P1.T1. Foundations of Risk Management

Bionic Turtle FRM 2013 Study Notes

Aleksander Hansen 2 3, 2013 1:53 PM
Comment [1]: Reformat obvious tables

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Comment [2]: Review AIMS and writings

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Comment [3]: Write new sections

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Comment [4]: Summary section

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Comment [5]: Q&A section

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Comment [6]: Add IMPORTANT CONCEPTS

Hull, Chapter 1, Introduction

Learning Outcomes:

Differentiate between an open outcry system and electronic trading.

Describe the over-the-counter market and how it differs from trading on an exchange, including advantages and disadvantages.

Differentiate between options, forwards, and Futures contracts.

Calculate and identify option and forward contract payoffs.

Describe, contrast, & calculate the payoffs from hedging strategies involving forward contracts and options.

Describe, contrast, and calculate the payoffs from speculative strategies involving Futures and options.

Calculate an arbitrage payoff and describe how arbitrage opportunities are ephemeral.

Describe some of the risks that can arise from the use of derivatives.

Differentiate between an open outcry system and electronic trading

Open outcry

Traders physically meet on exchange floor, shouting, using hand signals

Electronic trading

Electronic matching of trades has led to a growth in algorithmic trading (a.k.a., black-box trading, automated trading, high frequency trading or robo-trading).

"Traditionally derivatives exchanges have used what is known as the open outcry system. This involves traders physically meeting on the floor of the exchange, shouting, and using a complicated set of hand signals to indicate the trades they would like to carry out. Exchanges are increasingly replacing the open outcry system by electronic trading. This involves traders entering their desired trades at a keyboard and a computer being used to match buyers and sellers. The open outcry system has its advocates, but, as time passes, it is becoming less and less common." –Hull

Describe the over the counter market and how it differs from trading on an exchange, including advantages and disadvantages

Over-the-counter (OTC)
Network of dealers linked by recorded phone conversations and computers (If there is a dispute about what was agreed, the tapes are replayed to resolve the issue)
Trades between two counterparties. Trades in the over-the-counter market are typically much larger than trades in the exchange-traded market. And, in terms of total volume, the OTC market is "much larger."

Advantage of OTC

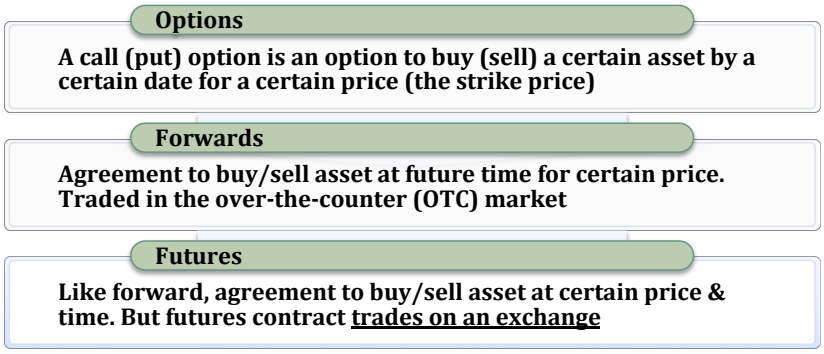
- Customization (a.k.a., "tailored" exposure): The terms of a contract do not have to be those specified by an exchange.
- Market participants are free to negotiate any mutually attractive deal.

Disadvantage of OTC

- Counterparty risk

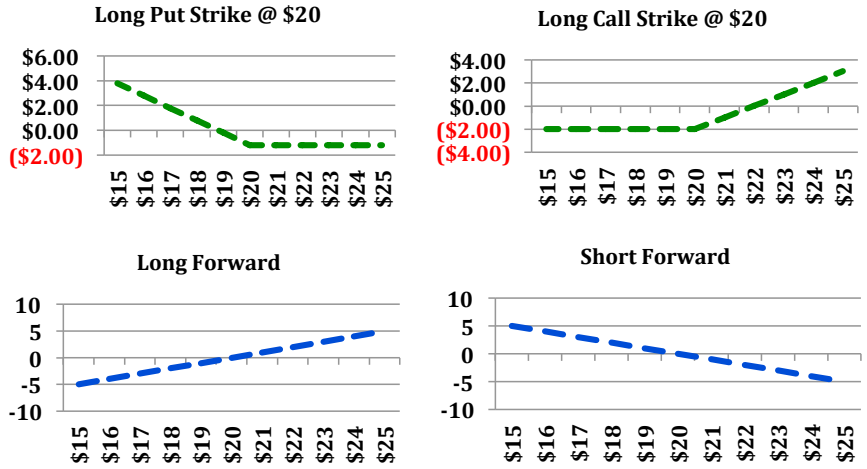
Differentiate between options, forwards, and Futures contracts

A forward contract is an obligation (agreement) to buy or sell an asset at a certain future time for a certain price. For example, an oil producer promised to sell 10 million barrels of oil next December for the pre-agreed price of $110.00 per barrel
An option gives holder the right (but not the obligation) to buy/sell at a certain price.
For example, an executive has the right (but not the obligation) to buy 10,000 shares of her company's stock next December, at the pre-agreed (strike or exercise) price of $35 per share. Unlike a long forward position, she will not be obligated to purchase.



Calculate and identify option and forward contract payoffs

The call and put option charts plot the option payoff: payoff = payout (-) minus premium cost of option. The forward has no initial cost, so its payoff plot equals its profit plot.



In regard to stock options:

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Comment [7]: Change to nicer pictures

Premium = initial cost (or initial investment or up-front cost)
Payoff = gain on exercise (i.e., intrinsic value at exercise)
To the long position, who buys the option, (Net) Profit = Payoff – Premium
To the short position, who writes the option, (Net) Profit = Premium - Payoff
For Example:
Question: If the price (premium) is $4.00 for a call option with a strike (exercise) of $30.00, what are the payoff and profit on a long position (option buyer), if the option expires when the stock is $38.50?

Answer: Payoff on a long call = MAX[0, S(t) – K] = MAX[0, 38.50 – 30.00] = $8.50
Profit on the long call = payoff – premium = $8.50 – 4.00 = $4.50.
(does not account for the time value of money)
Question: If the price (premium) is $3.80 for a put option with a strike (exercise) of $20.00, what are the payoff and profit on a short position (option writer), if the option expires when the stock is $13.00?

Answer: Payoff on a short put = -MAX[0, K – S(t)] = -MAX[0, 20 - 13] = -$7.00
Profit on the short put = premium – payoff = 3.80 - $7.00 = -$3.20.

Describe, contrast, and calculate the payoffs from hedging strategies involving forward contracts and options. Describe, contrast, and calculate the payoffs from speculative strategies involving Futures and options.

Both forwards and options can be used to hedge but there is a key difference.

Forward contract:
A forward contract does not require up-front investment. This is the advantage of "synthetic" exposure: instead of funding a purchase, our exposure is leveraged with a forward position. This is the essential difference between cash and synthetic markets: the spot market requires fully funding the purchase, but a forward does not. However, the contract can produce a loss as well as a profit. There is no guarantee that the outcome in a scenario with hedging will produce a more favorable outcome than one without hedging.

Option:

- Requires an up-front premium when buying the option.
- The payoff structure is asymmetric.
- Options can provide insurance.

Unlike the forward contract, when going long an option, there is a limited downside. This is the essential difference between a forward hedge and an option hedge (e.g., buying a put option): the forward does not have a premium, while the option requires a premium. But the option is asymmetric: it does not need to be exercised, so the gain can be preserved.

Example: Illustrating option leverage by comparing outright shares to options
The following comparison illustrates how options bestow leverage. The investor has $2,000 to invest. He/she can employ two strategies:

1. Buy 100 shares @ $20, or
2. Purchase 2,000 call options.

Then consider the payoff and profit outcomes under two scenarios: the stock price drops to $15 or the stock price rises to $27. Both strategies invest the same $2,000. But the option profits have greater upside but also greater downside. Invest $2,000 in either of two strategies (purchase 100 shares or purchase 2,000 call options):

Share Price in October:		$20
Call option price, Strike @ $22.50		$1
Investor's Two Strategies:		
Buy 100 Shares, or	$2,000	
Buy 2,000 Call Options	$2,000	
	December Stock Price	
Payoff	$15	$27
Buy 100 Shares	$1,500	$2,700
Buy 2,000 Call Options	$0	$9,000
Profit		
Buy 100 Shares	($500)	$700
Buy 2,000 Call Options	($2,000)	$7,000

Calculate an arbitrage payoff & ephemeral arbitrage opportunities

Consider the following assumptions:

- The spot price of gold, S_0 is $900.00
- The risk-free interest rate, r_f is 10.0%
- Assume no transaction costs[1]
- Assume zero storage cost, zero convenience yield, and no lease rate.

These add a sense of reality to our cost of carry model, however; our carry model is simple so we do not expect accuracy. Our cost of carry model returns a "model forward price" of $990; i.e., our model "predicts a forward price, $F_{0,1}$ of $990. Then we "analyze" two scenarios:

1. The observed one-year forward price, $F_{0,1}$ is $1,000. In this case, the forward is "*trading rich*" as the observed [trading] price of $1,000 is greater than the model price of $990.

[1] The learning spreadsheet allows for transaction costs; if we enter a non-zero transaction cost the model forward price becomes, instead, a model forward interval with a lower and upper bound. Below, as we assume zero transaction costs, the lower and upper bound give the same value

2. The observed one-year forward price, $F_{0,1}$ is $980.00. In this case, the forward is "*trading cheap*" as the observed [trading] price of $1,000 is less than the model price of $990.

Futures trades rich: profit with cash and carry					
Spot price of gold:	$900.00				
Interest rate:	10%				
Transaction:	0%				
Model (carry) price:	$990.00	No lower/upper bound since transaction cost = 0			
Forward price:	$1,000.00	← "Trades rich" as 1,000 > 990			
Cash & carry: Short forward, borrow to buy spot					
			T0	T1	Net
		Spot commodity market	-$900		
		Transaction	$0		
		Cash	$900	-$990	
		Futures contract		$1,000	
		Net Cash Flow	$0	$10	+$10

In the first case, because the forward price "trades rich"—i.e., observed $F_{0,1}$ price exceeds the model's predicted $F_{0,1}$ price—the correct arbitrage is a cash and carry: short the forward, and borrow to buy the spot. In the second case, the forward price "trades cheap" and the arbitrageur should conduct a reverse cash and carry trade: long forward and lend the cash received from shorting the spot.

Futures trades cheap: profit with REVERSE cash and carry					
Spot price of gold:	$900.00				
Interest rate:	10%				
Transaction:	0%				
Model (carry) price:	$990.00	No lower/upper bound since transaction cost = 0			
Forward price:	$980.00	← "Trades cheap" as 980 < 990			
Reverse cash & carry: short spot, lend cash, long forward					
			T0	T1	Net
		Spot commodity market	$900		
		Transaction	$0		
		Cash	-$900	$990	
		Futures contract		-$980	
		Net Cash Flow	$0	$10	+$10

If the Futures price is "*trading rich*," the arbitrage trade is cash and carry: borrow to buy the spot asset (buy the cheap thing) and short the forward (sell the expensive thing). If the Futures price is "trading cheap," the arbitrage trade is reverse cash and carry: sell short the spot asset & lend the cash (sell the expensive thing) and go long the forward (buy the cheap thing).

Describe some of the risks that can arise from the use of derivatives

There are three primary derivative uses:

1. Hedging
2. Speculation
3. Arbitrage

The key risk (danger) is that traders with mandates to hedge (or arbitrage) become speculators.

Lessons for Financial Institutions (Unassigned Hull, Chapter 34):

A bucket list of important points:

- Risk must be quantified and risk limits defined
- Exceeding risk limits not acceptable even when profits result as this is unknown ex-ante.
- Do not assume that a trader with a good track record will always be right
- Be diversified
- Scenario analysis and stress testing is important
- Do not give too much independence to star traders
- Separate the front middle and back office

- Models can be wrong
- Be conservative in recognizing inception profits
- Do not sell clients inappropriate products
- Liquidity risk is very important
- There are dangers when many are following the same strategy
- Do not finance long-term assets with short-term liabilities
- Market transparency is important
- It is important to fully understand the products you trade
- Beware of hedgers becoming speculators
- It can be dangerous to make the Treasurer's department a profit center

Hull, Chapter 2: Mechanics of Futures Markets

Learning Outcomes:

Define and describe the key features of a Futures contract including the asset, the contract price and size, delivery and limits.

Explain the convergence of Futures and spot prices.

Describe the rationale for margin requirements and explain how they work.

Describe the role of a clearinghouse in Futures transactions.

Describe the role of collateralization in the over-the-counter market and compare it to the margining system.

Identify and describe the differences between a normal and inverted Futures market.

Describe the mechanics of the delivery process and contrast it with cash settlement.

Define and demonstrate an understanding of the impact of different order types, including: market, limit, stop-loss, stop-limit, market-if-touched, discretionary, time-of-day, open, and fill-or-kill.

Compare and contrast forward and Futures contracts.

Define and describe the key features of a Futures contract including the asset, the contract price and size, delivery and limits.

A Futures contract is a standardized contract that trades on a Futures exchange to buy or to sell an underlying asset at a delivery date at a pre-set Futures price. The specifications of a Futures contract include, but are not limited to:

- Asset
- Contract Size
- Delivery Arrangement
- Delivery Months
- Price Quotes
- Price limits and position limits

For example, consider the underlying asset in the case of a Treasury bond/note:
A Treasury bond Futures contract is made on the underlying U.S. Treasury with maturity of at least 15 years and not callable within 15 years (15 years ≤ T bond).
A Treasury note Futures contract is made on the underlying U.S. Treasury with maturity of at least 6.5 years but not greater than 10 years (6.5 ≤ T note ≤ 10 years).
When the asset is a commodity (e.g., cotton, orange juice), the exchange specifies a grade (quality).
Contract Size

Contract size varies by the type of Futures contract:

Treasury bond Futures: contract size is a face value of $100,000
S&P 500 Futures contract is index × $250 (multiplier of 250X)
NASDAQ Futures contract is index × $100 (multiplier of 100X)
Recently, "mini contracts" have been introduced: These have multipliers of 50X for the S&P and 20X for the NASDAQ. In other words, each contract is one-fifth the price in order to attract smaller investors.

A common test question involves S&P 500 Index Futures contract. Please note the multiple for the S&P 500 contract is $250; e.g., if the index value is 1400, then one contract is worth $350,00

Delivery Arrangement

The exchange specifies delivery location. The exchange must specify the delivery month; this can be the entire month or a sub-period of the month.
Delivery Months
The exchange must specify the precise period during the month when delivery can be made. For many Futures contracts, the delivery period is the whole month.
Price Quotes
The exchange defines how prices are quoted; e.g., crude oil is quoted in dollars and cents

Price limits and position limits

For most contracts, daily price move limits are specified by the exchange. Normally, if the limit is breached, trading stops for the day. Position limits are the maximum number of contracts that a speculator made hold (the purpose is to prevent speculators from an undue influence on the overall market for the commodity).

Example I: Futures Contract on Light Sweet Crude Oil

Asset	Light, Sweet, Crude Oil
Contract Size	1,000 barrels (42K gallons)
Delivery Arrangement	FOB Seller's Facility
Delivery Months	Ratable over month
Price Quotes	U.S. dollars & cents
Price limits and position limits	Any one-month - 10,000 net Futures; all months - 20,000 net Futures; but not to exceed 3,000 contracts in the last three days of trading in the spot month.

Example II: Corn Futures

Asset	Corn (No. 2 Yellow..)
Contract Size	5000 bushels
Delivery Arrangement	Toledo, St. Louis
Delivery Months	Dec, Mar, May, Jul, Sep
Price Quotes	1/4 cent/bushel ($12.50/contract)
Price limits and position limits	Daily Price Limit: Thirty cent ($0.30) per bushel ($1,500/contract) above or below the previous day's settlement price. No limit in the spot month

Example III: S&P 500 Index Futures

Asset	S&P 500 Index
Contract Size	$250 x S&P 500 Futures Price
Delivery Arrangement	Cash settlement
Delivery Months	Mar, Jun, Sep, Dec
Price Quotes	0.05 index points = $12.50
Price limits and position limits	20,000 net long or short in all contract months combined

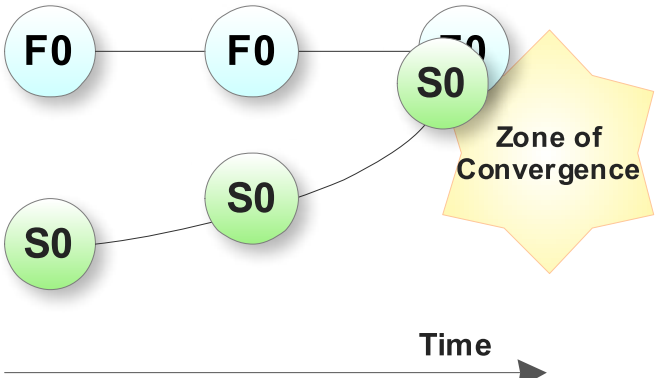
Mini contracts tend to be 1/5th the size
As the S&P 500 Futures contract is index × $250 (multiplier of 250X),
the S&P 500 "mini" = $50 x S&P Index
As the NASDAQ Futures contract is index × $100 (multiplier of 100X),
the NASDAQ "mini" = $20 x NASDQ (each contract is 1/5th price, to attract smaller investors).

Long versus Short Positions:
A long position agrees to buy in the future and a short position agrees to sell in the future. The price mechanism maintains a balance between buyers and sellers. For example, if there are more buyers than sellers, the price increases until new sellers enter the Futures market.

Most Futures contracts do not lead to delivery, because most trades "close out" their positions before delivery. Closing out a position means entering into the opposite type of trade from the original.

Explain the convergence of Futures and spot prices

At the Futures contract approaches maturity, the spot price should converge with the Futures price (at least to a so-called "zone of convergence"). Put another way, the basis (the difference between the spot and Futures price) should converge toward zero as the Futures contract approaches maturity.



In an (unrealistic) world where there is no risk premium, we can view this as the forward price representing an estimate of the expected future spot price, on the assumption that, as the maturity of its contract tends toward (shrinks) to zero, the forward price will converge on the spot price:

$$F_o = E(S_T) \rightarrow F_o = S_o e^{rT}$$

Describe the rationale for margin requirements and explain how they work

Margin is one kind of credit risk mitigation (CRM)

Other CRM include:
- Netting
- Guarantees
- Credit Derivatives

A margin is cash or marketable securities deposited by an investor with his or her broker. The balance in the margin account is adjusted to reflect daily settlement. Margins thus minimize the possibility of a loss through a default on a contract because of the daily netting.

Operations of Margins:

1. Describe the marking to market procedure, the initial margin, and the maintenance margin.
2. Compute the variation margin.

When an investor enters into a Futures contract, the broker requires an initial margin deposit into the margin account. At the end of each trading day, the margin account is marked-to-market. If the account balance falls below the maintenance margin (i.e., typically lower than the initial margin), a margin call requires the investors to “top up” the account back to the initial margin amount.

Margin account: Broker requires deposit.

Initial margin: Must be deposited when contract is initiated.

Mark-to-market: At the end of each trading day, margin account is adjusted to reflect gains or losses.

Maintenance margin: Investor can withdraw funds in the margin account in excess of the initial margin. A maintenance margin guarantees that the balance in the margin account never gets negative (the maintenance margin is lower than the initial margin).

Margin call: When the balance in the margin account falls below the maintenance margin, broker executes a margin call. The next day, the investor needs to “top up” the margin account back to the initial margin level.

Variation margin: Extra funds deposited by the investor after receiving a margin call. There is only a variation margin if and when there is a margin call.
Variation margin = initial margin – margin account balance

In the following example (Hull, 2012), the investor is long two contracts, the initial margin is $4,000 ($2,000 per contract) and the maintenance margin is $3,000 ($1,500 per contract). Note the margin call is triggered when the margin account balance breaches the maintenance margin; however, the investor must "top off" the account back to the initial margin, not just to the maintenance margin.

Contract Specifications:	
Contract Size (ounces)	100
# Contracts	2
Ounces:	200
Initial Futures	$600

Margin	Per	Total
Initial margin	$2,000	$4,000
Maintenance margin	$1,500	$3,000

Date	Futures Price	Daily gain/loss	Cumulative Gain/loss	Margin Balance	Margin Call
	$600			$4,000	
5-Jun	$597	-$600	-$600	$3,400	$0
6-Jun	$596	-$180	-$780	$3,220	$0
7-Jun	$598	$420	-$360	$3,640	$0
8-Jun	$597	-$220	-$580	$3,420	$0
9-Jun	$597	-$80	-$660	$3,340	$0
10-Jun	$595	-$260	-$920	$3,080	$0
11-Jun	$593	-$420	-$1,340	$2,660	$1,340
12-Jun	$594	$60	-$1,280	$4,060	$0
13-Jun	$592	-$360	-$1,640	$3,700	$0
14-Jun	$593	$180	-$1,460	$3,880	$0
15-Jun	$587	-$1,140	-$2,600	$2,740	$1,260
16-Jun	$587	$0	-$2,600	$4,000	$0
17-Jun	$588	$220	-$2,380	$4,220	$0
18-Jun	$589	$120	-$2,260	$4,340	$0
19-Jun	$591	$460	-$1,800	$4,800	$0
20-Jun	$592	$260	-$1,540	$5,060	$0

June 11th: Because account falls below the maintenance, margin call (to "top up" to the initial margin) for $1,340 = $4,000 - $2,660.
June 15th: Because account falls below the maintenance, margin call (to "top up" to the initial margin) for $1,260 = $4,000 - $2,740.