Chapter 3: Financial Decision Making and the Law of One Price

Note: Read the chapter then look at the following.

Fundamental question: What are assets worth?

- => starting point: any two assets that always pay the same cash flows should have the same price
  - => if not the case, a lot of money can be made very quickly.
  - => all mispriced assets will disappear almost immediately as bought (if price too low) or sold (if price too high)

3.1 Valuing Decisions

Key issues:

- => good decision: benefits exceed costs
- => role of other disciplines in financial decisions: help estimate costs and benefits of decisions
  - => need help from marketing, accounting, economics, organizational behavior, strategy, and operations

A. Analyzing Costs and Benefits

Key issues:

- => quantify costs and benefits
- => determining equivalent cash today

B. Using Market Prices To Determine Cash Values

Key issues:

- => competitive market: goods can be bought and sold at the same price
- => valuation principle: value of an asset equals its competitive market price

Q: Do competitive markets exist in the real world?

- => the stock market is pretty close for many stocks
- => compare bid and ask prices for Ford stock

  http://finance.yahoo.com/quote/F

Note: Can buy immediately at ask price and sell immediately at bid price if submit a market order

Q: Assume your uncle gives your 100 shares of Ford. What is the gift worth?
Q: Would you trade your shares for $1000?
Q: Would you trade your shares for 100 shares of Honda?

http://finance.yahoo.com/quote/HMC

Concept Checks: all

3.2 Interest rates and the Time Value of Money

Key issues:

=> borrowing and lending to convert money between future and today
=> risk-free interest rate

Comment: Discussing the time value of money in terms of exchange rates is excellent. Another slightly different way to think about the time value of money follows. Think about the issue whichever way makes the most sense to you.

A. Future values

Note: the future value of any amount paid or received today equals the cash have today plus interest would earn over the coming year if had invested it today

Ex. How much will you have one year from today if you invest $100 today at an interest rate of 1% per year? (What is the future value of $100?)

Interest = \$1 = 100 x .01
Amount have in one year = \$101 = 100 + 1

General Equation:

Let:

C_t = cash "t" years from today

Notes:

1) cash inflows are positive; cash outflows are negative
2) C_0 = cash today
3) C_1 = cash a year from today

I_t = interest earned over year t
Note: I_1 = interest earned between today and a year from today
r = interest rate

V_t = value "t" years from today

Notes:

1) V_0 = value today
2) PV = present value = V_0
3) V_1 = value a year from today

$$V_1 = C_0 + I_1 = C_0 + C_0 \times r = C_0(1+r)$$

$$V_1 = C_0(1+r) \qquad (3.A)$$

Ex.

V_1 = 100(1.01) = \$101

B. Present values

=> the present value of any cash paid or received in the future equals the amount of future cash less the interest could have earned if had invested the present value today.

Ex. How much must you deposit today to have \$101 a year from today if the interest rate is 1%? (What is the present value of \$101?)

Note: From previous example, we know the answer has to be $100!

PV = V_0 = 101 – I_1

=> V_0 = 101 –V_0(.01)
=> V_0 + V_0(.01) = 101
=> V_0(1.01) = 101
=> $V_0 = \frac{101}{1.01} = 100$

General Equation:

$V_0 = C - I = C_1 - r \times V_0$

=> $V_0 + r \times V_0 = C_1$

=> $V_0(1+r) = C_1$

$$V_0 = \frac{C_1}{(1+r)} \qquad (3.B)$$

Ex.

$$V_0 = \frac{C_1}{(1+r)} = \frac{101}{(1.01)} = 100$$

Concept Checks: all

3.3 Present Value and the NPV Decision Rule

Key issues:

=> net present value: present value of all cash flows associated with a project or decision
=> present value: amount need to invest at current interest rate to recreate cash flow in the future
=> NPV decision rule: undertake investment with highest NPV

Note: doing nothing usually has an NPV of $0

=> NPV and preferences for cash today versus cash in the future

$$NPV = PV(CF) \qquad (3.2)$$

Note: In example on p. 69, text assumes can borrow more than the project costs (hiring a manager) and keep the difference.

Q: Is it realistic to assume that a firm or individual could borrow more than a project costs and to keep the difference?

A: Not really. New rules implemented after the financial crisis prevent borrowing more than the value of an asset. Before the financial crisis, some people borrowed more than the value of a house, but most of that involved fraud. But the idea is theoretically sound.

Concept Checks: all

3.4 Arbitrage and the Law of One Price

A. Key issues:

=> equivalent assets: assets with exactly the same cash flows in all periods under all conditions
=> arbitrage: trading to take advantage of price differences between equivalent assets trading in different markets

=> key: buy low-priced asset and simultaneously sell the high-priced-asset (buy low – sell high).

Notes:

1) requires no investment and creates riskless payoff today
2) as arbitrage occurs, all of the mispriced assets get bought and sold very quickly
3) when all misprice assets bought and sold, arbitrage opportunity gone

Ex. Assume Ford trades for $14 on the New York Stock Exchange and for $13 on the BATS exchange

=> arbitrage: simultaneously buy Ford on BATS and sell it on NYSE

=> trade as many sets of shares (buy and sell) as possible

Ex. Assume the following prices for GE stock are available on the Boston Stock Exchange and the New York Stock exchange:

Note: GE stock traded on Boston Stock Exchange and NYSE are equivalent since same exact asset

Boston Stock Exch				New York Stock Exch			
Bid		Ask		Bid		Ask	
Price	Size	Price	Size	Price	Size	Price	Size
25.73	7000	25.76	6000	25.88	26,000	25.89	35,000

Arbitrage: simultaneously buy 6000 shares on the Boston Exchange and sell 6-6000 shares on the NYSE for risk-free profit of $720.

Note: Arbitrage profit = 6000 x (25.88 – 25.76) = 720
Q: Why do we use $25.88 and $25.76?
Q: Why not trade more than 6000 shares?
Q: How long will these conditions last?

GE Arbitrage Video

=> exploiting arbitrage eliminates arbitrage opportunities
=> law of one price: equivalent assets trading in different competitive markets must have same price in both markets
=> normal market: competitive market in which there are no arbitrage opportunities

B. Short-selling

Note: There is no problem if arbitrage requires selling an asset you don't own

=> short-sell the asset

1) today: borrow a security (usually from a broker) and sell it
    => receive cash from whoever buys the security from you
    => owe the security (not cash) to whoever loaned it to you

2) later: buy same security and give it back to whoever you borrowed it from

Notes:

1) if the security has matured, might pay the cash equivalent to maturity value rather than buying the security and giving it back
2) must make up any cash flows the lender would have received while the security was borrowed
3) short seller can buy and return the security at any time
4) lender of security can demand the return of the loaned security at any time
5) it is important to distinguish between:
    a) buy: buy stock to create a long position
    b) buy to cover (a short position): buy stock and give back to lender of shares
    c) sell: sell to close out a long position

d) short-sell: borrow and sell shares to create a short position

Ex. Assume you want to short-sell 100 shares of GE today for the market price of $12.50 per share

1) borrow 100 shares from your broker and sell them on the NYSE

Q: Where stand?
=> owe your broker 100 shares of GE
=> have $1250 in your brokerage account

2) assume price falls from $12.50 to $10

3) Q: How close out short position?
=> buy 100 shares in market at $10 per share and give the shares to broker

4) assume that while you were short GE paid a dividend of $0.10 per share
=> must give $10 to your broker.

5) Profit = +1250 – 10 – 1000 = $240

Q: What would lead to a loss?

Concept Checks: all

3.5 No-Arbitrage and Security Prices
Key issues:
=> financial securities (security)
=> value of security equals price of equivalent asset with known price

A. Valuing a Security with the Law of One Price

1. Identifying Arbitrage Opportunities with Securities

a. Goal:
=> when setting up arbitrage want: positive cash flow today, no possible net cash flow after today

b. Basic questions to ask when setting up an arbitrage:
1) What transaction (or set of transactions) is equivalent to the mispriced security?
2) Do you want to buy or sell the security?
3) What cash flows does this create?
4) What transaction today offsets the security's cash flows in the future?

Ex. Assume you can borrow or lend (or deposit money in a bank) at the risk-free rate of 7% and that a risk-free bond pays $1000 a year from today

$$PV = \frac{1000}{1.07} = 934.58$$

a) Assume the price of the bond is $920 (rather than its present value of $934.58)

=> arbitrage is possible

Q: What transactions today are equivalent to buying/short-selling the bond?

Bond Position	Equivalent	Reason Equivalent
Buy bond	Lend $934.58	CF = +$1000 one year from today
Short-sell bond	Borrow $934.58	CF = – $1000 one year from today

Q: Buy or sell the bond?
Q: What cash flows does this create?
Q: How end up with no cash flow next year?

Table 1

Transaction(t=0)	$ today	$ in one year	Transaction(t=1)
Buy bond	-920.00	+1000.00	Payoff from bond
Borrow $934.58	+934.58	-1000.00	Pay off loan
Total	+14.58	0.00	

Arbitrage profit = $14.58

Table 1 Video

b) Assume the price of the bond is $950 (rather than its present value of $934.58)

Q: Buy or sell the bond?
Q: What cash flows does this create?
Q: How end up with no cash flow next year?

Table 2

Transaction (t=0)	$ today	$ in one year	Transaction (t=1)
Short-sell bond	+950.00	-1000.00	Buy to cover the bond
Lend $934.58	-934.58	+1000.00	Payoff on loan
Total	+15.42	0.00	

Arbitrage profit = $15.42

Table 2 Video

Very Important: investors rushing to take advantage of any arbitrage opportunity in the previous example will quickly drive the price to $934.58

2. Determining the No-Arbitrage Price

=> For there to be no arbitrage, the price of any security must equal the present value of its cash flows

=> in previous examples, the only way there is no arbitrage: price = $934.58 = present value of $1000

3. Determining the Interest Rate from Bond Prices

=> interest rates are usually extracted from security prices rather than the other way around

Ex. Assume bond in previous example is trading at its no-arbitrage price. => C_1 = $1000, Price = $934.58. What is rate of return on the bond?

=> $934.58 = \frac{1000}{1+r}$ => r = .07 = 7%

=> no arbitrage: all risk-free investments offer the same return

B. The NPV of Trading Securities and Firm Decision Making

Key issues:
=> no arbitrage pricing implies that price = present value of cash flows
=> trading securities in a normal market does not destroy or create value
=> NPV of buying any security = PV(cash flows) – price = 0
=> NPV of selling any security = price – PV(cash flows) = 0

Q: Why would anyone ever trade securities if NPV of both buying and selling securities equals $0?

C. Valuing a Portfolio

1. Value Additivity

a. Portfolio: collection of securities

Key: In a normal market, equivalent portfolios (exactly same cash flows) must have same price

=> otherwise arbitrage is possible

b. ETF: exchange traded fund
=> essentially a portfolio of securities that you can trade on an exchange

c. Value Additivity: the price of a portfolio must equal the combined values of the securities in the portfolio

=> *Price(A+B) = Price(A) + Price(B)* (3.5)

Ex. Assume the following:

ETF1 holds one share of security A and one share of security B.
ETF2 holds one share of security C and one share of security D.
Security A pays $100 a year from today and has a market price of $95.24.
Security B pays $150 a year from today and has a market price of $142.86.
Security C pays $200 a year from today and security D pays $50 a year from today. Both are illiquid securities that are not traded in financial markets.

Q: What portfolio is equivalent to buying ETF1?

Transaction	$ in one year
Buy A	+100.00
Buy B	+150.00
Total	+250.00

Q: Why is buying an A and buying a B equivalent to buying ETF1?

Q: What is the no-arbitrage price for ETF1?

=> 238.10 = 95.24 + 142.86

Reason: ETF1 must have the same price as a portfolio of A and B I build myself

Key to arbitrage with equivalent portfolios with different prices: buy low and sell high

Assume price of ETF1 is $220 instead of no-arbitrage price of $238.10

Arbitrage: Buy ETF1, short-sell equivalent portfolio

Table 3

Transaction (t=0)	$ today	$ in one year	Transaction (t=1)
Buy ETF1	-220.00	+250.00	Payoff on ETF
Short-sell A	+95.24	-100.00	Buy to cover A
Short-sell B	+142.86	-150.00	Buy to cover B
Total	+18.10	0.00	

Table 3 Video

Assume price of ETF1 is $245 instead of no-arbitrage price of $238.10

Arbitrage: short-sell ETF1, buy equivalent portfolio

Table 4

Transaction (t=0)	$ today	$ in one year	Transaction (t=1)
Short-sell ETF1	+245.00	-250.00	Buy to cover ETF
Buy A	-95.24	+100.00	Payoff on A
Buy B	-142.86	+150.00	Payoff on B
Total	+6.90	0.00	

Table 4 Video

=> only way no arbitrage: price of ETF1 = 238.10
=> arbitrage will quickly drive the price of ETF1 to $238.10

Q: What does the market price for ETF2 have to be?

Note: payoff on ETF2 next year: 200 + 50 = 250

Q: What portfolio is equivalent to ETF2?

=> ETF1

=> must be worth 238.10

Reason: otherwise arbitrage is possible between ETF1 and ETF2

2. Value Additivity and Firm Value

Key issues:

=> value of firm = sum of value of individual assets
=> change in value of firm from decision = NPV of decision

Concept Checks: all

Appendix to Chapter 3: The Price of Risk

A. Risky Verses Risk-Free Cash Flows

1. Key ideas

1) investors prefer less risk other things equal

Reason: for most people a $1 loss is a bigger deal than a $1 gain

=> especially since loss tends to come in bad times

Note: preference for less risk called risk aversion and risk aversion varies across people

2) Expected return on a risky asset

$$E(R) = \frac{E(G)}{IC} \qquad (3A.1)$$

where:

E(R) = expected return on a risky asset
E(G) = expected gain at end of the year
IC = initial cost

3) Risk premium: extra return demanded by investors for holding risky assets instead of risk-free Treasuries

=> compensates investors for taking any risk

Note: risk premium can be negative if asset moves opposite to the market

=> reduces overall risk if have already invested in the market

2. Risk premium on the stock market (market for short)

=> the compensation for taking the market's risk

=> serves as a baseline of the premium for any risky asset

Note: the market risk premium will increase if:

- the risk of the market increases or,
- investors become more risk averse

3. Risk premium on a security

Key => Depends on two things:

1) risk premium on market index
2) degree to which security's return varies with market index.

=> the more it varies with the market, the higher the risk premium

Ex. Assume the following:

– risk-free interest rate = 2%

– a strong or weak economy is equally likely
– price of the market index: \$100
– payoff on stock market index depends on the economy as follows:
    weak economy = \$75
    strong economy = \$139

– payoff on Orange Inc. depends on the economy as follows:
    weak economy = \$95
    strong economy = \$159

Q: What are the expected cash flow next year, the possible returns, the expected return, and the risk premium on the market?

=> expected cash flow for the market index next year = $\frac{1}{2}(75)+\frac{1}{2}(139)=107$

=> return on the market depends on the economy as follows:

Strong: $\frac{139-100}{100}=39\%$

Weak: $\frac{75-100}{100}=-25\%$

=> expected return on the market index: $\frac{107-100}{100}=7\%=\frac{1}{2}(39\%)+\frac{1}{2}(-25\%)$

=> risk premium on the market index = 5% = 7 – 2

Q: What is the no-arbitrage price of Orange Inc.?

Q: How does the payoff on Orange compare to the payoff on the market?

=> Orange always pays $20 more than the market

Q: How create a portfolio that is equivalent to buying Orange?

	$ in one year	
Transaction	Weak	Strong
Buy market index	+75.00	+139.00
Buy risk-free bond	+20.00	+20.00
Total	+95.00	+159.00

Cost to buy a portfolio that is equivalent to Orange:

=> Cost of equivalent portfolio $=119.61=100+\frac{20}{1.02}=100+19.61$

=> the price of Orange must equal 119.61 => otherwise arbitrage

Q: What is arbitrage profit if the price of Orange is $125 instead of the no-arbitrage price of $119.61?

Table 5

Transaction	$ today	$ in one year: Weak	$ in one year: Strong	Transaction
Short-sell Orange	+125.00	– 95.00	– 159.00	Buy to cover Orange
Buy market index	– 100.00	+75.00	+139.00	Payoff on market
Buy risk-free bond	– 19.61	+20.00	+20.00	Payoff on bond
Total	+5.39	0.00	0.00	

Table 5 Video

Q: What is the arbitrage profit if the price of Orange is $110 instead of the no-arbitrage price of $119.61?

Table 6

Transaction	$ today	$ in one year Weak	Strong	Transaction
Buy Orange	– 110.00	+95.00	+159.00	Payoff Orange
Short-sell market index	+100.00	– 75.00	– 139.00	Buy to cover market
Short-sell risk-free bond	+19.61	– 20.00	– 20.00	Buy to cover bond
Total	+9.61	0.00	0.00	

Table 6 Video

Q: What are the possible returns, expected return, and risk premium on Orange if it is correctly priced at $119.61?

Return on Orange if strong economy = 32.9% = $\frac{159-119.61}{119.61}$

Return on Orange if weak economy = -20.6% = $\frac{95-119.61}{119.61}$

Note: return on Orange less volatile than the market (+39% or -25%)

Note: The risk premium on Orange should be less than the market (5%).

Q: Why?

Expected cash flow for Orange = $\frac{1}{2}(159)+\frac{1}{2}(95)$= 127

Expected return on Orange = $\frac{127-119.61}{119.61}=\frac{1}{2}(32.9\%)+\frac{1}{2}(-20.6\%)$= .062 = 6.2%

Risk premium on Orange = .062 – .02 = .042

Ex. Assume that all of the information in the Orange example still holds. Assume also that we can invest in Pineapple which pays $65 when the economy is weak and $129 when the economy is strong?

Q1: What is the no-arbitrage price for Pineapple?
Q2: What is the arbitrage profit if Pineapple's price is $95 or $80?
Q3: If Pineapple is correctly priced, what are the possible returns, expected return, and risk premium on the stock?

Note: Pineapple always pays $10 less than the market.

Equivalent portfolio:

	$ in one year	
Transaction	Weak	Strong
Buy market index	+75.00	+139.00
Short-sell risk-free bond	– 10.00	– 10.00
Total	+65.00	+129.00

Cost of equivalent portfolio $= 90.20 = 100 - \frac{10}{1.02} = 100 - 9.80$

A1: no-arbitrage price of Pineapple = $90.20

A2 ($95): Arbitrage profit if the price of Pineapple is $95 instead of the no-arbitrage price of $90.20.

Table 7

Transaction	$ today	$ in one year: Weak	$ in one year: Strong	Transaction
Short-sell Pineapple	+95.00	– 65.00	– 129.00	Buy to cover Pineapple
Buy market index	– 100.00	+75.00	+139.00	Payoff on market
Short-sell risk-free bond	+9.80	– 10.00	– 10.00	Buy to cover bond
Total	+4.80	0.00	0.00	

Table 7 Video

A2 ($80): Arbitrage profit if the price of Pineapple is $80 instead of the no-arbitrage price of $90.20.

Table 8

Transaction	$ today	$ in one year: Weak	$ in one year: Strong	Transaction
Buy Pineapple	– 80.00	+65.00	+129.00	Payoff on Pineapple
Short-sell market index	+100.00	– 75.00	– 139.00	Buy to cover market
Buy risk-free bond	– 9.80	+10.00	+10.00	Payoff on bond
Total	+10.20	0.00	0.00	

Table 8 Video

A3: Possible returns, expected return, and risk premium on Pineapple if it is correctly priced at $90.20

Return on Pineapple if strong economy = 43% = $\frac{129-90.20}{90.20}$

Return on Pineapple if weak economy = -27.9% = $\frac{65-90.20}{90.20}$

Note: return on Pineapple is more volatile than the market (+39% or -25%)

Expected return on Pineapple $=\frac{1}{2}(43\%)+\frac{1}{2}(-27.9\%)$ = .0755 = 7.55%

Risk premium on Pineapple = .0755 – .02 = .0555 (larger than market)

Concept Checks: all

B. Arbitrage with Transaction Costs

Transaction costs: costs to trade securities

Note: transaction costs include:
1. commission to broker
2. bid-ask spread: difference between bid price and ask price
3. fees to borrow stock (varies with demand for shares to short)

Key: Transaction costs lead to the following modifications of earlier definitions:

Normal market => no arbitrage after transaction costs covered
Law of one price => difference in prices for equivalent securities must be less than transaction costs of engaging in arbitrage
No arbitrage price => differences between price and the PV(CF) must be less than transaction costs
Portfolio prices => Difference between the price of a portfolio and the sum of the prices

of assets in the portfolio must be less than the transaction costs to build or break apart the portfolio

Concept Checks: all