Commodity Derivatives and Risk Management
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Lecture 43
Crack Spread Futures, Spread Options & Crude Oil Price Risk

So, welcome to the 43rd lecture on Commodity Derivatives and Risk Management. And today we will be continuing with the discussion related to various aspects of crude oil and its refined product risk management. And today we will be basically focusing on crack spread futures contract and spread option contracts. Please recall in the previous session we had discussed that companies use various kinds of derivative products such as options, swaps, forwards, futures to mitigate their price risk associated with the different kind of a crude oil or the refined product they are producing or consuming. In fact, we had briefly discussed about three companies annual report details given in three companies annual report that is the Reliance India annual report, Southwest Airlines Company annual report and Shell annual report. And as you can see very clearly the Southwest Airlines which is exposed to the aviation turbine fuel, ATF fuel price risk enters into different kind of a derivative position such as they enter into call options, they enter into collar structure, they also enter into spread call spread as well as put spread contract and various kinds of swap agreement. So, in this background let us understand different aspects related to the spread contracts. Here we would be understanding more on a concept called a crack spread futures contract. Please note that the exchanges offer a wide array of futures option contracts on crude oil and its refined product. In fact, the Intercontinental Exchange and Chicago Mercantile Exchange jointly have about 1000 different futures option contracts under the category of crude oil and refined product. I have given the web link to those these two websites. If you are more interested in understanding the nuances or a product specification associated with each of these different derivative contracts, you can visit this link and download and learn more about this interesting and innovative derivative product. However, for the sake of discussion with respect to this particular subject, we will be only discussing a few interesting derivative contracts which have been used by companies to mitigate the price risk. So, one such interesting derivative contract is the crack spread futures contract. Now who uses the crack spread futures contract and what exactly is a crack spread let us understand that aspect. Please note that the standalone oil refinery and marketing companies like our IOCL, BPCL, HPCL etcetera, they are exposed to the crude oil price risk as well as refined product price risk. They buy crude oil and refine and produce refined products and sell these refined products. And their profitability is dependent on how the price movement between the crude oil and the refined products moves. So, to mitigate the price

risk normally standalone refinery company would enter into a long futures contract on crude oil and also simultaneously entering into short futures contract on the refined product to protect their margin. Now instead of taking position in two different futures contracts, they can now take position in one futures contract which is basically a crack spread futures contract. And how exactly crack spread is calculated or measured? Crack spread is measured as the price difference between two refined products between the refined products and the crude oil. For example, popular futures contract on crack spread is based on 1: 1, 2: 1: 1, 3: 2: 1 or 5: 3: 2. So, what exactly do each of these ratios indicate? For example, 1: 1 futures contract will derive its value from 1 unit of crude oil price and 1 unit of gasoline price. Similarly, 2: 1: 1 a crack spread futures contract will derive its value from 2 units of crude oil contract, 1 heating oil contract and 1 diesel contract. Please recall in the initial part of the discussion or about in session 41 if I am not mistaken, we had discussed how crude oil can be refined to generate different kinds of refined products. So, depending on a refinery who is producing different kinds of refined products that particular refinery will be able to mitigate the risk associated with narrowing of the profitability of the margin by entering into this futures contract. Now, let us understand how exactly this crack spread is calculated. I have taken some data related to the price of crude oil which is expressed in US dollars per barrel. Similarly, I have taken the price related to petrol or gasoline spot price, I have also taken the price of heating oil. Now, when we are talking about a 3: 2: crack spread, 3: 2: crack spread is related to let us say 2 units of price of petrol or gasoline plus the price of a heating oil, 1 unit of heating oil price minus the 3 unit of price of crude oil. So, crack spread is basically the measure of output price minus the input price. So, let us say a particular refiner who is buying crude oil and refining the crude oil to generate petrol or gasoline and also generating heating oil. So, the spread or the benefit this particular refiner is going to be dependent on how the price of petrol and gasoline moves as well as how does the price of heating oil with respect to the price of crude oil. So, going by this excel calculation which is crude oil price per barrel is 72.5 and please note that the petrol and gasoline as well as heating oil price is normally expressed or normally quoted in the form of gallon. So, if petrol price is 2.1 gallon per dollar, we convert the same to a barrel price which is your US dollar per barrel. Similarly, we have also expressed the heating oil price per barrel which is coming to about your 73.5 and 3: 2: 1 crack spread will be price of gasoline plus the price of heating oil minus the price of crude oil and the calculation is very clearly mentioned here. So, 3: 2: crack spread for 3 barrels of crude oil comes to about 32.4 dollar which is equivalent to 10.8 dollar per barrel. So, if a particular refiner who is using crude oil and producing gasoline which is double the amount of the heating oil that particular refiner profit margin or gross profit margin is going to be 10.8 dollar. In this context crack spread is also used as a quick measure of gross refining margin of the refiners. Please note that for the refiner or standalone refiners one of the very important performance parameters is the gross refining margin. So, gross refining margin is defined

as the difference between the cost of the crude oil and the weighted average price of the petroleum product or the refined product they are producing and selling in the market. And this particular table shows the gross refining margin for 4 of the Indian standalone refiners for example, IOCL Indian Oil Corporation Limited its gross refining margin for the year actually there is a slight mistake it would be 2020 to 21 it was 5.64 and, in this case, it will be 2021 to 22. So, the previous 2 years the gross refining margin is 11.25, let me repeat for IOCL the gross refining margin for the year financial year 2020-21 was 5.64 and the same for the financial year 2021-22 has nearly doubled to 11.25 and the same is also for the other refiners or the state-owned refiners in India. And refiners can alter the product mix to sell high value products to increase their refining margin. Let us understand this concept with respect to the second example here please note that the data remains same the price of crude oil remains same price of gasoline remains same, and price of heating oil remains same, but what has changed is the amount of heating oil another refiner is producing with respect to the amount of petrol it is producing. In the first case 2 units of petrol were produced and 1 unit of heating oil was produced. In the reverse case when 1 unit of petrol is produced and 2 units of heating oil is produced the 3: 2 crack spread margin is reduced to 5.9 dollar per barrel. So, refiners keep an eye on the high value product and try to produce or refine the crude oil to produce more of a high value product to generate better refining margin. However, a refinery will be able to alter the output mix depending upon the Nelson complexity index of that particular refinery. Any refinery which has a higher Nelson complexity index is in a better position to alter the output mix. So, depending upon the price prevailing in the market they will be able to change the output mix and generate a refined product which is commanding a higher premium as compared to another refined product. Now, in this context let us see how exactly the refinery margin is moving. This particular graph which shows the refinery margin for the 3: 2: crack spread a margin for about 5 years as you can see during the COVID period the refining margin increased to significantly high value of positive. So, ignoring this particular aberration period as you can see that during January 2021 to May 2023 data maximum value of 3: 2: crack spread has gone from 59.44 to a minimum value of 7.12. So, you can imagine one particular refinery company which is let us say buying WTI crude oil in the spot market and selling petrol and gasoline as well as heating oil in the spot market its profitability will be significantly be changing because at some point in time this refinery crack spread 3: 2, 3: 2: 1 crack spread has gone up to 59.44 and sometime it has come down to 7.2 over a period of about 2 and half years. So, refineries are exposed to the risk of the crack spread margin changing from time to time and the same risk can be mitigated by the refiners by entering into short position in crack spread futures contract. Please note that the exchanges both Chicago Mercantile Exchange as well as Intercontinental Exchange are offering futures contract on crack spread and this crack spread futures contract derive their value from the price difference between the futures price of a refined product and a crude oil. For example, let us say 2: 1: 1 crack

spread futures contract will derive its value from the future price of 2 refined products and the crude oil price. Now if a particular refiner is hoping that the refinery margin or the crack spread value is going to go down that particular company can enter into a short futures position in the crack spread and if actually the refiner here comes true, and the crack spread margin declines the refiner will benefit from the short futures position. In this context when we are talking about a short crack spread futures position. So, a party who is entering into short crack spread futures position that party is taking a short futures position in refined products and a long position in the crude oil futures. Let me repeat a short spread futures position is same as somebody taking short position in refined product futures contract and long position in crude oil futures contract. And the moment somebody takes a short spread position another counter party will be entering into a long spread position and obviously, the other counter party will be exactly entering into the reverse position that is long position in the refined product futures contract and short position in the crude oil futures contract. Now with this we end our discussion related to the crack spread futures contract. Now let us understand another interesting derivative contract which is used by many companies to mitigate the price risk which is related to a put option in crude oil. But what we are going to discuss is with respect to an OTC contract it is not exactly an option contract offered and traded on an exchange. In this context let us understand hedge done by the Mexico government. Please note that the crude oil produced by Mexico which is named as a "Maya" and having a API gravity about 21 to 22 and Mexico ranks 12th largest crude oil producer in the world. And Mexico government fear is that if crude oil price goes down it will be earning very less amount by selling the Maya variety of crude oil. So, to mitigate that particular risk the government enters into a long-put option position. So, the long-put option position to sell crude oil is undertaken by the Mexican state oil company which is popularly known as a PEMEX. And this hedge or the government entering into a long-put option position is one of the biggest sovereign crude oil price risk management activities done by any country government. And this particular hedge is popularly known as a Hacienda hedge. And this Hacienda is the name of the building of the ministry of finance which decides about the different aspects of the option. And as I mentioned this particular put option is an OTC contract and counterparties to the Mexican government are the oil trading desks of big banks such as your Barclays bank, Goldman Sachs, JP Morgan etcetera. And as a buyer of the option PEMEX pays the put premium and if the crude oil price falls below the exercise price PEMEX exercises the option and receives the difference between the exercise price and the crude oil market price. Please note that in the earlier sessions we have also discussed that buying a long-put option is akin to buying an insurance contract. So, by paying a premium of or by paying a premium the country government is assured of selling crude oil at a fixed price. And in the past Mexico has previously received payouts in the year 2009, 2015, 2016 and 2020. And in the year 2020 during the COVID period of time when the crude oil price substantially went down Mexico government

exercised its long-put option and received about 2.38 billion dollars from the counterparties which is in the year 2020. And also in other years 2009, 2015, 2016 the Mexico government has exercised the option and benefited from the long-put option. Here I would also like to draw your attention to the fact that every year the country's government enters into a long-put option. And in a given year if the actual crude oil price Maya variety of crude oil price is more than the exercise price the country government forgoes the option premium and does not exercise. And the year those years when the crude oil prices have gone down or has fallen below the exercise price the Mexico government exercises, but every year Mexico government enters into this long-put option contract. And interestingly the put premium to be paid by the PEMEX is borrowed from different banks. And PEMEX conducts an auction process to decide from which bank it will borrow the premium. And it borrows the put premium from those banks which are willing to lend at a lower rate. In this context I would also like all of you to go through this particular interesting aspect which I have taken from this website. So, in the year 2019 Mexico completed its oil hedge program at a strike price of 55 dollar per barrel. And it paid about 1.23 billion dollars as a put premium. So, the exercise price is 55-dollar premium paid by the Mexico government to the counterparty banks which is sum total of about 1.23 billion dollars. And the total amount of underlying which is committed by the Mexican government to sell which is about 200 million to 300 million barrels. And as this particular article also mentions this trade is also known as Hacienda hedge which is considered as the largest oil deal on the wall street. And banks who are writing the put option for the Mexico that is this international bank which take counterparty position to the to the long-put option taken by the government, they take the short put position, or they write the short put position. They also have to mitigate the risk and they hedge themselves in the market by selling crude and refined product futures and swap. Please recall in the session related to the gold hedge we had discussed a concept called a gold hedge trap. And during that session we also discussed how banks and financial institutions which enter into a short call or short put position also have to mitigate their risk by making themselves delta neutral. So, by entering into short position the banks have naked put option position and banks have to hedge themselves to become a delta neutral. So, to become delta neutral banks are entering into different kinds of hedging arrangements and they do so by selling crude oil and refined product futures contracts as well as swap contracts. So, with this we will be ending today's discussion related to a crude oil and other refined product risk management using crack spread futures contract as well as a long-put option contract. We will be continuing with the other interesting aspect of crude oil price risk management in the next session, and I eagerly look forward to interacting with all of you in the next session. Thank you all of you.