Commodity Derivatives and Risk Management
Prof. Prabina Rajib
Vinod Gupta School of Management
Indian Institute of Technology, Kharagpur
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Lecture 44
Crude Oil Price Risk Management: 3-way Collar, Spread Options & Swaps

Welcome to the 44th lecture on Commodity Derivatives and Risk Management. And we will continue with our discussion related to various aspects of Crude Oil and Refined Products Risk Management. In the previous session, please recall that we had discussed crack spread futures contract as well as long put option. And today we will be focusing more on different aspects of crude oil price risk management using 3-way collar spread option and swaps. Now, please recall in the previous session, we discussed about crack spread futures contract. In this crack spread futures contract refiners take short position in different types of crack spread to protect margin. And basically, this crack spread futures contracts are inter commodity spread combining crude oil and various refined product futures. In addition to the crack spread futures contract, we also discussed extensively how the Mexico government is using the long-put option to set the floor price for the crude oil Mexico government is producing and this particular hedge is popularly known as Hacienda hedge. Now, in addition to using crack spread futures contract and long put option contract, companies which are either producing crude oil or refining crude oil or airline companies which are using aviation turbine fuel, they enter into various other kind of derivative positions to mitigate the risk. For example, the Southwest airline company annual report 2022 mentions that the company enters into call option enters into collar structure which is basically combination of call option and put option and also enters into call spreads basically it is a combination of buying one call option and selling another call option. Similarly, it also enters into put spreads as well as different kinds of swap agreements. Now, today we will be focusing more on understanding the collar structure, the spread structure and commodity swaps, how companies utilize these three derivative structures to mitigate price risk. Now, in fact, collars as a zero-cost hedging strategy we have been discussed in detail with respect to gold, if exactly the lecture 39 we have discussed about this collar structure in detail. And with respect to the same collar structure which is applicable also in this case a crude oil producer who is fearing that the price of crude oil is going to go down will be able to create a collar structure by entering into long put and a short call position in crude oil. Similarly, a refiner who is fearing that the crude oil price is going to go up and it will be buying crude oil at a higher price will be able to mitigate the risk by entering into long call and short put position in crude oil futures contract. Similarly, you have airlines who are fearing that the price of aviation

turbine fuel or jet fuel is going to go up they can enter into the collar structure by entering into the same long call and short put position, but of course, the underlying is jet fuel. Now, these collar structures are also known as two-way collars in the sense the company is either taking a long call and short long put and short call or the company is taking long call and short put position. Let me repeat these collars are known as two-way collar because a company will be entering into hedge position in two option contracts. And in today's session we will be focusing more on this aspect which is known as also a three-way collar. Now, in addition to the collar structure companies also enter into spread contracts and these spread contracts are positioned which are taken either in call option or put option. Please note that in the case of a collar a company will be entering into both a put option and a call option, but in case of a spread a company will be only taking call option for different strike price. Now, coming to swaps, swaps are also another way of mitigating the risk where the parties exchange the net price difference between a fixed leg and a floating leg. So, today we will be discussing in detail related to three-way collar structure, the spread contracts using either call option or put option and commodity swaps related to crude oil and refined products. Now, let us come to the discussion related to the collar and a three-way collar. As I have mentioned, in case of a collar where a company enters into two option position let us say let us say a crude oil producer who is fearing that the price is going to decline. So, that is the fear of the crude oil producer. So, it enters into a long-put position let us say at a strike price of 70 dollars and pays a premium of 6 dollars. Simultaneously it also enters into a short call position at an exercise price of 85 dollars and also receives a premium of 6 dollars and long put and short call having the same premium makes it a zero-cost collar structure. Now, in the case of a three-way collar structure in addition to position number 1 and 2 this particular company also enters into a position which is short put on a strike price which is lesser than the long-put strike price. Please note that in case of a long put the strike price is 70, in case of a short put the strike price is 60 and because it is a short put option, and this particular company is selling the put option it is receiving a premium of 2 rupees. But in the first two cases it is receiving 6 rupees paying 6 rupees or receiving 6 dollars and paying 6 dollars and it is netted off. Now, coming to this normal zero cost collar structure the total receipt by selling crude oil the crude oil producer is producing crude oil and by employing a zero-cost collar structure its total receipt will have a floor value of 70 and a ceiling price of 85. Why will this happen? Let us say if the price falls to let us say 50 dollars this company has a long-put option it will exercise the option and sell the underlying, in this case crude oil at 70 dollars. So, whatever happens to the market, whatever happens to the crude oil price, this company will realize the 70 dollars. So, the floor price is going to be 70 dollars. Now, let us take a case of where the price increases let us say price goes up to 95 dollars. Now, if the price increases to 95 dollars this counter party who to the short call position will exercise and this particular company will be delivering crude oil and receive 85. So, the maximum price it will receive will be 85 and the minimum price it will be

receiving because of the long-put option is going to be 70. So, this is the combination which will happen in case of a normal zero cost two-way collar and this diagram which shows in the blue the blue line indicates the payoff to the crude oil producer from the two-way collar structure. Now, let us understand how this particular pay off to the crude oil producer will change when the company is entering into a three-way collar in that sense that it is taking another short put position at 60 dollars premium and receives a premium of 2 dollars. Now, compared to the zero-cost collar, if the market price falls below 60 then the company is losing the benefit associated with the long put. Please note that when the price is less than 60 this particular person this company which has taken the long-put position that particular company will be exercised in the option. So, this company the crude oil producer will also exercise the option at exercise price of 70 the counter party will also counter party to the short put position will also exercise the option and hence the benefit which this particular company would have got if it would have only entered into a two-way collar that benefit is going to be lost out. And as you can see if the price is less than let us say 60 dollars this company will be actually receiving less amount of money compared to a two-way collar. Otherwise, if the price is more than 60 dollars this is a better position for this company as it will be selling crude oil at 2 dollars higher than your two-way collar position. So, any price higher than US 60 dollars the company owns additional 2 dollars as compared to the zero-cost collar, but if the price falls less than 60 dollars then this particular company will be earning less US dollars as compared to a two-way collar situation. In fact, this particular diagram which I have drawn based on the excel file this calculation related to the excel file is available to those who will be attending or doing this NPTEL course. So, the excel calculation is self-explanatory and I would urge each of you to go through the excel calculation to see how exactly three way collar as well as two way collar structure has been this has been derived and how the three way collar structure acts as a superior option beyond a certain price rates while two way collar acts as a superior option when the price is less than 60 dollars. Now please recall that during COVID period when the crude oil price went down significantly when it was probably in this range lot of companies incurred significant amount of loss and in this context, there is a nice article which is available on the internet which is titled as the collar that strangling oil stocks. So, a lot of oil producing companies incurred substantial amount of loss because of they had entered into a three-way collar. Had they entered into a two-way collar then they would have been probably in a better situation they would have been in the blue line range rather than the gray range. And the link to this particular article is mentioned here in your spare time I would urge each of you to go through this interesting article. Now coming to the again three-way collar, but it will be used by the counterparty. Please note that a previous discussion was where a crude oil producer was fearing that the price of crude oil is going to go down. Now let us come to the other side of the discussion that is a refiner who is fearing that the crude oil price is going to go up. So, in this case the refiner will be entering into three-way collar, but of different

combination it will take a long call at exercise price of 80 short put at an exercise price of 65 and it will take a short call with an exercise price which is higher than your long call exercise price. And in the first two cases premium paid and premium received are same making it a zero-cost two-way collar structure. And in the third case this particular company will be receiving a premium of 5 dollars because it is selling a call option. Now in a normal zero cost collar structure this total payment would have been had a floor price of 65 and ceiling price of 80. 65 and 80 will come from these first two options. So, the long call if the price let us say if the price goes up to 90 dollars, then this particular company would exercise the option and buy the crude oil at 80. So, irrespective of whatever happens it is going to pay a price of 80 dollars. Hence in a two-way structure the ceiling price would be 80 dollars per barrel. Similarly, the floor price would be 65 dollars per barrel, but that combination will be happening in case of a two-way collar and this diagram this blue diagram blue line indicates that structure. Now coming to the three-way collar when the refiner enters into another short call position at an exercise price of 95 and receives a premium of 5 dollars then the payoff structure changes as you can see if the price is more than like 95 let us say price goes up to 100 rupees. If the price goes up to 100 rupees, then this particular company would have bought crude oil at 85 dollars this particular company would have bought crude oil at 80 dollars without the three-way collar, but now it will be paying a higher price to buy the crude oil. So, the benefit of entering into the three-way collar will only be available to this particular company it will be paying a lesser price to buy crude oil if the crude oil price is less than 95, but if the crude oil price increases beyond 95 then three-way collar is not a better option as compared to a two-way collar. And here I would also like you all to pay attention to the reason associated with the diagram here it is related to the total payment because of the three-way collar or total payment because of the two-way collar in while compared to the previous diagram in the previous diagram it is related to how much of total receipt. So, the diagram may look almost similar, but in this case, you have of the price received by the crude oil producer in case of this diagram it is the total price paid by the refiner to pay total price paid by the refiner to purchase the crude oil. So, these two are examples of how companies are utilizing three-way collar to mitigate price risk associated with crude oil and refined products. Now, coming to the next discussion which relates to a spread option. Please recall in the beginning of the session we discussed that in case of a spread options a particular party will be either taking call positions or taking put positions, but at different exercise price. Now, let us say a crude oil refiner who wants to buy crude oil and of course, it is fearing that the price is going to go up. So, to mitigate that risk the refiner could enter only into a long call option and pay premium. However, the refiner does not want to enter into long call option and pay premium what it does simultaneously that along with a long call option it also enters into a short call option. So, let us take this example let us say spot price for the crude oil is 80 dollars and let us say this particular refiner is entering into a long call at an exercise price of 75 dollars and paying a premium

of 7 dollars and also taking a short call position at an exercise price of 85 and receiving a premium of 5 dollars. And please note that the moment this refiner is taking a short call there will be a counterparty who will take a long call let us name that counterparty as CLC that is counterparty long call position because it is easier for us to discuss about the counterparty. Now here this particular company is paying the premium of 7 dollars, and it is receiving the premium of 5 dollars hence the net premium paid is 2 dollars. Now let us come to the exercise date on the day of exercise and also please note that both options will have a different strike price, but both options will have the same exercise. Now let us come to the exercise date and on the exercise, date let us assume that the price is less than 75. If the actual price is less than 75 neither the long call will exercise nor the CLC will exercise both parties will not exercise. So, what will happen this refiner will go ahead and buy the crude oil at the market price and of course, it has paid a premium of 2 dollars. So, the total purchase price is going to be the market price of crude oil plus 2 dollars. Now let us take the next situation where the spot price is greater than 75, but less than 85, maybe around 80 or 79. So if the spot price is greater than 75 and less than 85 only the long call will exercise the refiner will exercise and how much it will be paying it will pay 75 dollars plus 2 dollars as a premium. So maximum purchase price is going to be 77 dollars. Now let us say the third situation when the spot price is greater than 85. Now if the spot price is 85, please note that both long call and the counterparty long call will exercise. So, both long call and CLC will exercise and total purchase cost by the refiner is going to be the market price minus the net benefit from the long call position and a short call position plus 2 dollars. Now the same exercise I have done it here and this particular diagram shows the payoff related to the refiner in terms of if the company would have gone ahead and bought the crude oil at spot. So, the orange line orange line indicates the purchase cost without any kind of an option which is the spot purchase, and the yellow line indicates if the company would have gone only for long call and the gray line indicates if the company has gone for long call as well as a short call position. Now let us take the example suppose the spot price is 100 dollars in that case long call and the counterparty to long call both parties will exercise. So, the benefit from the long call is going to be 25 dollars because 70 exercise price is 75, market price is 100. So, the benefit is going to be 25 dollars for the long call position and loss from the counterparty exercise is going to be 15 dollars. So, the net benefit is going to be 8 dollars so that is 25 dollars minus 15 dollars minus 2 dollars which it has paid that premium which it has paid so that is coming to your 8 dollars. And the total purchase price is going to be it will buy the crude oil at 100 dollars it is benefiting 8 dollars from the from the all the option combinations and hence the net purchase price is going to be 92 rupees. So, the pay of structure is indicated, and this particular combination is known as a short asset and bull call spread. So, this spread position has a combination of two call options. Again, the excel calculation for this particular file will also be available for all of you to check how exactly these numbers and these diagrams have been derived. Now coming to the other

kind of spread option which is known as a beer put option. In this case a crude oil producer wants to sell crude oil and it is fearing the price decrease. Please note that in the previous case where the refiner wants to buy crude oil and his fear was a price increase hence it was entering into a bull call option. But in the next situation where a crude oil producer it wants to sell crude oil and fearing that the price is going to go down. So, to mitigate the risk the producer could have taken just a long-put option and paid premium, but it does not want to do so in addition to entering into a long put option it also enters into a short put option. So put spread strategy is a combination of long put option as well as a short put option at a different exercise price and both options have to have the same exercise state. Now coming back to this again same discussion let us say the refiner or the crude oil producer in this case. The crude oil producer enters into a long-put option at an exercise price of 85 pays a premium of 17 dollars simultaneously takes a short put position exercise at 55 dollars and receives a premium of 10 dollars and hence the net premium paid is 7 dollars. And please note when the please note that when the crude oil producer is taking short put there will be a counter party who will enter into a long-put position, and we will name that counter party as CLP. Now let us come to the exercise date let us say on the exercise date spot price is less than 55 and, in that case, both the long put and the counter party to long put will counter party long put will exercise. So, both parties will be exercising, and the crude oil sell price is going to be market price of the crude oil plus the net benefit from long put and a short put minus the 7 dollars of premium. Similarly let us say the spot price is greater than 55, but less than 85. If the spot price is greater than 55 then only the long put will exercise because this particular long put exercise is 85 dollars. So, if the market price is less than 85 which is in this case greater than 55, but less than 85. So, the long-put option will only exercise and crude sell price is going to be the market price plus the benefit of market price plus the benefit of the long put please this will not be this is not the correct one. So, it will be market price plus benefit of the long-put exercise minus the 7 dollars and also when the spot price is greater than 85, please note that neither of the party will be exercising and crude oil sell price is going to be market price minus the 7 dollars. Now this diagram again shows the same combination the orange line indicates the price the company would realize if it had not entered into any kind of option position the orange line indicates if it would have been entered into a long-put position and the third grey line indicates if the company enters into a bear put spread as well as a long asset. So long asset bear put spread combination is mentioned here. Now let us come to the important aspect. So, for example, let us say the producer fear is correct and the producer is expecting the price of the crude oil to go down. Now let us say actually the price goes down to 50 dollars and the long put and the counter party to the long put will be exercising. Let me repeat if the spot price is 50 this long put will also exercise and the counter party long put position will also exercise in that case the long put will be benefiting 35 dollars that is 85 minus the 50 and it will also loss from the counter party long put exercise which is coming to

your 5 dollars. So, the net benefit is going to be 30 dollars and of course, this particular company has paid a premium of 7 dollars hence it is coming to 23 US dollars. So, net benefit is going to be 23 US dollars and total sale price is going to be it will be selling the asset at 50 dollars and it will be receiving 23 dollars from the option combination hence total benefit is going to be 73 dollars. So, this again this aspect also is available in the excel file. So, this particular diagram shows the long asset and bear put spread detail and this worksheet also shows the short asset and bull call spread and these are other related diagrams. So, all these again all these excel files will be available for all of you to check and practice how to how this bull call option, bear put option, three-way collar and other combinations are taken by companies to mitigate the risk. So, with this we will come to today's discussion. In today's session let me summarize what we discussed. We discussed that in addition to two way collar combination which is basically a combination related to call and put option companies also enter into three way collar combination many a times there is this three way collar combination gives a better result as compared to as compared to a two way collar situation a two way collar hedging structure, but many a times even three way collar situation may result in a higher loss to a company. Similarly, in case of a spread position companies enter into long call and short call position or companies enter into long put as well as short put position depending upon whether they are expecting the price to go up or go down and accordingly they are their payoff is compared and please note that these payoffs at times may be better as compared to single long put or single long call option or at times it could be or so situation. For example, in this case if you see this particular company is paying money and without a long with a long put option it is its total payment is going to be in the line which is represented in the yellow line, but in case of a bull call option total payment is going to be as per the grey line and as you can see at some point in time blue line sorry grey line payment is higher than the yellow line payment and some point in time grey line payment is lesser than the yellow line. So, whenever the gray line payment is lesser than the yellow line payment the company is better off and whenever the grey line payment is more than the yellow line the company is worse off. So, by entering into these spread options and three-way collar companies may benefit or company may be losing money depending on how the underlying price of the underlying asset price is moving. So, with this we will be ending today's session, and I would also like to say here that for the for those of you who would be doing this particular discussion or will be discussing about long call short put long all these call option put option long and short can be little confusing. So, I would urge again all of you to use the excel file and take some other numbers to practice the payoff related to this three-way collar and bull call option and bear put option. With this we will be ending our session though we wanted to discuss relate how companies hedge using swap. So, it will not be possible in today's session we will be continuing with the discussion related to swap as a hedging mechanism in the next session. Again, I eagerly look forward to interacting with all of you in the next session. Thanking all of you.