International Journal of Research in Economics and Social Sciences(IJRESS)
Available online at: http://euroasiapub.org
Vol. 9 Issue 12, December - 2019
ISSN(o): 2249-7382 | Impact Factor: 6.939 |

Risk Hedging Using Swap Instruments - Examples from Natural Gas Markets and Crude Oil Market

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Abstract

Swap Markets have seen the fastest growth for financial instruments dealing with Commodities. The Reason is not very far to seek. They are efficient, flexible, and resourceful and can be customized. Financial engineers give them a big Thumbs Up.Swaps have been hugely, appreciated by financial managers because of the variety of the importance of Hedging Risk in a volatile interest rate, exchange rate, and commodity price environment. Swaps are now used by industrial corporations, financial corporations, thrifts, banks, insurance companies, world organizations, and sovereign governments. Swaps are used to reduce the cost of capital, manage risks, exploit economies of scale, arbitrage the world's capital markets, enter new markets, and create synthetic instruments. Swaps are thought to be very complex. In reality, this seeming complexity looks so because of the extensive documentation needed to fully specify the terms of contract and varied provisions for customization. Swaps are relatively new form of OTC derivative trading instrument that have proven to be suited to the needs of energy Markets more specifically for Natural Gas and crude oil market, which is highly volatile and creates price risk for the inclusive parties. This paper illustrates the various examples of how swaps are used to mitigate risks.

Keywords: Risk Management, Hedging, Swap, Price Risk, Syndicated Loans

Introduction & The Context

Edwards, Davis. W. (9) defines the energy market as a collection of interested business focused on producing and delivering energy products like electricity, petroleum, natural gas, coal and heating fuel to consumers. Some market participants like power plants, wind farms, and solar installation are involved in energy production while other converts raw materials into finished products. Another set market participants seeks to find and develop new sources of energy i.e. for example drilling for new fuel reserves etc. Another group of market participants transport power or energy sources and are also involved in distribution. **Edwards, Davis. W. (9)** *illustrates that*, *major commodities in the energy market are petroleum, natural gas and electricity, Coal, carbon emission (greenhouse gases), and renewable sources of energy. The Industries which are associated with the above fuel resources and providing their final outreach to end user form part of energy markets.* Oil exploration companies, power grid operation and pipeline operators are all example of energy companies.

According the International Energy Outlook 2018(17) *the Use of oil and Natural gas fuels shall constitute to be almost 50 % of the total energy demand till around 2040 as per the projections and use of Oil slowly shall be replaced by natural gas which is a more efficient and less polluting fuel reserve.* Thus Participants in Crude Oil & Natural Gas Markets are subjected to varied risks. They can thus originate from supply **and demand imbalances** (recession or booms), **political events** (wars, blockades, diplomatic tensions) or unexpected events (earthquakes etc) ***Fattouh Bassam. (10.)*** Thus we see that the inherent risk perspective in Energy commodity markets primarily crude oil & natural gas markets come from **Price risk**, **speculation risk** & **event** risk which exposes all the participants to the need of Risk Management in Energy Domain.

Risk Management in Energy Domain

The need for Risk Management is inherent for the crude oil (petroleum) and natural gas market's and one of the techniques used is hedging. Experts on Energy Risk Management like **Fusaro P.C. (11)** & **Chance Don M. (3)** Define *hedging as a process in which an organization exposed to energy price risk will use a strategy for mitigating risk by creating an offsetting position to the financial exposure with the help of a derivative instrument that gives an (mirror) equal and opposite financial exposure to the underlying physical position*. This is done so as to protect against adverse price changes.

Advantages of Hedging include efficient financial management, fiscal planning, and creates room for commodity buyers and sellers to protect themselves against the potential consequences of sudden and unforeseen changes in market conditions. **Hull (15)** defines derivative instrument as an instrument whose price depends on, or is derived from, the price of another asset. Hull's work on derivatives provided in-depth information on derivatives and their application. **Long, Kaminski, and James,** classifies derivatives and derivative markets and provides a lot of information on swaps.

Swap, Commodity Swap & Their Importance

John C Hull (15) Defines Swap as a financial Derivative in which parties (Two or more) make a series of payments to each other at specific dates. This definition of swap encompasses other definitions given by various noted authors like **Andrew M Chilsom (4) , Don M Chance (3) and Robert Kolb (22) which** define swap in many ways:

- An agreement or transaction in which parties (two or more than two) exchange their cash flows at a predetermined series of payments.
- Exchange of interest rate payment for specific term or time maturity on an agreed upon notional principal amount.
- An arrangement whereby one party exchange with the other a set of interest payments for another, say fixed rate to floating rate or vice versa.

The basic idea is that swaps are utilized to transfer assets or liabilities to owners benefit. One of the above definitions refers to the simultaneous sale purchase transaction of cash flows at different maturities. The other definition states that it is the agreed exchange of futures cash flows with or without any exchange present cash flows. However the cash flow exchanges may be different and may give rise to different types of swaps. Swap Can Help to convert, a floating rate to fixed rate liability (loan), ensuring that the volatility in the interest rates does not increase the burden of payments. It can also convert fixed rate of interest to a floating rate liability (loan) when interest rates fall steeply in the market. In the same way, an asset can be changed to convert floating rate to a fixed rate earning asset or vice versa, as per the requirements of the holder. Swap can be applied to any asset for which a mutually acceptable pricing mechanism can be established and, since it does not involve delivery, leaves the swap user free to make separate arrangements for the physical disposal of the asset.

It guarantees the swap user (who is risk averse) payments of fixed price for a specified asset over an agreed time period in future and assigns any profit (or loss) that might come because of price volatility to the swap provider (who is a risk taker). Swap and Futures differ in the sense that a swap agreement offers a single fixed price amount for an entire period while the portfolio of futures contracts offers a sequence of different prices for each delivery month**.**

S.L.Gupta (14) defines Commodity swaps as purely financial transactions designed to manage the exposure to two different commodities over a given period of time. Commodity swaps hedge price risk for a commodity. Payments are made by counterparties on the basis of price of a fixed quantity of a certain commodity in which first party pays fixed price amount for the commodity and second party pays market rate interest over the term of swap. Periodic payments are made by first counter party to the second counterparty at fixed price amount per unit of the commodity for a given quantity. The First counterparty is paid by Second counterparty, floating price amount per unit (usually an average price based on periodic observations of the spot price) for the commodity at a given quantity. The commodities may be same (the usual case) or different.

If they are the same, then no exchanges of notional are required. If they are different, exchanges of notional could be required but, as a general rule, no exchanges of notional take place-all transactions in actual take place in the cash markets. The structure of commodity swap envisages one set of the exchanged cash flows which depends on underlying commodity pricing amount and the other set of payments which can be either fixed or floating price or rate and the resultant exchange. In a commodity swap, the payments are made on fixed amount price of a certain commodity in which First party pays a fixed price amount for the commodity and the second party pays a market rate over the swap period. Commodity swaps have become popular in the energy markets and agro industries, where supply and demand deal with uncertainty.

Dana Julie (5) elaborates that Commodity swaps were first conceived in 1986 by The Chase Manhattan Bank. The Legal imbroglio between the Commodity Futures Trading Commission (CFTC) and ISDA initially cast a cloud over the legality of Swap product. In 1989, the CFTC adopted more favorable stand on commodity swap by legalizing swap contracts and provisions in a framework. By the end of1989 the volume of commodity swap outstanding was nearly $8 billion.

In order to regularize the commodity swaps, the **Commodity Futures Trade Commission (CFTC)** has come out with the following rules and regulations:

i. No commodity swap can be terminated by either party, without consent of other party.

ii. Contracts to be entered into by the parties only for commodities dealt by them.

iii. Only institutions & companies can indulge in commodity swaps and no Individuals.

iv. No mark-to-market process with variation margins allowed.

v. No collateral or margin loans permitted for commodity swaps.

Swaps Commonly used in Oil Markets

Swaps are a relatively new form of OTC derivative trading instrument that has proved to be ideally suited to the complexities of the Oil and Natural gas market. **Kaminski V. (21)** elaborates that energy swap are typically used by market participants such as airlines to protest against unforeseen price increases by locking in the price of an energy asset, as budgetary provisions for markets uncertainties and execute long term hedges.

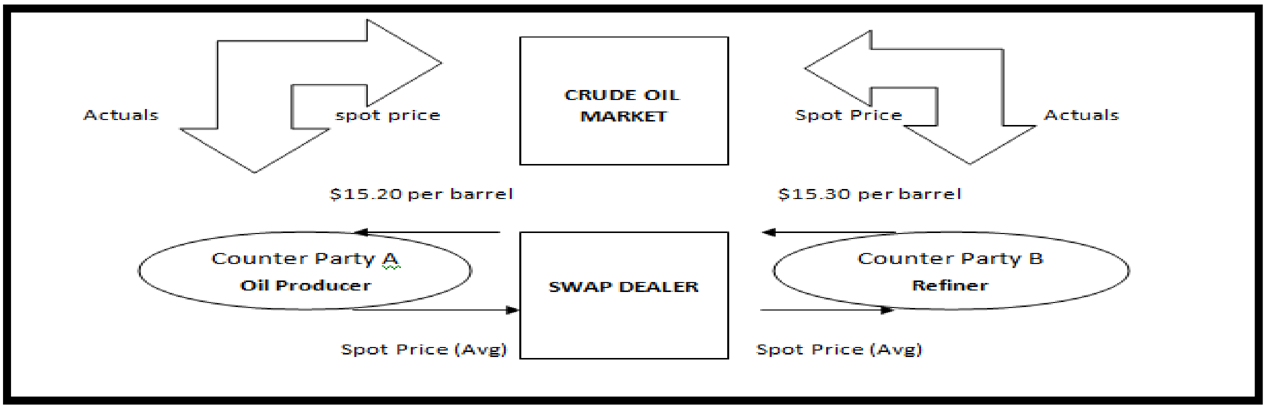
"Plain Vanilla" Swap": A simple oil swap is a contractual agreement in which a floating price value is exchanged for a fixed price value between counterparties over a term period. It does not involve any transfer of physical oil and settlement of contractual obligations is done by cash transfer between both parties. Terms of Contract include volume, duration, fixed price value and floating price value. A difference between both values is settled in cash for specific periods. Hence Swaps are also called "contracts for differences" and as "fixed-for-floating" contracts.

Fixed For Floating Plain Vanilla Swap

Illustration **1: Crude oil swap Hedging Example 1** Consider a simple case, a crude oil producer (Counterparty A) wants fixed price to be paid for his oil for five years-his monthly production averages 8,000 barrels. Simultaneously, oil refiner and chemicals manufacturer (Counterparty B) wants to fix the price he pays for oil for five years-his monthly need is 12,000 barrels. To obtain the desired outcomes, they enter swaps with a swap dealer but continue their transactions in actual in the cash markets. At the time these end users enter their swaps, price of appropriate grade of crude oil in spot market is $15.25 a barrel.

Counterparty B makes an agreement to pay monthly payments to dealer at a rate of $15.30 a barrel and dealer agrees for paying average daily price for oil in the preceding month to B. At the same time, A makes an agreement for payment to swap dealer the average daily spot price for the preceding month for oil in exchange for payments from the dealer at the rate of $15.20 a barrel. As can be seen in Fig 3, these payments have the effect of fixing the crude oil price for both the oil producer and the oil refiner. The difference in the notional quantities in these two swaps raises an interesting point. If Counterparty A and Counterparty B had attempted to do a swap agreement directly, it would not have been possible since the parties have different notional requirements. But, by using a swap dealer, both swaps are viable. The swap dealer can offset the risk from the mismatched notional by entering a third swap as fixed-price payer on 4000 barrels. And, until an appropriate counterparty can be found, swap dealer can hedge in futures

Fig. 1 Commodity Swap Crude oil Cash Market Transaction



How Swaps are used in energy market by producers and consumers can be illustrated as below.

Producers sell swaps to lock in their sales price. The producer and its market counterpart agree a fixed price say X $per barrel, for an agreed oil specification index, and a floating price, almost always a reference price derived from Platt's or Argus (oil reporting services who publish daily prices for a range of commodities) or one of the futures markets. For the period agreed, the producer receives from the intermediary the difference between fixed price value and floating price value if the latter is lower. If the floating price value is higher, difference gets paid from producer to the intermediary.

Differential Swap or Basis Swap : A basis swap is so defined in energy market as a swap which is based on price differential for a product and a major index product. It can also be based on the difference between a fixed differential for two products, and / or the actual and floating. These swaps do not eliminate the variability of cash flow; instead, they change the basis or index of variability. Some examples of energy products that might attract differential swaps include jet versus gasoil, physical (Platt's) gasoil versus futures, 3.5% fuel versus 1% and Brent versus

NYMEX WTI but possibilities are limited only by number of indices that exist. ***Differential swaps are used by Oil refineries to hedge changing margins of refined products.*** Refiners usually receive fixed-price side of the swap, ensuring a known, forward relationship for what will be eventually the price of products they carry. If they sell the differential (underlying difference) and differential swap narrows (the margin has fallen for the covered period), then refiner gets paid, difference which exists in between the contractually fixed differential and the floating differential; if it expands, refiner pays out the gap. ***Differential swaps may also be applied by industry participants to manage the basis risk assumed during their normal hedging activity***. For ex., an airline company may prefer to hedge its jet exposure with gasoil swaps, because of perceived value of these deals, may enter into a jet-gasoil differential swap to hedge this potential basis risk.

Margin or Crack Spread using swaps : Refiners who prefer to fix a known refining margin can enter into a refining margin swap, whereby product output of the refinery and crude (or feedstock) input are simultaneously hedged, i.e., products are sold and the crude is bought for forward periods. Deal is usually expressed as US$x per barrel margin. At settlement, refiner either pays or receives margin difference which is calculated on basis of price settlements in spot markets and those locked in. In this way, probability of a refinery can be guaranteed for a few years forward. This kind of hedging is often integrated into development projects and upgrading schemes when financiers are keen to ensure projects feasibility / profitability and seek to underwrite a minimum revenue stream. ***The consumer of energy uses a swap in order to stabilize the buying price***. For example, an airline buying jet fuel (jet) would contract to buy a jet swap with a fixed price element of $140 per tonne. If floating average was $150 per tonne, then airline would receive a monthly settlement of $10 per tonne multiplied by volume hedged. If floating price averaged $135 per tonne, then airline would pay out $5 per tonne**.** Thus Swaps are used by energy consumers fix or lock their payment costs, while energy refiners, traders and marketers utilize swaps for hedging their profit margins and inventories (stocks).

Illustration 2: Crude oil swap Hedging Example 2 This example will help understand the profit potential for swaps: Suppose a small WTI crude oil producer wants to gain on high oil prices during the fourth quarter of 2004 to fix a good price for part of his next year's production in case prices collapse. He decides in October 26, 2004 that prices have peaked and agrees a price swap to sell 1,000 b/d (average barrels daily) at the current swap market price of $56/barrel (according to the U.S. Department of Energy) for the first 3 quarters of 2005.The structure of the swap deal is as follows:

- The producer agrees to sell 1,000 b/d of WTI crude oil to swap dealer at fixed value pricing of $56/barrel throughout first 3 quarters of 2005;
- Producer agrees to buy back the same quantity from the dealer at a floating value price based on quarterly average spot price FOB of WTI crude oil at Cushing, Oklahoma;
- Payments are to be made quarterly in five business days at quarter end based on difference between agreed fixed value price of $56/barrel and the value of price index. If index price is greater than fixed value price, swap dealer is paid by producer. If index price is less than fixed value price swap dealer pays the producer.

In first 3 quarters of 2005, producer sells his output in physical market at market rates, which combined with the net value of payments from swap deal, provides him with the fixed price guaranteed by the swap deal.

The net payments to (+) or by (-) the producers in the swap deal are as follows (actual prices):

Table 1.(a) Payments of Swap deal						Table 1.(b) Receipt from sale of Physical Oil			
Period	WTI Price	Fixed Price	Price Difference	Quantity (BL)	Payments ($)	Period	WTI Price	Quantity (BL)	Payments ($)
05Q1	50.03	56	5.97	91000	543180	05Q1	50.03	91000	4552819
05Q2	54.44	56	1.56	91000	141874	05Q2	54.44	91000	4954125
05Q3	63.99	56	-7.99	91000	-727829	05Q3	63.99	91000	5823829
Q1-Q3	56.15	56	-0.15	273000	-42774	Q1-Q3	56.15	273000	15330774

Table 1.(C) Combined Proceeds

	Swap Proceeds	Sale Proceeds	Total Proceeds		Price Achieved ($/bl)
Period	Payments ($)	Payments ($)	Payments ($)	Quantity (BL)	
05Q1	543180	4552819	5096000	91000	56
05Q2	141874	4954125	5096000	91000	56
05Q3	-727829	5823829	5096000	91000	56
Q1-Q3	-42774	15330774	15288000	273000	56

Thus, the producer achieved the target price of $56/barrel for his output in the first 3 quarters of 2005, compared with an annual average price of $56.15/barrel, which he would have received if he had not entered into the swap. In this case the swap price turned out to be lower than the actual market price. But prices could have fallen sharply as well. Either way, the producer can be sure of receiving an average price of $56/barrel for his crude – whatever happens to market prices in the first 3 quarters of 2005.

Illustration 3: Crude oil swap Hedging Example 3 From a consumer point of view we can take an example a large fuel consuming company in Houston, which wants to lock monthly price for ultra-low sulphur diesel fuel (ULSD). If the company wants to hedge say, October fuel consumption, which is approximately 100,000 gallons. Company then purchases October Platt's Gulf Coast ULSD swap from a commodity trading firm. Approx price picked from market is (approximately) $1.3166/gallon ($55.30/BBL). Following analysis will help us know what shall happen if Gulf Coast ULSD prices settle both higher and lower than price value of $1.3166/gallon. If price value is higher than $1.3166/gallon say for each business day in October, is $1.50/gallon, in that case there would be a hedging gain of $0.1834/gallon ($1.50 - $1.3166 = $0.1834) or $18,340. Thus company will receive a payment of $18,340 from counterparty, which offsets increase in fuel cost of $1.50/gallon by amount gained i.e. $0.1834/gallon. If price value is less than $1.3166/gallon say, for each business day in October, is $1.20/gallon, in that case swap would result in a hedging loss of $0.1166/gallon ($1.3166 - $1.20 = $0.1166) or $11,660. Here company pays the counterparty $11,660. Thus loss on swap will offset the decrease in physical fuel price. In both outcomes purchasing of a ULSD swap for $1.3166/gallon, net fuel cost will work out to $1.3166 regardless of price values settling higher or lower than $1.3166.

Participation Swap: Participation swap contract establishes a maximum average forward purchase price, while offering between 25% - 100% participation in downward price moves. It is an attractive alternative to many other end user hedging strategies because it overcomes the problem of forfeited downside price movement in a conventional swap. Because of the forward purchase, End User achieves complete price protection from any increase in crude oil prices. If prices fall instead, the End User participates in favourable price move at the participation rate once average prices fall below the forward purchase level.

Participation swap strategy outperforms the basis swap if price drop sufficiently. It is most appropriate if strong downward price moves are expected, yet prices also seem vulnerable to sudden upward spikes. The hedging strategy is like this. The End User purchases forward, establishing a maximum average purchase price. Participation swap price is set at a slight premium to regular swap price. In exchange for a higher price, End User receives right to participate in favourable price moves below a specified participation price level at an agreed upon participation rate. There is no up-front payment.

Spread Swap

Spread swap are designed to allow End User to lock in difference between price values of commodity at different time period (e.g., calendar swaps), or price value difference between different commodities (e.g., crack swaps). In a spread swap, swap purchaser (e.g., the End User) pays a pre negotiated fixed spread level to swap provider in exchange for a floating spread level (e.g., SET). Transactions are settled financially. Through the use spread swap, the End User achieves complete price protection from significant shits in price in differentials, without affecting its traditional physical customer relationships. There is no commission for a spread swap.

Example: Of Spread Swaps: ***Continuous Oil Backwardation Swap (COBS)***

Since NYMEX started Crude oil Future trading in 1983, the trend has been backwardation, which is presumed to be caused by a tight near term supply picture coupled with positive refinery margins. Such backwardation has a negative impact on refineries which have to sell petroleum products at a forward price which is a discount to spot price. In order to hedge and/or profit from the backwardation market structure, an oil Refinery uses a five-year continuous oil backwardation swap with SET (Counterparty) for 500,000 barrels of crude oil per year. Under the agreement, the refinery pays a pre-agreement fixed spread level (on a per-barrel basis) and SET(Counterparty) pays a floating price equal to the average daily spread of difference between the first and twelfth oil contract on the NYMEX. Year ends sees the transaction settled financially in swap term period. As we see below in example below. Swap enables the oil end user to fix the purchase price for future periods. The End User receives a positive pay- off from the swap if oil price rise. However, the End User faces opportunity cost under the transactions if oil price fall. Financial settlement ensures that the end user can offset its SET sap transaction with transactions carried out with its traditional suppliers.

Illustration 4: Crude oil swap Hedging Example 4

- A large U.S. refinery wants to establish a new marketing program for its key industrial customer in order to strengthen their long term relationship. Program allows the customer to fix the price they pay to the Refinery for a pre specified quality of oil product during the coming year.
- The Refinery which buys most of its crude at spot- index prices, realize that it would be lose of money if the price it pays for crude exceeds the price it has "guaranteed" to its customers.
- To protect itself from such financial loss, the refinery initiates a one year fixed floating swap deal with SET with a view to hedge a quantity of 100,000 barrels of fuel oil per month keeping the price fixed at $22.00/bbl.
- The swap agreement necessitates, Refinery to make a monthly fixed payment to SET at price of $22.00/barrel.
- Also according to agreement SET, will make a floating payment to refinery in exchange. This shall be based on the value achieved on arithmetic averaging of daily settlement prices of NYMEX crude oil future contracts for each of pricing periods in reference.

During the life of swap,

- Refinery purchases crude oil, as needed from regular suppliers at index price
- Settlement date, necessitates the exchange of payments between Refinery and SET which is equal to a value of differential between index pricing and $22.00/bbl (Pricing of Swap).

- The floating payment received from SET should closely approximate the payment the Refinery made to its supplier(s) for physical purchase of crude oil.
- Net Resultant will be that end user or Customer will end up paying $22.00/bbl for its crude oil purchase as a consequence of swap deal hedged with current physical crude oil contract prices.

Swap Related Syndicated loan The provisions of Syndicated credit agreements allows member banks may enter to initiate contracts like bilateral swaps and other derivatives with borrower with credit exposure being secured by collateral and is backed by guaranty provisions in the credit agreement. These may also include interest rates being hedged with loan, foreign exchange being hedged by loan facility and facilitate commodity hedging also.

Illustration 5: Swap Related Syndicated Loan example An example is provided by Algeria's State-owned hydrocarbon concern, Sonatrach, which in order to fund part of its investment programme initiated a syndicated loan with number of international banks in November 1989 (see fig). The loan, coordinated by Chase Manhattan, consisted of a US$ 100 million conventional floating-rate loan (with a seven year maturity and a four-year grace period) & an option-related swap. This scheme helped Algeria to re-enter, medium term syndicated loan market at a low cost. **(UNCTAD Report 1998(19); A Survey of Commodity Risk Management Instruments)**. loan was structured as follows:
1. Sonatrach paid the investors LIBOR + 1 per cent; and sold four call options written on oil (with maturities of 6, 12, 18 and 24 months), at strike price of US$ 25, to Chase Manhattan.
2. Chase Manhattan sold a series of profit-sharing options to the investors, valid for seven years, which gave them a supplementary 0.5 per cent interest for every dollar that the reference price was above US$ 22; and it sold a series of options to the investors, valid for seven years, which gave them a supplementary 0.5 per cent interest for every dollar that the reference price was below US$ 16. This range of US$ 16-22 held for the first year; in the following years it progressively widened to US$ 13-26.
The benefits of the deal were that firstly, investors would be able to benefit of periods of high oil prices; and secondly, that they would also receive a higher interest rate in declining oil price scenarios, as a compensation for the higher default risk of Sonatrach during such periods. Without this Scheme rate of interest would have been 3 to 4 percent above LIBOR.

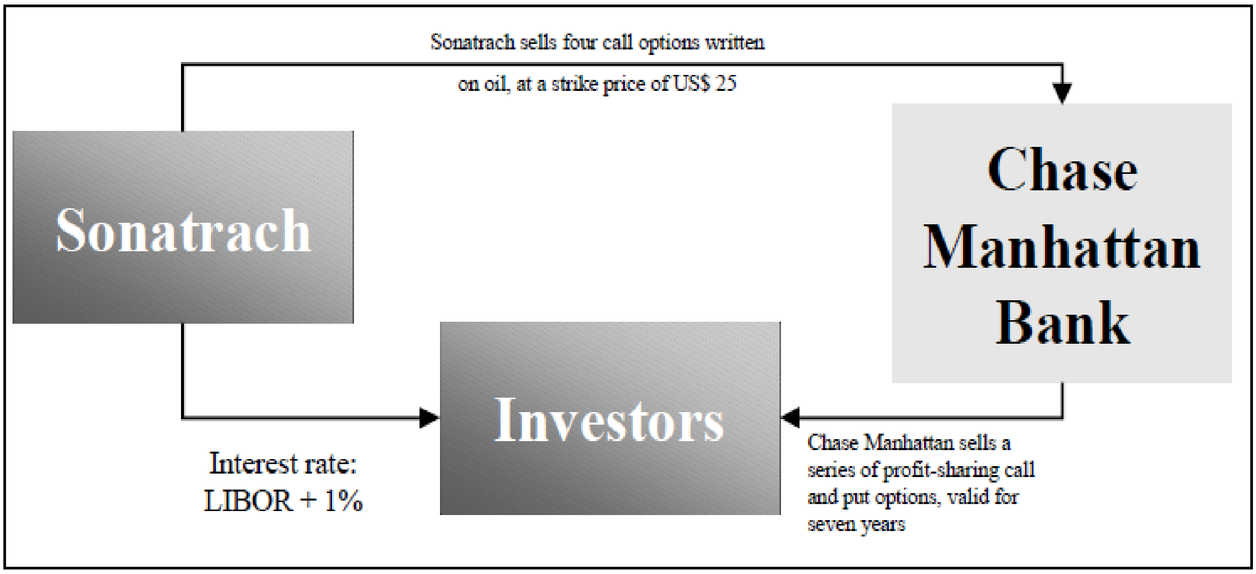


Fig. 2 Example of Swap Related Syndicated Loan
(Source: (19) UNCTAD Report 1998; A Survey of Commodity Risk Management Instruments)

Swaps commonly used in Natural Gas Market: Include (a) Futures look-alike swaps/fixed-float futures swaps/futures swap (b) Basis Swaps (c) Index Swaps (d) Swing swaps.

Fixed – Floating Price Swap: Current Market price which is the price of timing of deal always remains the fixed price. Payment exchange occurs when settlement price at NYMEX arrives and this is the floating le of price since it is not known until last trading day of contract. Differential represents payment dues between two parties. Natural gas traders can use swaps to convert one form of pricing to another, eliminating discrepancies between pricing structures. Suppose a trading company is buying gas at a fixed price and selling it at a floating price, it can swap these kinds of fixed and floating prices or vice versa, with a party that has opposite risk, hedging the exposure. ***Futures look-alike swaps/fixed-float futures swaps/futures swaps:*** They perform same function as a futures contract with exception that, after expiration of futures contract, there is a financial settlement for futures swaps, as opposed to a physical settlement; some companies don't have actual futures accounts so swaps allow them to participate without having actual futures accounts. Fixed price of a futures contract is the value of that contract in market for that particular month at that particular moment; the fixed price for a futures swap is theoretically same as current futures contract price. ***Futures swap: floating price:*** Current price is floating price for a futures contract i.e. price at which the contracts are bought or sold before expiration, or final settlement price on expiration day before delivery; floating price for a futures Swap is an often calculated price known as L3D price which is standard floating price for all futures swaps; i.e. simple average of futures settlement prices for last three trading days of a given contract month, chosen with consensus that it would be less volatile than using last trading day's settlement price;

Illustration 6: Futures Swap Suppose in December 2018 NYMEX Gas oil contract trade value is $61.16. If a ABC ltd. bought a swap with XYZ as counterparty, the contract *price* will be at $61.16. If on November 20th, 2018, contract will settle down or terminate, difference between $61.16 and the NYMEX Final Settlement price that day, will be the amount exchanged between ABC and counterparty XYZ. If the contract settles at $61.66 (i.e. L3D = $61.66), since ABC bought the swap, ABC would be selling it back at that price for a profit of $0.50 per contract and, counterparty XYZ would be paid $0.50 per contract (1,000 MMbtu), or $500. On the other hand, if the contract settled at $60.66, ABC would be selling the contracts back at a loss of ($0.50) and counterparty XYZ will get $0.50 per contract, or $500.

Basis Swap: A gas basis swap can alter future cash flow to be based off of a regional commodities index rather than a national future exchange. For basis swaps, the current market price which can be obtained through electronic platforms such as NYMEX *Clearport* or ICE is the "fixed" price. Some brokers give quotes over phone also. The "floating" price is discovered when NYMEX contract for that particular month is settled and monthly index posted value for location is published. This is the "actual" or "settlement" basis and performs the function of settling value of swap. Counterparty settlement necessitates, waiting till basis settlement. When the NYMEX final settlement occurs, the basis swap settlement value is created to be compared with cash prices which are traced from Platts Oilgram or Inside FERC postings. These are the first-of-month cash prices for respective locations. NYMEX settlement value which is compared with cash location value, difference arrived is actual basis, which is the settlement price for basis swap for that particular location.

Illustration 7: Example of Basis or Differential Swap This case study illustrates how a natural gas producer can use energy derivative based on NYMEX natural gas future price to hedge its natural gas production in Alberta, Canada. This producer can also use a basis swap to reduce ineffectiveness in its hedging strategies (ATB financial 2012). This Caters to location Basis Risk. Suppose a natural gas producer has a contract to sell 100,000 gigajoules (GJ) each month at Alberta monthly index price. (note: 1 GJ ~ 0.947 MMbtu.) The producer wants to guarantee that its revenues from this volume for the next 12 month will not be less than the NYMEX price less $0.75/GJ. Hence, producer enters into an Alberta basis swap with Alberta

International Journal of Research in Economics and Social Sciences(IJRESS)
Vol. 9 Issue 12, -December-2019
ISSN(o): 2249-7382 | Impact Factor: 6.939

Treasury Branches (ATB). Natural gas basis swap fixes the difference between NYMEX and the Alberta index price (Alberta basis). Seller of an Alberta basis swap receives future NYMEX price less negotiated fixed amount of $0.75/GJ multiplied by 100,000 GJ and agrees to pay ATB future Alberta monthly index price multiplied by 100,000 GJ to buyer. This basis swap generally settles five days after Alberta index is published. However, settlement days can be negotiated to match cash flow from physical sale of natural gas.

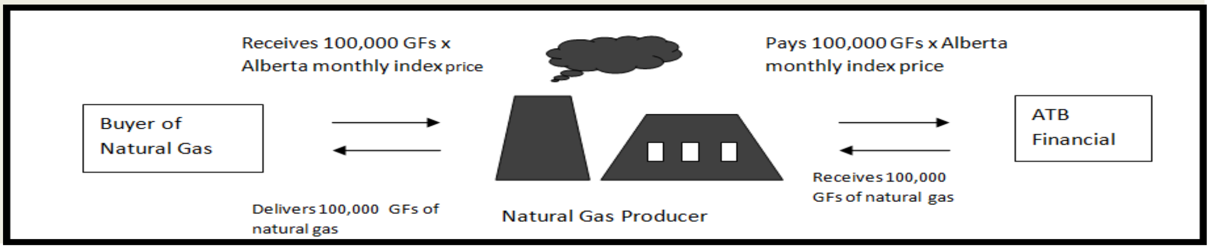


Fig. 2 Basis Swap

Calendar Swap: It is often used to Hedge Calendar spread Risk. Calendar basis risk or calendar spread risk, is risk arising from an exposure of contract used for hedging and it also does not expire, settle or mature on the same date as the underlying exposure. For example, consider a large consumer of gas, say a vehicle fleet, decides to hedge its exposure to price of gas with purchase of NYMEX Gas futures. Thus, the consumer is exposed to calendar basis risk if NYMEX Gas futures expire on the last day of month proceeding to the month of delivery. Suppose July 29 is the last trading day of month and August Gas futures contract expired on that day. It might look like that consumer cannot hedge this risk but it can be. Calendar Swaps are the solution. They will settle as against the monthly average of calendar of future contract price. This is advantageous to the consumer as compared to futures contract because they are consuming gas daily, not only the last trading day of the month.

Illustration 8: Example of Calendar Swap The NYMEX New York Heating Oil Calendar Swap allows hedger to take positions in market of heating oil to the tune of 36 months forward. Price settlement of contract happens on arithmetic averaging of NYMEX New York Heating Oil futures month settlement price for each business day during contract month. The Oil Future Contract has an specification of 42,000 Gallons- which is the specification of swap also. Suppose a 18-month swap is currently trading at a fixed price of $2.7716 per gallons, and the average daily price of future for the month is $2.88.Hedger who longs the future contract (ex. a trucking company using heating oil contract to hedge diesel) will receive a payment from counterparty of $4,552.80 [i.e., (2.88-2.7716) X 42,000]. If The basis i.e., the high correlation between the heating oil and diesel remains unchanged , the gain on the future contracts will be offset by the higher cash price of diesel fuel, i.e. trucking company will be purchasing diesel in spot market. Thus fixed price for diesel is paid over the period of the swap contract.

Swing swaps and Gas Daily Swaps: The natural gas market deals with another daily delivery derivative called swing swaps. These are used to manage volumetric risk- the risk faced by consumers that they will consume more gas than expected. Swap is initiated by exchange a fixed amount based on prices of delivery month stating for daily spot price for reported services. In the physical market, a swing transaction is a purchase or sale under an interruptible contract which is renegotiated (in terms of price and volume) day-by-day. These types of transactions are extremely popular and make up the bulk of the trading activity in the day-by-day natural gas market.

Basically a swing swap is a fixed-float index swap that references the average (pricing) of daily indexes as published by various platforms (Gas Dailies) as floating price instead of the commonly referenced monthly indexes. These Gas Dailies platforms publish a high and low daily price range for the location for which monthly indexes are being published. Daily index is calculated as average of low and high prices of published range for that location on that trading day. If the swap is of greater maturity in tenure than one day, simple average of each of the daily indexes is used as the floating price. A fixed price is paid by buyer of swing swap and in turn receives daily index, or average of the daily indexes for swap tenure. Swing swaps hedge fixed-price risk in day-to-day physical transactions, discover price information, and also to speculate on changes in prices in the day-to-day market. Swing swap is basically a future swap, deriving its value from fixed prices in physical market during a given month instead of a future contract for a given month.

Illustration 9: Example of Swing Swap: An example of how swing swap can be used by producers to take gain from rising fixed prices for physical gas during a current month. Let's suppose FJS production company has sold all of its physical gas supply for the month of Jan, at $2,00 to an End User in the premium basin under a firm contract. Since FJS has sold the gas to the end user under a firm contract, the end user is obligated to take all the supply every day for entire month of Jan, and pays $2,00 for its regardless of price changes during the month. On the eighth day of January, the weather pattern change such that, FJS believes price in the Permian will rise due to increasing demand from colder weather in the western United States. Although producer has already sold its supply at one fixed price for the entire month, it can still participate in price action during the month with a swing swap. To take advantage of expected increase in prices for remaining month, FJS pays $2.00 to XYZ for a Permian swing swap for the 10th of Jan through the 31st (assume prices were in changed from first of the month levels over the first nine days).

Conclusion

Swaps emerged as developed long-term price risk management instrument on the OTC market. With swaps, producers can fix, in other words lock in, the prices they will get over the medium to long term period and consumers can also fix prices they have to pay. Since No delivery of commodities is involved: the mechanism of swaps is purely financial. Commodity risk management instruments with greater maturities than a year have for a long time been very difficult to acquire. Increased deregulation and innovations in financial engineering have increased the usage of swaps over last three decades.

Initially, banks and a number of trading companies (generally with production or refining interests which catered to their risk management needs) were the only participants. They are still the main participants, but a number of swap brokers traditionally active on the financial swaps market have now entered the business. The risks of swap contracts can be negated by rolling over exchange-traded futures to obtain longer-term hedges (that is, regularly selling almost expired futures contracts and buying new ones).Only few banks and trading houses (Bankers Trust, British Petroleum, Elf, Shell, Phibro Energy, Metallgesellschaft and Marc Rich) are willing to take principal risks. The advantage of using an intermediary is that intermediary carries all risks associated with performance of the swap. The producer and consumer still buy and sell the commodity on the open market, but the swap compensates the participants so that in effect they have each locked price fixed for the commodity.

The overwhelming majority of these commodity swaps (approximately three-quarters of the market) have been related to **petroleum**, and consequently natural gas. The development of the commodity swap market has been particularly strong on the consumer side in developed countries, with banks and oil companies selling fuel swaps to airline companies, and several metal consumers locking in their long-term prices. This review paper has portrayed swap applications in the petroleum and natural gas market to show that real time dynamic hedging applications of risk management for managing price and other risks inherent in the operational domain.

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