Commodity Derivatives and Risk Management
Prof. Prabina Rajib
Vinod Gupta School of Management
Indian Institute of Technology, Kharagpur
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Lecture 41
Crude Oil and Crude Oil Derivatives Price Risk Management

Welcome to the 41st lecture on Commodity Derivatives and Risk Management. And today we are going to discuss various aspects of crude oil and its derivative price risk management aspect. But before we proceed to the crude oil and other derivative price risk management, I thought of discussing an interesting aspect with respect to the gold price risk management which I could not discuss in the previous session. So, let us briefly discuss about that aspect for couple of minutes before we go to the today's agenda of crude oil and its price risk management. So, in case of a gold mining companies, gold mining companies are entering into streaming deals to mitigate the gold price risk. So, what exactly is a streaming deal? A streaming deal is an agreement between a gold mining producer and a bank or a financial institution. And the bank or the financial institution funds the gold mine development expense and in return agrees to receive gold for some time to come. In fact, it is nothing, but a project financing agreement and the seller of the stream is the gold mining company and uses the upfront lump sum amount given by the bank and financial institution. And obviously, the buyer of the stream is the bank or the financial institution company. Let us take some examples where streaming deal has been done. In fact, many streaming deals have been done in the recent past. I have just mentioned two of the recent streaming deals. In fact, in March 2023 Equinox Gold received an upfront amount of 140 million dollar from a syndicate of lenders. And as part of this streaming deal, this particular company that is Equinox Gold will receive 140 million and will deliver about 79,300 ounces of gold in equally monthly deliveries starting from October 2024 to July 2026. And these 140 million dollars has been calculated based on the average of the gold forward curve prices which is basically equivalent to about 2,170 US dollar per ounce. Now the next example of a streaming deal which was signed in 2015 and both companies which signed this deal are Anani Investment Limited which is a wholly owned subsidiary of Glencore. And this particular company entered into a streaming deal with a company titled Silver Wheaton (Caymans) Limited. And as part of this streaming deal Silver Wheaton agreed to pay about 900 million US dollars to Anani Investment. And as part of this upfront payment Silver Wheaton will receive about 33.75 percent of all silver which is going to be produced by Anani Investment Limited to the tune of 140 million ounce and subsequently 22.5 percent of the silver produced thereafter for the life of the mine. So, these 900 million dollars have two components. So, initially the Silver Wheaton will be paying about 140 million

ounces of the 140 million ounces of silver. Silver Wheaton will receive 140-million-ounce silver initially and subsequently whatever amount of silver which will be produced by Anani Investment 22.50 percent of that silver production will also be going to Silver Wheaton. Of course, there is also another aspect to this arrangement for every ounce of silver which is going to be delivered by Anani Investment to Silver Wheaton, Silver Wheaton will also pay 20 percent of the spot price. So, these are some of the examples of how gold price gold price risk aspects are being managed by gold mining companies, gold mining companies as well as silver mining companies. Of course, I would like to also highlight here that this is not only peculiar to gold mining or silver mining companies, other metal mining companies base metal companies are also entering into such streaming deals. With this we will be introducing, or we will be starting with the different aspects related to crude oil and crude oil price risk management. Now, let us understand what exactly crude oil is. So, the importance of crude oil is so vital in our life, Mr. James Buchan once mentioned that a century ago petroleum, what we call oil was just an obscure commodity, but today it is almost as vital as human existence as water. So, from this sentence we can make out the importance of a crude oil in our life and crude oil means rock oil which is a complex mixture of hydrocarbons plus other organic compound and trace materials like nitrogen and sulfur. And please note that the crude oil cannot be used by us as it is, crude oil has to be refined and the refined products are used by us. So, let us understand how crude oil is refined to generate different byproducts or different derivatives from the crude oil. This particular right-side image which I have taken from this image source clearly indicates what are the different byproducts or different products of the crude oil. Crude oil when it is heated, it generates about your liquid petroleum gas, you can also see crude oil when gets heated it generates a naphtha, naphtha is used for your petrochemical come naphtha is used by petrochemical companies. Similarly, crude oil is you this crude oil is refined to generate petrol, diesel, crude oil is refined for kerosene, kerosene is a pure form of kerosene is used as jet fuel. Similarly, you have other output such as lubricants, waxes, paraffin etcetera also is a byproduct of the crude oil refining process. Finally, another interesting output from the crude oil is the bunker fuel which is known as a residual kind of an oil which is used by ships which are used to carry freight. So, bunker fuel is used to run the boiler of these sea borne ships and the last product is the asphalt which is used for your roads and roofing. So, as you can see crude oil has many derived products which has its own demand which has its own usage and crude oil is processed and this particular the second table as you can see from a one barrel of crude oil which is equivalent to about 42 gallons of 42 gallons or 159 liters of crude oil can be processed to generate about 45 gallons of different output such as LPG, petrol, diesel, kerosene, fuel oil, heating oil and other residue like paraffin, wax and asphalt. So, the sum total of this comes to about your 45 gallon and thus 3 gallon is known as your processing gain and processing gain simply refers to the volume by which output increases compared to the input due to the

processed petroleum products have a lower specific gravity than the initial crude oil. So, this is a brief introduction about crude oil and the derivatives from the crude oil. Now, let us understand some other interesting facts associated with crude oil. Please note this first block shows the major producing countries of the world. So, crude oil is produced majorly by United States, Saudi Arabia and Russia and these three countries together almost control about 42 percent of the global crude oil production. Similarly, this second block indicates the 10 largest oil consumers. So, the largest consumer is United States, then China followed by India, but compared to United States and China, India is at a significant distance in terms of the crude oil consumption. And another interesting concept associated with crude oil refining is the Nelson complexity index. So, the Nelson complexity index measures the capability of a refiner to alter the product mix in response to the market demand as well as capability of a particular refiner to take different type and quality of crude oil as input. Please note that crude oil can be heavy crude oil or light crude oil, crude oil can be sour crude or sweet crude, we will be understanding about this aspect in little later. So, a particular refinery which has a higher Nelson complexity index that particular refinery will be able to take in different varieties and different quality of crude oil and will also be able to change the output mix depending upon the need of the day. And higher the index higher is the capability of the refiner to achieve the desired product mix and the index ranges from the low of 1 to high of 20 and this third block indicates the refining capacity of top crude oil refiner in the world and the Nelson complexity details. So, Reliance Jamnagar factory India has it has a refining capacity which is about 1.24 million barrels per day. This is one of the biggest oil refiners in the world and it has a Nelson complexity value of 14. Similarly, you have other refiners belonging to different countries what is the per day processing capacity or refining capacity as well as the different Nelson complexity indexes mentioned. This is just for understanding crude oil as a product and the process of refining and how Nelson complexity index is a very important parameter with respect to refining process of crude oil. Now coming back to some other facts related to the crude oil in the previous slide though I mentioned about the Jamnagar Reliance refinery of Reliance India also has many other refinery units. So, the first block shows the different refineries and who are the owner of each of these refinery as well as the place where these refineries are based. In addition to this refinery details of India we also have the top tail oil producing companies in India. So Saudi Aramco which is the Saudi Arabs state owned petroleum or crude oil producing company which is the by far the largest or biggest company which produces about 109 million barrels per day. Similarly, other company names are mentioned here which are the largest or biggest crude oil companies in the world as of today. And many of these companies are owned by the national government such as like Rosneft is the state-owned petroleum company of Russia, Kuwait petroleum companies again owned by the Kuwait company, national Iranian oil companies also owned by the Iran, China national petrol company petroleum companies owned by the Chinese

government. So, similarly, you also have many other major oil producing companies that are owned by the government of that particular country. Now in this context of the USA being one of the most important or largest producers of crude oil it is very important to understand the concept of shale oil. Please note that shale oil is different than conventional crude oil. So, this block shows the difference between conventional crude oil and the shale oil. Conventional crude oil is found at a depth of around 6000 feet in the deposits and crude oil is often drilled through a hole and a hole is drilled straight into the earth and pump jack is set up and the oil is essentially shocked out from the ground. As compared to conventional crude oil, shale oil is little different in the sense that the way shale oil is extracted otherwise shale oil and crude oil is not different. Only the process of extracting the shale oil is different. Please note that the shale oil is also high-quality crude oil that lies between the layers of the shale rock, and it is also known as the tight oil and the US Energy Information Administration has mentioned that about 8 million barrels per day is produced directly from the shale oil in the US. Please recall that the USA is the biggest producer of crude oil which is about 21.9 million barrels per day. Out of these 21.9 million barrels per day, 8 million are shale oil. And shale oil has become more accessible due to the advance in the technology of horizontal drilling and hydraulic fracturing which is also known as fracking. And USA, Canada, Argentina, China are the major producer of the shale oil and shale gas producers. In this context, I would also like to draw your attention that guar gum is used in the fracking process and India is one of the major exporters of the guar gum. In fact, these derivative contracts on guar gum and how guar gum prices were manipulated, we have discussed some time back. So, just to refresh your memory that guar gum is used in the fracking process and India is one of the major exporters of guar gum and guar gum and guar seed futures and option contracts are traded at NCDEX platform. And the right-side block indicates the major US companies which are involved in the shale oil extraction process. And as you can see the shale oil extraction process, shale oil, which was started about 2007, shale oil production process in USA which started about 2007 at a very small amount, it has gone up to a significant amount which is about as you can see total running about 8 million barrels per day. Now let us also continue with our discussion related to crude oil facts. In fact, as per the International Crude Oil Market Handbook 2019, there are about 200 odd varieties of crude oil in terms of their origin of production and quality grade. But out of these 200 varieties of crude oil, only 4 or 5 are known as oil markers or marker crudes. So, what exactly is a marker crude? So, marker crude is that crude that the price of that crude serves as a reference price for other crude oil varieties. So, let me repeat what exactly is a marker crude. Marker crude is a variety of crude oil and price of that crude oil serves as a reference price for other crude oil varieties. So, prominent marker crudes which are reported internationally and other crude oil varieties are priced against these marker crudes are 4. So, these 4 are the prominent marker crudes. So, these 4 marker crudes are North American West Texas Intermediate WTI Crude, North Sea Brent Crude, I am sure

many a times you must have heard about WTI Crude and Brent Crude. So, these are your popularly discussed popularly analyzed crude oil prices. So, in addition to the WTI Crude and Brent Crude, the other important marker is the OPEC reference basket crude. So, that is also another marker crude, and the fourth important marker crude is the E way to Dubai Crude. So, we will be understanding more about each of these 4 crude oils in little detail. Now when we are talking about quality of the crude oil, we have also mentioned that the crude oil could be a sweet crude oil or sour crude oil, crude oil could be heavy and light. So, with respect to that discussion quality of the crude oil is measured by API, which is nothing, but your American Petroleum Institute Gravity. So, API gravity is one major of measuring the quality of crude oil and API gravity measures the relative density of crude oil against water, higher the API better is the quality of the crude oil. In addition to the API, the amount of Sulphur percent present in a crude oil also decides the quality. So, if a particular crude oil has a higher Sulphur percentage, it will be known as a sour crude otherwise it will be known as a sweet crude. Now this particular table, the first block shows the different statistics related to the API and the Sulphur content. So, any crude oil which has an API index of more than 31.1 degrees will be known as a light crude oil. Similarly, any crude oil which has an API value of less than 22.3, will be known as heat A B crude oil. Similarly, any crude oil which has got a Sulphur percentage of 0.5 percent will be known as a sweet crude oil and sour crude oil will be having a Sulphur percentage more than 1 percentage. And light sweet crude oil is the best crude oil and why are we mentioning that the light sweet crude oil is the best crude oil because it requires less refining cost. So, with lesser cost we will be able to refine the derivatives or byproducts from the crude oil which is a light sweet crude oil. So, obviously, any crude oil which is of light sweet category that will command a premium in the market. Now coming back to the 4-marker crude, this second table shows the API gravity and Sulphur percentage associated with these 4-marker crude which are WTI crude, North Sea Brent crude, OPEC reference basket crude and EY Dubai crude. Now when we were talking about these marker crudes acting as a reference price, please note that the other crude oil is priced as a premium or a discount to these marker crudes depending upon the API gravity and Sulphur percentage of that particular crude. So, if a particular crude has a lesser API gravity and a higher Sulphur content, so obviously, it will be priced at a discount to any of the marker crudes. With this we end the discussion related to different aspects of crude oil. Now let us understand what we mean by the spot price associated with crude oil. Now WTI spot price when somebody is talking that today's WTI spot price is x dollar or y dollar per barrel. So, what exactly does one mean by the spot price of WTI crude. So WTI spot price is the price of a barrel of crude which is expressed in US dollars for delivery at Cushing, Oklahoma, USA. So, what exactly happens in Cushing, Oklahoma, USA lets us understand this. So, Cushing, Oklahoma is a city small city in USA which is having population less than only 8,000 and, in this city, there are about hundreds and thousands of steel storage tanks which fan out from the outskirts of

town tank farms and that march on for miles and miles and connect every major oil patch in North America. And this city that is Cushing, Oklahoma is also known as the pipeline crossroad of the world, and it is one of the largest crude oil storage hubs on the earth and in the US and it is arguably the most important and delivery of waste excess intermediate crude oil is taking place here which is basically the underlying contract for the NYMEX WTI futures contract. So let me summarize what I just now discussed that is when somebody is talking about WTI spot price of let us say 70 dollar per barrel that is nothing but as if somebody is delivering one barrel of WTI crude oil at any storage tank at Cushing, Oklahoma or if somebody is saying that we have bought crude oil at let us say 70 dollar per barrel that means that particular buyer has taken delivery of the crude oil at Cushing of Oklahoma, USA. So, this particular image shows the importance of Cushing as you can see these are the again the images of the tank farms this particular image which I have taken from the source of international agency energy agency of USA. So, this shows the extent of tank farms each of these tank farms where crude oil is stored and this particular image which again, I have taken from the image source given here this shows the location of the Cushing and as you can see the green lines are the major pipelines you have tanker terminal locations you have refining facility you have underground crude oil storage. So, as you can see this Cushing, Oklahoma is the center point where it connects the total crude oil and all refined product storage location all over USA. And as just now also I mentioned NYMEX WTI futures delivery detail also mentions that if somebody has taken a short futures position that short futures position holder has the obligation to deliver crude oil at a specific storage location at Cushing, Oklahoma. And the seller will transfer the pipeline ticket to the buyer as part of the delivery detail with respect to the NYMEX WTI futures contract. So, with this let us come to our understanding related to Brent crude oil. And Brent crude oil is crude oil which is produced in dozens of different North Sea oil fields which is delivered at Sullom Voe terminal in the Scotland. So, this again this particular image which I have taken from the web source mentioned here. So, this is basically all offshore crude oil producing terminals at the North Sea. And this terminal was constructed during 1975 to 1981 and it covers about 1000 acres and in these terminal oil tankers are filled into ship oil out to the refineries in the world worldwide. So, when somebody is talking about the Brent crude. So, Brent crude spot price is the price at which somebody will be buying the crude oil at a North Sea which is basically at the Sullom Voe terminal in Scotland. And the terminal also has crude oil storage units to buffer between the producing offshore fields and the oil tankers. Three times when we are talking about the Brent crude, we also hear the word BFOET Brent blend. Please note that the Brent blend consists of crude oil produced from different oil fields and B stands for Brent and F stands for 40. So, different varieties or different blends of Brent crude oil are produced at different oil fields and all these Brents are combined all these oils are combined and which is known as your BFOET Brent blend. In context of the Brent, we also hear a word called Dated Brent. So, Dated Brent

refers to the physical cargo of crude oil in the North Sea that had been assigned a specific delivery date and this rate reflects the spot price of the Brent. So, whenever somebody is interested in buying crude oil the authority will allocate a specific date on which the physical cargo of crude oil will be loaded to a specific tanker and that price is known as your Dated Brent price. And please note that spot market transactions are generally not public. So, the rate at which somebody is buying and selling crude oil is not generally public. A few price reporting agencies which are known as your PRS such as Argus Media and Platts collect this private transactions data and aggregate them and make this available which act as a surrogate for spot price. So, Dated Brent is the spot price in which buyers, sellers negotiate to buy and sell the crude oil, but this data is not directly available. This price reporting agencies different price reporting agencies such as Argus and Platts correlate this information and make this information available as and which is known as the spot price for the Dated Brent. With this we will end our today's session with respect to introduction to crude oil. We will be continuing with the remaining part of crude oil understanding more about crude oil and crude oil futures options and derivative contracts and how companies are using these derivative contracts to mitigate various price risk associated with crude oil and other derivatives. So, thanking all of you we will be continuing with this session in the next lecture session that is lecture session 42. Again, I eagerly look forward to interacting with all of you in the next lecture session. Thank you.