Commodity Derivatives and Risk Management
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Lecture 23
Commodity options

Welcome to the 23rd lecture on Commodity Derivatives and Risk Management. And today we are going to discuss various aspects of commodity options. And options are another mechanism to mitigate the commodity price risk. In the past sessions, we have extensively discussed related to forward futures and swaps. And like forward futures and swaps, options are also derivative contracts. And because options are derivative contracts, they derive their value from underlying asset and that underlying could be commodity spot or commodity futures. And please note that the exchange traded commodity options normally have commodity futures as underlying, while bilateral or over the counter contracts normally have commodity spot as underlying. And options can be call option or a put option. As you can see from this slide side panel, a call for a call option there will be a buyer of a call who will be taking a long position, there will also be simultaneously a seller of a call who will take the short position. So, buyer of a call and seller of a call are going to be the counter party in case of a call option. Similarly, in case of a put option, there will be a buyer of a put option who will take the long position in the put option. And the counter party is going to be the seller of the put option and that counter party is going to take a short position in the put option. Now, let us take some real-life examples of how this call option as well as put option is used to mitigate various types of commodity price risk. Let us take a simple example in a bilateral set up and the same logic or the same concept can be applicable to exchange traded commodity option with commodity futures as underlying. Let us say a bulk buyer of wheat which is a branded atta manufacturer, let us name this particular company as BAM Limited. And this particular company's fear is that wheat price is going to increase. And to mitigate that price risk, what the particular company does is that it contacts a cooperative unit of wheat farmers. Let us name this particular organization as Wheat Co-op and on day 0 both parties, that is BAM Limited and Wheat cooperative company, both of these entities are entering into an agreement and what is the nature of agreement. On day 0 BAM Limited pays 2 rupees a kg upfront to the Wheat Co-op for 130 tons of wheat. So, this is one part of the agreement where BAM Limited is paying 2 rupees a kg upfront to the Wheat Co-op.

Now, what is the other part of the agreement? The other part of the agreement is that if BAM Limited decides it will buy wheat from the cooperative at 23 rupees a kg after 36 days. And if BAM Limited decides to buy the wheat from the wheat cooperative, the

wheat cooperative is obligated to deliver 130 tons of wheat at a price of 23 rupees a kg. So, this is the day 0 agreement in which BAM Limited is paying some upfront money to the counterparty which is wheat cooperative and also agreeing to do certain things on the 36^{th} day. Now, let us proceed to day 36. On this date BAM Limited has the option or choice to buy or not buy wheat from the cooperative company. Now, BAM Limited's decision will be based on the spot price of wheat prevailing on the 36^{th} date. So, on the 36^{th} date BAM Limited will compare the negotiated price of 23 rupees with the prevailing spot market price. If the actual market price is much higher than 23 rupees, obviously, BAM Limited will exercise its option and call the wheat cooperative contact person and say that yes, we are coming and we are going to buy wheat from you at a price of 23 rupees a kg for 130 tons. So, this is an example of a call option. Please note that BAM Limited has the right to buy the underlying at 130 tons of wheat and BAM Limited is the buyer of the call. And why are we saying that BAM Limited is the buyer of the call? Because it is paying an upfront call premium of rupees 2 per kg and by paying this you know option premium it is taking a long call position. Similarly, the counterparty which is the wheat cooperative is the seller of the call option and it is receiving an upfront premium and taking a short call position. And in this option contract what are the other aspects of this option? These 23 rupees are known as your exercise price or a strike price, 36 days is your time to expiry and 2 rupees a kg which BAM Limited has paid upfront to the wheat cooperative will be known as a call premium. Please note that exercise price or strike price is popularly represented as the symbol x, time to maturity t and the call premium is represented as small c. And this option is an example of a European option. And what do we mean by European option, and can there be a option which is other than European? Yes, the answer to this question is option can be two types it can be European option, or it can be American option. So, what is the difference between European option and American option? Please note that in case of a European option the long position holder can exercise the option only on the expiry date. In this case BAM Limited can exercise the option only on the 36th day. Had it been an American option the long position holder can exercise the option on any day up to the expiry date.

So, if this option would have been an American option, then BAM Limited can exercise any day from the contract start date that is day 0 to 36 days. Now, what is the meaning of exercise? The exercise means that BAM Limited will collect wheat from the wheat cooperative by paying 23 rupees a kg for 130 tons of wheat. So, BAM Limited has the right to exercise depending upon whether the option is a call of whether the option is a European option or American option BAM Limited may decide to exercise. If it is a European option, it can exercise the option to buy wheat from the cooperative only on the 36th day. Had it been an American option the BAM Limited can choose any day between day 0 to 36 days and decide to exercise the option.

Now, let us take the profit or loss for both parties which we call as an option payoff. Let us say on day 36 it is a European option and BAM Limited can exercise its right only on the 36th day. So, let us move on to the days let us go to days 36 to find out what is going to be the profit and loss for both parties that is BAM Limited as well as wheat cooperative. Let us take the first case where the option where the spot price is greater than 23. So, on the day 36 BAM Limited is going to compare these 23 rupees with the prevailing spot price.

Let us say spot price is anywhere higher than 23 rupees. So, BAM Limited will definitely exercise its option. Why? If it goes to the market, it will buy wheat at a price higher than 23 rupees and buy the option because it has the option it will exercise and it will go and buy the wheat from the counterparty at 23 rupees. Any price less than 23 rupees BAM Limited will not exercise because it can go to the open market, it will be able to buy wheat at a price which is less than 23 rupees. So, why should BAM Limited go to the counterparty to buy wheat at 23 rupees. So, it will not exercise its right and it will forego its right to buy wheat from the wheat cooperative. Now, let us come to a price which is exactly 25 rupees and at a price of 25 rupees BAM Limited's profit is 0. In fact, this situation is known as zero profit or zero loss situation or a break-even point. Now, why are we calling a break-even point? Please note that if the spot price is 25 rupees, BAM Limited will exercise the option, definitely it will go to the wheat cooperative and buy wheat at 23 rupees. It will benefit 2 rupees from this exercise, it is buying wheat at 23 rupees when the prevailing market price is 25 rupees. However, it had paid an upfront premium of 2 rupees. So, profit of 2 rupees by exercising the option minus the 2 rupees upfront premium it had paid is giving rise to a zero profit or zero loss situation. So, exactly at a price of 25 rupees BAM Limited's payoff is going to be 0. Hence, these 25 rupees is known as a break-even point and please note that any price higher than 25 rupees is going to be beneficial for BAM Limited. Let us take a price of let us say 30 rupees, the prevailing market price is 30 rupees, BAM Limited has the option to buy wheat from wheat cooperative at 23 rupees.

So, obviously, BAM Limited will exercise the option by the wheat from the counterparty at 23 rupees in the process ends up making a 7-rupee profit and it had paid 2 rupees as an upfront premium. So, net benefit is going to be 5 rupees, 7 rupees profit minus the option premium of 2 rupees. So, the benefit is going to be 5 rupees and please note that when BAM Limited is making a profit of 5 rupees the counterparty is going to incur a loss of 5 rupees. So, like your futures and forward options are also zero-sum gains and one party gain one party's gain is going to be exactly equal to the other party's loss and please see that any price less than 23 rupees BAM Limited will not exercise, it will go to the open market and buy wheat from the open market. So, on account of the option it will be incurring a loss of 2 rupees and when BAM Limited is incurring a loss of 2 rupees the counterparty wheat cooperative will be incurring a or benefiting by 2 rupees.

So, as you can see this red line is the payoff for the BAM Limited and the grey line is the payoff related to the wheat cooperative and these two lines are mirror image of each other and sum total of the benefit and loss of both parties is going to be zero, hence options are zero sum gain. And as you can see the option buyer in this case BAM Limited has unlimited profit potential and limited downside risk. So, what do we mean by unlimited profit potential? Let us take a hypothetical situation where wheat price let us say goes up to 50 rupees a kg. Let us say there is an issue related to the production, weather did not support. So, a lot of farmers could not produce the extent of wheat they were planning, they were anticipating to produce. So, wheat price increased to 50 rupees. So, without this option contract BAM Limited would have bought wheat at 50 rupees a kg, but with this option contract this particular company will be buying wheat at 23 rupees. So, benefiting by 27 rupees, but it had paid an option premium of 2 rupees as upfront. So, net benefit is going to be 25 rupees a kg. So, as you can see, depending upon the prevailing spot price of wheat, BAM Limited can get a significant amount of profit.

Hence as a buyer BAM Limited has unlimited profit potential and limited downside risk. This limited downside risk is a maximum of negative 2 rupees as you can see any price less than 23 or less will be incurring a loss of 2 rupees maximum. Hence it has a limited downside risk. So, obviously, the counterparty in this case wheat cooperative will have a limited profit potential and unlimited downside risk. With this, let us understand the long call party's payoff on the expiry. This payoff for the long call option holder is going to be governed by this formula which is Maximum [Spot price on day 36- X,0]-c and that we represent by this formula which is Max [S_T -X,0]-c. Let us take some price point. So, S_T is equal to 50 wheat price goes up to 50. So, obviously, the benefit by exercising the option is going to be 27 rupees, that is 50 rupees minus 23 rupees which is going to be the benefit from exercising the option, but it had paid 2-rupee upfront premium. So, net benefit is going to be 25 rupees. Similarly, let us go to the price of 25 rupees, the firm the BAM limited will exercise the option benefit 2 rupees from the option it had paid 2 rupees as option premium. So, the net benefit is going to be 0 which is your break-even spot price point. Now, coming to the other price let us say the price is 24. Obviously, BAM limited will exercise because if it goes to the market, it will be buying wheat at 24 rupees, but if it goes to the counterparty which is the wheat cooperative it will be able to buy it at 23 rupees. So, obviously, BAM limited will exercise its right to buy from the counterparty in the in this case it will be benefiting 1 rupee, but please note that it had paid a upfront premium of 2 rupees. Hence, a total benefit is going to be negative 1 beyond 24 point or any price less than 24 rupees the particular party is going to be incurring a loss of 2 rupees. Let us say spot price is 23 rupees. So, it does not matter for BAM limited whether to exercise or not exercise because if it goes to the counterparty, it will be buying wheat at 23 rupees, if it goes to the market, it will also be buying wheat at 23 rupees. So, obviously, total loss is going to be the option premium which it has paid which is your negative of 2 rupees.

So, any price less than 23 rupees let us say 22, 10, 6 whatever it is, total loss by the BAM limited is going to be minus 2 or negative of 2 rupees. Why this is happening, if you can see, let us say S_T is equal to 10, in that case the payoff is going to be max [10-23,0]-2 which is maximum [-13,0]-2= 0-2 =-2 and this is going to be the payoff for the long call party before the long call party on the expiry date. And please note that whatever benefit the long call party is going to get the counterparty is going to be incurring the same amount of loss. Now, coming back to a long call pay off for American option this formula changes to Max [S_t -X,0]-C. And what is this S_t small t? S_t represents the spot price prevailing on any day of the exercise. Please note that as an American option holder the buyer of the option can exercise any day it wishes to do so. So, on that day whatever is the spot price prevailing that will be represented as S_t and normally as per the nomenclature most of the textbooks use capital C as the option premium for American option and c is used for the option premium related to the call option for European option. So, as you can see, this c is the call option premium for European option and capital C is the call option premium for American option. With this, we have kind introduced what exactly is a call option let us take an example to understand what a put option is. Let us say a potato wholesaler who has already bought and stored potatoes but has not yet identified a customer to whom it will sell the potato. So, the potato wholesaler is fearful of price decrease and let us name this particular company as PWS Co and to mitigate this price risk it contacts a major grocery or vegetable chain which is let us name this particular unit as GVC limited. So, like the call option both parties will be entering into an agreement on day 0. So, what is the agreement on day 0 between both parties? In day 0 PWC Co will pay let us say 3 rupees a kg as an upfront premium to the GVC limited for 500 quintal and what is the other side of the agreement? The other side is if PWS company decides it will sell potato to GVC limited at 19 rupees a kg after 27 days. So, let me repeat what is the agreement between both parties on the day 0, PWS Co pays 3 rupees as upfront premium to GVC limited for 500 quintal and also both party agree that if PWS Co decides it will sell potato to GVC limited at 19 rupees a kg after 27 days and on 27th day if PWS company decides then it will deliver 500 quintal of potato to GVC limited and GVC limited is obligated to buy potato from the PWS company.

Now, let us go to days 27. Now, PWS company has the option or choice to sell or not sell the potato to GVC limited. Now, PWS company's decision will also be based on the spot price of potato prevailing on the 19th day. Let us say spot price is greater than 19. So, in a local market if the spot price is higher than 19. So, obviously, PWS company will not exercise because it can go to an open market and sell potatoes at a price which is higher than 19. The Spot price is exactly 19, it does not matter whether you know PWS company sells potato to GVC limited or sells it to somebody else in the open market. Anyway, it is going to get 19 rupees from either party. Now, let us come to the most interesting part let us say spot price is less than 19 rupees. If spot price is less than 19 rupees it will definitely exercise the right to sell the potato to the counterparty in this case

GVC limited. And this particular diagram shows the payoff for both PWS company and GVC limited.

Let us take a hypothetical situation, let us say potato price comes down to 10 rupees. Obviously, PWS company is going to exercise because if it sells in the open market, it will be selling at 10 rupees, but if it is going and selling to the counterparty it will be receiving 19 rupees. So, obviously, PWS company will be exercising the option to exercising the option and what is the option it has the right to sell the underlying. So, it will sell potato at 19 rupees a kg and by so, it will be benefiting 9 rupees a kg, but upfront premium it has paid 3 rupees a kg. So, 9 rupees benefit minus 3 rupees which is going to be the 6 rupees benefit to the PWS company.

So, this part is going to be 6 rupees for PWS company and obviously, the counterparty which is your GVC limited is going to be incurring loss to the tune of 6 rupees. So, please note that this red color is the payoff diagram for the PWS company, and the counterparty will be exactly the reverse or mirror image payoff for the GVC limited and in this case PWS company has taken a long-put position. Please note that PWS company has paid the upfront premium of 3 rupees and by paying this upfront premium it is buying something long means buying something and what is that something it has the right to sell put is your right to sell. So, it pays an upfront premium of 3 rupees, and it has taken a right and that right gives the power to the PWS company to sell potato to the counterparty. And what is going to be the long-put payoff on the expiry date is exactly in the same manner, but I want all of you to please pay attention to this little change in the formula. So, in this case the formula changes to MAX $[X-S_T,0]-p$. So, with this, we will come to our discussion on the introduction to commodity options. So, as I discussed that options can be call option or put option and call option gives the buyer of the call buyer of the call option the right to buy the underlying at a negotiated price and that negotiated price is normally known as an exercise price or a strike price. And, for every long call option there will be a short call who will take a counterparty position. Similarly, the buyer of a put option has the right to sell the underlying at an exercise price and for every buyer of a put option there is going to be the seller of put option. And the payoff of long call position will be exactly opposite to the short call position such that the total payoff is going to be the 0. Hence, we call that derivatives zero-sum games and options are one type of derivative and options are also zero-sum game. And the right to exercise will always be with the long call or long put position holder and depending upon the underlying spot price the long call and long put position holder will decide whether to exercise or not exercise. With this we will come to an end on today's discussion we will continue with the remaining part of the discussion in the next session related to the options. So, I look forward to interacting with all of you in the next session. Thank you all of you.