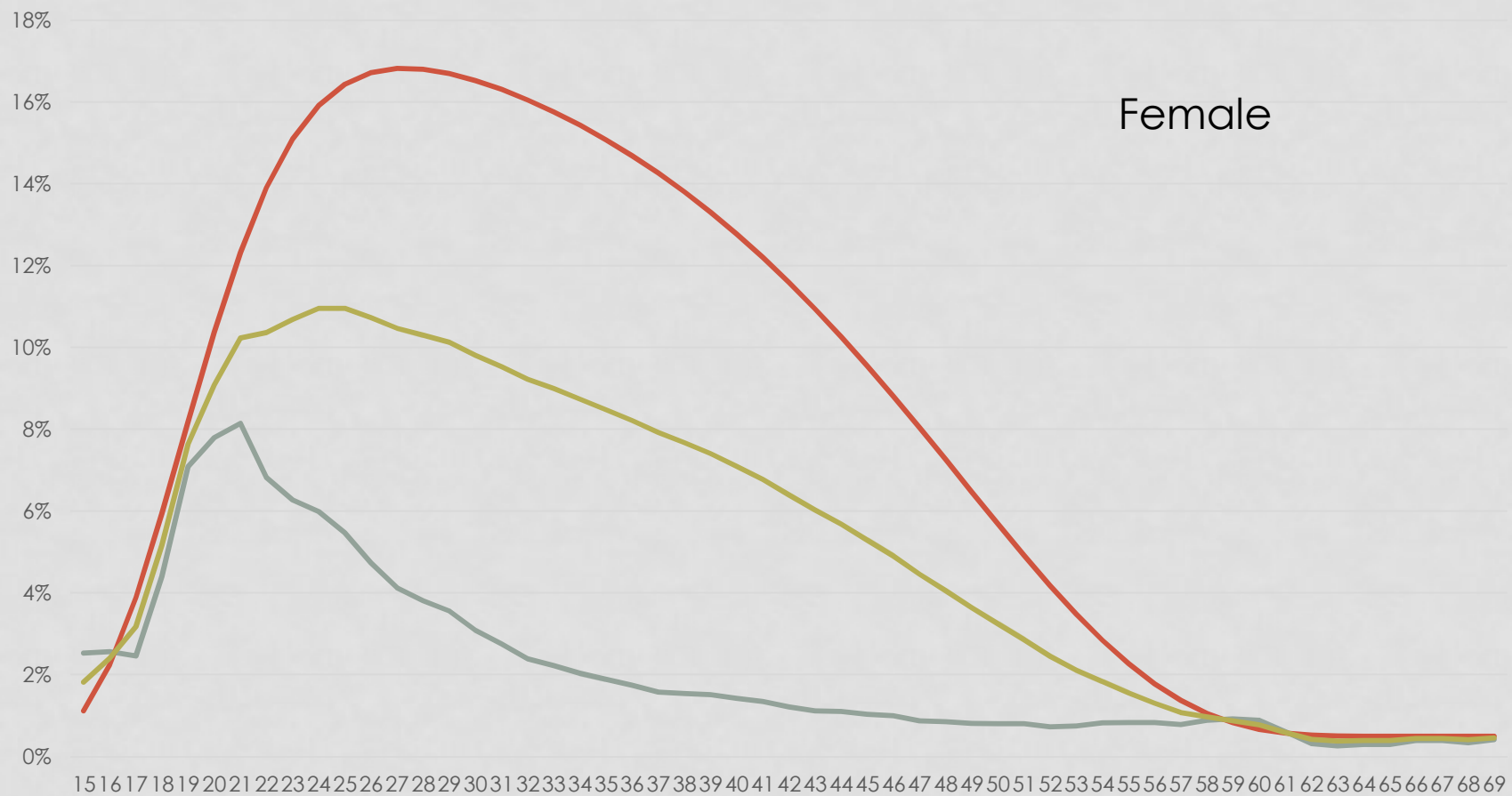
- Coverage and compliance
  - Coverage rate: legal
    - Possible extension to new group of workers
    - Depend on the overall coverage rate and on coverage rate of other groups (civil servants...)
  - Compliance rate: administrative
    - Future improvement of collection process
- Active vs inactive
  - Treatment of new entrants and re-entrants
  - Cohort vs aggregate approaches (3 next slides)

# THE SSB MODEL – THE COVERED POPULATION

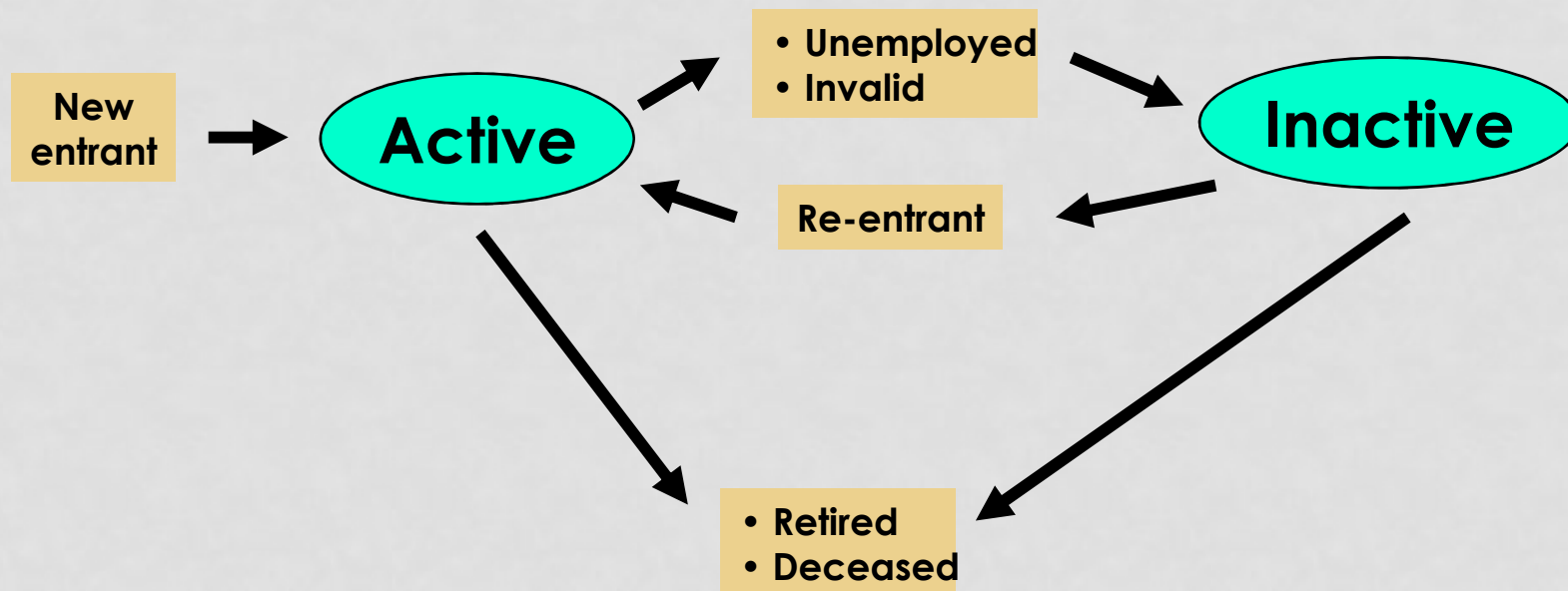
- Increasing from 2,5% to 10% over 20 years



# THE SSB MODEL – THE COVERED POPULATION



# MOVEMENTS OF THE INSURED POPULATION



Not so important for short term benefits

# PROJECTION OF INSURED EARNINGS

- Annual earnings increase
  - General increase (according to general economic framework)
  - Salary scale (individual increase related to experience and promotion)
- Covered earnings
  - Future evolution of floor and ceiling
- Density of contribution
  - Linked with future unemployment
  - Linked to evolution of job types (part-time)

# Density of contributions

- (c) The “average number of months of paid contributions” is determined on an annual basis and it is equal to  $A / B$

where A and B are defined as follows:

$$\begin{aligned} A = & [1 \text{ mth} * \text{No. of actives of age X who contributed exactly for 1 month}] \\ & + [2 \text{ mths} * \text{No. of actives of age X who contributed exactly for 2 months}] \\ & + [3 \text{ mths} * \text{No. of actives of age X who contributed exactly for 3 months}] \\ & + \dots\dots \\ & + [12 \text{ mths} * \text{No. actives of age X who contributed exactly for 12 months}] \end{aligned}$$

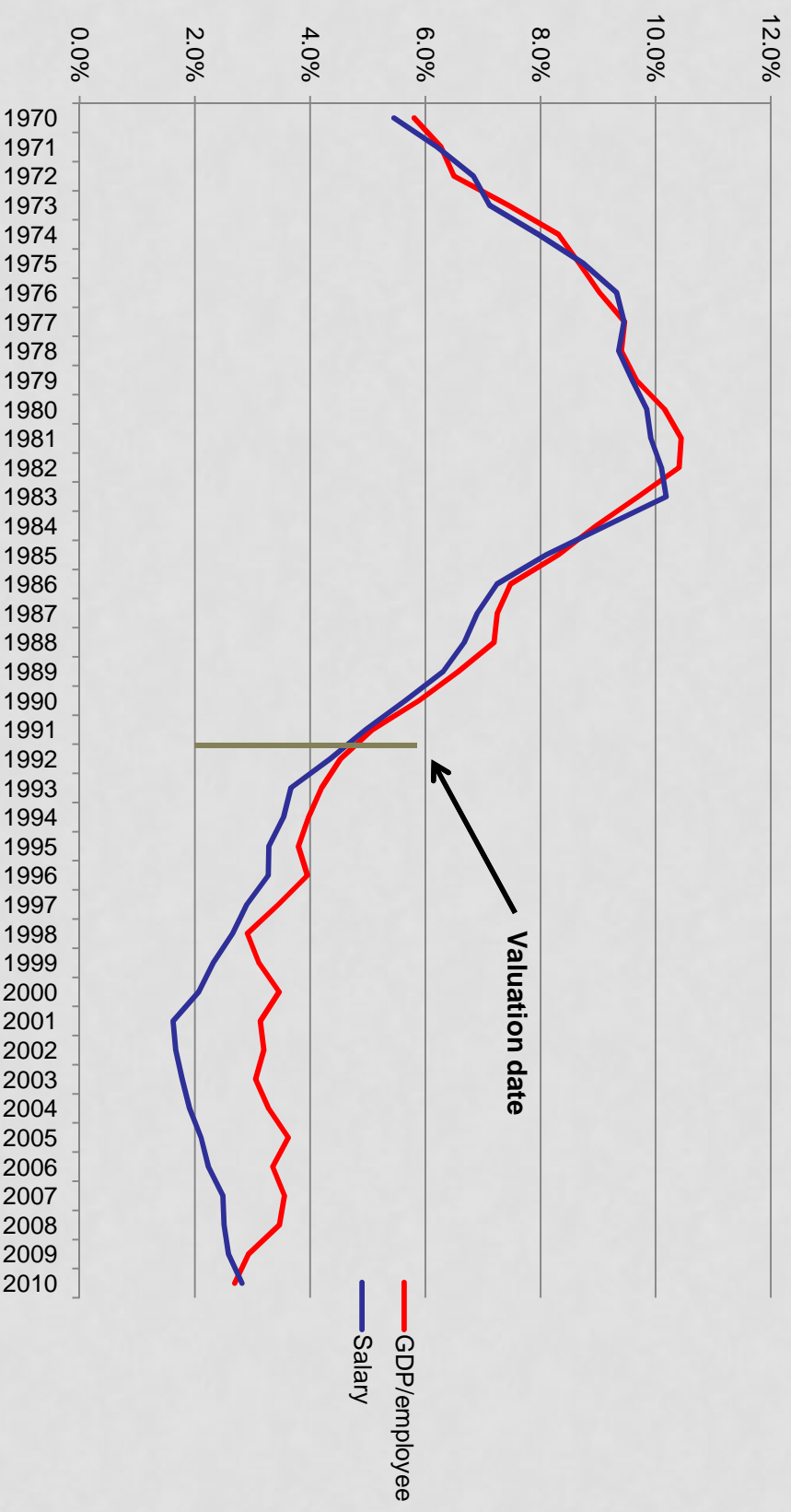
$$B = \text{Total No. of actives of age X}$$

- (d) The “density factor” is determined on an annual basis and it is equal to the “Average number of months of paid contributions” divided by 12.

# THE SSB MODEL – THE DENSITY OF CONTRIBUTION

- No data on it
  - Will need it, big link with unemployment insurance
  - Depends also on the increase in the covered population
- Simple assumption
  - 80% going up to 90% in 10 years and stay level thereafter
  - Same density for all ages

# IT'S VERY TOUGH TO MAKE ASSUMPTIONS:



# MORTALITY RATES

- Start with mortality of general population
- Ideally develop scheme's specific mortality for each separate group:
  - Contributors (workers: lower mortality)
  - Old-age pensioners (may be lower than general population)
  - Survivors (normally equal to general population)
  - Invalidity pensioners
    - generally higher than general population at younger ages
- **For SSB population**, we made the assumptions that the mortality rates are 75% the one of the general population

# INCIDENCE RATES

$$\text{Incidence rate (s,x)} = \frac{\text{Number of new incidence (s,x)}}{\text{Population exposed to risk (s,x)}}$$

- Ideally: use the experience of the scheme
- Otherwise
  - Incidence rates of another scheme with similar definition of invalidity, or
  - Loading applied to a standard table

# INVESTMENT RETURN

- Linked with general economic framework
  - real long-term interest rate
  - inflation rate
- Linked with the investment policy
- Not really important for short term benefits

# ADMINISTRATIVE EXPENSES

- Choice of a basis for projection
  - % of contributions
  - % of benefits
  - % of insured earnings (avoids fluctuations due to contribution rate increases)
- Separate components, e.g.:
  - Future staff expenditure related to wage increases
  - Other expenses increasing with price inflation



**More on assumptions to come...**

**By branches**



**Thank you**