11-06 Class 12 Forwards and Futures

- **From banks to futures markets**
- **Financial markets as insurance markets**
- **Instruments and exchanges;**
- **The counterparty risk problem**

From last time

- Banks face bank runs why?
- Because depositors worry about the solvency of banks and if the risk of insolvency rises above some threshold it becomes a dominant strategy to withdraw your funds.
- One definition and one implication

Definition

- Bank runs occur because depositors face counter party risk.
- Counter party risk arises in a contract when there is a likelihood that one party in the contract will be unable or unwilling to execute it.
- Example:
  - bank cannot meet depositors withdrawal requests.
  - Insurance company does not have resources to pay claims
- Notice this requires leverage of some sort (equity to equity deals do not have these problems)

Implication

- The bank has to deal with two problems

(1) how much risk to take on?

(2) how to avoid insolvency (this is a specific set of outcomes)

- These are connected
  - if it takes on no risk it cannot become insolvent
  - Portfolio approach minimizes risk conditional on return and thus insolvency risk.
- But it may want to pass of some specific downside risk
  - To do so it has to buy insurance
  - This could be against the default of its largest clients (credit default swaps)
  - This could be against the poor performance of a sector that is over represented (so it might want to short so assets that are highly correlated with that sector).

From short sales to future

- Short sales might be part of an optimal portfolio strategy
  - you might want to short a low return asset so as to buy more high return assets.
- In CAPM structure you only ever short the riskless asset
  - (because everyone owns the same risky assets)
- A short is a promise to sell and is the reverse of a forward contract
- Future's contract is a specific form of a forward contract

Forwards

- A forward contract is a promise to purchase a specific quantity of some item at a specified date.
  - These are common in B2B environments where both the buyer and the seller may want to stabilize delivery and prices (say a laptop manufacturer and a hard drive manufacturer)
  - Commercial Aircrafts, government contracts…
- In general over the counter (privately agreed)
  - Firm (not option)
  - Details (price, quantity, maturity,…) decided for each contract
  - Payment is due upon delivery.
  - Illiquid
- Identity of the counterparty really matters. You do not want to produce a 747 and not have anyone who wants to pay for it.
- When you sign a long term contract with a cell phone company you are in effect signing a forward (buying X minutes a month at some pre-specified price). But there are escape clauses

Counter party risk is inherent to forward contracts

Let the price of asset X be p_t today evolve at in such a way that with probability 0.5 $p_{t+1}=1.5\ p_t$ and with probability 0.5 $p_{t+1}=2/3p_t$.

Ex ante the fair bargain is to sign the forward contract with a price equal to the expected value. The expected value of X at time t+i is simply p_t.

But the set of possible payoffs looks like:

After one period			After two period			After three periods	
p_1	Likelihood		p_2	Likelihood		p_2	Likelihood
1.5	0.5		2.25	0.25		3.375	0.125
0.67	0.5		1	0.5		1.5	0.375
			0.45	0.25		0.67	0.375
						0.30	0.125

- Suppose price appreciation has been high after three periods.
  - The seller executes contract gets 1 or does not and sell the item on the open market at $p_3=3.375$ Difference in profit is 2.375
- Suppose price depreciation has been high after three periods.
  - The buyer executes contract pays 1 or does not and buy it the item on the open market at $p_3=0.3$ Difference in profit is 0.7.

Forward contracts as zero sum game

- From before
  - Suppose price appreciation has been high after three periods.
    - The seller executes contract gets 1 or does not and sell the item on the open market at p_3=3.375 Difference in profit is 2.375
  - Suppose price depreciation has been high after three periods.
    - The buyer executes contract pays 1 or does not and buy it the item on the open market at p_3=0.3 Difference in profit is 0.7.
- More generally
  - What buyer gains is what seller looses
  - $\Pi_b=p_1-p_0$ $\Pi_S=p_0-p_1 \Leftrightarrow \Pi_b=-\Pi_S$
  - That is a zero sum game. And incentives to pay up have to be low for one side or the other, this is particularly true if p_1-p_0 is large
  - Need an enforcement mechanism

Problem and Solution

- Courts
  - For reasons not clear, there has been a lot of suspicion about forward markets in past
  - Courts have tried to suppress them or refused to enforce such contracts.
  - Then after the 1850s more enforcement
- Repeated dealings
  - Small number of players who contract repeatedly, if these are fair bargains then, you can secure cooperation (people pay up) as long as $p_T - p_0$ is not too large. (this involve forwards being relative short durations).
- Trading mechanism

Futures Contracts

- Futures are a specific set of forward contracts. Designed to solve both the enforcement problem and the liquidity problem.
- Contracts available for a small number of standardized commodities and delivery is not expected.
  - (e.g. Standardized commodities delivered at a specified location and date).
  - (e.g. 20 short tons (40,000 lb or 18,000 kg) of frozen, trimmed bellies for delivery in Chicago on the first of the March of 2012)
- Individual who takes a position (long or short position) contracts with an intermediary (not with a party on the other side).
  - Intermediary is an market maker. In US Chicago Mercantile exchange
- To take the position the individual has to establish a collateral account and her position is marked to market every day.
  - If the collateral requirement is 10% of contract then at the end of trading day the individual must add to her account if it has fallen below that or can withdraw from it.
- Position are closed by selling the contract back to the intermediary before expiration.
- Market maker operates an order book (so its position is always balanced)

More details

Contract is initiated when some seller accepts a bid (from a buyer). Value is V_0 .
The exchange then initiates two contracts.

One between itself and the buyer, one between itself and the seller.

The two contracts offset each other so the exchange has no aggregate liability.
Both sides post and maintain collateral in an account. Its value at time ti is A^i_t

(e.g. 10% of contract value, then collateral can never fall below 80% of the initial collateral). $A^b_0=0.1V_0$; $A^b_t \geq 0.8A_0$; $A^s_0=0.1V_0$; $A^s_t \geq 0.8A_0$

Buyer			Seller		Exchange
Period 0 V_0					
A^b_0	$0.1V_0$		A^s_0	$0.1V_0$	$A^b_0+A^s_0$
Period 0 V_1					
A^b_1	$0.1V_0+(V_1-V_0)$		A^s_t	$0.1V_0-(V_1-V_0)$	$A^b_1+A^s_1$
Period t V_t Value change V_t-V_0					
A^b_t	$0.1V_0+(V_t-V_0)$		A^s_t	$0.1V_0-(V_t-V_0)$	$A^b_t+A^s_t$
Period t+1 V_{t+1} Total Value change V_t-V_0. Period value change $V_{t+1}-V_t$					
A^b_{t+1}	$A^b_t+(V_{t+1}-V_t)$		A^s_{t+1}	$A^s_t-(V_{t+1}-V_t)$	$A^b_{t+1}+A^s_{t+1}$

The balance rule

- **All value changes flow directly from the buyer to the seller. If either account fall below the minimum ($A^i_t<0.8A^i_o$) then that party has to post new collateral.**
- **If not the exchange liquidates his or her position the next period.**
- **If buyer $C_b=A^b_t-(V_{t+1}-V_0)$.**
- **If seller $C_s=A^s_t-(V_0-V_{t+1})$.**

Futures keep incentives in check

- The whole idea is to keep the incentive to execute the contract constant.
  - Suppose we contracted at $20.000, but that at time T the price is $30,000.
  - The buyer has made a lot of money (he bought at $20,000 something that is now worth $30,000).
  - The seller finds executing the contract expensive (he loose the same amount). Hence the problem with forwards.

- Assume a price increase from $20,000 to $30,000 the incentive to default is on the seller.
- The seller:
  - As the price rose the seller was forced to post more collateral so as to maintain his account above $1,600. By settlement time he has had to transfer $9,600.
  - If he sells the unit on the open market he receives 30,000 but foregoes the collateral. His net income is $30,000-9600.
  - If he executes the contract he turns over the unit and receives $20,000 plus the residual of his collateral account $1,600.
- The buyer
  - The buyer pays the spot price to execute the contract 30,000 and keeps his collateral account ($12000). Net cost is $20,000 (the contract price) relative to purchase on the market. Net gain $10,0000
  - If he resells it immediately his net income is -30000 +30000+12000-2000=$10,000.
- The exchange
  - if the seller fails to provide the unit, the exchange buys it at $30,000, collects $30,000 from the buyer and keeps the net collateral account ($1600).
  - If seller provides the unit just makes transaction fees
- The dynamic adjustment keeps incentives balanced

Forwards' and Futures' prices

- What drives futures prices?
- Lets go back to the defunct pork belly futures.
- Suppose I'm in the Pork belly business (a restaurant chain) and I want to insure a steady supply say 6 months in advance.
- Two choices buy ahead and store, or buy futures
  - In equilibrium I must be indifferent.
- Storing can be either costly or not.
  - In the case of pork bellies they have to be frozen.
  - I also have to pay for the bellies I store while I may be able to post very cheap collateral (US bonds)
  - So the spot price S and the future price for delivery T periods (F^T)have to be connected because there is an arbitrage condition
- $F^T=(1+r-c)^T S_0$ where r is the interest income foregone and c is the per unit storage cost.

More generally

- For some commodities storage costs are negligible so $F^T \approx (1+r)^T S_0$
- So you can use futures contracts to back out short term interest rates.
- For other commodities there is a per period storage cost c so $F^T \approx (1+r-c)^T S_0$
- For financials there is a per period return $F^T \approx (1+r+y)^T S_0$

- **(what about things that appreciate over time like expensive wine?)**
- **Clearly two possibilities arise**
- **Spot prices can be higher or lower than the future price. It all depends on how the asset is *expected* to evolve.**

Hedging (1/3)

- The original purpose of futures contract was hedging—removing risk
- In many cases individuals (and firms) are forced to take very heavy long positions in particular assets.
- Particularly true of very specialized firms
- E.g. farmers in the corn belt, the wheat belt, the cotton belt…
- Eg. highly specialized manufacturers
  - E.g. Alcoa and electricity prices
- Airlines
  - E.g. Fuel prices
- As a result they face a very large price risk.
- If risk neutral then no need to hedge

Hedging (2/3)

- Now suppose you have a farmer with a silo full of wheat and a baker.
- Both face a lottery over the price of wheat next month
  - High good for the farmer bad for the baker
  - Low good for the baker bad for the farmer
  - Now let the future price be $F^T \approx (1+r-c)^T S_0 \approx qp_h+(1-q)p_l$
- If both are risk averse then
  - $U_b(F^T) > qp_h +(1-q)p_l$
  - And $U_f(F^T) > qp_h+(1-q)p_l$
- Notice the futures' market exists even if only one side is risk averse

Hedging (3/3)

- Perfect hedging (creates a riskless asset; so that is precisely what you want to complete CAPM)
- But if you perfectly hedge your business means you remove BOTH the down side and the upside.
- If you do not bear risk you only earn the riskless rate of return
- That may be ok because you expect to earn you rents in some other part of the business (you have great ideas).

Should firms hedge?

- Last time we looked at how firms could increase their expected return by increasing leverage and how that made them more risky.
- Futures allow firms to be less risky
- Are either strategies a good idea? And if so for whom?
- Shareholders
- Principals
- Workers

Shareholders

- In principle shareholders should not care whether the firm hedges.
- If the firm's risk is diversifiable
  - (there other firms that benefit), then the shareholders prefer to forego the cost of hedging.
  - Except if firm is highly leveraged and the cost of default is high.
- If the firm's risk is undiversifiable
  - The probably no good hedge
  - And any insurance contract is just going to transfer the return to the firm that bears risk
  - So if CAPM process nothing to gain,

Principals

- If they have a large position in the firm then they are not CAPM diversified
- And they may want to hedge because they are exposed to the firm's idiosyncratic and systemic risk
- Example: farmers and other sole proprietors.
  - At issue is should they hedge the firm's position or should they hedge their position in the firm
  - It may be easier to hedge the firm than the individual's wealth

Workers

- Worker may be like principals especially if they have firm specific skills.

Futures beyond hedging

- Futures and speculation
- Suppose you think a firm is significantly undervalued (or overvalued)
- Then you might well want to take long or short positions
- But that is speculation.
- In fact today most of the (short) activity in futures markets are not composed of individuals or firms with current long positions.

Forwards again

- In the last two decades
- Rise of the derivative market
- Partly involves futures markets for specific or exotic securities.
- Operates not like an exchange but over the counter
- Here again serious counter party risk
- But more on that after options,

11-11 Class 13 Options and Hedging

- **Why Hedge; Why options; Pricing options, the one period problem;, the multi-period problem; The Black-Sholes equation and formula**
- **Reading:** JW11; Arnold Chapter 17.
- **Original Paper: Black, F. and Scholes, M.** The Pricing of Options and Corporate Liabilities *Journal of Political Economy*, Vol. 81, No. 3 (May - Jun., 1973), pp. 637-654