Review of Last Class

- Financial Instrument (Financial assets)
  - Real assets vs. financial assets
  - Function: Allocation of capital, consumption smoothing, allocation of risk
  - Important instruments
    - Bonds – fixed future cash flow, no voting rights
    - Stocks – residual claim, voting rights
    - Derivatives – payoff depends on the value of other assets

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Review of Last Class

- What determines the equilibrium price
  - In economics theory: Supply and Demand
  - In reality
    - Primary market: Auction or Bookbuilding by underwriters
    - Secondary market: Market Maker quotes bid and ask price
- Some special (not very special) form of investment (speculative and risky)
  - Buy on margin
  - Short sale

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Market Maker

- Social function: make the market (meet the needs of all buyers and sellers)
- Profit: Bid - Ask spread
  - Bid: the price that MM buys (public investor sells)
  - Ask/offer: the price that MM sells (public investor buys)
  - Ask>Bid
- Hold time varying inventory (can be negative some time)
- Goal: to earn bid-ask spread, not to speculate on price movement (try to hold 0 inventory)
  - Why? They want to earn bid-ask spread, not speculative profit. Avoid the risk of future price movements that are against their holdings
  - How? Constantly change bid and ask quotes to make them around equilibrium price

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Market Maker

FYI: there are 7 Specialist firms on NYSE:

- Bear Wagner Specialist LLC.
- Fleet Specialist, Inc.
- LaBranche & Co., LLC.
- Performance Specialist Group, LLC.
- Spear, Leeds & Kellogg Specialists LLC.
- SIG Specialists, Inc.
- Van der Moolen Specialists USA, LLC.

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Principles of Security Valuation

André de Souza

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Outline

- Time value of money
- FV, PV, return
- Securities that make only one payment
  - Example: zero coupon bond
- Securities that make multiple payments
  - Annuities and perpetuities
  - Coupon bonds
- Return Measures

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Time Value of Money

Two questions to think about

1) If someone wants to borrow $1000 from you today and promises to pay you back in one month, would you lend it to him or her?

2) Would you consider the repayment of only the $1000 to be fair?

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Time Value of Money

In answering the questions, there are a couple of things that you need to take into consideration

1) If you don't lend the $1000, what could you do with it?
   a) you could invest (or save) it
   b) you could buy something you enjoy

2) Is there a chance that the borrower may not pay you back? Are you sure that if you do get the money back you will get it back when it was promised to you?

3) What if the price of goods increases in a year?

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Time Value of Money

If you lend money today, you require some compensation for the *opportunity cost*, *inflation*, and any uncertainty (*risk*) that the loan will not be repaid as promised

In other words, we can write

- future value = present value + required compensation

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Time Value of Money

- So now we know why people need compensation for delayed payment
- How do you actually compute future values and present values?

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Future Value, FV (1)

- Example 1: Have a bank account that pays 10% per year. Invest $100 today.
  - How much is in the account one year later?
  - What is the FV after two years?
  - What are the values above if investing in simple interest?

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Future Value, FV (2)

- Timeline
- Investing for a single period
  - $FV=PV(1+r)$
- Investing for multiple periods
  - Simple interest:
  - Compounding interest: Interest on Interest

  $FV=PV(1+r)^t$

  $(1+r)^t$ *is the future value factor*

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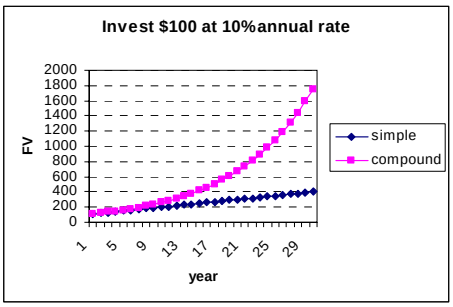
Does compounding matter?



What about 100 years?

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Present Value, PV(1)

- Example: You need $100 for text books next year. How much you need to put in the bank today at 7% annual interest rate?
- Need $100 2 years from now, how much do you need to save?

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Present Value, PV(2)

- How much do you need to invest today, with an interest rate of r, to have $FV t period later?
- Single-period
  - *PV=FV *1/(1+r)*
- Multiple-period
  - $PV=FV*1/(1+r)^t$
  - $1/(1+r)^t$ *is the present value factor or discount factor*

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PV, FV, r, t are tied together

If you know 3 of them, you can find the fourth one

- return r (also called **yield**)
  - Suppose you know PV and FV at a given future time t, how do you figure out the return?
- investment period t
  - Suppose you have a given amount of money PV, you know the interest rate, and you know the FV you need, how many period do you need to invest?

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Borrowing

- If I borrow $100 at 10% per year today, how much do I need to pay back in two years' time?
  - Unsurprising
- A distant uncle dies and leaves me $5000 in his will, to be given to me in two years. I want to use the money now. How much can I borrow against this $5000, if the interest rate is 8% ?

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Example: Zero Coupon Bond

- An example of single cash-flow payment
- Where do zero coupon bonds (zeros) come from?
  - issued in primary markets (Treasury notes)
  - Stripping of coupon bonds
- Pricing of zeros by arbitrage .(extremely important pricing principle!)
  - What's arbitrage?

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Arbitrage

- If you have two ways of generating the same payoff, both must have the same price
  - If not? Buy low sell high
- Suppose

One year zero coupon bond, face value $1000, price is $800	Bank account, can borrow/lend at 10% per year

- What would you do?
- What if the bond cost $980?

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Multiple Payments

- Timeline !
- Suppose 7%, $1000 face value, 2-year coupon bond
- Future value of stream of cash flows C*(0),C(1),…,C(T):*

$$FV(T) = \mathrm{C}(0)(1+r)^{T} + \mathrm{C}(1)(1+r)^{T-1} + \ldots + C(T)$$

- Present value:

$$PV = \mathrm{C}(0) + \mathrm{C}(1)\frac{1}{(1+r)} + \ldots + C(T)\frac{1}{(1+r)^{T}}$$

- Yield: Internal Rate of Return (discussed in later class)

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Annuities

- Annuities:
  - Definition: pays a fixed cash flow, *C*, for *T* periods
  - Price:
    $PV = C\,(1 - 1/(1+r)^{T}) / r$
- Example: Which car can you afford?
  - You have no large amount of cash.
  - You can afford $632 per month.
  - You can borrow at an interest rate of 1% per month.
  - You want to have paid the loan in full in 48 months.

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Perpetuities

- Perpetuities
  - Definition:
    Pays a fixed cash flow, *C*, every period forever
  - Example: consol bond
  - Pricing: $PV = C / r$
- Example:
  - Suppose that maintenance of a grave costs $100 every year, forever.
  - The interest rate is 5% per year.
  - How much money should you leave the trustee of a grave?
  - Let's actually work it out

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Relationship between interest rate and price

- For perpetuities?
- For other bonds?
- Later in class: duration.
- For stocks?

- Does Ben Bernanke matter?

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Return Measures

Andre de Souza

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Return Measures: outline

- Quoted rate = Annual Percent Rate (APR)
- Compounding and Effective Annual Rate (EAR)
- Single period realized return:
  - holding period return
- Multiple-period realized return:
  - Arithmetic average
  - Geometric average
  - Internal Rate of Return (IRR)

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Compounding more frequently

- Until now: annual compounding
- Suppose you can invest $100 in an account that *compounds every six months* and pays you *5% every six months*
- How much do you have in six months? In a year?
- Is this the same as 10% compounded annually?
- Is this the same as 10.25% compounded annually?
- This rate is quoted as "10% [per year] with semiannual compounding"
  - Just a *convention*

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Quoted rates

- So if I say, "12% per year with monthly compounding", what do you understand?
- How much is the effective annual rate (EAR) in this case?

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Quoted Rates and EAR

- Example:
  - Interest rate quoted at 10% compounded semi-annually
- Example: Which loan is cheapest:
  - 10%, compounded semi-annually
  - 10%, compounded quarterly
  - 10%, compounded daily
- Effective Annual Rate EAR if interest is compounded *m* times a year:
  - $EAR = (1 + \text{quoted rate} / m)^m - 1$

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Continuous Compounding

- Suppose the quoted rate is given.
- Consider increasingly frequent compounding:
  annually, quarterly, daily, every second,...
- What happens to the EAR?
- When compounding happens "all the time," it is called continuous compounding
- $EAR = \exp(\text{quoted rate}) - 1$
- If I invest a dollar today ...

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APR

- Lenders are required by law to report the Annual Percentage Rate, APR.
- APR = Quoted Rate
  = interest per period
  times
  number of periods per year
- How do you make a loan seem cheaper?

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Single-Period Realized Return

- Holding period return (HPR):

$$HPR = \frac{\text{ending price} + \text{cash dividend}}{\text{beginning price}} - 1$$

- Annualized holding period return (HPR) for a holding period of t years:

$$\text{annualized } HPR = (1 + HPR)^{1/t} - 1$$

$$= \left(\frac{\text{ending price} + \text{cash dividend}}{\text{beginning price}} \right)^{1/t} - 1$$

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Multiple-Period Realized Return

(1) Arithmetic Average:

$$\frac{1}{T}(r_1 + r_2 + r_3 + \ldots + r_T)$$

- Not equivalent per-period return because it neglects compounding
- Useful for forecasting the return next period

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Multiple-Period Realized Return

(2) Geometric Average

- Gives the equivalent per-period return

$$[(1+r_1)(1+r_2)(1+r_3)\ldots(1+r_T)]^{1/T} - 1$$

$$= \left[\frac{\text{accumulated value}_T}{\text{value}_0} \right]^{1/T} - 1$$

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Multiple-Period Realized Return

(3) Internal rate of return, IRR

- Return if one can re-invest cash-flows at this rate
- "Dollar-weighted average"
- IRR is the rate that makes:

Initial price = present value of future net profits

$$P(0) = \sum_{t=1}^{\infty} \frac{C(t)}{(1+IRR)^t}$$

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Readings for next class

- Review Concept Questions after Ch4 and Ch5 of RWJ
- Required Reading:
  - BKM: 5.1*, 5.2*, 5.3*, 5.5* RWJ: 5.3*
- Check course webpage for additional suggested problems.
- Problem Set 1 is due on Tuesday May 22.

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