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CONFERENCE

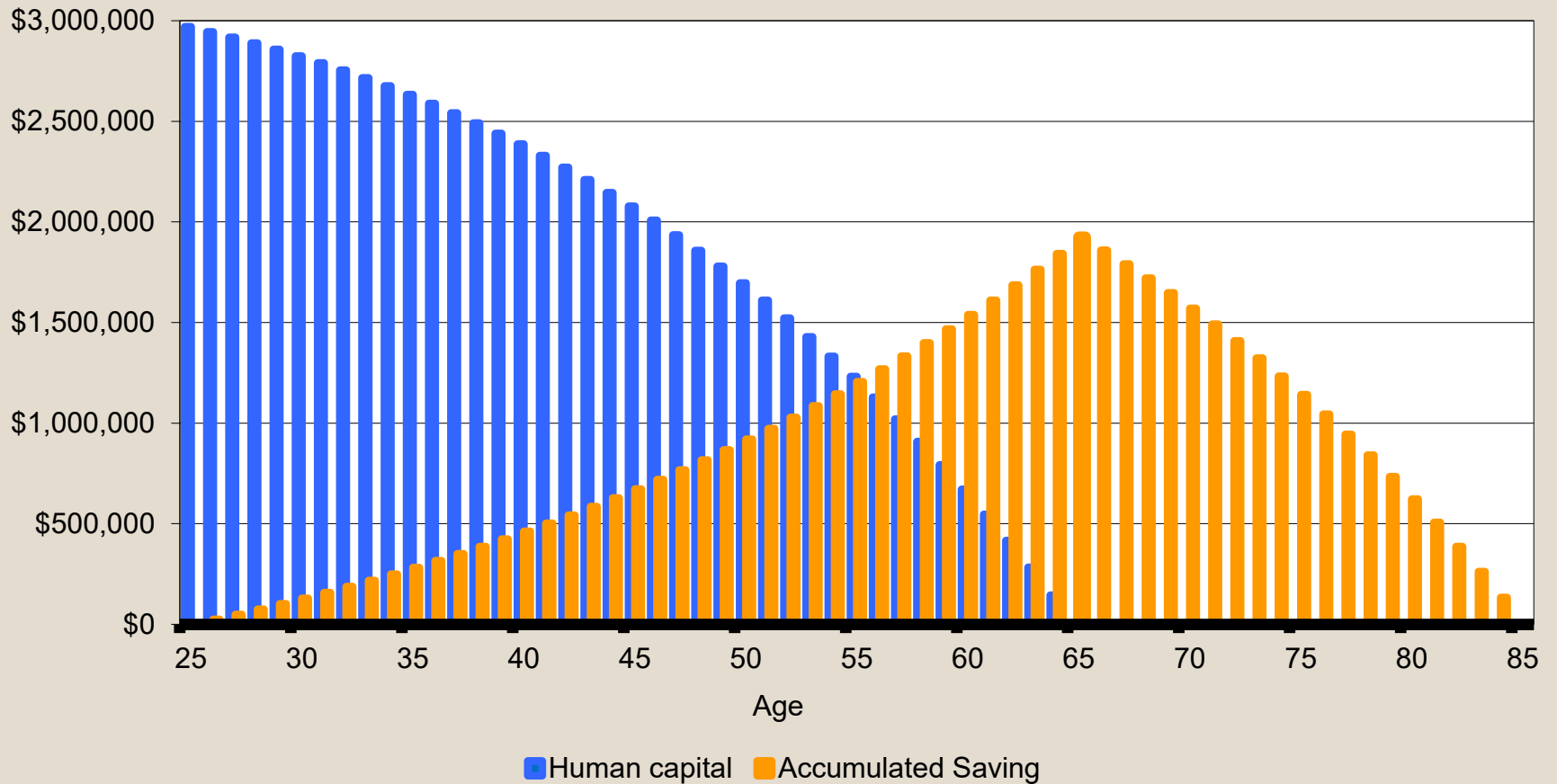
LIFE-CYCLE FINANCE IN THEORY AND PRACTICE

ZVI BODIE

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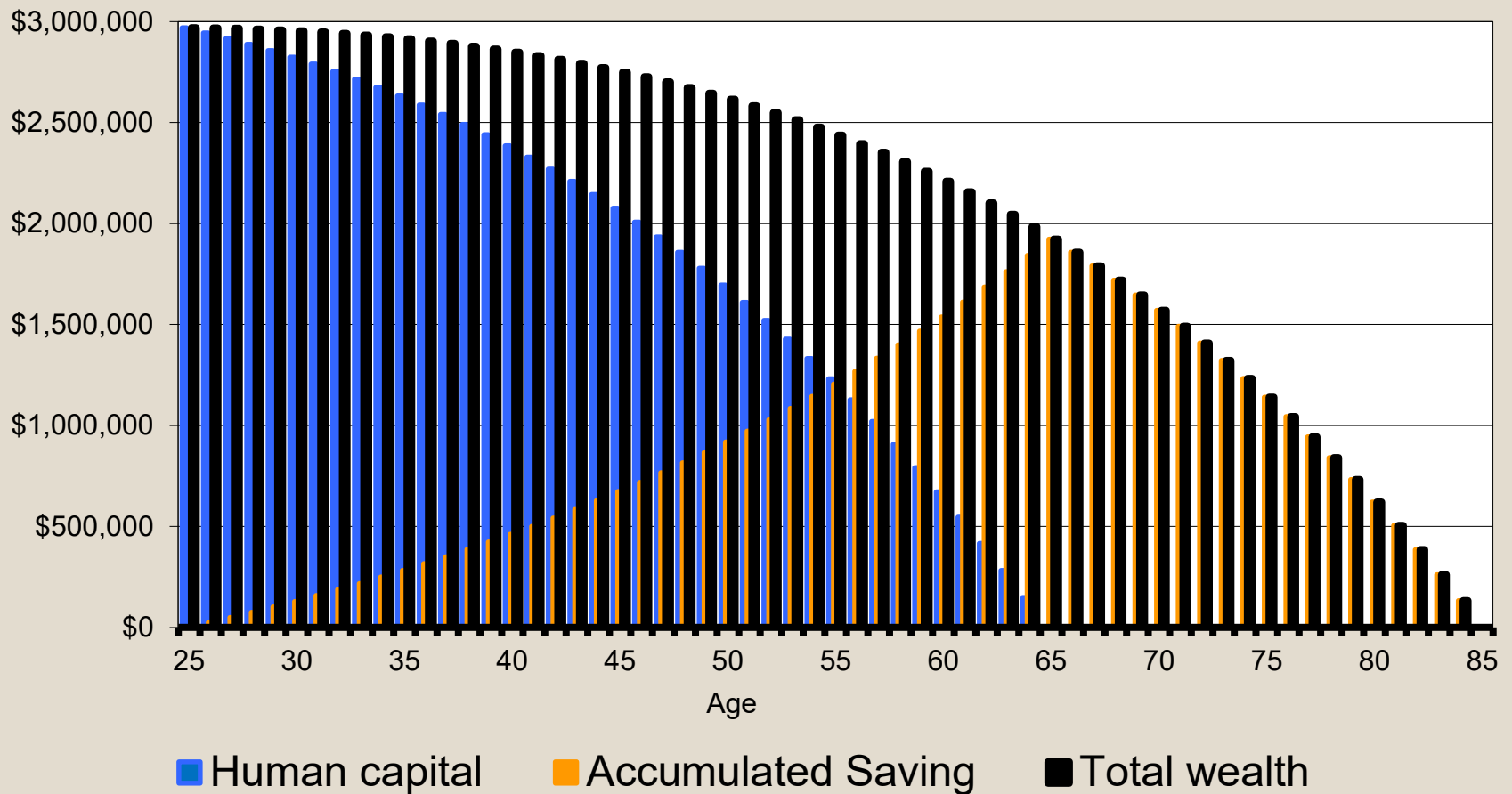
LIFETIME WEALTH PROFILE

THE CHALLENGE EVERY PERSON FACES



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ELEMENTS OF LIFE-CYCLE MODEL

- Total wealth is the sum of human capital and non-human wealth.
- Human capital is the present value of lifetime potential earnings assuming full-time work.
- Present value of lifetime consumption cannot exceed total wealth.
- Over their lifetimes, individuals choose to spend on goods, services, and leisure in a way that maximizes their overall happiness (expected utility).
- Consumption “smoothing” across time and states of nature is optimal. Individuals generally prefer a steady standard of living throughout their lives.
- Distinction between needs (minimum required consumption) and wants (discretionary spending): floor plus upside.

PRINCIPLES OF LIFE-CYCLE INVESTING

1. Frame choices in terms of objectives and constraints.
2. Smooth consumption over time and contingencies.
3. Don't be fooled by inflation. Do not mix real and nominal dollars.
4. 3 ways to manage risk: hedging, insuring, and diversifying.
5. Stocks are not safe in the long run. (Shortfall Risk = magnitude -- not probability -- of shortfall.) Measure of shortfall risk is price of shortfall put option.
6. A security's market price is probably a fair estimate of its value.
7. Beware of survivorship bias in evaluating investment managers.
8. Take account of taxes, fees, and other transaction costs when evaluating investments.
9. Trust but verify the advice of experts. Beware of conflict of interests. Is advisor a fiduciary?

COMPARISON OF PARADIGMS OF LIFE-CYCLE FINANCE

Feature	Old Paradigm	BMS Paradigm
Measure of Welfare	Wealth	Lifetime consumption
Time frame	Single period (Stocks seem safe in long run)	Many periods (Stocks are risky in short and long run)
Risk management techniques	<ul style="list-style-type: none"> • Precautionary saving • Diversification 	<ul style="list-style-type: none"> • Precautionary saving • Diversification • Hedging • Insuring
Retail financial products	<ul style="list-style-type: none"> • Cash • Insurance policies • Mutual funds 	<ul style="list-style-type: none"> • Targeted saving accounts (e.g., tuition-linked CDs) • Structured standard of living contracts
Quantitative model	Mean-Variance Optimization and Monte Carlo Simulation	Dynamic Programming and Contingent Claims Analysis
Control variables	<ul style="list-style-type: none"> • Saving • Asset allocation – stocks, bonds, and cash • Retirement date 	<ul style="list-style-type: none"> • Saving • Portfolio of contingent contracts • Flexible labor supply

FROM THEORY TO PRACTICE

- Life-cycle investing will be about choosing among features of products designed for consumers by financial engineers.
- Technological progress will make these products affordable for middle-class consumers, not just the wealthy.
- Investor education will focus on helping consumers choose appropriate product features they can afford.

LIFE-CYCLE INVESTMENT PRODUCTS TODAY

- Target-date retirement accounts
- Target-date college tuition accounts
- Health saving accounts
- Common characteristics
 - Specific purpose
 - Specific maturity date
 - Tax advantaged because society wants to encourage saving for this purpose
- Most of the money in these accounts is invested in mutual funds

RETIREMENT GOAL

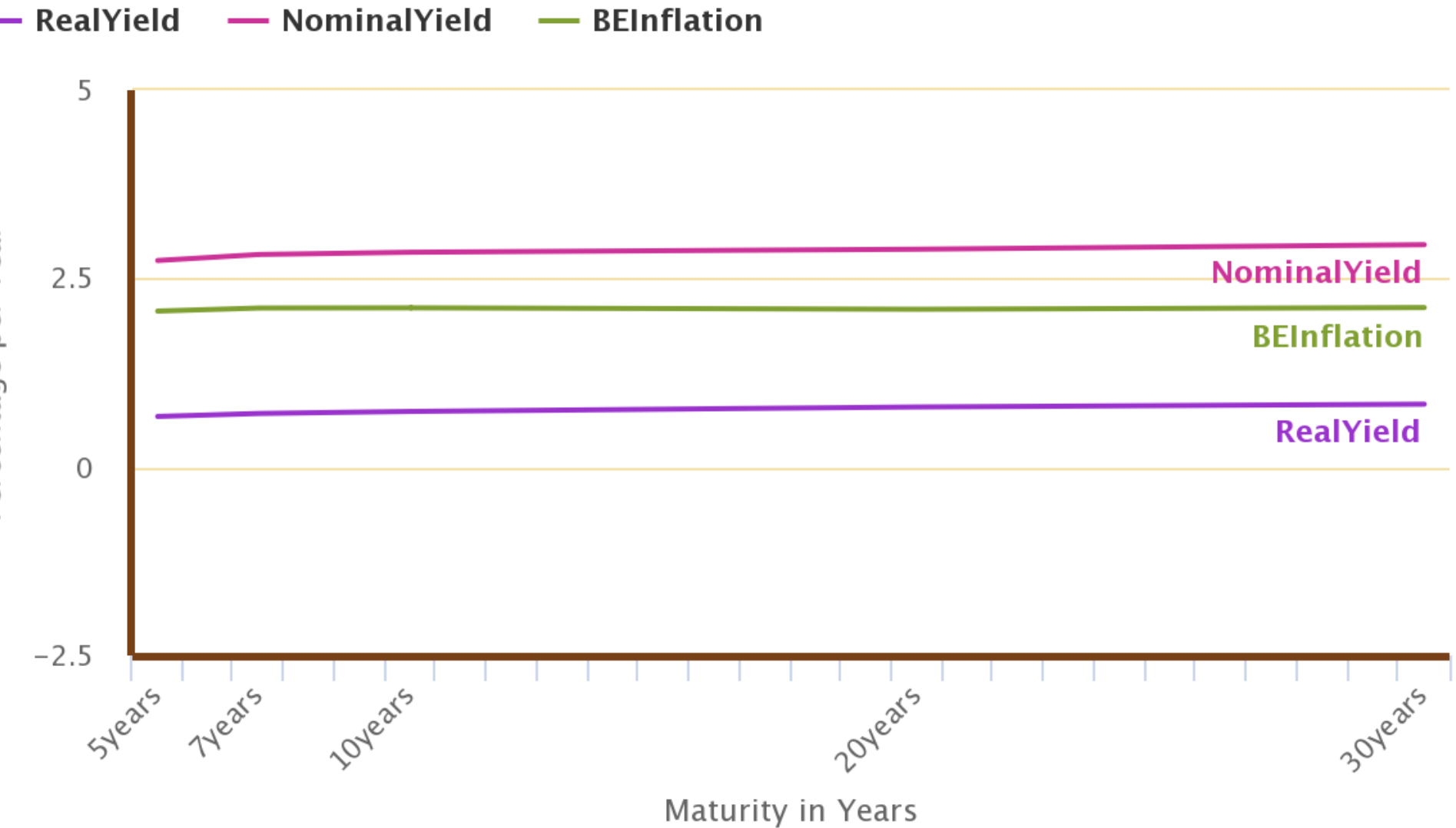
- An inflation-protected income for life that allows you to sustain the standard of living you enjoyed in the latter part of your working life.
- Cover the gap between desired income and Social Security benefits

IMPLEMENTATION: SAFETY-FIRST APPROACH

- Compute required contribution rate if invest in TIPS with matched maturity (LDI)
- Term Structure of Real Rates

DATE	5 YR	7 YR	10 YR	20 YR	30 YR
06/25/18	0.69	0.74	0.77	0.85	0.91

Term Structure of Interest Rates



STEPS IN THE PROCESS

- Find contribution rate based on safety-first solution.
- Determine risk capacity
- Dynamically adjust portfolio allocations and goals in response to changes in both market and personal conditions
- Start withdrawing income at target date

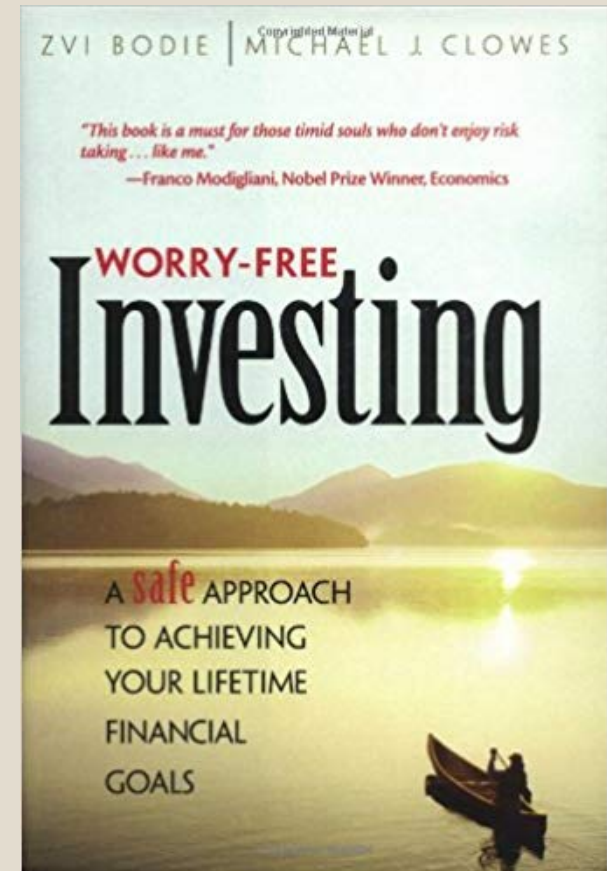
THE ADVISOR'S VALUE: LEADERSHIP, GOVERNANCE, STEWARDSHIP

Key Design Principals to Achieve a Good Retirement

1. Set **replacement income** as the goal for retirement
2. Address risks relevant to the goal: **income shortfall**, not return volatility
3. Deliver an asset allocation strategy to manage **retirement income risk**
4. Make efficient use of all **dedicated retirement assets**
5. Offer **personalization** based on one's retirement account characteristics
6. Take account of changes in both **market and personal** circumstances
7. Be **effective** even for those who are **completely unengaged**
8. Supply **only meaningful information** and offer **actionable choices** to improve outlook
9. Offer **robust, scalable and low cost** investment strategies
10. Offer **seamless transition** and **payout flexibility at retirement**

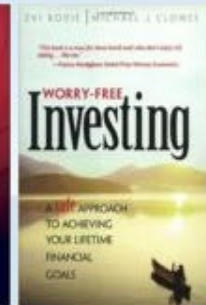
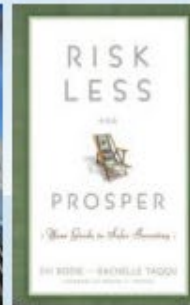
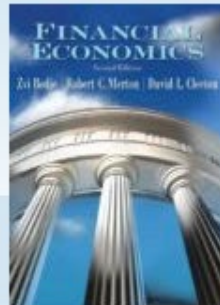
MY VERSION OF LIFE CYCLE INVESTING: THE SIX STEPS

1. Set goals.
2. Specify targets.
3. Compute required no-risk saving rate.
4. Determine tolerance for risk.
5. Choose risky asset portfolio.
6. Minimize taxes and transaction costs.



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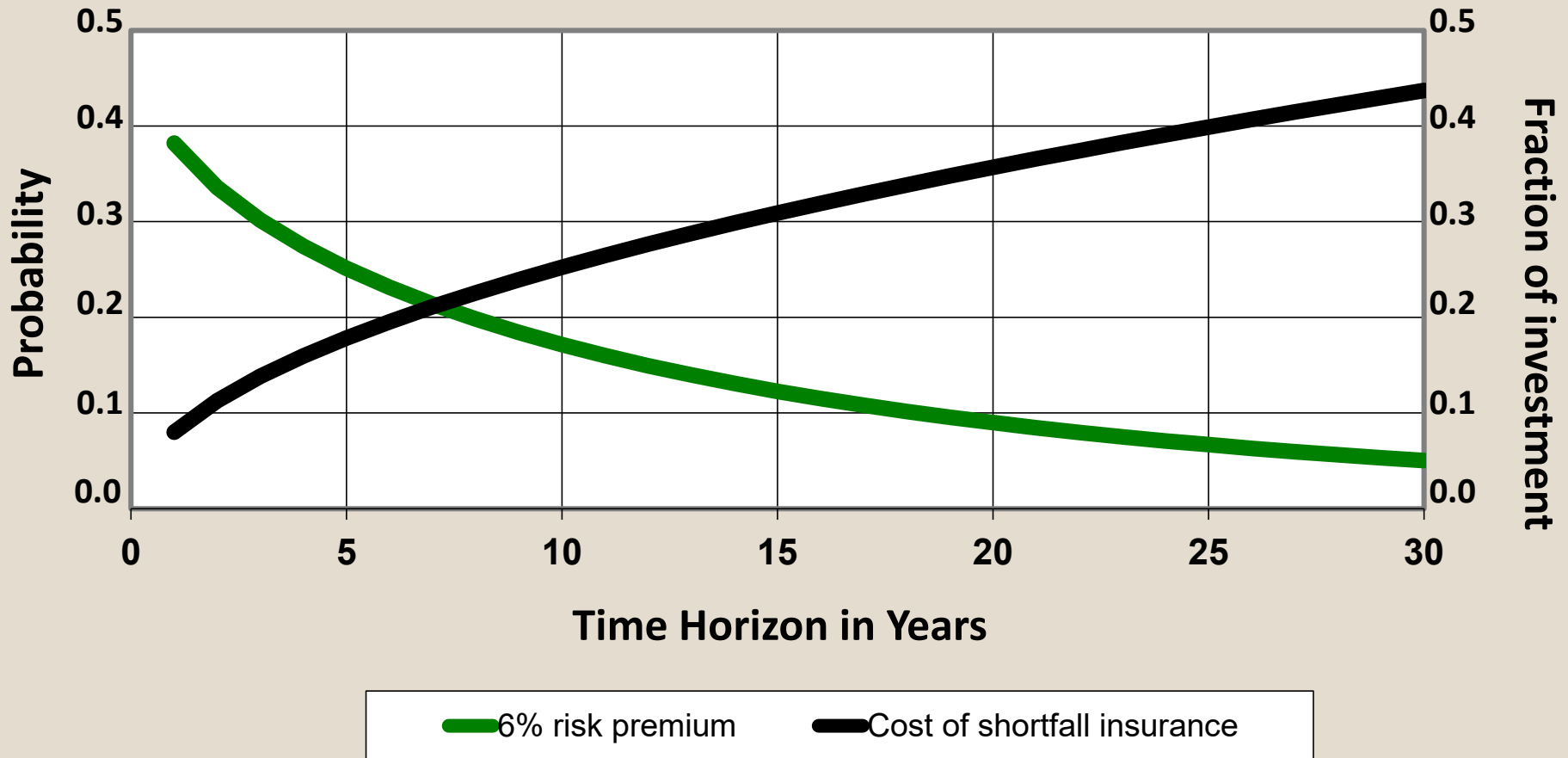
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ECONOMIC PRINCIPLES

- No free lunch. The present value of achieving a future target cannot be lowered by taking risk.
- But it can be lowered through contingent contracts that only pay off when needed. Example: life annuities only pay off if annuitant is alive.

The Fallacy of Time Diversification

PROBABILITY OF SHORTFALL VS. COST OF
SHORTFALL INSURANCE



EXAMPLES OF MATCHING

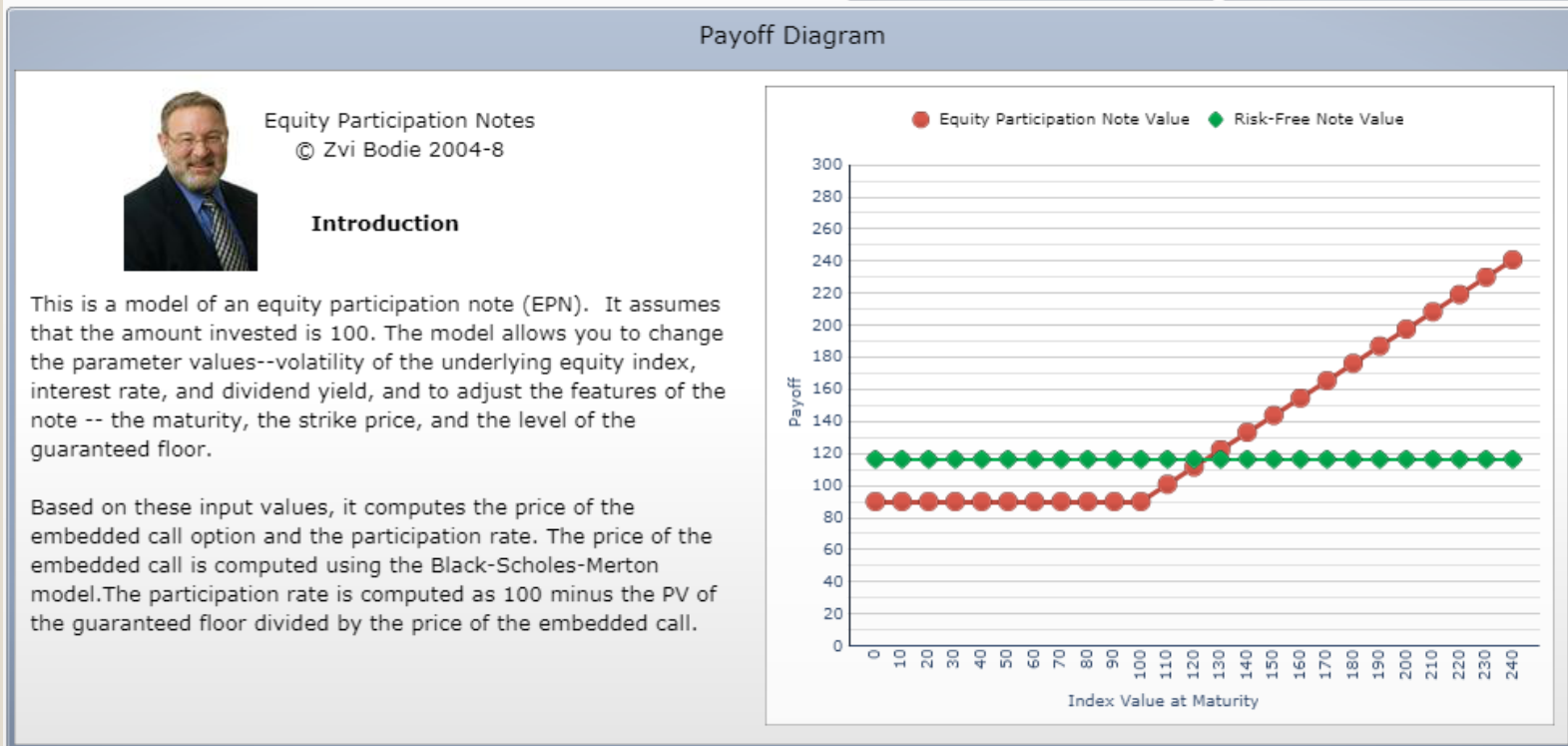
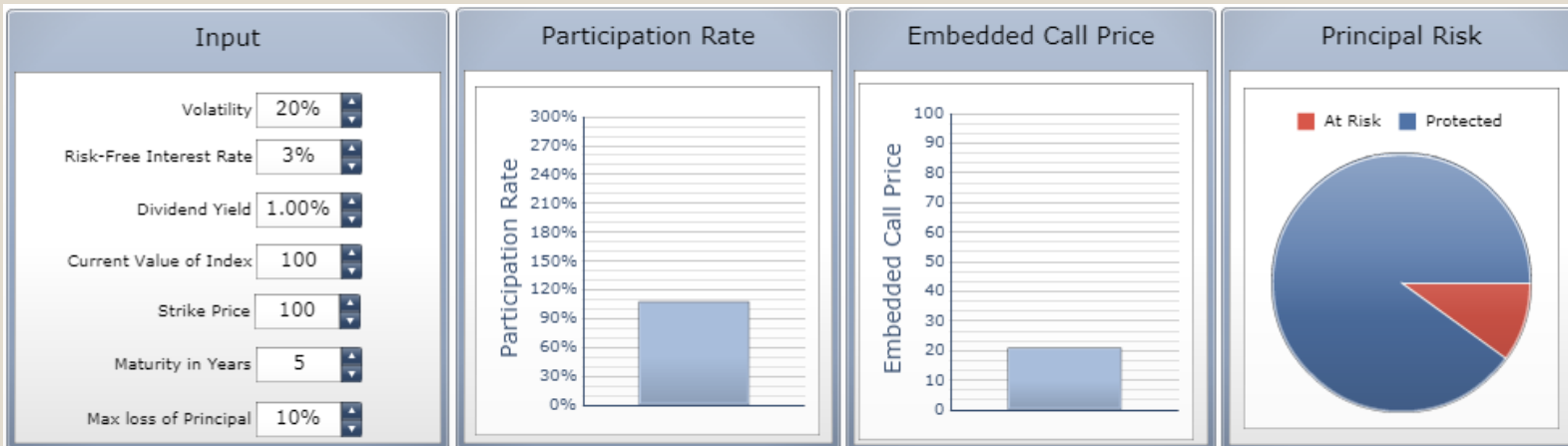
- Annuities linked to cost of living to achieve a target standard of living in retirement.
- Contracts linked to college tuition.
- Contracts linked to health care costs.

THE ROLE OF GUARANTEES

- *Caveat emptor* -- Can a client trust a firm that does not guarantee its products?
- Risk is most efficiently managed by the investment firm, not by the client.
- A guarantee transfers risk from the client to the investment firm.
- If risk is truly small, then the cost of the guarantee will be low.
- If the cost of the guarantee is high, then the risk is obviously *not* small.

STRUCTURED INVESTMENTS

- Standard design: Guaranteed minimum plus upside participation.
- Options: Caps, multiple indexes.
- Decomposing a structured investment into bonds, calls, and puts.



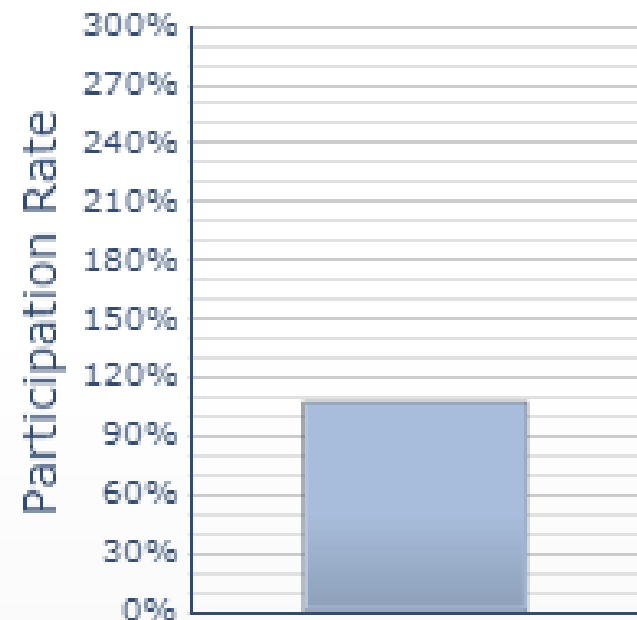
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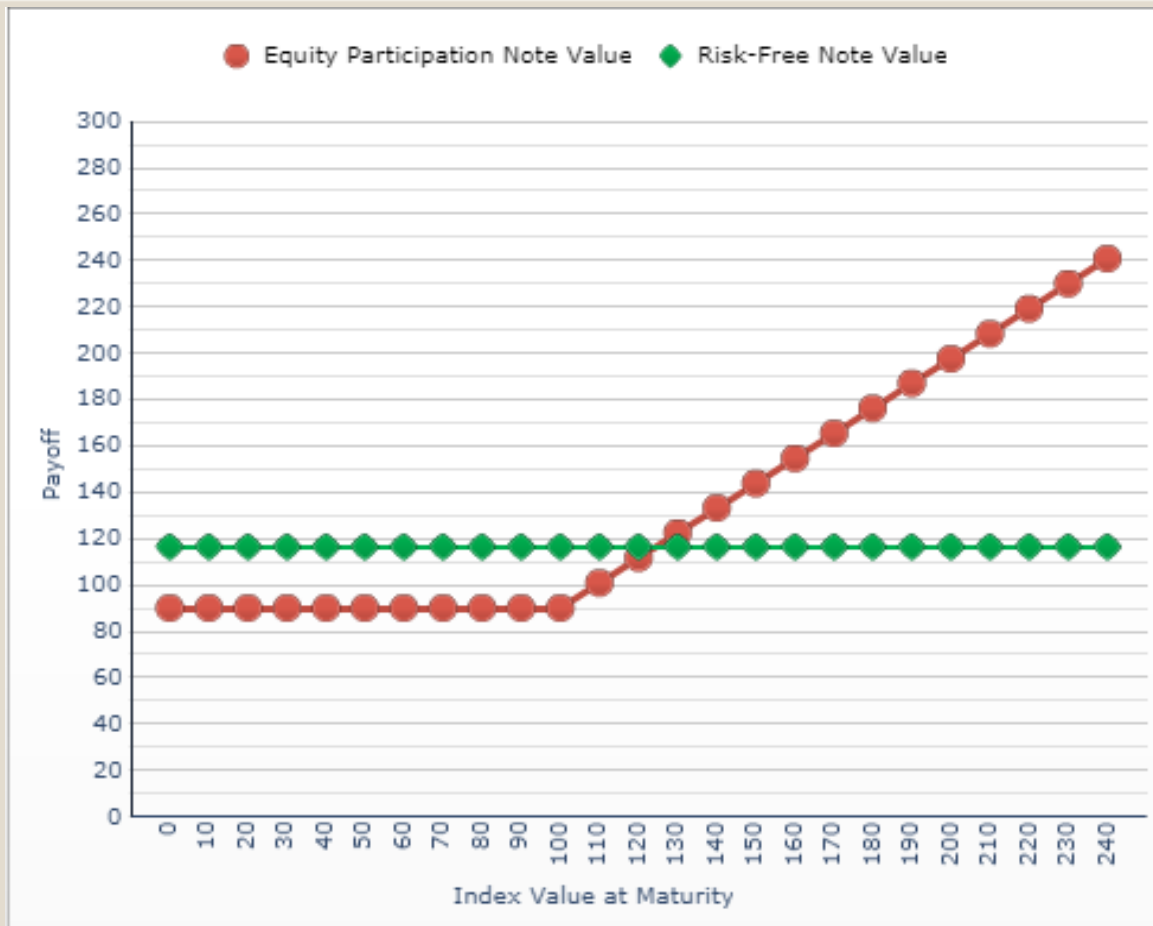
Input

Volatility	20%
Risk-Free Interest Rate	3%
Dividend Yield	1.00%
Current Value of Index	100
Strike Price	100
Maturity in Years	5
Max loss of Principal	10%

Participation Rate



PAYOFF DIAGRAM



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MY STORY: 1970-2018

- MIT PhD Thesis: Hedging Against Inflation 1970-1975 [Common Stocks as a Hedge Against Inflation 1976](#)
- NBER Pension Project 1979-1985 [Financial Aspects of the U.S. Pension System](#)
- Bodie, Kane, Marcus [INVESTMENTS](#) 1989-2018
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- Bodie-Merton-Samuelson Life-Cycle Model 1992 [Labor Supply Flexibility and Portfolio Choice in a Life Cycle Model](#)
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- Integrated Finance Limited 2002-2006 [SmartNest Project](#)
- Life-Cycle Saving and Investing Conferences 2006-11 [CFA Institute and Boston Fed](#) [Worry Free Investing](#) and [Risk Less and Prosper](#)