

The Value, Price and Cost of a Pension Guarantee

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Agenda

- Review the general structure of guarantees within pension products:
 - Account Value guarantees
 - Interest Rate guarantees
 - Mortality Table guarantees
- What is a guarantee “worth”?
 - Argue that there are three ways to define “worth”
 - Explain the difference: Value, Price and Cost
- The Florida pension experiment**
 - Will individuals rationally use these guarantees?

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So, what are they worth?

- Provide a number of examples...

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Q#1: Fair Actuarial Premium?

- Age 100 pure endowment policy pays \$20 in one year, conditional on survival.
- Probability of survival (IAM2000) is 75%.
- Opportunity cost of funds is 10%.
- Fair actuarial premium (no loading) is:

$$\$13.636 = \frac{(0.75)(\$20)}{1.10}$$

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Q#2: Fair Actuarial Premium?

- You must pay \$20, in one year, if the temperature in Buenos Aires exceeds 45c, during the year. You pay nothing otherwise.
- Meteorologists estimate the probability of this event is 75%.
- Opportunity cost of funds is 10%.
- Fair insurance premium (no loading) is:

$$\$13.636 = \frac{(0.75)(\$20)}{1.10}$$

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Traditional Actuarial Pricing: Law of Large Numbers

Today...

...Tomorrow



Probability of Survival: **p**

Interest Rate: **R**

The current price (present value) of \$1
conditional on survival is:

$$\alpha = \frac{p}{1 + R}$$

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Q#3: Fair Actuarial Premium?

- You are obligated to pay \$20, in exactly one year, if the Dow Jones Industrial Average exceeds 11,000 by the end of the year.
- Stock market experts estimate the probability of event is 75%.
- Cost of funds is 10%; fair premium is?

$$\$13.636 = \frac{(0.75)(\$20)}{1.10}$$

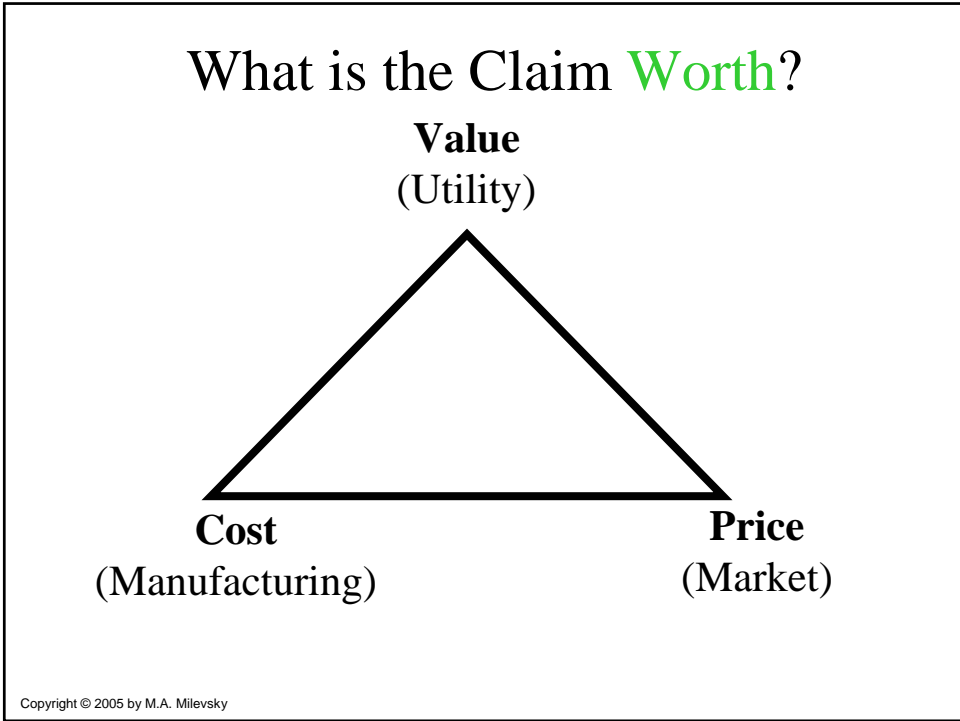
- **WRONG!** Why?

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Manufacturing & Replication

- If the underlying contingent-claim can be perfectly replicated using the underlying security, then the market price of this risk is **zero** and economic value of this liability is the capital market **manufacturing** cost.
- This manufacturing cost may be higher or lower than the expected (or quantile of) loss from this exposure.

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PENSION SCHEMES

BNP offers hedge against longevity

By Norma Cohen in London

The first-ever investment hedge designed to protect pension schemes against the risk that their members might live longer than predicted is to be launched today by BNP Paribas.

The hedge, a £50m (\$1bn) bond with a 25-year maturity issued by the AAA rated European Investment Bank, will have interest payments that are highest in the first year and decrease each year as members of each pension

Although the bond is to be denominated in sterling, BNP Paribas said there was no reason why similar issues could not be launched in the future to match pension liabilities on the European continent or in the US, where longer lives were also straining pension finances.

Longevity risk for pension schemes has emerged in recent years as a growing threat to the stability of companies that have promised to pay pensions to retirees until they die

their schemes to cover the costs of longer life.

The issue of longevity has taken on particular urgency for defined benefit schemes in the US and Europe because it is one that is difficult to measure - and so far impossible to hedge.

Life expectancy among those aged 65 and over has risen sharply in recent years. According to data from the UK Office for National Statistics, life expectancy for higher-paid men aged 65 - those most

1997-99. This increase has caused an equivalent rise in the size of pension schemes' liabilities.

This so-called longevity risk is also emerging as a political issue.

David Willetts, the Tory party's shadow pensions minister, has called on the government to shoulder longevity risk itself by issuing bonds similar to those launched today by BNP Paribas.

Jacques d'Estais, global head of BNP Paribas's fixed

product in the risk management of pension funds that offers a hedge against the unexpected changes in longevity."

Mr d'Estais noted that the bond was not a perfect hedge because pension scheme members, on average, lived longer than the UK population overall.

However, he added that it was considerably less expensive than the alternative option for pension schemes, which required the purchase of an annuity from

national cumulative survival rate calculated annually by the Office of National Statistics. If the UK's male population lives longer than is currently the case, the bond's interest payments will stay higher for longer.

Payments to investors come from the EIB but the exposure to longevity risk is assumed by AA rated BNP Paribas. The Paris-based bank, in turn, has hedged its own risk on life expectancy through a contract with

Financial Times, Monday, November 8, 2004

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Florida Pension Conversion

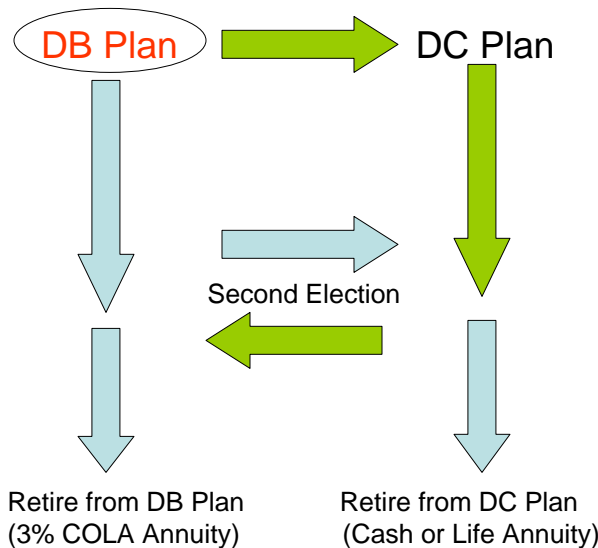
- In early 2002, over 650,000 employees of the State of Florida were given the choice to convert their traditional Defined Benefit (DB) pension plan, into a self-managed Defined Contribution (DC) account.
- Each employee electing to participate was given an initial DC balance equal to the Accumulated Benefit Obligation (ABO).
- They could choose from a limited set of mutual funds and some institutional investment products.

Florida Pension Election

- In order to mitigate some of the investment risk, the State legislature provided the option to **make a second election** and possibly return to the Defined Benefit plan at any time prior to retirement.
- The **strike price** of this option, or the cost of re-entry to the DB plan, is the value of the accumulated benefit obligation (ABO) at the time of the second election. (For existing employees.)
- A massive education campaign conducted in the State of Florida, spearheaded by Financial Engines (a.k.a. Nobel laureate Prof. Bill Sharpe)

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The Florida Decision Tree



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Deterministic Analysis:

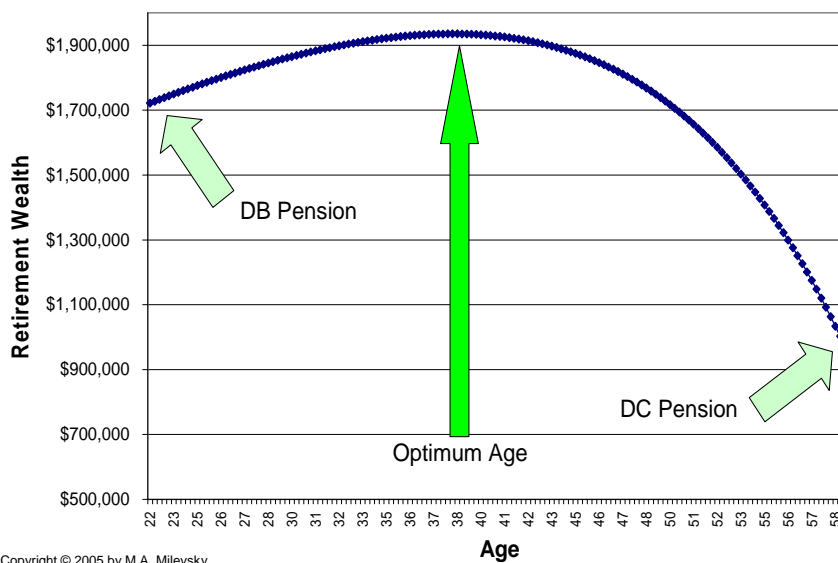
Retirement Wealth, assuming the Option is Exercised at Time s

$$W_T(s) = B_T + (C_s - B_s)e^{\mu(T-s)}$$

...where μ denotes the force of interest inside the individual DC account.

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Retirement Wealth:
Assuming 2nd Election at Age...



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Definition of the Option Value

- We can define the **option value** as the (expected) percentage increase in retirement wealth as a result of the second election.

$$v(s) := \frac{W_T(s) - \max[C_T, B_T]}{\max[C_T, B_T]}$$

How much more has to be contributed to the DC plan, in order to generate the same retirement benefit?

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Another way to think...

- One can define a threshold rate of return μ , needed to justify staying in the DC plan.
- If the instantaneous rate of return in the DC plan is lower than this threshold, the participant should switch (back) to the DB plan since the 'implied' return is higher.
- As the participant ages, the threshold return grows...

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The Threshold Investment Return (μ),
Required to Justify Staying in the DC Plan.

Entry Age	Initial Service	Age at which the second election is being contemplated					
		30	35	40	45	50	55
50	5					15.7%	17.1%
	10					14.3%	15.6%
	15					13.8%	14.9%
	20					13.5%	14.5%
	25					13.4%	14.2%
40	5			-5.0%	10.0%	13.8%	14.9%
	10			3.9%	10.1%	13.5%	14.5%
	15			6.8%	11.4%	13.3%	14.2%
30	5	-51.3%	-5.4%	6.8%	11.4%	13.3%	14.2%
	10	-19.3%	0.6%	8.3%	11.6%	13.2%	13.9%

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What is the value of the option?
and when should you switch?

Service	Age 42	Age 37	Age 32	Age 27	Age 22
22yrs	0.0% (s = 0)				
17yrs	0.0% (s = 0)	0.5% (s = 2)			
12yrs	0.0% (s = 0)	1.3% (s = 3)	4.6% (s = 7)		
7yrs	0.3% (s = 1)	2.8% (s = 5)	7.0% (s = 8)	12.3% (s = 13)	
2yrs	1.6% (s = 3)	5.5% (s = 6)	10.6% (s = 10)	16.6% (s = 14)	23.4% (s = 20)

Assuming: 4.75% salary growth, and 8% valuation and risk-free rate.

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Florida 401(a) Plan Update: March 2005

- In person...

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Conclusion:

- There is a large universe of investment guarantees offered on savings (pension) products.
 - Account value
 - Interest rate
 - Mortality tables
- The question *What are they worth?* is not easy to answer...it truly depends.
- Additional reading and references...

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