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Corporate Finance
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Options Theory[1]

1. What is an option? [right but not an obligation]

2. What is the difference between American and European options?

3. What are puts and calls? [in interest rate settings?]

4. What are the different types of options available?

5. Define the concept of a "derivative" security.

6. Notation:

S	current stock price
S_T	terminal stock price
T	maturity
K	strike price
C, P	calls, puts
r	interest rate
σ	volatility

7. **Call Options**

   When a call is exercised, the buyer pays the writer the strike price, and gives up the call in exchange for the asset.

   For the privilege of exercising only if desirable, the buyer of the call initially pays the writer a price called the *call price.*

   From the *Wall Street Journal* 01.20.95:

   Asset: GM Stock
   Current asset price: $40\frac{1}{4}$
   Strike Price: 35
   Maturity date: February
   Call price: $5\frac{3}{8}$

[1]Some of these notes are adapted from work by my co-author, Prof. Rangarajan Sundaram, and mistakes here are entirely my responsibility.

8. **Put Options**

   When a put is exercised, the buyer gives up the put, and receives from the writer the exercise price in exchange for the asset.

   For the privilege of exercising the put only if desirable, the buyer initially pays the writer a price called the *put price*.

   From the *Wall Street Journal* 01.20.95:

   Asset: GM Stock
   Current asset price: $40\frac{1}{4}$
   Strike Price: 35
   Maturity date: February
   Put price: $\frac{1}{8}$

9. **Basic Trading Strategies**

   This segment examines the payoffs from:

   (a) Covered call.
   (b) Protective put.
   (c) Spreads:
      i. Bullish vertical spread.
      ii. Bearish vertical spread.
      iii. Butterfly spread.
   (d) Combinations:
      i. Straddles and strangles.
      ii. Strips and straps.

10. **Covered Call: Long stock, short call**

    If $S_T < K$:

    Value of stock: S_T
    Value of option: 0
    Total value: S_T

    If $S_T \geq K$:

Value of stock: S_T
Value of option: $-(S_T - K)$
Total value: $S_T - S_T + K = K$

Long stock position "covers" writer of option from sharp increase in stock price.

11. **Protective Put: Long stock, long put**

    If $S_T < K$:

    Value of stock: S_T
    Value of option: $K - S_T$
    Total value: $S_T + K - S_T = K$

    If $S_T \geq K$:

    Value of stock: S_T
    Value of option: 0
    Total Value: S_T

    A protective put portfolio protects the investor from a decrease in stock price.

12. **Spreads**

    A *spread* involves taking positions in two or more options of the *same* type (i.e., all calls, or all puts).

    For example:

    - A *bullish vertical spread* involves buying a call option at exercise price K_1 and selling an otherwise identical call option at another exercise price $K_2 > K_1$.
    - A *bearish vertical spread* involves selling a call option at exercise price K_1 and buying an otherwise identical call option at another exercise price $K_2 > K_1$.
    - A *butterfly spread* is obtained by buying a call option each at strike prices K_1 and K_3, and selling two call options at a strike price of K_2, $K_1 < K_2 < K_3$.
    - A *horizontal* or *calendar spread* is obtained by selling a call option with maturity T_1, and selling an otherwise identical call option with maturity $T_2 > T_1$.

Bullish Vertical Spread: Gross Payoffs

- If $S_T < K_1$: Neither option is exercised.
  Payoffs = 0
- If $K_1 \leq S_T < K_2$: Only first option is exercised.
  Payoffs = $S_T - K_1$
- If $K_2 \leq S_T$: Both options are exercised.
  Payoff from first option = $S_T - K_1$
  Payoff from second option = $-(S_T - K_2)$
  Total payoff = $K_2 - K_1$

Bearish Vertical Spread: Gross Payoffs

- If $S_T < K_1$: Neither option is exercised.
  Payoffs = 0
- If $K_1 \leq S_T < K_2$: Only first option is exercised.
  Payoffs = $-(S_T - K_1)$.
- If $K_2 \leq S_T$: Both options are exercised.
  Payoff from first option = $-(S_T - K_1)$
  Payoff from second option = $(S_T - K_2)$
  Total payoff = $K_1 - K_2$

Butterfly Spread: Gross Payoffs

Assume $K_2 = \frac{1}{2}(K_1 + K_3)$

- If $S_T < K_1$: No option is exercised.
  Payoffs: 0
- If $K_1 \leq S_T < K_2$: Only K_1-strike option is exercised. Payoffs: $S_T - K_1$
- If $K_2 \leq S_T \leq K_3$: Only options with strikes K_1 and K_2 are exercised.
  Payoffs: $S_T - K_1 - 2S_T + 2K_2 = K_3 - S_T$
- If $K_3 < S_T$: All options are exercised.
  Payoffs: $S_T - K_1 + S_T - K_3 - 2(S_T - K_2) = 0$

13. **Combinations:**

A *combination* is a trading strategy that involves taking a position in both calls and puts in the same stock. For example:

- A *straddle* is a put and a call with the same strike and maturity.
- A *strangle* is a call and a put with the same maturity, but different strikes.
- A *strip* is one call and two puts with the same strike and maturity.
- A *strap* is two calls and one put with the same strike and maturity.

Straddle: Gross Payoffs

If $S_T < K$:

Value of call $= 0$
Value of put $= K - S_T$
Total value $= K - S_T$

If $S_T \geq K$:

Value of call $= S_T - K$
Value of put $= 0$
Total value $= S_T - K$

Strip: Gross Payoffs

If $S_T < K$:

Value of call $= 0$
Value of puts $= 2(K - S_T)$
Total value $= 2(K - S_T)$

If $S_T \geq K$:

Value of call $= S_T - K$
Value of puts $= 0$
Total value $= S_T - K$

14. **No-Arbitrage Restrictions**

Idea: To identify restrictions on prices of puts and calls based on the notion that a competitive market should not admit the possibility of a riskless profit.

Two portfolios which imply the presence of arbitrage:

(a) A portfolio which involves no cash outflow today, but will lead to positive cash inflows in the future.

(b) A portfolio which involves a net cash inflow today, and which will not involve cash outflows in the future.

Restrictions on Call-Option Pricing

We identify eight restrictions that "rational" call option prices must satisfy:

- The first four relate the price of the call to the price of the underlying asset.
- The next three relate the price of the call to the exercise price.
- The last relates the price of the call to the time to maturity.

Notes

- We will not distinguish between European and American options in this exercise.
- However, if a restriction holds only for American (or only for European) options, this is highlighted.
- The task of identifying the analogous restrictions for *put* option prices is left to the reader as an exercise.

15. **Relationship between C and S**

(a) $C \geq 0$.

(b) $C \leq S$.

(c) $C \geq S - K$.

(d) $C \geq S - PV(K) - PV(D)$.

Note Restriction 3 holds only for American call options.

Remark In 4, $PV(K)$ is the present value of an amount K received at time T, and $PV(D)$ is the present value of dividend inflows

Proof of Restriction 1

If $C < 0$, then an arbitrage results (buy the option and throw it away).

Proof of Restriction 2

A rational investor would not pay more than S for right to purchase asset at a price of S.

Proof of Restriction 3

If $C < S - K$, then an arbitrage results (buy the option and exercise it immediately).

Proof of Restriction 4

Consider two portfolios:

(a) Portfolio A: Long one stock.

(b) Portfolio B: Long one call option, lend $PV(K)$, lend $PV(D)$.

At date T, if $S_T < K$:

Value of Portfolio A: $S_T + D$
Value of Portfolio B: $K + D$

At date T, if $S_T \geq K$:

Value of Portfolio A: S_T
Value of Portfolio B: $S_T - K + K + D$

So portfolio B always does as well as portfolio A, and in some cases does strictly better. Therefore, the cost of portfolio B must be higher than that of portfolio A. (Otherwise, an arbitrage results from selling portfolio A and buying portfolio B.) That is, we must have

$C + PV(K) + PV(D) \geq S$

which is the same as

$C \geq S - PV(K) - PV(D)$.

16. **Relationship between C and K**

(a) If $K_1 < K_2$, then $C(K_2) < C(K_1)$.

(b) If $K_1 < K_2$, then $C(K_1) - C(K_2) \leq K_2 - K_1$.

(c) If $K_1 < K_2 < K_3$, then
$C(K_2) \leq wC(K_1) + (1 - w)C(K_3)$,

where w is defined by

$$w = \frac{K_3 - K_2}{K_3 - K_1}.$$

Note The property described in Restriction 7 is called "convexity."

Proof of Restriction 5

If $K_1 < K_2$ and $C(K_1) < C(K_2)$, an arbitrage results (buy the option with strike K_1 and write the option with strike K_2). Note that Restriction 5 is simply the statement that a bullish vertical spread cannot be purchased "for free."

Proof of Restriction 6

We first prove the result assuming the options are European. Then we explain how the arguments may be extended to American options. Suppose $K_1 < K_2$, but $C(K_1) - C(K_2) > K_2 - K_1$.

Then, an arbitrage may be created as follows:

- Sell the call with strike K_1, buy the call with strike K_2, and lend $(K_2 - K_1)$ for maturity at T.
- At time T, exercise the K_2-strike option if and only if $S_T \geq K_2$.

The initial cash inflow from this strategy is

$$C(K_1) - C(K_2) - (K_2 - K_1) \ > \ 0.$$

There are three possible cases at time T: $S_T < K_1$, $K_1 \leq S_T < K_2$, and $S_T > K_2$.

We will show that the net cash inflow at T is nonnegative in all three cases.

Case 1: $S_T \leq K_1$

In this case, both options lapse unexercised. The only cash inflow is from the loan made, which is positive.

Case 2: $K_1 \leq S_T < K_2$

Here, only the K_1 call is exercised leading to a cash outflow of $(S_T - K_1)$, and a cash inflow from the loan of $(K_2 - K_1) +$ int.

Case 2: (cont'd) $K_1 \leq S_T < K_2$

The net cash inflow that results is

$$K_2 - S_T + \text{ int} > 0.$$

Case 3: $S_T > K_2$

Now both options are exercised, leading to a cash outflow of $(S_T - K_1)$, and cash inflows of $(S_T - K_2)$ and $(K_2 - K_1) +$ int. The net cash flow is the interest, which is nonnegative. Thus, the suggested strategy provides an arbitrage.

If the options are American, rather than European, an arbitrage can be created by setting up the same portfolio, but modifying the strategy as follows:

- Close out the loan at the time the K_1-strike option is exercised.
- Exercise the K_2 option at any this point if $S_t \geq K_2$.
- Otherwise exercise the K_2 option at T, provided $S_T \geq K_2$.

Note that at any time t, the value of the loan is equal to the principal $(K_2 - K_1)$ plus the interest accumulated upto that point.

Proof of Restriction 7

Suppose $K_1 < K_2 < K_3$, but

$C((K_2) > wC(K_1) + (1 - w)C(K_3)$,

where

$$w = \frac{K_3 - K_2}{K_3 - K_1}.$$

We will show that an arbitrage profit may be created.

Once again, we will first do this for the case of European options, and then extend the arguemnts to cover American options also. Consider the following strategy:

- Buy w calls with strike K_1, buy $(1 - w)$ calls with strike K_3, and sell one call with strike K_2.

The initial cash flow from this strategy is positive.

We will show that all future cash flows are nonnegative, so the strategy is an arbitrage.

There are four possible cases at time T:

Case 1: $S_T < K_1$

In this case, all options lapse unexercised, so there are no cash flows at T.

Case 2: $K_1 \leq S_T < K_2$

Here, only the K_1 option is in the money, so the cash inflow is positive, and there is no cash outflow.

Case 3: $K_2 \leq S_T < K_3$

Now, the K_1 and K_2 options are both in the money, and will be exercised. The cash inflow from the K_1 options is $w(S_T - K_1)$, while the outflow from the K_2 option is $S_T - K_2$. Substituting for w, some algebra shows that the net inflow is:

$$\left(\frac{K_2 - K_1}{K_3 - K_1}\right)(K_3 - S_T) \;>\; 0.$$

Case 4: $K_3 < S_T$

Now all the calls are in the money. The net cash inflow at T is, therefore,

$$\begin{aligned} w(S_T - K_1) + (1-w)(S_T - K_3) \\ - (S_T - K_2), \end{aligned}$$

which equals

$$K_2 - wK_1 - (1-w)K_3 \;=\; 0.$$

This completes the proof of restriction 7 for European options.

If the options are American, rather than European, the same portfolio will result in an arbitrage, provided the exercise strategy is modified as follows:

- When the K_2-call is exercised, exercise all the calls that are in the money.
- At time T, exercise all unexercised calls that are in the money.

The initial cash inflow is still strictly positive.

Minor modifications of the arguments given above show that all cash inflows under the suggested strategy are nonnegative.

17. **Relationship between C and T**

    (a) If $T_1 < T_2$, then $C(T_1) \leq C(T_2)$.

    Note: Restriction 8 need not hold for European calls.

    Proof of Restriction 8:

    If $C(T_1) > C(T_2)$, an arbitrage opportunity can be created by adopting the following strategy:

    - Buy the call with expiration T_2, and write the call with expiration T_1.
    - Exercise the T_2-call when the holder of the T_1 call exercises.
    - If the T_2-call is still unexercised at T_1, exercise it at any time that it is in the money.

    This strategy leads to a positive cash inflow at time 0.

    At any time prior to T_1, either both calls are exercised, or neither is, and in either case, there is no net cash flow.

    After T_1, only the T_2 call is alive, so there is no cash outflow.

18. **Restrictions on Put Option Pricing**

    Analogous to the restrictions for call, we can derive the following restrictions on put option prices (the proofs are omitted):

    (a) $P \geq 0$.

    (b) $P \leq K$.

    (c) $P \geq (K - S)$ (only American puts).

(d) $P \geq PV(K) + PV(D) - S$.

(e) If $K_1 < K_2$, then $P(K_1) < P(K_2)$.

(f) If $K_1 < K_2$, then $P(K_2) - P(K_1) \leq K_2 - K_1$.

(g) If $K_1 < K_2 < K_3$, then
$$P(K_2) \leq wP(K_1) + (1-w)P(K_3).$$
where $w = (K_3 - K_2)/K_3 - K_1)$.

(h) If $T_1 < T_2$, then $P(T_1) < P(T_2)$ (American puts only).

We examine two issues in this segment:

(a) European Option Prices vs. American Option Prices, when both options are of the same type (i.e., both calls, or both puts).

(b) Put Option Prices vs. Call Option Prices, when both options are of the same style (i.e., both European, or both American).

The restrictions we derive will be based solely on no–arbitrage arguments, so they will have a very general validity.

19. European Option Prices vs. American Option Prices

Only difference between American and European options is right to exercise early. We examine when this right is important (i.e., under what conditions it may be exercised). It is important to understanding relative prices of European and American options. In particular, if right to early-exercise is never used in some American options, then these options must trade at the same price as the corresponding European options.

We examine question of early-exercise in each of four cases:

(a) No Interim Payouts on Asset.

  i. American Call.

  ii. American Put.

(b) Interim payouts exist.

  i. American Call.

  ii. American Put.

20. **Case 1(a): American Call, No Dividends**

Recall no-arbitrage restriction that

$$C \geq S - PV(K).$$

Define $IV(C) = C - (S - PV(K))$.

$IV(C)$ is the *insurance value* of having the call. The no-arbitrage restriction may now be expressed as

$$C = S - PV(K) + IV(C).$$

Adding K to both sides, and rearranging:

$$C - S + K = K - PV(K) + IV(C).$$

This is the same as:

$$C - (S - K) = (K - PV(K)) + IV(C).$$

Left-Hand Side (LHS): Loss/gain from immediate exercise.

Right-Hand Side (RHS): Expresses loss/gain as sum of two terms:

- First term $K - PV(K)$ is pure *time-value* of exercise price that is *lost* from early exercise.
- Second term $IV(C)$ is insurance value of call which is *lost* from early exercise.

There are no gains from early exercise.

Conclusion: American option on asset with no interim payouts is never exercised early.

21. **Case 1(b): American Put, No Dividends**

Recall no-arbitrage restriction that

$$P \geq PV(K) - S.$$

Define $IV(P) = P - (PV(K) - S)$.

$IV(P)$ is the *insurance value* of having the put. The no-arbitrage restriction may now be expressed as

$$P = PV(K) - S + IV(P).$$

Subtracting K from both sides and rearranging,

$$P - K + S = -K + PV(K) + IV(P).$$

which is the same as:

$$P - (K - S) = -(K - PV(K)) + IV(P).$$

LHS: Loss/gain from immediate exercise.

RHS: Expresses loss/gain as sum of 2 terms:

- First term $(K - PV(K))$ is time-value of money *gained* by exercising put immediately.
- Second term $IV(P)$ is insurance value of put *lost* by exercising put immediately.

Sign of RHS is ambiguous.

Conclusion: If insurance value of put is larger than time value gained, do not exercise put. Otherwise exercise put.

Example: If interest rates are "high," and volatility of stock price is "low," put should be exercised.

22. **Case 2(a): American Call with Dividends**

If American Call is payout protected, then this is the same as the no-dividend case. Assume call is *not* payout protected.

Recall no-arbitrage restriction that

$$C \geq S - PV(K) - PV(D).$$

Let $IV(C) = C - (S - PV(K) - P(D))$.

$IV(C)$ is the *insurance value* of having the call.

Adding K to both sides and rearranging, the no-arbitrage restriction may now be expressed as

$$C - (S - K) = (K - PV(K)) \\ - PV(D) + IV(C).$$

LHS: Loss/gain from immediate exercise.

RHS: Expresses loss/gain as sum of 3 terms:

- The first term $(K - PV(K))$ is the time-value of exercise price *lost* by immediate exercise.
- The second term $PV(D)$ is the dividend amount *gained* by immediate exercise.
- The third term, $IV(C)$ is the insurance value of the call that is *lost* from immediate exercise.

RHS could be positive or negative.

Conclusion 1: Could be optimal to exercise American option on a dividend-paying stock early.

Conclusion 2: If early exercise is optimal, maximum gain occurs from exercising just before stock goes ex-dividend.

Factors making early-exercise more likely:

- High dividends.
- Low interest rates.
- Short period left to maturity.
- Low volatility of stock price.
- High depth-in-the-money.

23. **Case 2(b): American Put with Dividends**

Recall arbitrage restriction

$$P \geq PV(K) + PV(D) - S.$$

Define $IV(P) = P - (PV(K) + PV(D) - S)$.

$IV(P)$ is the *insurance value* of having the put.

Subtracting K from both sides and rearranging, we get

$$P - (K - S) = -(K - PV(K)) + PV(D) + IV(P).$$

LHS: Loss/gain from immediate exercise.

RHS: Expresses loss/gain as sum of 3 terms:

- The first term $K - PV(K)$ is time-value of exercise price *gained* by immediate exercise.
- The second term $PV(D)$ is the value of dividends *lost* by immediate exercise.
- The third term $IV(P)$ is insurance value of option *lost* by immediate exercise.

RHS could be positive or negative.

Conclusion 1: Could be optimal to exercise put option on a dividend-paying stock early.

Conclusion 2: Early exercise could be optimal at any time, not just before stock goes ex-dividend.

Factors making early-exercise more likely:

- Low dividends.
- High interest rates.
- Low volatility of stock price.
- High depth-in-the-money.

24. **Put–Call Parity**

Consider put and call that are otherwise identical:

- Same underlying asset.
- Same exercise price.
- Same maturity date T.

- Same style (both American or both European).

How is put price P related to call price C?

We examine the answer in four cases:

(a) No interim payouts on stock.
   i. Both options are European.
   ii. Both options are American.

(b) Interim payouts exist.
   i. Both options are European.
   ii. Both options are American.

25. **Case 1(a): Both European, No Dividends**

Consider the following portfolios:

Portfolio A: Buy 1 put, buy 1 share of stock.

Portfolio B: Buy 1 call, lend $PV(K)$.

Cost of setting up Portfolio A: $P + S$.

Cost of setting up Portfolio B: $C + PV(K)$.

Value of Portfolio A at maturity:

(a) If $S_T < K$: Put option is worth $K - S_T$; stock is worth S_T. Total value: K.

(b) If $S_T \geq K$: Put option expires worthless; stock is worth S_T. Total value: S_T.

Value of Portfolio B at maturity:

(a) If $S_T < K$: Call option expires worthless; loan matures with face value K. Total value: K.

(b) If $S_T \geq K$: Call option is worth $S_T - K$; loan matures with face value K. Total value: S_T.

Thus, the portfolios have the same terminal value whether $S_T < K$ or $S_T \geq K$. To avoid arbitrage, portfolios must have same initial value:

$$P + S \;=\; C + PV(K).$$

Therefore, the put and call prices of European options are related by:

$$P \;=\; C + PV(K) - S.$$

This formula is called the "put-call parity" formula for European options.

Put-call parity can be used to create *synthetic puts* using *traded calls*, and *synthetic calls* using *traded puts*

For example, suppose the aim is to create a European put option with strike price K and maturity T. The following portfolio will mimic the payoff of such an option:

- Buy a European call with strike K and maturity T.
- Short one unit of the stock.
- Lend $PV(K)$ (i.e., buy a T-bill with maturity T and face value K).

The value of the portfolio at maturity is

$$\begin{array}{cl} K - S_T, & \text{if } S_T < K \\ 0, & \text{if } S_T \geq K \end{array}$$

which is exactly the payoff from the desired put.

26. **Case 1(b): Both American, No Dividends**

An American call on a stock that pays no dividends will not be exercised early. So, to prevent arbitrage, the price of an American call (denoted C_A) must coincide with the price of the corresponding European call (denoted C_E).

Since it may be optimal to exercise an American put early, the price of the American put (denoted P_A) must be at least as large as the price of the corresponding European put (denoted P_E).

Therefore, we have

$$C_A = C_E, \text{ and } P_A \geq P_E.$$

We have already shown that the following put-call parity formula must hold for European options:

$$P_E = C_E + PV(K) - S.$$

Since $P_A \geq P_E$, we must have

$$P_A \geq C_E + PV(K) - S.$$

Since $C_A = C_E$, we must finally have

$$P_A \geq C_A + PV(K) - S.$$

This formula may be regarded as the put-call parity formula for American options on stocks that do not pay any dividends.

27. **Case 2(a): Both European, Stock Pays Dividends**

This is similar to Case 1(a). Consider the following portfolios:

Portfolio A: Buy one put, buy one share of stock.

Portfolio B: Buy 1 call, lend an amount equal to $PV(K) + PV(D)$.

Cost of setting up Portfolio A: $P + S$.

Cost of setting up Portfolio B: $C + PV(K) + PV(D)$.

Value of Portfolio A at maturity:

(a) If $S_T < K$: Put option is worth $K - S_T$; stock is worth S_T; dividends of D have been received on stock. Total value: $K + D$.

(b) If $S_T \geq K$: Put option expires worthless; stock is worth S_T; dividends of D have been received on stock. Total value: $S_T + D$.

Value of Portfolio B at maturity:

(a) If $S_T < K$: Call option expires worthless; loan matures with face value $K + D$. Total value: $K + D$.

(b) If $S_T \geq K$: Call option is worth $S_T - K$; loan matures with face value $K + D$. Total value: $S_T + D$.

Thus, the portfolios have the same terminal value whether $S_T < K$ or $S_T \geq K$. To avoid arbitrage, portfolios must have same initial value:

$$P + S = C + PV(K) + PV(D).$$

Therefore, the put and call prices of European options on dividend-paying stocks are related by:

$$P = C + PV(K) + PV(D) - S.$$

This is the "put-call parity" formula for European options on dividend-paying stocks.

28. **Case 2(b): Both American, Stock Pays Dividends**

Once again, let C_A and P_A denote, respectively, the call and put option prices for American options, and let C_E and P_E denote the corresponding European option prices.

Since early exercise may be optimal for American put options on dividend-paying stocks, we must have

$$P_A \geq P_E.$$

Since the only reason to exercise the American call early is the presence of dividends, the *maximum* gain from early exercise is $PV(D)$. Therefore,

$$C_A \leq C_E + PV(D).$$

Finally, we have shown that

$$P_E = C_E + PV(D) + PV(K) - S.$$

Combining all these inequalities, we have:

$$P_A \geq P_E$$
$$P_E = C_E + PV(D) + PV(K) - S$$
$$C_A \leq C_E + PV(D)$$

And we finally obtain:

$$P_A \geq C_A + PV(K) - S.$$

This formula may be regarded as the put-call parity for American options on dividend paying stocks.

29. How can you synthesize forward contracts with options?

    - $F = C(K) - P(K), K = FV(S)$
    - $C - P = S - PV(F) = F = 0.$
    - Analogy to swaps and bond market.

30. What is the analogy to valuing assets in a firm?

    - $V = D + E$
    - $E = \max(0, V - F) = C(V, F)$
    - $D = \min(V, F) = F - \max(0, F - V) = F - P(V, F)$
    - $D + E = C - P + F = PV(V)$ [put-call parity]
    - Business risk (vary σ)
    - Financial risk (vary D/E)

31. How does this analogy help in understanding FDIC insurance and the S&L crisis?

32. Replication and risk-neutral pricing (see Risk, Not Return case).