

# Risk and Pensions

*SUPERINTENDENCIA DE BANCA, SEGUROS Y AFP DEL PERÚ  
Y  
ASOCIACIÓN INTERNACIONAL DE ORGANISMOS DE SUPERVISIÓN DE FONDOS  
DE PENSIONES (AIOS)*

SEMINARIO INTERNACIONAL: “Desarrollo y desafíos de los sistemas de  
capitalización individual: Un enfoque integral”

**LIMA, PERÚ  
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# Context

- We focus on pensions upon retirement
  - Not on disability insurance or other kinds of benefits related to pension systems
- The analysis in general doesn't consider other explicit or implicit guarantees
  - Minimum pensions, option of returning to the old system, other pillars, etc.
- We set aside political risks faced by pension systems
- My talk is closer to policy makers
  - Investment policy design
  - “Long-term asset allocation” (Campbell & Viceira)
  - Risk

# Introduction

- *A practical (quantitative)* definition of risk is very difficult when dealing with pensions
  - Especially if they are far in the future
  - It is even more complicated for defined contribution systems
- We focus on the considerations that are necessary for a meaningful definition of “risk”
  - Most measures will be very sensitive to the assumptions used
  - Specific answers will be partial

# Introduction

- Risk must be defined in relation to
  - Meeting a liability
  - Meeting an objective
- Defined contribution systems don't have explicit liabilities...

=>

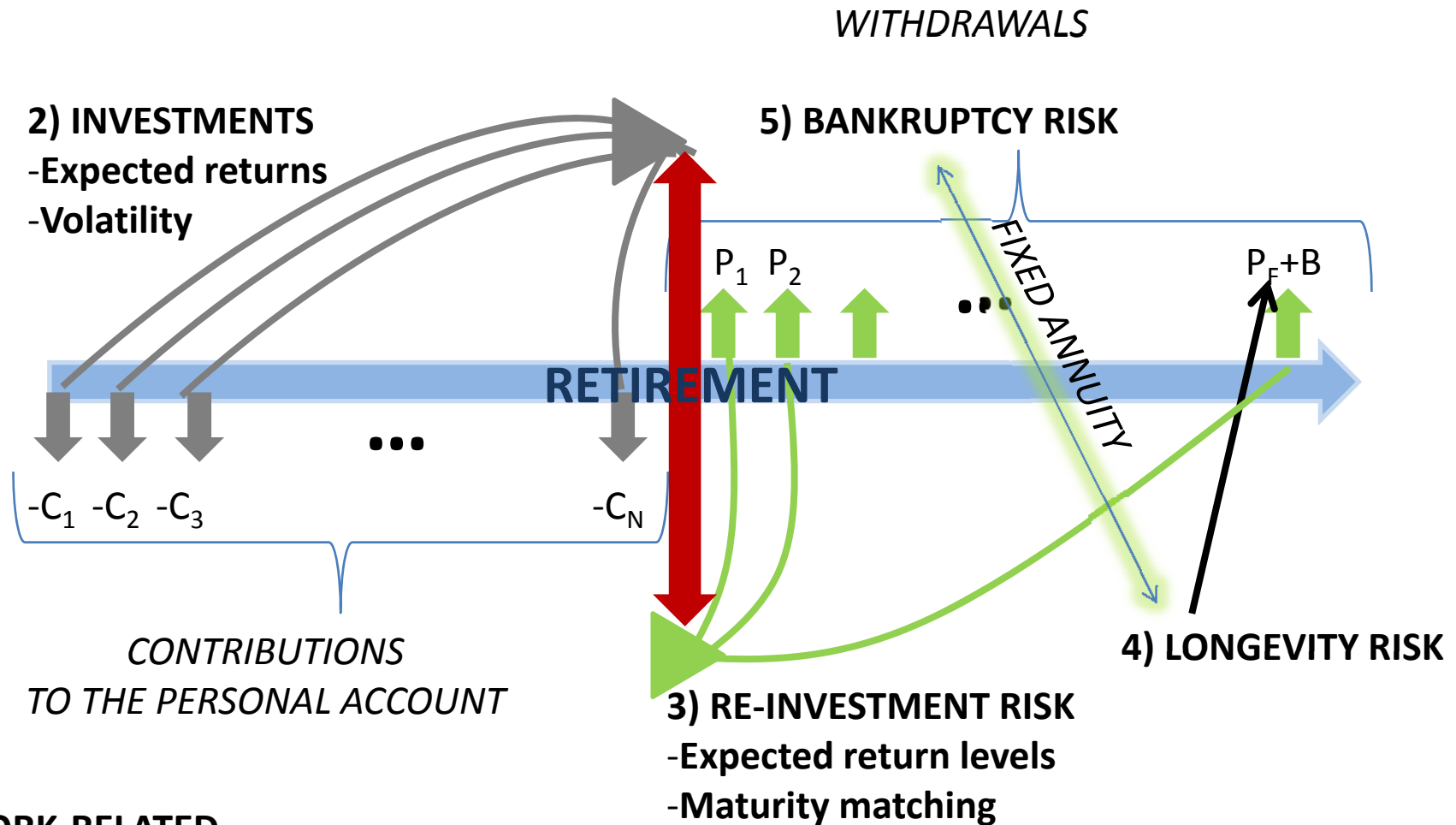
# Introduction

- Meeting an objective:
  - Achieving certain (absolute) pension levels
    - With a given probability
  - Achieving certain replacement ratios
    - ( $R = \text{pension/average salary}$ )
    - With a given probability
- Choosing among these objectives may have relevant policy implications
  - To determine the “playing field” for portfolio managers
  - To determine reasonable asset allocations

# Contents

- General risks in the pensioner's life cycle
  - Five life-cycle risks
- Investment-related risks
- Financial / Human capital
- Factors that affect the replacement ratio  $R$ 
  - *Consequences of investing in equity*
  - *Consequences of investing in long-term bonds*
- Risks
  - How should they be measured (ideally)
  - Recognizable *a priori*
  - What risk is probably not
  - What investments are not safe
- An application
- How much risk is tolerable?

# Five life-cycle *risks* for a pensioner in DC systems

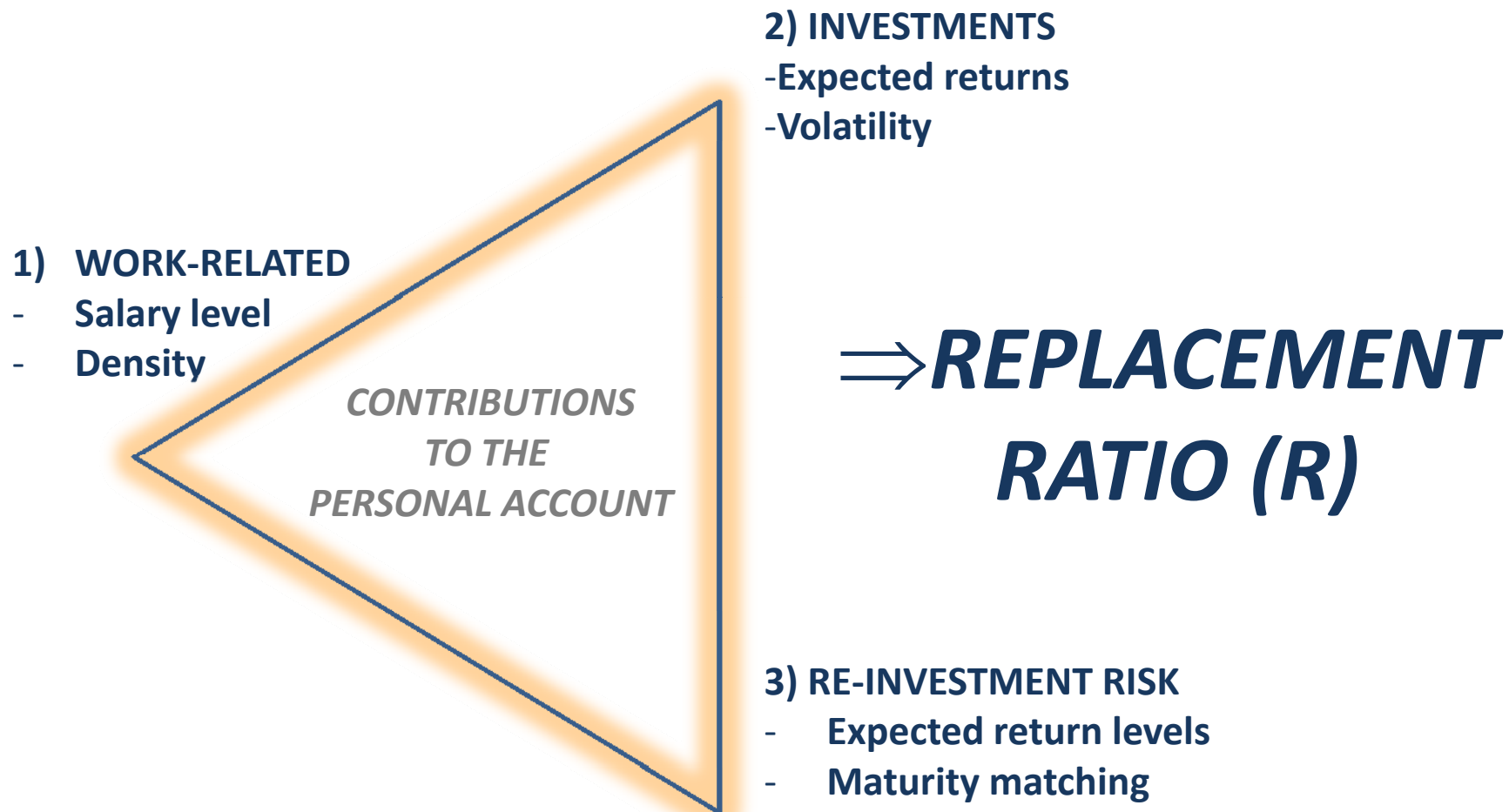


- 1) WORK-RELATED**
  - Salary level
  - Density

# *Five* life-cycle *risks* for the pensioner

1. WORK-RELATED
  - Average salaries
  - Contribution density: unemployment or self-employment
2. INVESTMENTS DURING THE ACCUMULATION PERIOD
  - *Level* of expected returns
  - Security returns exhibit *volatility*
3. RE-INVESTMENT RISK UPON RETIREMENT
  - Accumulated wealth has to be re-invested upon retirement; at that point expected return levels may be “low”
  - Generating fixed inflation-protected pensions without long-maturity inflation-adjusted instruments is risky
4. LONGEVITY
  - “Outlive” one’s savings
5. BANKRUPTCY
  - When longevity risk is transferred to a third party (for example, when buying a fixed annuity)

# **Three** investment-related **risks** for a pensioner in DC systems



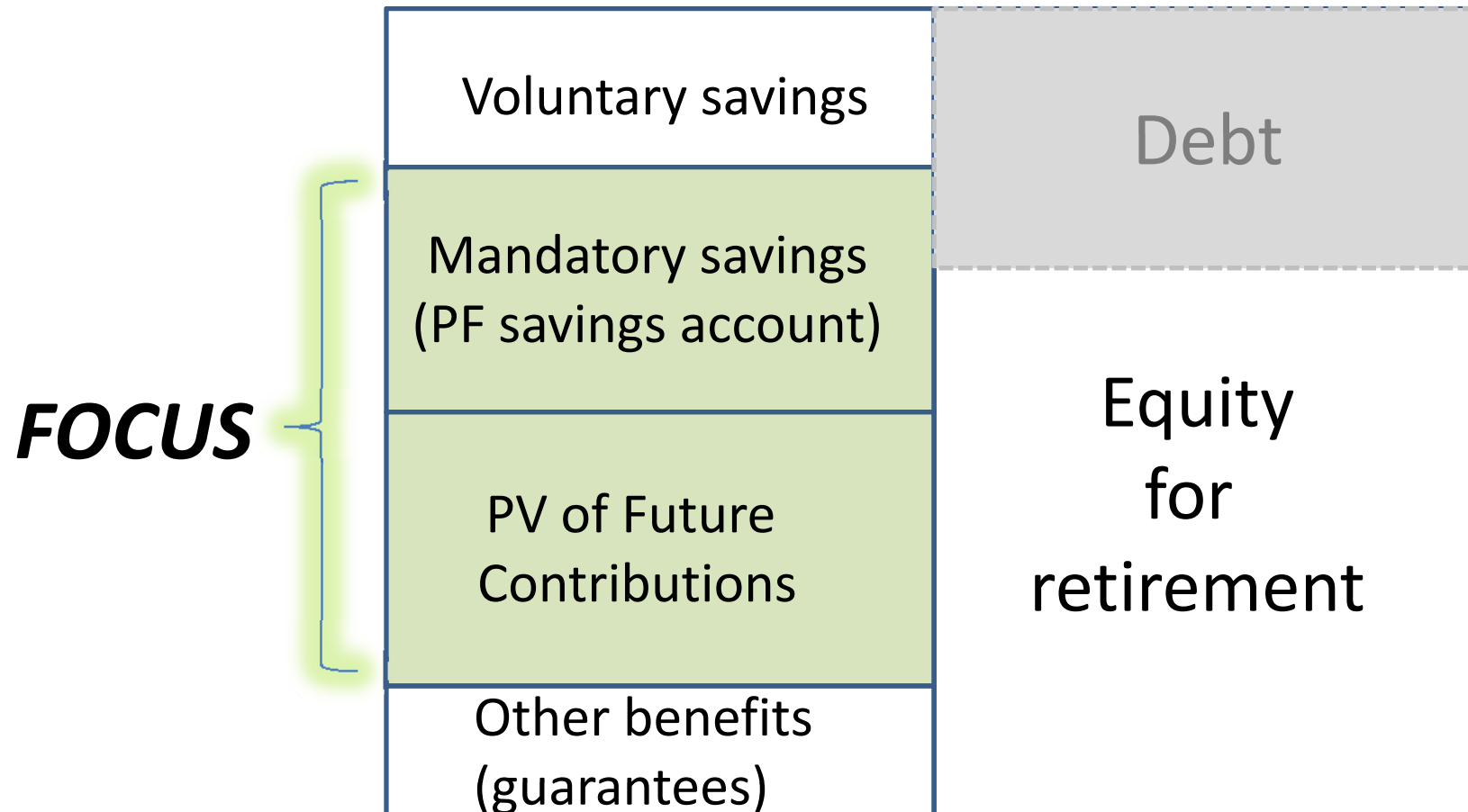
# *Human and financial capital*

- Conceptually, we can think that pensions are generated from two sources of wealth
  - Present value of future contributions (PVFC)
    - A fraction of “Human capital”
  - Financial capital
    - Cumulative savings in the personal account
- The relative importance of each changes through time

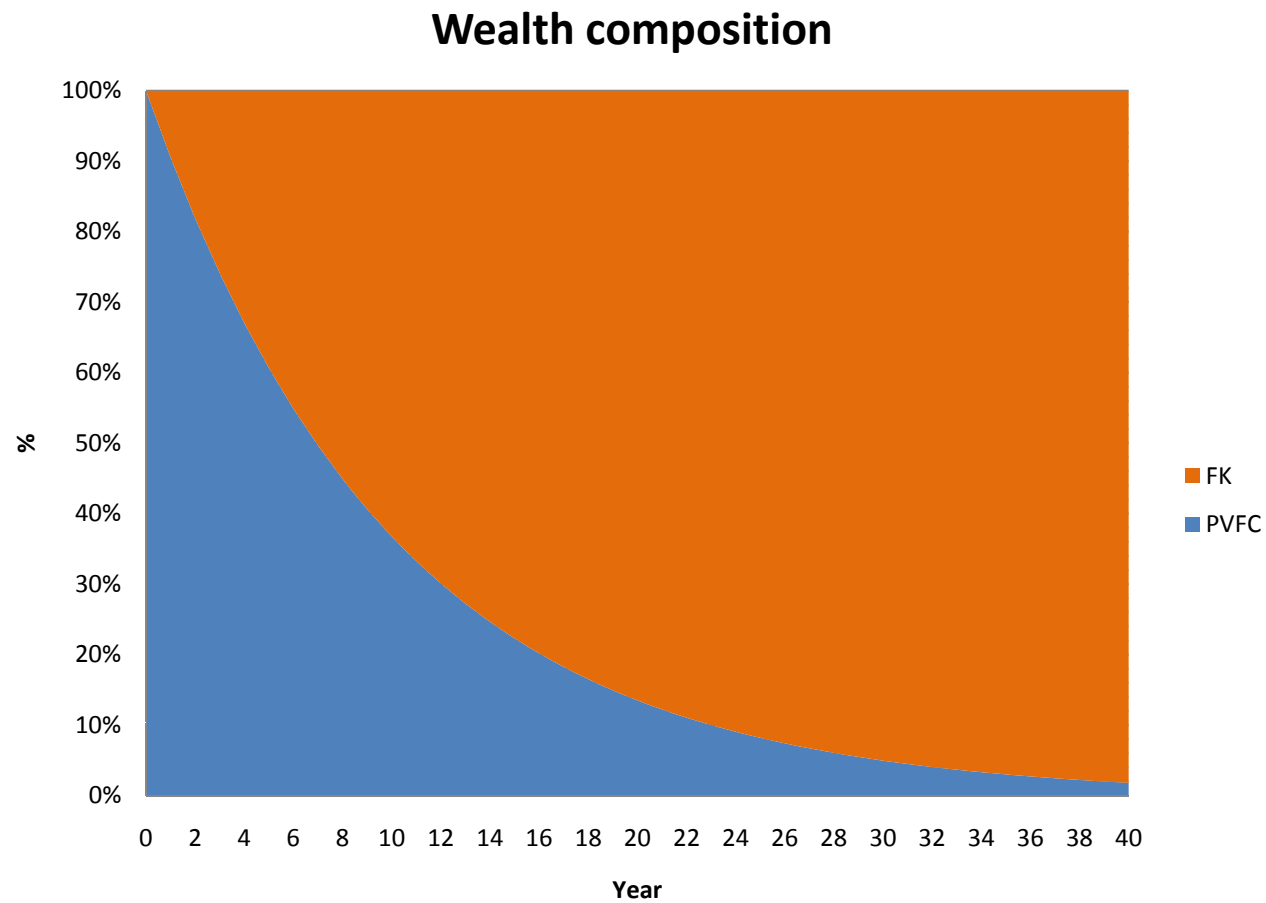
# *Sources of wealth for pensions – future pensioner's balance sheet*

	Voluntary savings	Debt
	Mandatory savings (PF savings account)	
Bond or equity-like?	PV of Future Contributions	Equity for retirement
Bond-like	Other benefits (guarantees)	

# *Sources of wealth for pensions – future pensioner's balance sheet*



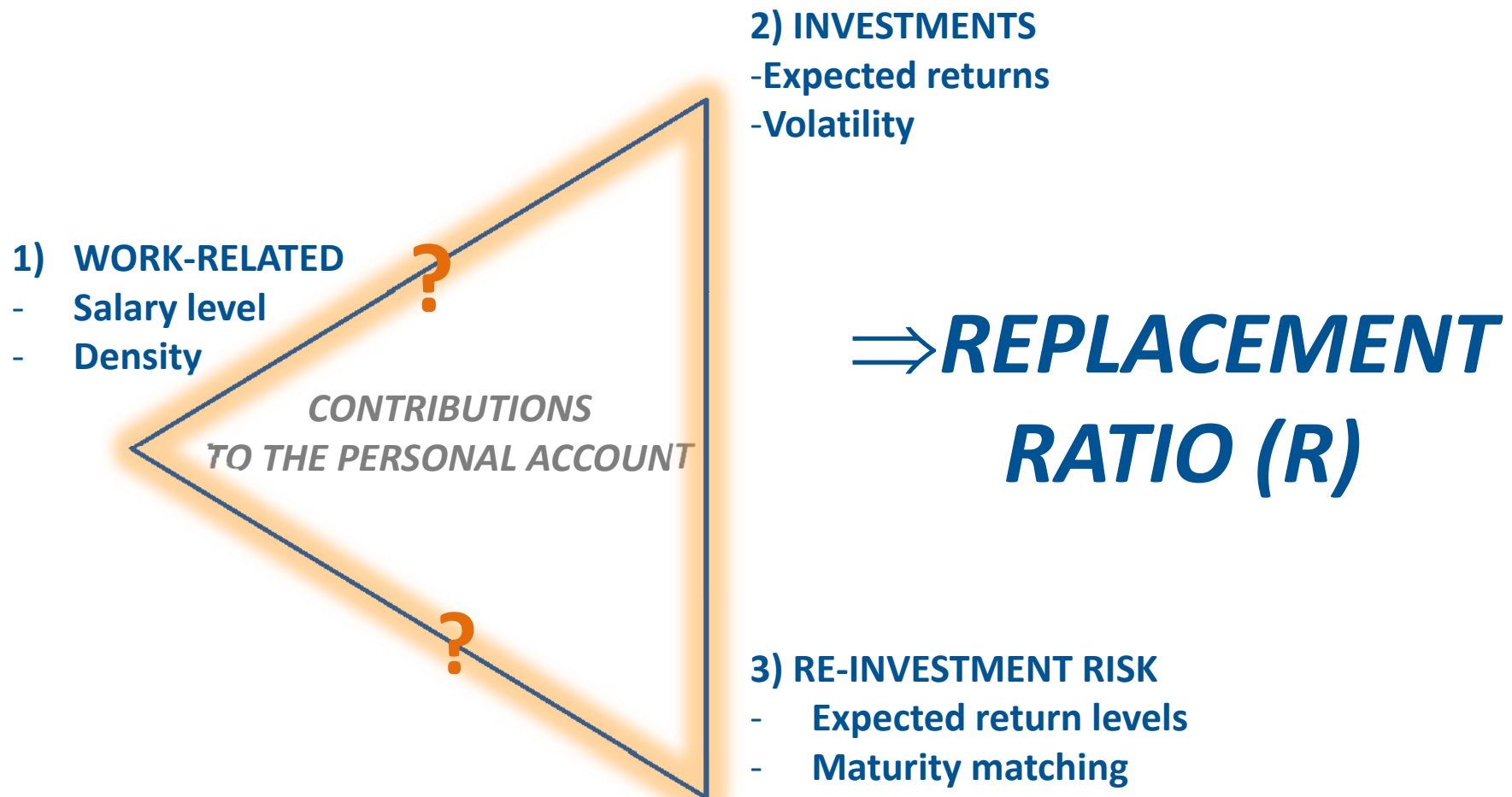
# *Sources of wealth for pensions*



# *Hedging* labor risk

- Can the choice of an investment policy mitigate labor-related risks?
  - *Perhaps “too large and too individual-specific (idiosyncratic) to be hedged”*
  - *Needs to be studied*

# *Three* investment-related *risks* for a pensioner in DC systems



# *Replacement ratio*

- Even if labor risk is *not hedgeable*...
- ... focusing on the replacement ratio  $R$  still makes sense
  - It's a way of separating the effects of investment decisions from that of the individual contributions
  - High labor risk should imply more conservative portfolios
  - Otherwise
    - $\max(\text{pensions})$  subject to  $\text{risk}(\text{pensions})$  is similar to
    - $\max(R)$  subject to  $\text{risk}(R)$

# *Factors affecting R*

## 1. *Cumulative* expected returns

- Tend to be larger for riskier asset classes
  - Local, emerging markets and global equity
- Increases with the horizon

## 2. *Cumulative* volatility

- Tends to be larger for riskier asset classes
  - Local, emerging markets and global equity
  - Increases with the horizon
- Tends to be *lower* for long-term indexed bonds
  - Minimizes risk when there is horizon-matching
- Tends to be *higher* for short-term fixed income
  - Increases with the investment horizon

## 3. *Currency risk*

- *When to hedge it*

## 4. *Cost of a pension* upon retirement

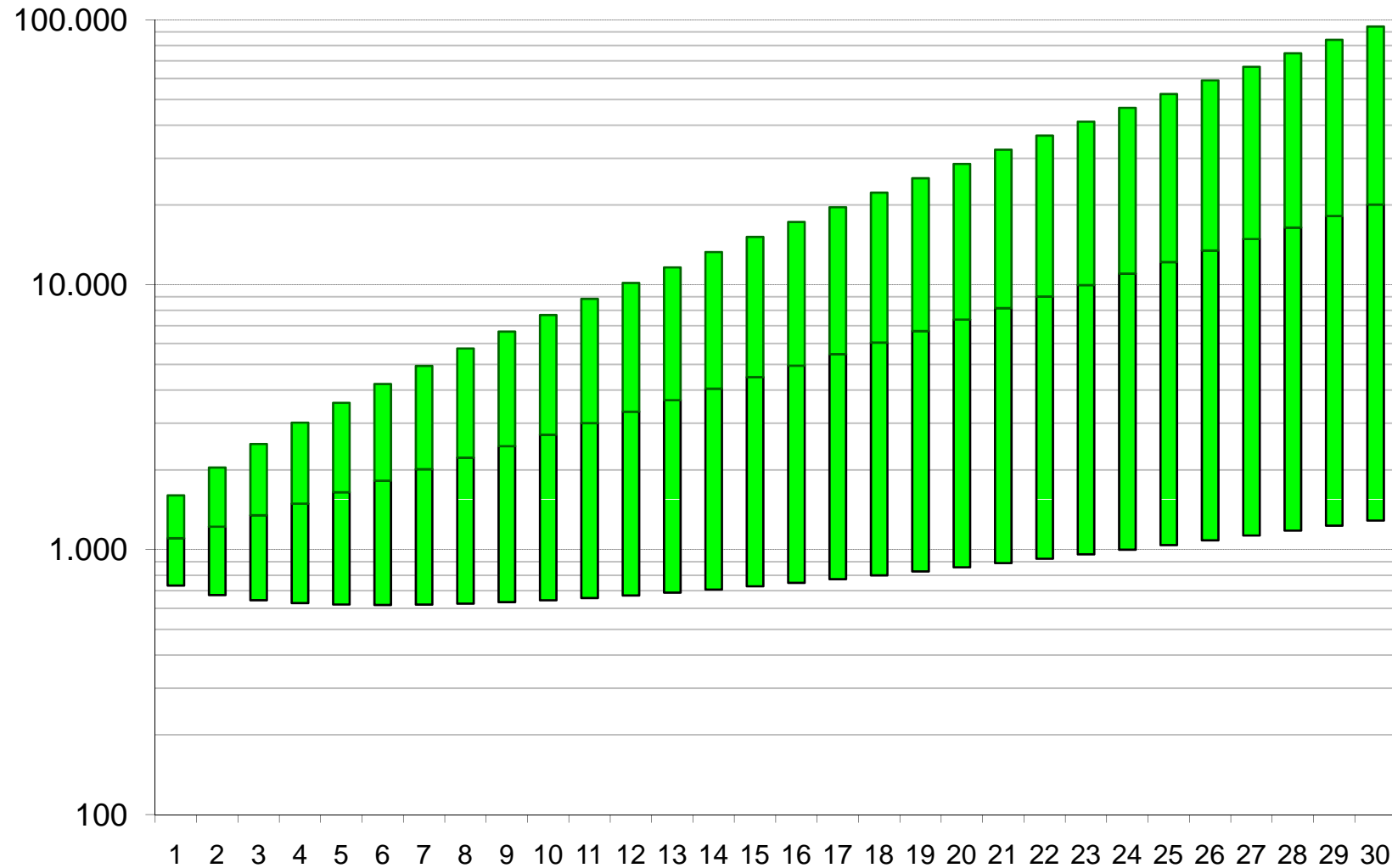
- Can be partially hedged...

# Illustration: Cumulative wealth in stocks

## Cumulative return volatility: $\sigma \times \sqrt{T}$

95% Terminal Wealth CI; Result of inverting UF1000 for N years  
Real annual return = 8%; Volatility = 20%

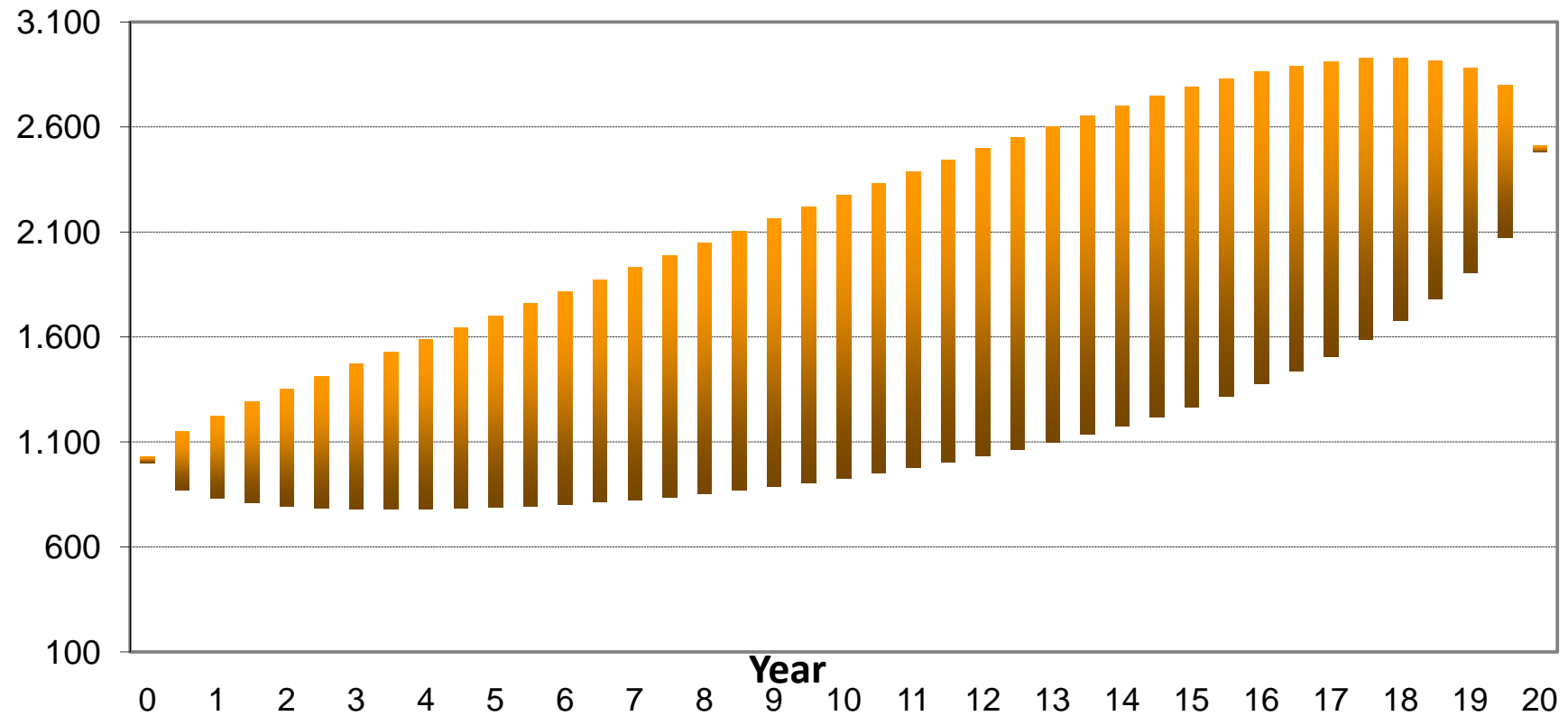
### Real Wealth



# “The carrot”: Cumulative wealth in long-term zero-coupon real bonds

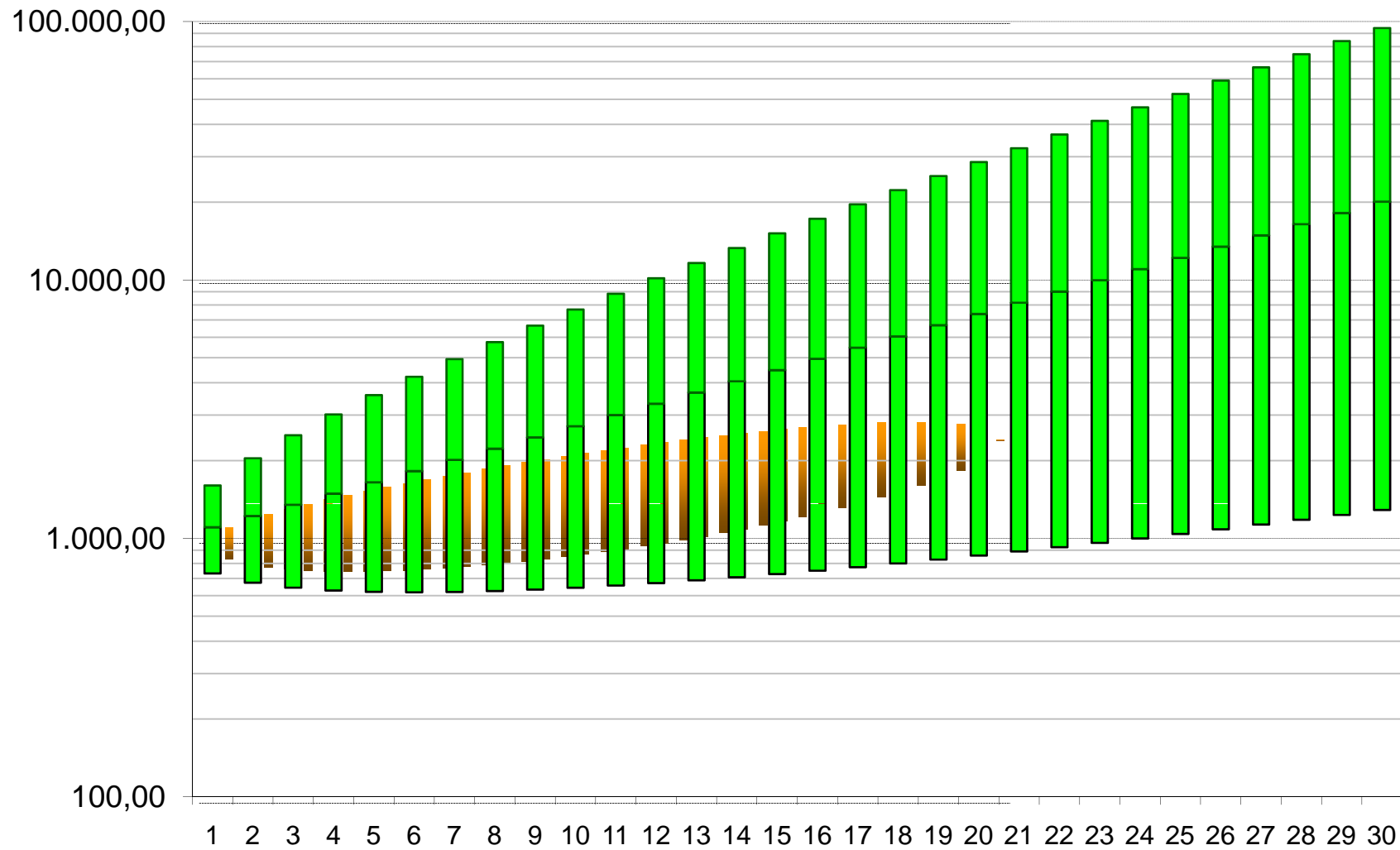
ILLUSTRATION OF A C.I. FOR TERMINAL WEALTH  
(20 yr rate: 4.65%)

## Real Wealth



# Illustration: both together

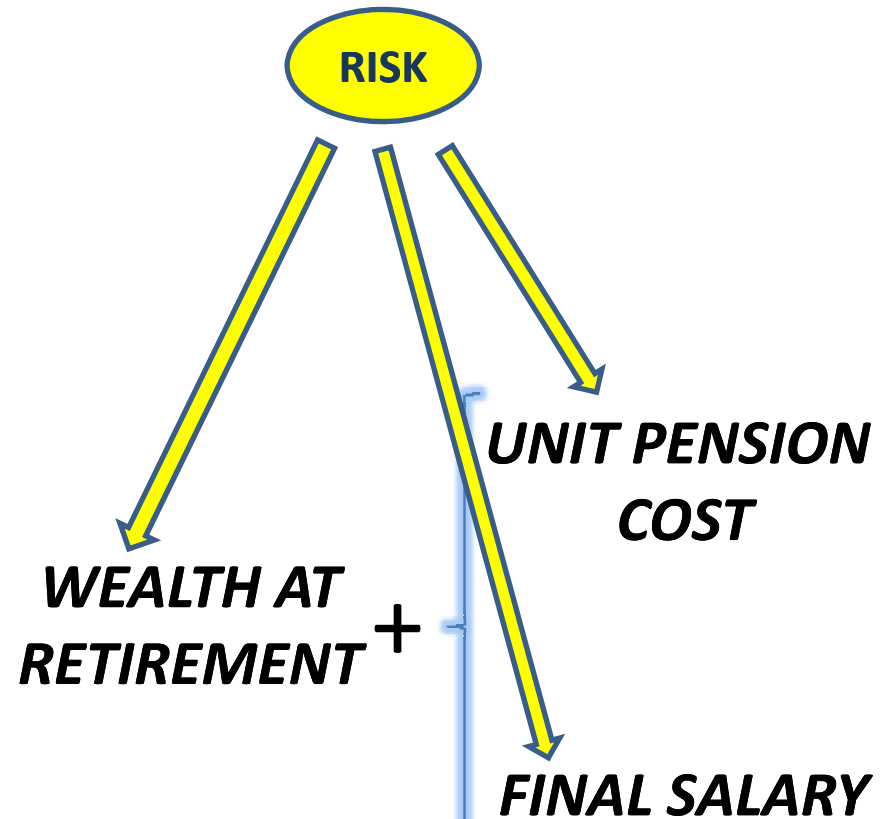
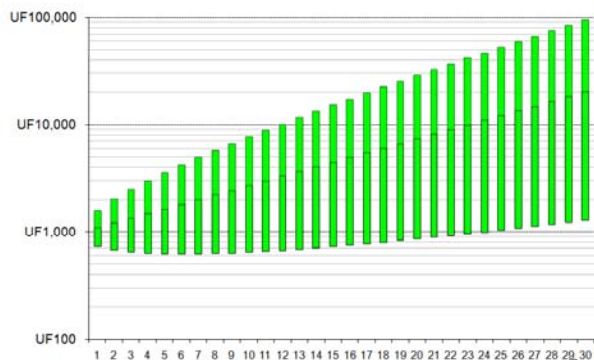
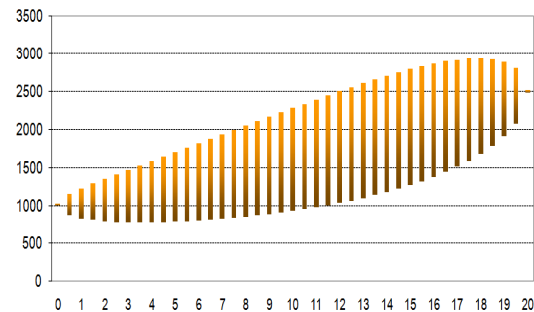
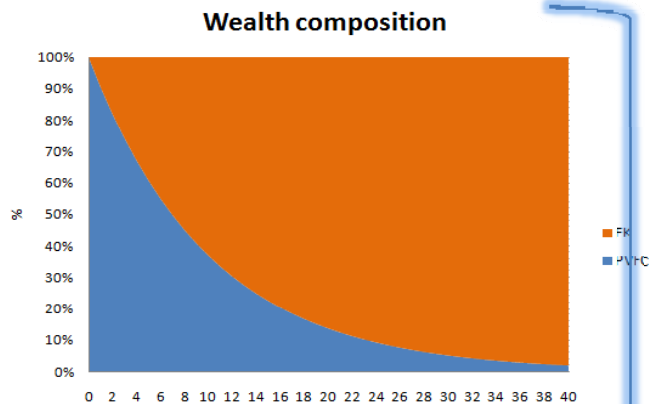
## Real Wealth



# *Investment risks...*

- Previous figures are incomplete in illustrating investment risk for pensions:
  - Cumulative wealth has to be *re-invested* upon retirement in order to generate a pension
  - *This risk can be partially hedged by investing in instruments that behave like very long-term **LOCAL** indexed bonds*

# Final pension/replacement ratio



**PENSION /  
REPLACEMENT RATIO**

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***Risk!***

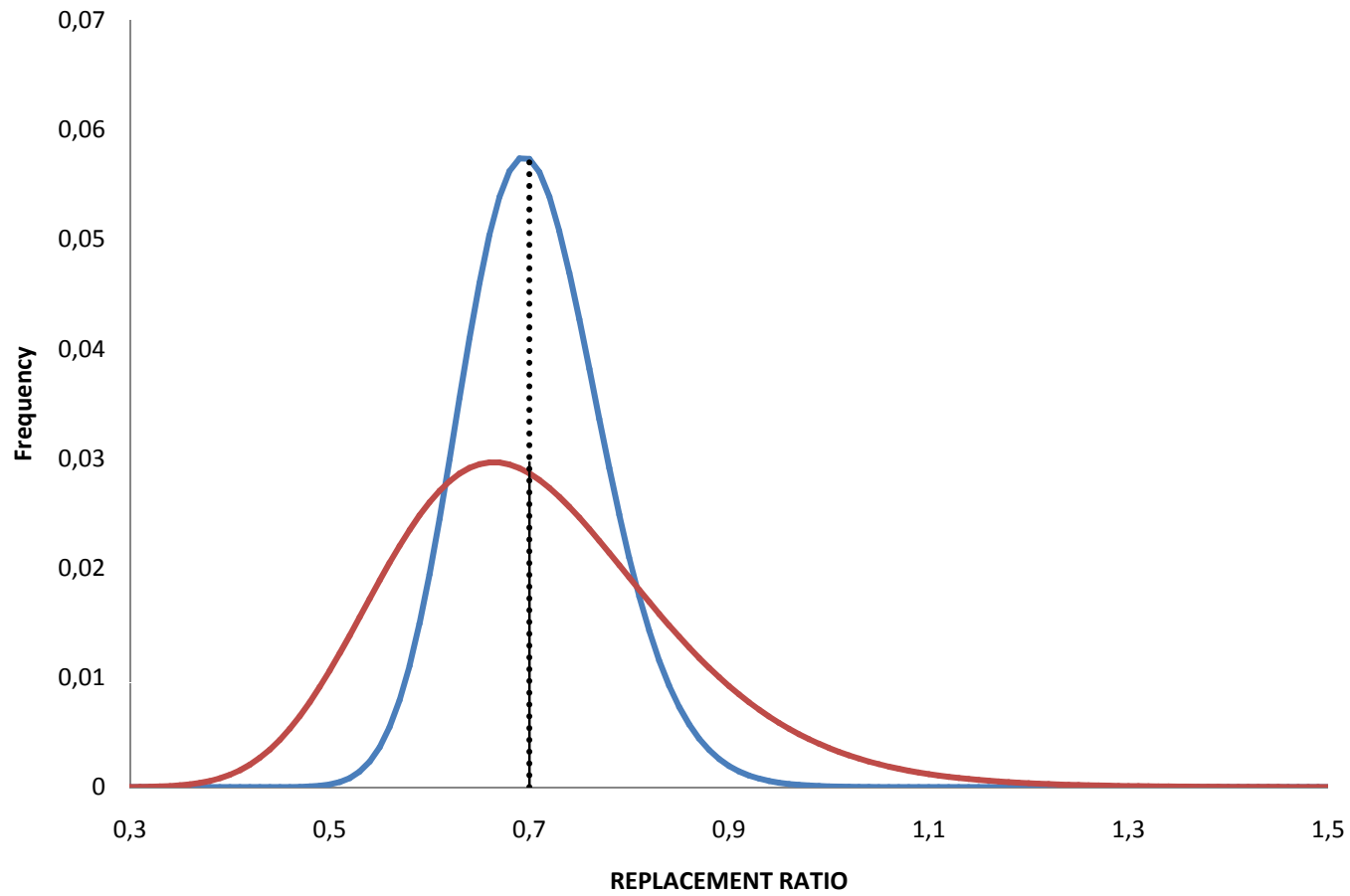


# ***Measuring relevant investment risks...***

- The relevant investment risk is the “*incremental effect*” of an investment on the shape of the probability distribution of  $R$ 
  - Marginal effect on the *mean*  $R$
  - Marginal effect on the *volatility* of  $R$
- ***Easier said than done...***

# Examples

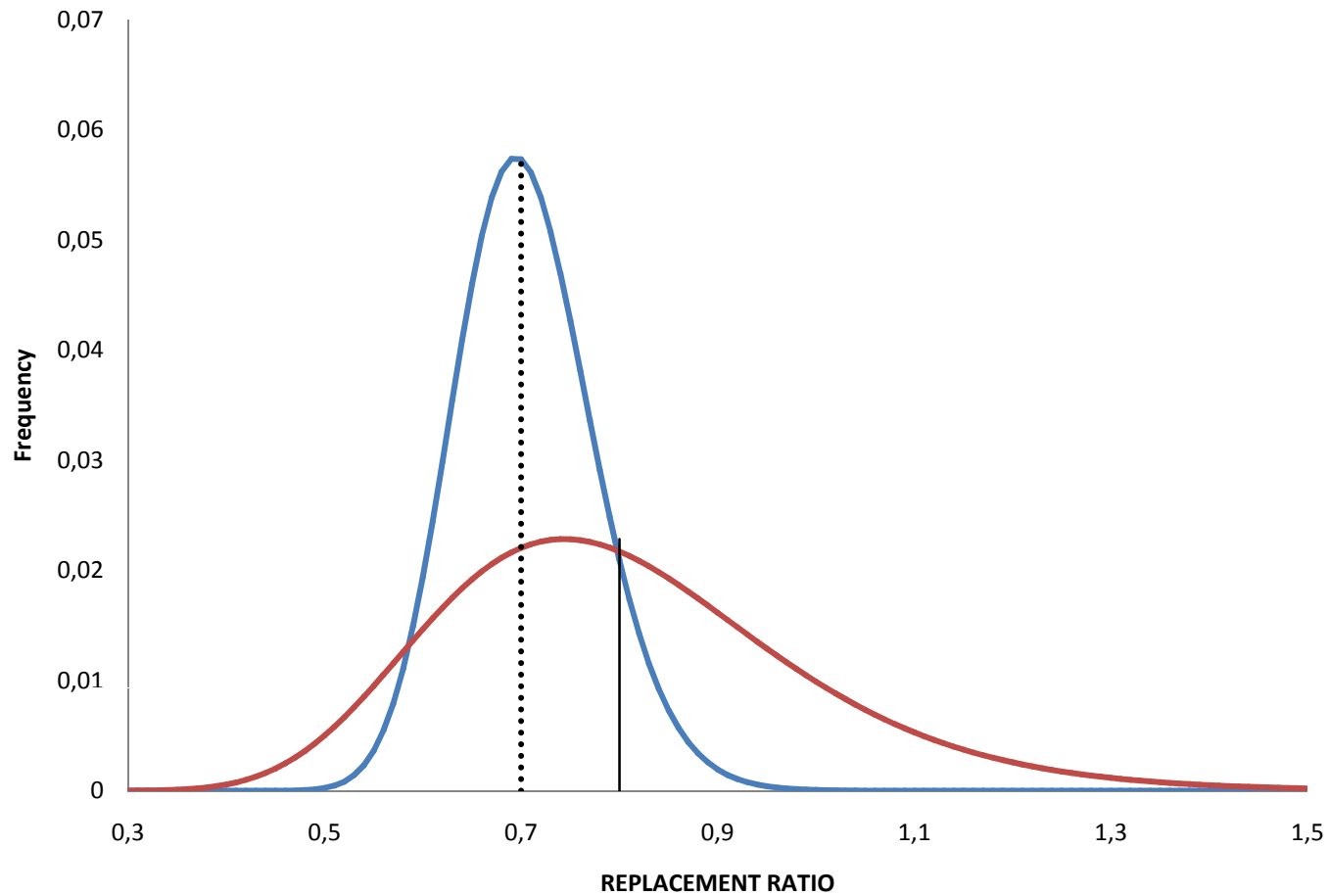
Frequency Dist. of Replacement Ratios  
 $E(R) = 0.7$



— Sigma = 0.1 — Sigma = 0.2 — Avg 1 — Avg 2

# Examples

Frequency Dist. of Replacement Ratios  
 $E(R) = 0.7 \text{ \& } 0.8$



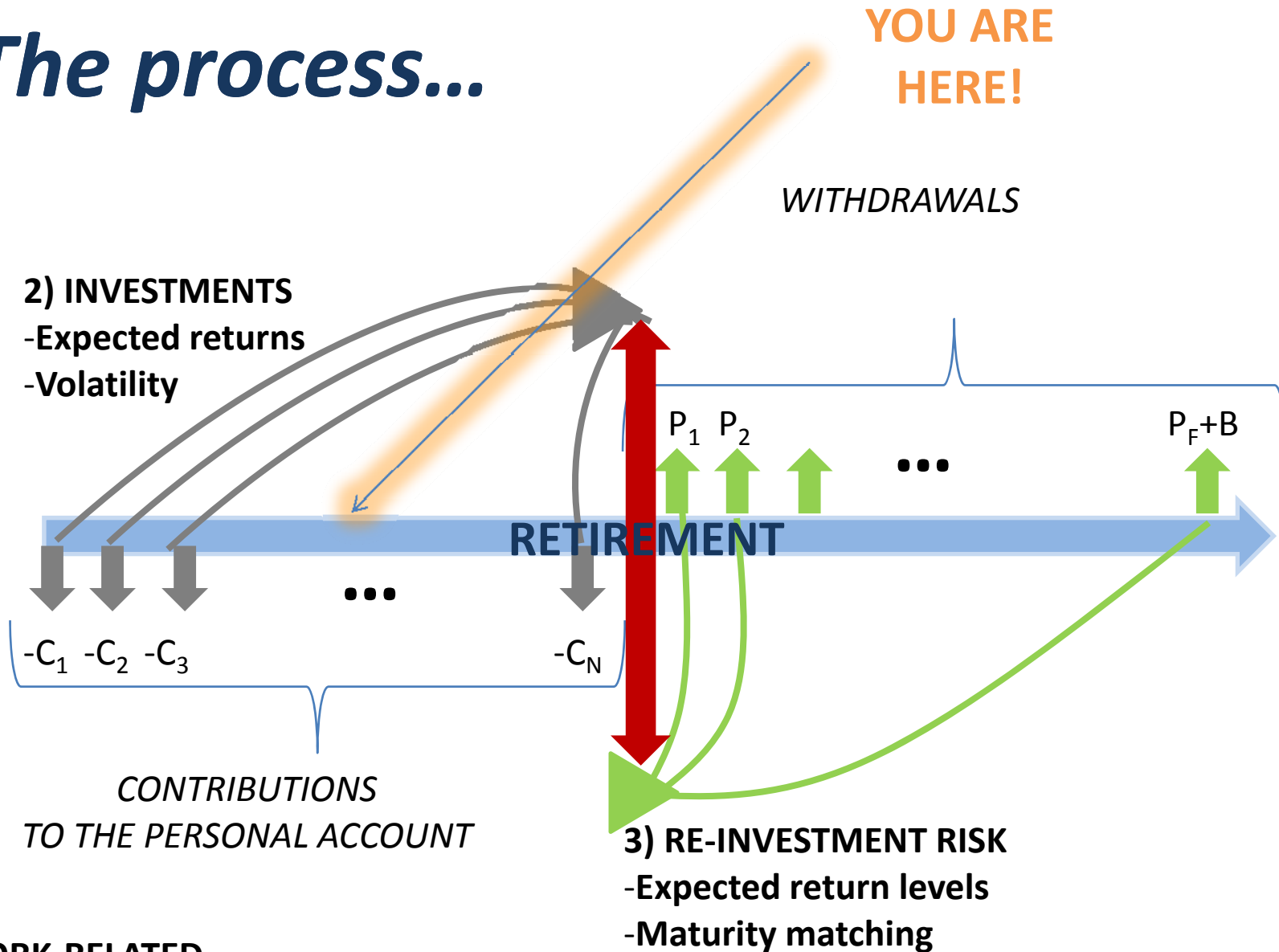
— Sigma = 0.1 — Sigma = 0.23 ..... Avg 1 — Avg 2

# *A real-world (...) application...*

[Work in progress]

- We wish to maximize the expected replacement ratio  $R$  subject to a level of risk
  - Time passed: 20 years
  - Investment horizon: 20 years
  - Contribution to the pension account: 10% of salary
  - Total wealth for pensions
    - Present value of future contributions, 35%
    - Individual account, 65%
    - Growth rate in salaries year 20 to 40: 0%

# The process...



## 1) WORK-RELATED

- Salary level
- Density

# *A real-world application...*

[Work in progress]

- We consider estimated parameters for Chile
  - Quarterly data
  - Sample: 1990:Q1-2007:Q4
  - Asset classes
    - Local short and long-term indexed fixed income
    - US short and long-term (nominal) fixed income
    - Local, World and Emerging Market equity
  - All returns are measured in *local* inflation-adjusted currency
- Expect qualitatively similar results for small-open economies in general

# A real-world application...

[Work in progress]

- 20-year cumulative return correlations between assets and other variables
  - Estimated using a VAR

	1 RCHL_TB	2 ERUS_02Y	3 ERUS_30Y	4 ERW_EQTY	5 EREM_EQTY	6 ERCHL_BND	7 ERCHL_EQTY	8 ERG_GDP	9 WG_GDP	10 TOFT_V12M
1 RCHL_TB	1.00	-0.09	-0.17	0.38	-0.48	-0.64	-0.19	-0.73	0.49	-0.36
2 ERUS_02Y	-0.09	1.00	0.82	-0.21	-0.21	-0.20	-0.28	-0.02	-0.10	-0.62
3 ERUS_30Y	-0.17	0.82	1.00	-0.34	-0.33	-0.10	-0.41	0.15	-0.14	-0.74
4 ERW_EQTY	0.38	-0.21	-0.34	1.00	0.39	-0.54	0.24	-0.36	0.06	0.14
5 EREM_EQTY	-0.48	-0.21	-0.33	0.39	1.00	0.46	0.74	0.24	-0.52	0.44
6 ERCHL_BND	-0.64	-0.20	-0.10	-0.54	0.46	1.00	0.59	0.40	-0.56	-0.11
7 ERCHL_EQTY	-0.19	-0.28	-0.41	0.24	0.74	0.59	1.00	0.13	-0.51	0.22
8 ERG_GDP	-0.73	-0.02	0.15	-0.36	0.24	0.40	0.13	1.00	-0.27	0.38
9 WG_GDP	0.49	-0.10	-0.14	0.06	-0.52	-0.56	-0.51	-0.27	1.00	0.10
10 TOFT_V12M	-0.36	-0.62	-0.74	0.14	0.44	-0.11	0.22	0.38	0.10	1.00

# A real-world application...

[Work in progress]

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# *A real-world application...*

[Work in progress]

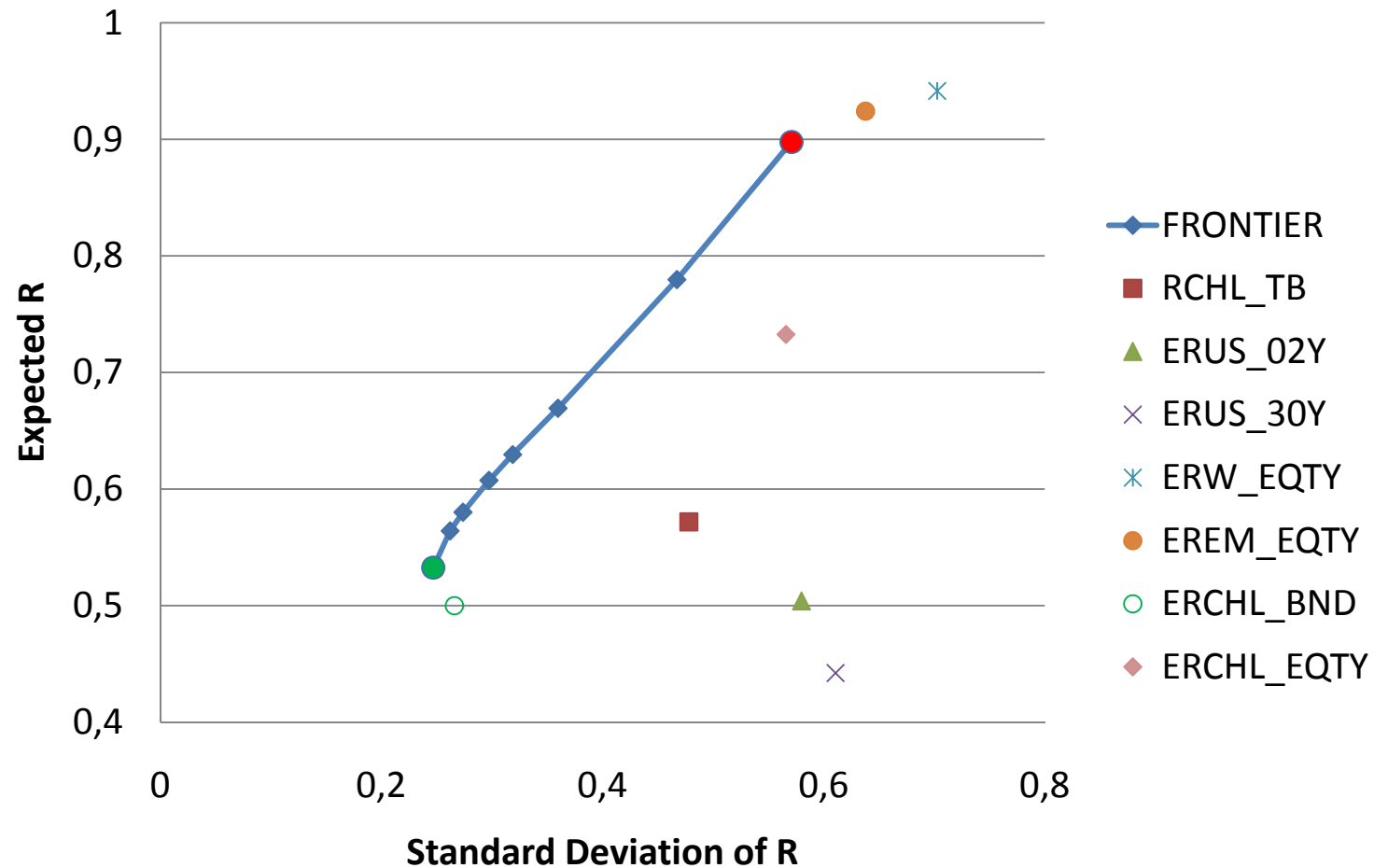
- Long-term expected returns in local inflation-adjusted currency

	RETURNS
CHL_TB	3.2%
RUS_02Y	2.1%
RUS_30Y	1.3%
RW_EQTY	6.8%
REM_EQTY	8.1%
RCHL_BND	3.0%
RCHL_EQTY	6.7%

# A real-world application...

[Work in progress]



## 20-Year Horizon Risk-Return Trade-off for $R$

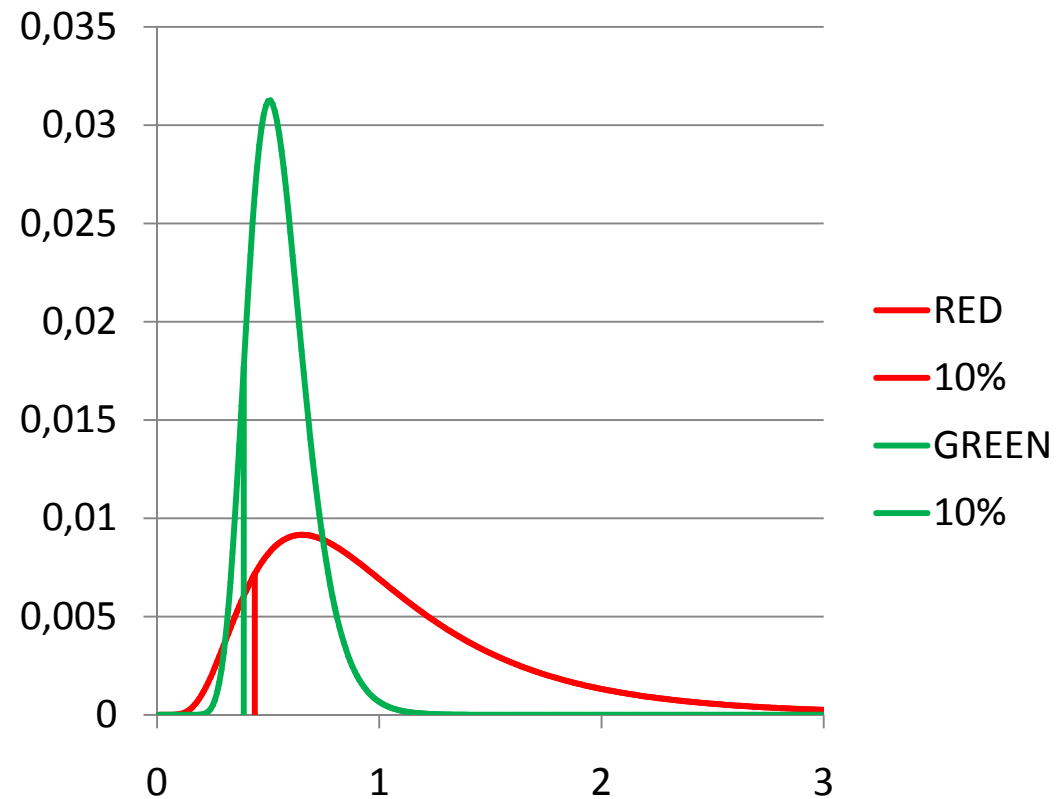


# A real-world application –

## Frequency Distributions for the Replacement Ratio ◆

[Work in progress]

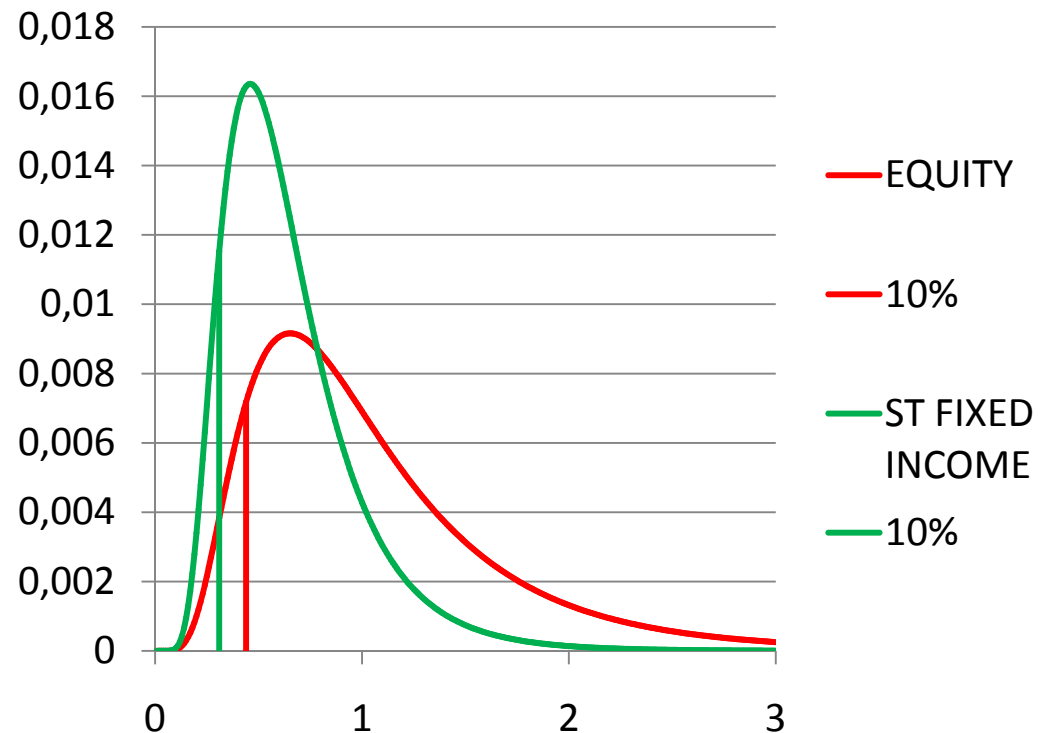
	 RED DOT	 GREEN DOT
RCHL_TB	0%	0%
ERUS_02Y	0%	0%
ERUS_30Y	0%	0%
ERW_EQTY	37%	0%
EREM_EQTY	54%	0%
ERCHL_BND	0%	83%
ERCHL_EQTY	9%	17%
EXPEC RR	<b>0.90</b>	<b>0.53</b>
STD DEV RR	<b>0.57</b>	<b>0.25</b>
ETV (10%)	0.35	0.39



# What is riskier...

- ... in a 20-year horizon, 100% local short-term fixed income or 100% equity?

	EQUITY	ST FIXED INCOME
RCHL_TB	0%	100%
ERUS_02Y	0%	0%
ERUS_30Y	0%	0%
ERW_EQTY	37%	0%
EREM_EQTY	54%	0%
ERCHL_BND	0%	0%
ERCHL_EQTY	9%	0%
EXPEC RR	<b>0.90</b>	<b>0.57</b>
STD DEV RR	<b>0.57</b>	<b>0.48</b>
ETV (10%)	0.35	0.34



# *So, how much risk is tolerable?*

- What risk?
  - Headline risk?
    - To avoid it we should invest a large fraction in short-term fixed income...
    - ... increasing pension risk
    - A 100% short-term fixed income apparently safe portfolio is riskier than a 100% equity portfolio
  - Pension risk?
    - It is significantly reduced by investing in long-term inflation-adjusted bonds (which appear risky at market prices)
    - Is *very difficult to eliminate it* in any pension system

# ***In the context of pensions, risk is not necessarily well described by...***

- Short-term volatility
- Value at Risk (VaR)
- Expected (short-term) tail loss
- The proportion invested in equity
- Unhedged currency risk
- ...

# *Policy implications*

- I don't believe we can adopt a "Risk Based Supervision" approach for investments in this context
- We *can* estimate the impact of different asset classes on the probability distribution of  $R...$ 
  - ...with "model risk"
- Even so, we can use these results to set up reasonable investment guidelines
- Will "the market" spontaneously move us toward efficient risk-return trade-offs measured in replacement-ratio-units?
  - Not unless appropriate guidelines exist

# *Long-term risks for pensions to keep an eye on...*

- ***Cumulative volatility***
  - Usually but not only associated with equity
    - There is some mean-reversion in the long-term
  - Also associated with short-term fixed income
  - Despite the higher volatility, equity it may have lower long-term risk

# Long-term risks for pensions to keep an eye on...

- Tail risks (“Sleeping monsters” – they don’t show up in day to day volatility)
  - **CREDIT RISK** (*What’s the average credit quality of the portfolio?*)
    - World and/or local crises: payment capacity of security issuers deteriorates
  - **INFLATION RISK** (*Is there “too much” in nominal bonds?*)
    - Unexpected surge in **local** inflation: erodes purchasing power of investments
  - **EXCHANGE RATE RISK** (*What fraction of the portfolio is effectively denominated in foreign currency?*)
    - Unexpected systematic appreciation of the **local** real exchange rate; value of foreign investment deteriorates
  - **REINVESTMENT RISK** (*Is the portfolio “too short”?*)
    - Unexpected systematic drop in **local** real interest rates - the cost of generating a pension increases



**THANK YOU!**

# **Risk and Pensions**

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