APPENDIX II

REVIEW OF FINACIAL PRODUCTS AND STRUCTURES

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REVIEW OF FINANCIAL PRODUCTS AND STRUCTURES

1. INTRODUCTION

In general, most risk mitigation tools can be broken down into basic financial "building blocks." The following section provides a review of these basic financial instruments, and then describes an example of how a more complex structure can be replicated using these basic instruments.

Forwards: A privately negotiated contract in which two counterparties agree to the purchase and sale of a product (the "underlying") at some time in the future. The terms of the forward transaction are customized and require careful delineation of all relevant terms and conditions (e.g., for electricity: price schedule, the peak demand, amount of energy in MWh, term, delivery point(s) and time(s), scheduling requirements, curtailment provisions, etc.). Forward contracts are not traded on formal exchanges and accordingly may be less liquid and involve more credit risk than futures contracts.

Futures: Futures are a forward based contract to make or take delivery of a standardized amount of a product during a specific future time period at delivery points specified by the rules of the exchange. The terms and conditions of the contract are pre-established by the exchange.

Electricity futures contracts are traded on the NYMEX for firm energy delivery at the California-Oregon Border (COB) and the Palo Verde Switchyard (PV) in the West and at the Cinergy, Entergy, and PJM interconnections in the East/Midwest. The most liquid natural gas futures contracts are traded on the NYMEX with settlement at the Henry Hub in Louisiana.

An important settlement variation of a futures contract is the "Exchange of Futures for Physical" or EFP. These are unique and have wide appeal as they allow physical delivery at locations other than the reference hub of the NYMEX contract (e.g., COB or Henry Hub). EFPs include both the underlying futures as well as a basis component. Under such a contract, two parties enter into a firm commitment for the commodity and agree on the basis price (e.g. $3.00 over COB). Each party can then use NYMEX contracts at any time to fix the final price of the contractual obligation to make or take delivery of the physical.

Options: A financial option is characterized by the right, but not the obligation, to perform a transaction. There are two basic types of financial options: calls and puts. A call option is the right, but not the obligation, to buy an asset at a given price while a put option is the right to sell the asset. To obtain this option, the buyer pays an amount of money, called the "option premium."

Different types of options allow the purchase or sale of the asset at different times. For the European option this right to buy or sell can only be exercised on a specific date in the future while for an American option, the option may be exercised at any time up to a specific date.

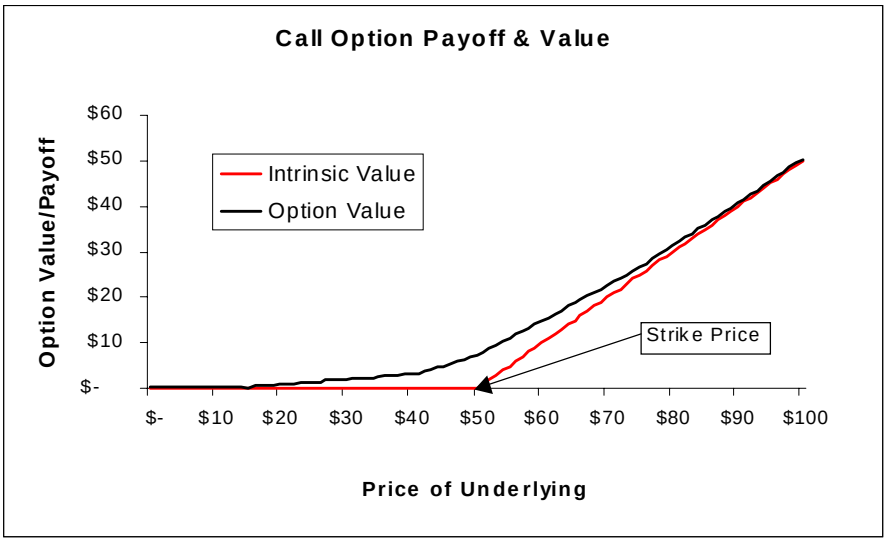
The agreed upon price at which the option sale or purchase occurs is known as the strike price. Options with a strike price close to the actual asset price are known as "at-the-money" options. If exercising the option immediately would generate value,

then the option is referred to as an "in-the-money" option. For example, a call option with the right to purchase oil at $18/bbl when the market price is $22/bbl is considered an "in-the-money" option. Alternatively, if immediate exercise of the option would lead to a financial loss then the option is referred to as an "out-of-the-money" option.

The payout of a call option is seen in Figure 5. We can quickly see that the value of the option upon exercise is never negative. The value of a call option is the maximum of the *asset price minus the strike price* or 0 while the value of a put option would be the maximum of the *strike price minus the asset price* or 0. This non-linearity of potential values made creating a method of pricing options very difficult.

The option premium is made up of two components: intrinsic value and option (or insurance or time) value. The intrinsic value is never below zero. In other words, no rational option owner would exercise an option if doing so would result in a loss. We can see that in the money options always have a positive intrinsic value while out of the money options have no intrinsic value. However, simply because an option does not have intrinsic value does not mean that it has no value. Indeed, out of the money options have value based upon the possibility that they could eventually be exercised at a profit. This value above the intrinsic value is sometimes referred to as the option value or the insurance value. As the option value can only be positive the option premium is always greater than the intrinsic value of the option.

Graph: Option Price And Intrinsic Value



A formula for pricing a European option was developed in 1973 by Fischer Black, Myron Scholes and Robert Merton. This work would eventually lead to the Nobel Prize for Myron Scholes and Robert Merton in 1997[1]. To construct a formula for valuing options they began with a number of simplifying assumptions. The most important assumptions are:

- Asset returns are independent from period to period.
- Asset returns are distributed normally.
- Asset prices are distributed log normally.

[1] Fischer Black unfortunately died the previous year, or he undoubtedly would also have shared the Nobel.

- Volatility is constant over the life of the option.
- Interest rates are constant over the life of the option.
- There are no transaction costs.
- Borrowing and lending occur at the same rate and are unconstrained.

Given this set of assumptions, Black, Scholes and Merton went on to prove that an option could be priced based solely on five parameters. These parameters are:

- The current asset price (S)
- The strike price (X)
- The time to expiration (t)
- The interest rate (r)
- The volatility of the asset ( )

We can trace the roots of nearly every option pricing method to this seminal analysis. For the commodity markets a slight pricing variation is used known as the Black model. In the Black model the underlying is simply a forward price instead of the current asset price.

The effect of each parameter on the value of an option can easily be calculated. The table below indicates how changes in the five parameters affect the price of a put or call option in the Black model.

2. OPTION VALUE DRIVERS

Parameter	Change	Call Option Premium	Put Option Premium
Underlying Price	Up	Increase	Decrease
	Down	Decrease	Increase
Strike Price	Up	Decrease	Increase
	Down	Increase	Decrease
Volatility	Up	Increase	Increase
	Down	Decrease	Decrease
Interest Rates	Up	Decrease	Decrease
	Down	Increase	Increase
Time to Expiration	Up	Increase	Increase
	Down	Decrease	Decrease

Intuitively, we can explain the effect of each parameter as follows:

- A shift in the asset price or strike price affects the option value primarily by changing the intrinsic value of an option that is in the money and the probability that an out of the money option will become one that is in the money.

- An increase in volatility increases the value of options by making higher potential values more likely.
- A higher interest rates means that the present value of the option when exercised is now smaller.
- An option with a longer time to expiration is worth more because there is a greater likelihood of a more valuable outcome.

Of the five parameters necessary to price an option only volatility is not directly observable in the marketplace. One possible method of determining volatility is to estimate volatility using statistical methods. Alternatively, if we can identify quoted option prices, we can infer the volatility implied by the option price. This volatility is called an "implied volatility." This implied volatility can then be used to price other options on the same asset.

As we can see from the table above and accompanying intuitive explanation, option prices are sensitive to variables in the pricing equation. Practitioners and academics use a set of measures to estimate the sensitivity of option price to the various parameters above. They are known, collectively, as the Greeks. Mathematically, they represent the partial derivative of the option value, *O*, with respect to the underlying value drivers.

Delta = $\delta = \frac{\partial O}{\partial P}$ (Sensitivity to changes in asset price)

Gamma = $\gamma = \frac{\partial O}{\partial \delta}$ (Sensitivity to changes in Delta)

Rho = $\rho = \frac{\partial O}{\partial r}$ (Sensitivity to changes in interest rate)

Vega (or lambda) = $v = \frac{\partial O}{\partial \sigma}$ (Sensitivity to changes in volatility of asset)

Theta = T $= \frac{\partial O}{\partial \tau}$ (Sensitivity to changes in time to maturity)

Options can also take on much more complex forms. Such *complex options* may

a) depend in some way on the path of the underlying price over a certain period of time,
b) include more than one option,
c) modify the payout structure or
d) allow for some other modification to a standard option.

1. Complex options are used instead of simple options, because they can better match risk management needs with market views. Examples of complex options include the following:

- *Asian Option*: For a standard option, the payoff on maturity is a function of the difference between the strike price and the underlying price on the expiration date. For an Asian option, instead of using the underlying price solely on the expiration date, the average of the underlying asset prices over a period of time is used. This type of option would be used to hedge a continuous exposure over a period of time. For example, an electricity producer sells electricity every hour of the month priced at the

spot price. To guarantee that they receive a reasonable average price for their electricity they could buy an Asian put option. If on the exercise date the average price for the month had been lower than the strike price of the put they could exercise the put and receive a cash equivalent equal to the difference.

- *Knock in/Knock out or Barrier Option*: In the barrier option there are two price levels established at the outset. One is the normal strike price, but the other is a specified barrier or trigger level. What happens if and when the underlying asset price touches or moves through the barrier level depends on the type of barrier option. A knock-out option is an ordinary option but it disappears if the barrier level is breached. A knock-in option, on the other hand, is activated if and when the barrier is touched.[2] The advantage of a barrier option is that it is cheaper than a standard option. It may be used by a transactor who has a view of how they believe prices will behave over the life of the option.

- *Compound Option*: A compound option describes an option on an option. For example, an at-the-money[3] call option for natural gas in six months may be sold for $0.34. A producer may need to purchase extra gas only if a certain deal is landed. She may not wish to purchase a direct option on the gas, instead she could purchase an option on the call option. The underlying asset in this case becomes the original call option and the premium paid for that option. The premium for such a compound option would then be less than the premium of the underlying option, $0.34. How much less depends on the volatility of the premium of the underlying call

- *Min/max Option*: Min/max options allow the holder to buy (call) or sell (put) the cheaper or most expensive asset in a basket. For example, a call on the min allows the holder to buy the cheapest asset or index in a basket at a predefined strike price. Such an option could be used by an electricity generator with fuel switching capability.

- *Chooser Option*: This variation allows the holder to choose on some future date whether the option is a put or a call. This is similar to straddle (buying a put and buying a call) but cheaper, because after the choice is made the holder only has one type of option, whereas the holder of a straddle continues to have both a call and a put right up to maturity. This type of position may be taken if the user has a view on volatility but no view on the direction of prices.

- *Binary Option/Digital Option*: With a binary option, the payout is a predetermined fixed amount if the option is in-the-money at expiration or zero otherwise. This option can come in two types: all-or-nothing or one-touch. An all-or-nothing binary option only pays out if it is in-the-money at expiration, while a one touch digital option will pay out so long as the option was in-the-money at some stage during its life. The obvious use of such an option is to match fixed payments. For example, consider a generator with fuel switching capability, but where switching has a fixed cost. The owner could hedge this cost by buying a binary option on the spread between the two

[2] The knock-in and knock-out options are simply a way to divide a regular option. In fact, the price of a knock-in plus the price of a knock-out should be equal to the price of a standard option as long as all the variables are held constant.

[3] At-the-money implies that the strike price and the underlying price are approximately the same. In-the-money means that immediate exercise of the option has value while out-of -the-money means that exercising the option would lead to a loss.

fuel prices. If the spread reached a point that it was worthwhile to switch then the option could be exercised to pay for the switching costs.

Combinations: Although forwards, futures, and options provide many ways to meet financial management needs, by combining and linking them we create products that may better fill those needs.

*Financial swaps***:** Swaps are forward based, privately negotiated, financial contracts in which two parties agree to exchange or "swap" specific cash flows over a pre-determined period of time. Swaps are "over-the-counter" instruments that can be customized to meet a particular set of needs. Most transactions involve an exchange of periodic payments between two parties with one side paying a fixed price and the other side paying a variable price. In other cases, swaps may involve an exchange of two floating indices. The specific terms of swap agreements - including the fixed price and the floating price reference (or the two floating price references), the term of the contract, and the quantity to be swapped - are established by the two parties involved. A swap is simply a strip of forward agreements with a financial settlement.

Caps and floors: A set of options with the same strike price over a strip of settlement dates creates an instrument known as a cap or a floor. A set of calls is referred to as a "cap," while a set of put options is referred to as a "floor". A position that combines both a "cap" and a "floor" is known as a "collar." These types of positions *continually* limit exposure over a period of time.

Swaption: A swaption is an option to enter into a swap on some future date. A payer's swaption is the right to pay the fixed rate on the swap, while a receiver's swaption is the right to receive the fixed rate. The expiration date is the date upon which the swaption may be exercised into the underlying swap, while the strike price of the swaption is the fixed rate of the underlying swap.

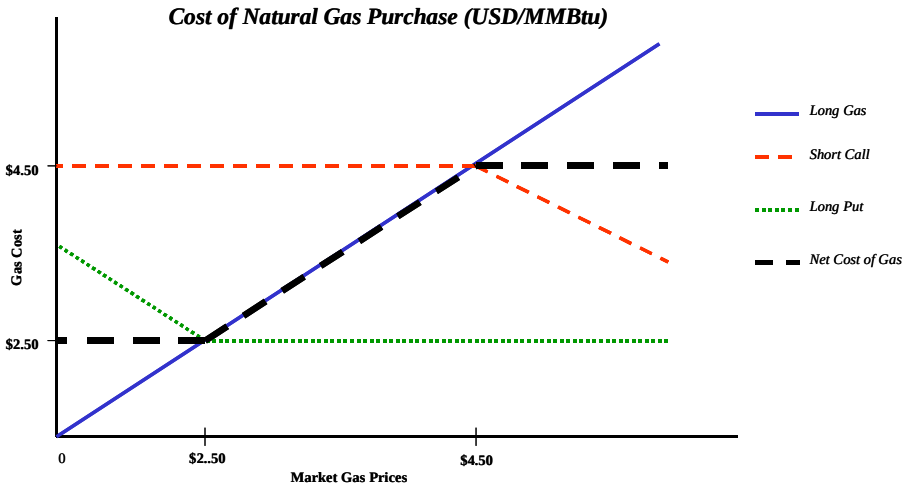
Many of these complex contracts can be broken down into combinations of forwards and options. The table below provides an example of replicating a cap and floor using forwards and options.

3. COMPLEX CONTRACT CONSTRUCTION & BREAKDOWN

The following is an example of how to replicate the payoff of a complex financial instrument by combining forwards and options. The following cap/floor structure is defined for the example in contract details.

Contract Details

Gas Market Price	Net Purchase Price
Gas > $4.50	$4.50
$2.50 < Gas < $4.50	Market Price
$2.50 > Gas	$2.50


Cost of Natural Gas Purchase (USD/MMBtu)
$4.50
$2.50
Gas Cost
0
$2..50
$4.50
Market Gas Prices
Long Gas
Short Call
Long Put
Net Cost of Gas