Economics of Capital Markets

The Structure of ROR

Major Topics

- Definitions
- Why use RORs?
- ROR Components
  - Fisher Equation
  - Introduction to Risk Premium

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The Structure of ROR
Introduction

- Although the stated intention is to determine the ***prices*** of financial assets, attention is really on ***rates of return*** (ROR)

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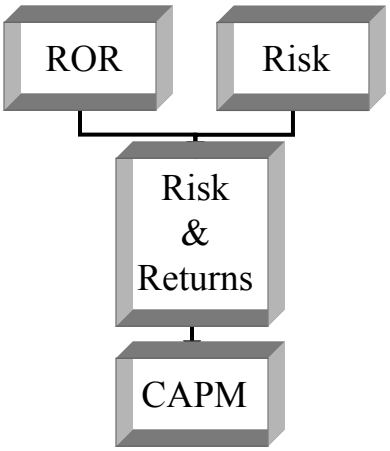
The Structure of ROR
Introduction (Continued)



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The Structure of ROR
Definitions

- ***Rate of return*** - the dollar amount received (returned) in period *t* from holding an asset relative to the dollar cost of the asset in a base period, say period *t-1*

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The Structure of ROR
Definitions (Continued)

- ***Simple net rate of return*** in period *t*

$$i_t = \frac{R_t}{C_{t-1}} - 1$$

- ***Simple gross rate of return*** in period *t*

$$1+i_t = \frac{R_t}{C_{t-1}}$$

R_t = Total dollar return from investment in period *t*

C_{t-1} = Dollar cost of investment in period *t-1*

– Subscript is usually dropped for convenience

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The Structure of ROR
Definitions (Continued)

- For stocks with one holding period:

$$i_t = \frac{D_{t+1}}{P_t} + \frac{P_{t+1} - P_t}{P_t}$$

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The Structure of ROR
Definitions (Continued)

- ROR have a time dimension to them

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The Structure of ROR
Why use ROR

- ROR are scale free meaning they are independent of the magnitude of prices

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The Structure of ROR
Why use ROR (Continued)

- ROR have a more desirable statistical property than prices

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Plot of SP500 index

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The Structure of ROR
Why use ROR (Continued)

- ROR have a more desirable statistical property than prices
  - ROR are said to be ***stationary*** meaning that distribution of returns looks the same no matter at what point in time they are examined

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Plot of SP500 returns

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The Structure of ROR
Why use ROR (Continued)

- Firms decide how much real, physical capital to invest in using a decision rule
  - Basic decision rule: ***Net Present Value*** (NPV)

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The Structure of ROR
Why use ROR (Continued)

- Firms issue the securities (stocks and bonds) investors purchase

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The Structure of ROR
Why use ROR (Continued)

- Cost of Capital
  - The weighted average of the required rates of return on stocks and bonds issued by a firm when it purchases real, physical capital

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The Structure of ROR
Why use ROR (Continued)

- Cost of Capital (Continued)

$$WACC = \theta i_e + (1-\theta)(1-\tau) i_B$$

where $\theta = \dfrac{\text{Equity Outstanding}}{\text{Debt} + \text{Equity}}$

τ = Corporate Marginal Tax Rate

i_e = Required ROR on Equity

i_B = Required ROR on Debt

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The Structure of ROR
Why use ROR (Continued)

- Cost of Capital (Continued)
  - WACC is the appropriate discount factor to use in the NPV calculations

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The Structure of ROR
ROR Components

- Three rates of return we will study are…

The nominal rate, i……posted rate

The "risky" real rate, r……decision making rate

The "riskfree" real rate, r_f…...base rate

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The Structure of ROR
ROR Components Interpretations

- The nominal rate, *i*, is the rate of return on money
- The real rate, *r*, is the rate of return on a real, physical asset

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The Structure of ROR
ROR Components Interpretations (Continued)

- It can be shown that

$$\frac{\partial Q}{\partial K} = i + \delta - \rho^e$$

or

$$i - \rho^e = \frac{\partial Q}{\partial K} - \delta$$

Q = production function

δ = depreciation rate

ρ^e = expected inflation rate

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The Structure of ROR
ROR Components (Continued)

- A basic, fundamental relationship is

$$i \approx r + \rho^e$$

where ρ^e is the expected inflation rate

  - To understand this relationship, we have to derive two models
    - » The ***Fisher Equation*** which models ***i*** as above
    - » The ***CAPM*** which models ***r*** as a function of r_f
  - Develop Fisher Equation first, CAPM later

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The Structure of ROR
ROR Components (Continued)

- To develop the Fisher Equation, assume...
  - Current price level is P_0
  - Price level next period is P_1
  - ***Nominal security*** paying \$(1 + i) next period
    - » Security valued in dollars today
  - ***Real security*** paying (1 + r) units next period
    - » In terms of consumption units

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The Structure of ROR
ROR Components (Continued)

- Investment options available
  - Option #1
    - » Buy a $ denominated security today yielding

consumption units tomorrow

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The Structure of ROR
ROR Components (Continued)

- Investment options available (Continued)
  - Option #2
    - » Use $1 today to buy $1/P_0$ consumption units today
    - » Then buy 1 ***real*** security yielding

consumption units tomorrow

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The Structure of ROR
ROR Components (Continued)

- Both options result in real consumption units tomorrow
  - Method of obtaining units differs
    - » Options #1: based on ***nominal*** or ***dollar denominated*** security
    - » Option #2: based on ***real*** security

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The Structure of ROR
ROR Components (Continued)

- Economic equilibrium requires indifference between options since can receive same consumption units tomorrow

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The Structure of ROR
ROR Components (Continued)

- Requirement

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The Structure of ROR
ROR Components (Continued)

- Define the inflation rate

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The Structure of ROR
ROR Components (Continued)

- Therefore

$$i = r + \rho + r\rho \approx r + \rho$$

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The Structure of ROR
ROR Components (Continued)

- Fisher Equation

$$i \approx r + \rho$$

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The Structure of ROR
ROR Components (Continued)

- Concerned with inflation over next year

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The Structure of ROR
ROR Components (Continued)

- Fisher Equation rewritten for expectations

$$i \approx r + \rho^e$$

Nominal ROR | Real ROR | Inflation Risk Adjustment

Moody's Real ROR

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The Structure of ROR
ROR Components Interpretations (Continued)

- Application of Fisher Equation

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The Structure of ROR
ROR Components (Continued)

- Application of Fisher Equation (Continued)
  - Suppose R is the nominal dollar return for one holding period from an asset and $\tilde{R}$ its real value
  - Suppose I_t is a price index (e.g., CPI or GDP Price Deflator)

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The Structure of ROR
ROR Components (Continued)

- Application of Fisher Equation (Continued)
  - But

$$I_t = I_0 (1+\rho)^t$$

Gross Inflation

with $I_0 = 1.0$

  - The deflation factor, therefore, is the gross inflation rate raised to a power

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The Structure of ROR
ROR Components (Continued)

- Application of Fisher Equation (Continued)
  - We can now see that

$$1 + r = \frac{1+i}{1+\rho}$$

from the Fisher Equation. The gross real ROR is the deflated gross nominal ROR

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The Structure of ROR
ROR Components (Continued)

- Application of Fisher Equation (Continued)
  - Then, for any one-holding-period

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The Structure of ROR
ROR Components (Continued)

- Application of Fisher Equation (Continued)

$$P_0^S = \frac{R_1}{(1+i)}$$

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The Structure of ROR
ROR Components (Continued)

- Application of Fisher Equation (Continued)
  - We can also relate the WACC to real terms

$$\begin{aligned} WACC &= i_{WACC} \\ &= \theta i_e + (1-\theta) * (1-\tau) i_B \end{aligned}$$

  - The WACC can be interpreted as the average return on a capital market portfolio that mimics the asset funding portfolio of the firm
    - » Gives what would be earned if held stocks/bonds in the same proportion

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The Structure of ROR
ROR Components (Continued)

- Application of Fisher Equation (Continued)
  - From the Fisher Equation, we have

$$(1 + i_{WACC}) = (1 + \rho^e) * (1 + r_{WACC})$$

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The Structure of ROR
ROR Components (Continued)

- Application of Fisher Equation (Continued)
  - So…

$$\left(1 + r_{WACC}\right) = \frac{\left(1 + i_{WACC}\right)}{\left(1 + \rho^{e}\right)}$$

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The Structure of ROR
ROR Components (Continued)

- Now need to model ***r***, the risky real interest rate, irregardless of WACC, equities, bonds

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The Structure of ROR
ROR Components (Continued)

- "Risky" assets should carry additional return - a ***premium*** - beyond that on the "riskfree" asset

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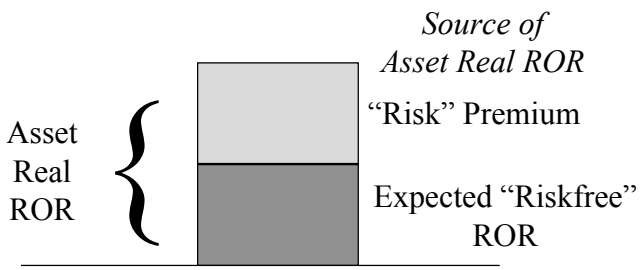
The Structure of ROR
ROR Components (Continued)



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The Structure of ROR
ROR Components (Continued)

- CAPM uses two important concepts
  - Risk
  - Risk premium

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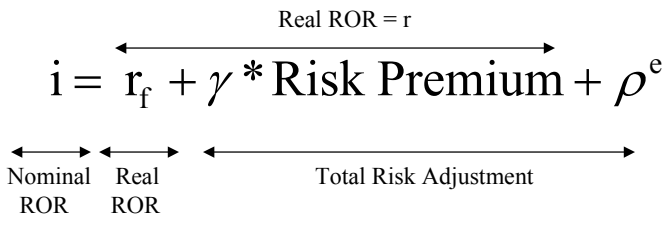
The Structure of ROR
ROR Components (Continued)

- Any observed, nominal market interest rate or ROR can be written as



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The Structure of ROR
ROR Components (Continued)

- One goal of financial economics and this course...
  - To determine the nature of the "risk" premium and the "riskfree" ROR

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The Structure of ROR
ROR Components (Continued)

- Final comment on ROR and Fisher Equation
  - The real rate and the expected inflation are both *ex ante* variables dependent on future SOW

Economics of Capital Markets

The Structure of ROR

Review of Statistical Expectations

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The Structure of ROR
Summary

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The Structure of ROR
Review Questions

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The Structure of ROR
Review Questions (Continued)

- Why are rates of return used instead of prices in analysis?
- How are rates of return calculated?
- Derive the Fisher Equation.
- What is the relationship between the price of a stock based on nominal returns discounted with a nominal discount factor and one with real returns discounted with a real factor? Does this hold for stocks and bonds alike?

Economics of Capital Markets

The Structure of ROR
Key Concepts and Terms

- Fisher Equation
- Simple Net Rate of Return
- Simple Gross Rate of Return

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The Structure of ROR
Suggested Readings