Commodity Derivatives and Risk Management
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Lecture 45
Swaps, Calendar Spreads: Crude Oil & Natural Gas Risk Management

Welcome to the 45th lecture on Commodity Derivatives and Risk Management. And we will continue with the discussion related to crude oil and natural gas price risk management. And today we would be focusing mostly on the swaps and calendar spread mechanism and how these two derivative instruments are used by crude oil producers and refinery product consumers to mitigate price risk. Now, coming to the swaps which we have also discussed in earlier sessions. So, I am not going to go into a great deal of discussion related to plain vanilla swaps. There are other complex structures related to the swaps which we will be discussing but let us just revise what exactly a swap and what are the terms and contracts related to the swap. And please note that crude oil and refined product market participants have been an extensive user of swap as a risk mitigation strategy. And as part of a swap agreement two parties exchange a series of cash flow based on a notional quantity of crude oil or a refined product. And as part of an agreement one party pays a fixed price while the other party pays the floating price. And normally in the case of a in case of this plain vanilla swap agreement the reference price which is the floating price is based on a marker crude price or a refined product spot price or exchange traded future price. So, it could be any of the price related to a marker crude if the underlying is crude oil or it could be the refined product spot price or it could be the exchange traded future price which acts as a reference price for the floating rate leg. And buyers of the swap pay the fixed price while the sellers pay the floating price. And the notional quantity is never actually exchanged between the swap counterparties. This notional quantity is used to calculate the swap payoff. And let us take a simple example with respect to how a refiner will use a plain vanilla swap. In this case, please note that the refiner is interested in buying crude oil and is fearing that the price is going to go up. And hence to mitigate this risk it will enter into a contract where it will be a buyer of a swap and basically it will be paying a fixed rate and receiving the floating price or floating amount. And who are the counterparties? The counter party could be a bank, could be a financial institution or a swap dealer. Similarly, let us say a crude oil producer which is anticipating of or fearing a decline in price of crude oil will enter into a swap contract where it will act as a seller of a swap, and it will be basically paying a fixed rate and it will be receiving fixed rate and paying a floating rate. And similarly, the crude oil producer is a seller of the swap and there has to be a counter party who would act as a buyer of the swap. Similarly, like your refiner the counter party could be a bank or a

financial institution or a swap dealer. And on the right-side block I have listed some of the registered swap dealer with the CFTC that is Commodity Futures Trading Commission of USA. So, as you can see, besides some of the important banks you also have other companies like BP Energy Company and Cargill incorporated. This company also acts as a swap dealer or swap counter party. Please note that this is not an extensive list, this is just a snapshot of 5-6 companies. There are about 100 odd banks financial institutions and other companies which have been registered with the CFTC to act as a swap dealer. With this let us understand some exotic types of swaps. The previous discussion was related to a plain vanilla swap which means plain vanilla swap and plain vanilla swap means the swap which has a very basic terms and condition. Now, one of the different terms and conditions with respect to a swap is related to a floating reference price where it is an arithmetic average. The floating reference price is averaged over a period of time and then the fixed party and the floating party will be paying or receiving the payment based on the average price rather than a specific date price. Let us understand how exactly this swap which is a floating reference price where average price is used. So, the left panel and the leftmost panel show the terms and standardization related to the swap agreement. Here let us say a refiner a standalone refiner which is interested in buying crude oil and is fearing that price is going to go up. It will be entering into a swap agreement and let us say the contract period and the settlement frequency is 1 year with 12 monthly settlements and the notional quantity is 25000 barrels per month. The fixed price is 72 dollars per barrel that means the standalone refinery as a buyer of the swap will pay 72 dollars per barrel and how much it is going to receive which is going to be the floating reference price. Please note that this floating reference price is going to be the arithmetic average of daily settlement price of near month WTI NYMEX future contract price. In normal plain vanilla swap, it will be only the settlement price on the contract last date or a on a given date. In this case the floating rate price will not be the price prevailing on a given date, but it will be an arithmetic average over a period of time and in this case, it is 1 month. And the number of months and a number of days in a month can vary and the contract terms will also mention whether the number of months is actual or 30 or 31 or 29 whatever it is that also they will be mentioning as part of the contract. And payment terms are financially settled means there will be no actual transaction or no actual delivery related to the crude oil only the price difference between the fixed price and the floating price will be exchanged between both counter parties. So, this is an example of a swap where the floating reference price is calculated as a arithmetic average. Now, let us take another example where the swap is known as a participating swap. The now the right block this right-side block indicates the terms and condition of the participating swap. The only difference between the left panel and the right panel is the way how the fixed payment is going to be calculated. Please note that the fixed payment is going to be calculated as fixed price into notional quantity minus a participation credit. So, the fixed payment will have a component which is

known as your participation credit hence this swap is known as a participating swap. Now, what exactly is a participation credit? Please note that there will be no credit if the floating price is greater than the fixed price, but there will be some credit if the floating price is less than the fixed price. And how much is going to be the participation credit? Participation credit is going to be fixed price minus the floating price into the reference quantity into let us say 40 percent. This 40 percent is the participation credit percentage, and this percent may vary from contract to contract. It could go up to 50, 60, 70 whatever both parties decide. Now, let us take a numerical example to understand how does the participating swap will work in real life? Now, let us say this standalone refinery it is fearing that price is going to go up and it had entered into a swap agreement which is a participating in nature. Let us say in scenario one where it has to pay 72 dollars and it is receiving floating rate let us say the floating rate is going to be 76 dollars. Now, in that case the floating rate is higher than the fixed rate. So, there is no credit due. So, it will be receiving 1 lakh US dollars from the counterparty. So, whichever is the bank or financial institution entered into this agreement, that party will pay 100,000 dollars to the standalone refinery. Now, let us take the reverse situation where the actual market price is going to be less than the spot price. Let us say the floating price which is the market price which comes to your 67 dollars and this refiner is supposed to pay 72 dollars and receive 67 dollars and, in that case, there is going to be some participation credit. So, how much is going to be the participation credit? So, this is going to be the price difference that is 72 dollars minus the 67 dollars which is coming to your 5 dollars into 25,000 as your notional principal notional quantity into 40 percent. So, that is coming to your 50,000 dollars. So, in real life this particular company or without this participation credit the refinery was supposed to pay 125,000, but now because of the participation credit it will be paying actually 75,000. So, it will get a benefit of 50,000 as a participation credit. So, this is how a participating swap works. However, one may question that why the bank or financial institution is paying in one hand the actual amount in the other leg instead of receiving 125,000 why it is agreeing to receive a less amount and giving some kind of a discount to the standalone refinery. The logic behind entering into participation credit lies with the fact that the commodity trading decks or of a bank or financial institution which is acting as a counterparty to the to the refinery will be interested to enter into a participating swap with the expectation that the notional quantity is going to be much higher in case of a participating swap as compared to a normal plain vanilla swap. So, that is the motivation behind which the bank or financial institution will be sharing some of the profit with the counterparty. Now, in this background let us understand another kind of swap agreement done by different crude oil mining companies specifically. In this case, I have said swap agreement between a company called Chesapeake Energy Corporation of USA and Barclays Capital both these companies entered into a deal known as a VPP or volumetric production payment deal. In this particular deal a crude oil company normally receives an upfront cash to develop the oil and gas property and in

return agrees to deliver a percentage of the production of crude oil over some future period. So, in that process, as you can see VPP contracts are like a swap. In this example the company is receiving a fixed amount the crude oil company which is receiving an upfront amount it is same as it is receiving a fixed amount and paying a floating amount because the counterparty will be able to sell the oil and gas which it is receiving from the oil company it will be able to sell the same at a prevailing market price at a future date. Hence by entering into a VPP contract the crude oil company becomes a buyer of a swap and the counterparty in this case Barclays has become a seller of the swap. This particular agreement which was done in 2011 please note that even though almost 12-13 years have gone by there are many such deals have been signed, but this particular contract I am mentioning here because this is the first time such innovative contract was agreed between crude oil producing company and a bank or financial institution. So, as part of this VPP deal Barclays Capital and CEC signed the deal in 2021 and that that deal duration was for 10 years and CEC received about 850 million upfront dollars from Barclays Capital and in turn agreed to deliver 180 billion cubic feet equivalent of natural gas. And the interesting dimension of this particular case is that this VPP deal balance the Barclays did not keep it in its balance it, Barclays Capital split the future cash flow into two separate pools or trust and these pools or trust were named as Glenpool oil and gas trust one and two and basically Barclays sold units of this trust or pools to individual investors and Barclays would sell the natural gas it will receive from CEC over the 10 years and in turn pay the investors of Glenpool oil and gas trust one and two who have invested in these two instruments. So, this is an example of a very innovative financial engineering example of how swap contracts have been used to mitigate the price risk associated with the crude oil for a company in this case the CEC. Now, in addition to the different types of swaps which we have discussed many a times companies enter into swaps which are known as time swap and destination swap. Please note that these have nothing to do with transfer of any fixed rate and floating rate or fixed price floating price these are little different kind of a swap we can call this as operational swaps rather than mitigating any financial risk. In this context I would like to share the case study of the gas authority of India limited. Please note that in the year 2011 gas authority of India limited entered into forward contract to buy 3.5 million tons of LNG for every year over the period of I think 11 to 12 years for a from a company called Chenier Energy Partners USA. So, let me repeat in the year 2011 gas authority of India limited entered into a forward contract to buy 3.5 million tons of LNG from Chenier Energy Partner of USA. Now, this contract was priced at a 3 dollars per million metric British thermal unit plus 115 percent of the final settlement price of NYMEX Henry herb natural gas futures contract. So, in this particular forward contract had a fixed component that is 3 dollars per mean million metric British thermal unit will be given by Gail to the Chenier Energy Partners. And also, in addition to that 115 percent of the NYMEX Henry herb natural gas future price also will be paid. However, subsequently when gas authority of India limited

started receiving the gas there was not much demand for LNG in India. So, to mitigate that particular risk what Gail did is Gail entered into something called a time swap. So, what exactly is a time swap? In a time, swap both parties agreed to exchange the same amount of underlying commodity, but at a different time. So, there is no exchange of any money, only the quantity is exchanged. Similarly, there is also another concept called a destination swap. In destination swap both parties swap the delivery location for saving the freight cost or the transportation cost. So, let us understand this destination swap let us say company A was supposed to deliver at location Y company B was supposed to deliver at location X, but if you can see the distance from company A to Y is higher similarly distance from company B to X is higher. Now, both company A and B can negotiate with each other. Company A starts delivering to the location X and company B starts delivering to the location Y. So, this is an example of a destination swap. So, this the   fourth block   fourth panel which is mentioned here with the title Gail in three-time swap deals for US LNG. So, this particular article shows that how gas authority of India limited has entered into time swap with other companies to mitigate the risk associated of associated with no Indian companies buying LNG from the from gas authority of India limited. Or let me rephrase that very few quantities were sold by gas authority of India limited, because there was not much demand for the LNG of sold by gas authority of India limited. In fact, as you can see that the LNG from USA to meet the demand of growing Indian economy with power sector being considered as a major buyer. So, in 2011 a gas authority of India was expecting that power sector is going to be a major buyer of LNG, hence it entered into long term forward contract. But electricity produced using imported LNG is not finding buyers due to cheaper alternatives including renewables. So, because of this particular reason gas authority of India is and was not able to sell the   natural gas it was procuring from the Chenier energy company in India. So, to mitigate that risk it entered into a time swap. Similarly, it also entered into the destination swap that detail is mentioned here I do not want to   utilize your time to just read out this detail you can read this detail which is given in the lower panel to understand more about the destination risk more about the destination swap. Now, coming to another interesting commodity from crude oil, that is your natural gas. Please note that after crude oil natural gas is the second most important commodity which attracts the attention of hedgers and speculators. And natural gas is normally priced in MMBTO that is million metric British thermal unit. And globally all over the world Henry hub gas price is known as the world benchmark for the natural gas price all over the world. And Henry hub is a gas storage and trading hub located in Louisiana, USA. And this is also the physical settlement delivery point for natural gas futures traded in NYMEX. And the right-side panel shows the top 5 largest natural gas producing countries with the United Nets topping the list which produces about 934 billion cubic meters of natural gas per year. And please note that natural gas is mostly used for electricity generation, heating residential and commercial building and industrial use.

And natural gas prices are highly seasonal. In fact, in the USA natural gas prices have two distinct periods, summer month which is coinciding with the April and October. And winter months coinciding with the months of November to March. And in the USA gas is injected into underground storage in the summer months because there is not much of a demand for natural gas for residential and commercial heating purposes. So, the gas companies normally inject the gas into underground storage in the summer month and gas is withdrawn from this underground storage in the winter months to meet the excess demand for heating residential as well as commercial buildings in USA. Normally March is the last month of the winter season and heating requirements come to an end by March. Hence there is a sharp decline in natural gas price in April. So, normally September, October, November, December months you will have a natural gas price much higher compared to the summer month period. And compared to March and April there is a significant decline in the natural gas price. In this context let us understand natural gas spread futures contract offered by NYMEX. Please note that NYMEX CME offers futures options and calendar spread contract on natural gas. We have discussed on many occasions different parameters related to futures and options. Hence today we will be discussing more on calendar spread option on natural gas. So, at NYMEX the calendar spread is calculated as price of near month futures contract minus the price of far month futures contract. It is very important to note here that many other commodity exchanges may define a calendar spread as price of far month contract minus the price of near month contract. In fact, in some of the earlier sessions I have also discussed that the calendar spread derives its value from the price of far month contract minus the price of near month contract. But in case of a NYMEX, NYMEX uses the other way around that is the calendar spread is calculated as price of near month futures contract minus the price of far month future contract. And for natural gas March-April calendar spread futures contract is of significant importance with respect to any discussion related to natural gas price risk management. In fact, this particular spread contract is popularly known as a widow maker spread. Now, this particular contract exhibits a significant amount of volatility because there is a different amount of, or different kinds of, supply demand applicable to the March month as compared to the April month. So, due to the significant change in supply demand situation for natural gas March-April natural gas spread contract exhibit significant amount of volatility and of course, higher volatility attracts speculators. We know that derivative contracts are like double edged sword one may kill the opponent, or one may get killed by entering into the derivative contracts. So, we will understand how this March-April contract has led to a 6.6 billion dollars loss for a particular hedge fund. And please note thus bottom panel indicates the snapshot of Henry herb natural gas calendar futures detail at CME. The link is also given the website link is also given as part of the image source. If you are more interested in understanding different aspects of calendar spread, you can visit this particular link. Now, coming to what exactly is a natural gas spread futures contract. Let us say natural gas spread futures

contract for March 2023 to April 2023 contract. So, the right panel indicates the price of this calendar spread. And NGH3, NGJ3 indicates the March 2023 and April 2023 calendar spread contract. Please note that CME uses the alphabet to represent a given month. The particular alphabet and the corresponding month are also given in this right panel. So, NGH3, NGJ3 that is your natural gas March 2023 to natural gas April 2023 futures contract derives its value from the price of March futures contract minus the price of April futures contract where both contracts are expiring in the March and April respectively. Please note that the spread contract expiry coincides with the expiry of the earliest month futures contract. In this case the March 2023 contract expired on 24th February 2023. And the right-side panel indicates the price movement, and the bottom panel indicates the daily traded volume of this futures contract calendar spread contract. As you can see the trading started from the year 2018, but very sporadic trading happens in the earlier time period and as the contract comes to a maturity there is significant amount of trading happens. And as you can see the maximum daily traded volume over this period of time was 66,647contracts. Please note that this data I have downloaded from the Bloomberg terminal. As I mentioned normally trading peaks up between 10 to 11 months prior to the maturity and each contract is for 10,000 million metric British thermal unit. Now, let us say how one will be able to utilize this calendar spread futures contract. Let us say on 9th May 2022 a trader is expecting this calendar spread March April 2023 contract to widen. How will a contract widen? That means, the future price for March is going to be much higher compared to the future price of April. So, because the trader is expecting that going forward the spread is going to be widening by let us say 30th November 2022. Please note that spot date 9th May 2022 stand on this spot date trader. This particular trader is expecting the spread to widen and spread widening means the March futures contract will be increasing at a higher rate as compared to the April futures contract. So, to benefit from this expectation of widening of the trade this trader entered into let us say, a long futures contract on 9th May and on that day the futures were priced at 1.57 dollars. Now, let us move to 30th November 2022. Now, we will consider two scenarios and depending upon the price of the spread we will see whether the trader has benefited or lost money from this calendar spread. Let us say the first option let us assume that the price is 1.996 million metric British thermal unit on the 30th of November. So, if this happens and on this date the trader squares of this position by taking a short position its benefit is going to be 21,950 dollars. Now, in contrast to the trader's expectation suppose the suppose the calendar spread narrows down now let us see what will happen in that case. Suppose on 30th November the spread narrow to about your 0.647 per million metric British thermal unit. So, in that case the profit is going to be negative in the sense the trader is going to incur a loss of 45,500. Now, it is very important to understand that though I am discussing a specific spread contract called March April spread contract CME or NYMEX offers calendar spread contract for many other months. So, more detail about other month spread contracts is available at these two

wavelengths. With this let us understand how this particular March April a spread contract came to be known as a widow maker contract. In this context let us understand a case study where hedge fund title Amaranth advisor incurred a loss of 6.6 billion dollars by entering into a March April natural gas spread contract in the year 2007. And this is by far the single largest loss to have been incurred by a single hedge fund. So, let us understand what happened and how the company incurred such a massive loss. Please note that during August 2005 and September 2005 hurricane Katrina and hurricane Rita caused major damage to oil pipelines and oil rigs in Gulf of Mexico, Louisiana and Texas which was basically the natural gas hub in USA. And during August to September 2005 the March April 2006 spread calendar spread widened significantly. And Mr. Brian Hunter who was a trader at the Amaranth advisor, Mr. Hunter was working for the Amaranth advisor and made a profit of 1 billion dollars by trading the March April spread contract in 2006. Please note that we are talking about a time period of August and September 2005, Mr. Brian Hunter entered into calendar spread contract and the spread widened significantly because of hurricane Katrina and hurricane Rita. And during this period of time the March April spread contract 2006 widened significantly and Mr. Brian Hunter made a significant amount of profit which is to the tune of 1 billion dollars. And he earned about 15 percent share of the profit he made for Amaranth advisor and this kind of a profit sharing which is popularly known as eat what you can kill bonus arrangement. Now, Mr. Brian Hunter wanted to repeat the same benefit or same trading strategy in 2006 August and September and with bigger trades by trading March and April 2007 spread contract. Please note that the US hurricane center also predicted there is going to be another big hurricane season. And Mr. Hunter was also viewed that hurricanes are going to be of similar severity to the previous year. However, contrary to his expectation there was mild winter and there were no major hurricanes. And by August 2006 the March 2007 calendar futures contract significantly dropped and basically the spread narrowed and because Mr. Brian Hunter had entered into a long futures position in this calendar spread, he incurred a significant amount of loss. And his loss also increased because Mr. Hunter also took long futures in the March 2007 contract. So, he took a long futures position in calendar spread contract in addition to that he also had taken a long futures position in March 2007 contract. And through that process Mr. Brian Hunter incurred about 5.6.6 billion dollars loss and Amaranth advisor incurred this total amount of loss and it closed its operation. The hedge fund came to exist. It is the hedge fund stopped existing from that day onwards. And subsequently please note that in September 2014 Mr. Hunter agreed to pay a fine of 750,000 US dollars to CFTC and also agreed for a permanent trading ban. He was banned from trading any kind of commodity derivative contracts in USA. So, in this context of natural gas spread contract this is a very interesting case which is known as a widow maker calendar spread contract because the contract exhibits significant amount of volatility and lot of people make big amount of money and lot of people also make big amount of loss by entering into this spread

contract. So, with this we will end today's discussion and we will be continuing with the discussion related to weather derivatives in the next session. Again I eagerly look forward to interacting with all of you in the next session.