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Haute école de gestion
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Saudi Arabia: too big to hedge?

Bachelor Project submitted for the degree of
Bachelor of Science HES in International Business Management

by

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Declaration

This Bachelor Project is submitted as part of the final examination requirements of the Haute école de gestion de Genève, for the Bachelor of Science HES-SO in International Business Management.

The student accepts the terms of the confidentiality agreement if one has been signed. The use of any conclusions or recommendations made in the Bachelor Project, with no prejudice to their value, engages neither the responsibility of the author, nor the adviser to the Bachelor Project, nor the jury members nor the HEG.

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Geneva, 31st May 2018

Ariana JUSUFI

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Executive Summary

As oil prices reached low levels in 2016, many countries dependent on oil revenues experienced significant budget deficit. Saudi Arabia, for which oil revenue accounts for more than 80% (FETEHA, 2017), chose to implement a fiscal reform to reduce its oil dependency by creating other sources of income through the diversification and the liberalization of the country.

Although fiscal reform is a good strategy for the long run and for the country in general, the solution does not take into account the price risk; a risk the national oil company will always have to face.

This research paper will describe the financial instruments available on the market to mitigate price risk. It examines the distinctive characteristics and lay out the similarities and differences in order to allow the reader to have a good understanding about the derivative instruments.

Moreover, this research paper will analyze the Hacienda Hedge – the biggest oil trade on Wall Street as well as three companies' hedging strategies in order to define their practices. On top of that, Equinor – the Norwegian Oil Company was also investigated.

My objective was to determine whether or not Saudi Arabia could have its national oil company – Saudi Aramco – hedging its production. The feasibility of such transactions was assessed by considering the derivatives market size as well as the power of Saudi Arabia within the global oil market. Saudi Arabia being considered as a price maker, a question arisen to know if there would be a counterparty taking the other side of the transaction, if any. Lastly, the hedging practices which were analyzed documented recommendations for potential hedging strategy.

This study comes to the conclusion that Saudi Aramco should hedge part of its production. The company should implement a strategy to lock in their revenues especially with the rise of the shale industry. The oil market will be well supplied for the coming years meaning that the price could possibly remain at low levels as OPEC cut-back measure to increase oil price is not sustainable by all the members and it reduces only OPEC's market share. The analysis based on Equinor has shown that the implementation of a government pension fund would be an opportunity to consider in the long run but would require a change in the structure of the company.

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1. Introduction

From 1970-1972 to 2011-2013, the price of oil recorded an astonishing increase of 886 percent (AGUILERA, RADETZKI, 2016, p.11). Like any other market, the oil market is influenced by supply and demand. Over the years, events such as the embargo on the United States of America (USA) concerning the Yom Kippur War, the Iran-Iraq war as well as the Arab spring has greatly influenced the price of the commodity.

Mid-2014, the global oversupply led to a decrease in price. No country was willing to cut production to foster the price of oil; the price went from a peak above $115/barrel in June 2014 to under $35/barrel at the end of February 2016 (ROGOFF, 2016). In May 2018 Brent oil price hit $80.00 per barrel and generally oil prices have been floating around $70/barrel since (OIL PRICE, 2018).

As a result, oil producing companies have been suffering from lower revenues and hence losses. Countries such as Venezuela, Kuwait and Saudi Arabia but not limited to, are highly dependent on oil revenues and are suffering the consequences of lower oil prices (AGUILERA, RADETZKI, 2016).

Saudi Arabia, for which oil revenue accounts for more than 80% of the country's income, experienced significant deficit in its budget. Its budget deficit in 2016 accounted for 12.8% of Gross Domestic Product (GDP) and 8.9% in 2017.The country still plan to run a deficit of 7.3% of GDP in 2018 (FETEHA, 2017). According to the International Monetary Fund , an oil price of $105.60 is needed to balance the budget which is roughly double of current price level (THE WORLD BANK, Unknown publication date). As low oil prices greatly impacted Saudi's economy, the country implemented a fiscal reform in which it wishes to diminish its oil dependency by creating other form of revenue for the government such as VAT, and through the liberalization and the diversification of the country.

While some countries implemented fiscal reform, Mexico and some private-owned oil producers have been implementing hedging strategies to minimize their risks and secure revenues. This is the reason why I have chosen this subject. In financial instruments I see a tool which a country such as Saudi Arabia should not neglect due to its high dependency. I believe Saudi Arabia should implement a hedging strategy and tackle the price risk which it is inevitably subject to, assuming that it is a viable option.

The objectives of this paper are to look at the different hedging strategies available for oil-producing companies. In the first part, I will present Saudi Aramco, the OPEC and

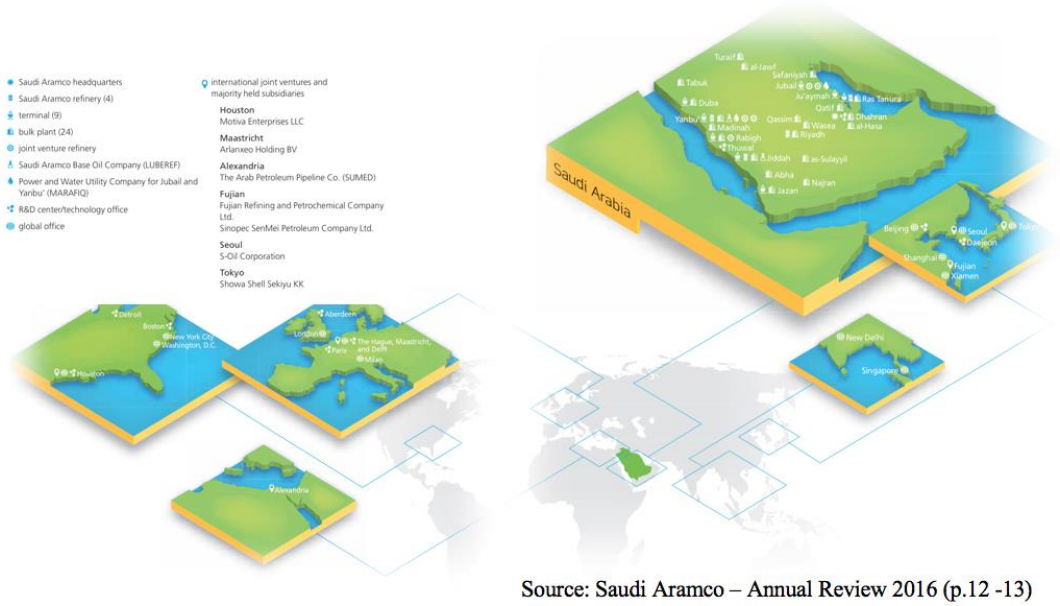
make a comparison of the Mexican state-owned oil producing company PEMEX and Saudi Aramco. I will follow with the introduction of derivatives and expose the theoretical aspects of derivatives instruments. In the second part, I will analyse three companies' financial reports to understand their hedging strategy. The companies chosen are PEMEX –including the Hacienda hedge, EOG Resources – a shale company and BP - a supermajor in oil & gas production. I will also look into the Norwegian oil company Equinor as the company walked Saudi Armaco's path in 2001 by going partially public. The purpose of the analysis is to understand the strategies available to Saudi Aramco and evaluate the feasibility of a hedging strategy. Because of the importance of Aramco's production and their position in the oil market, the question of the possibility for the company to hedge will be a crucial one to answer.

1.1 Saudi Aramco

1.1.1 The company

Saudi Aramco (Aramco) is the state-owned oil producing company of the Kingdom of Saudi Arabia (KSA) founded in 1933 through a concession with the Standard Oil Company of California (Socal). The company is headquartered in Dhahran (KSA). Aramco is engaged in hydrocarbons exploration, production, refining, distribution and marketing. The company has grown to be the top world exporter of oil and natural gas. It is a vertically integrated energy company employing more than 65'000 people worldwide (SAUDI ARAMCO, 2016).

Figure 1 Aramco's Global and Domestic Operations

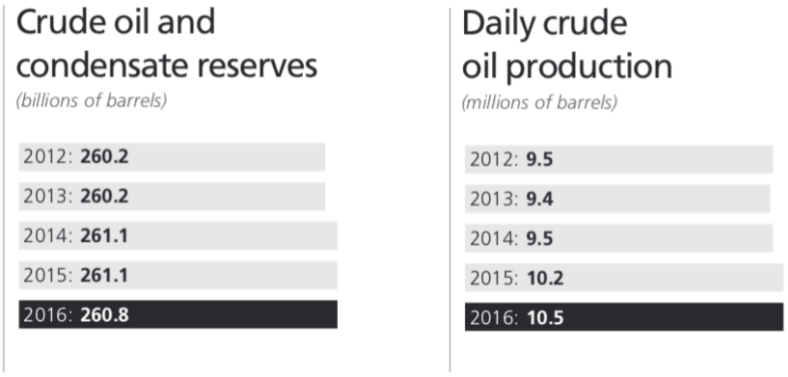


Source: Saudi Aramco – Annual Review 2016 (p.12 -13)

As per Figure 1, we can see that Aramco is active in three major global markets; North America, Asia and Europe with 13 global offices around the three regions. R&D center/technology offices are all located outside of Saudi Arabia within the three regions. Inversely, all shipping terminals, refineries and bulk plants are located within the country. Aramco possesses multiple joint ventures in the global markets (Houston, Maastricht, Alexandria, etc.)

Aramco's 2016 Annual Review (Figure 2) presented a slight increase in production of 300'000 barrels a day amounting to 10.5 million barrels per day (mmbpd). Its crude oil and condensate reserves increased as well to 260.8 billions barrels representing 21.9% of world's proven reserves (OPEC, 2017). Aramco experienced a rise in its crude oil exports; from 2'603 to 2'799 million barrels in 2016. Two third of its exports are headed to Asia, 15.8 percent to the USA – despite the rise of the shale industry, 11.3 percent to Europe and 6.2 percent to other countries. The exports amounted to $136 billion, representing 20 percent of the world crude oil exports (WORKMAN, 2018). There is no information available on financial results in the company's annual review.

Figure 2 Aramco's crude oil production, reserves and exports



Crude oil production and exports
(millions of barrels)

	2015	2016
Crude oil production, excluding condensate blended	3,708	3,828
Crude oil exports	**2,603**	**2,799**

Source: Saudi Aramco – Annual Review 2016 (p.74)

1.1.2 Organization of Petroleum Exporting Countries (OPEC)

OPEC is a permanent and intergovernmental organization created in 1960 at the Baghdad Conference by Saudi Arabia, Iran, Kuwait, Iraq and Venezuela. Throughout the years, the five founding members were joined by ten other countries: Qatar, Libya, United Arab Emirates, Algeria, Nigeria, Ecuador, Angola, Gabon and Equatorial Guinea. Indonesia joined the organization as well in 1962 but suspended its membership in November 2016. Today, OPEC's headquarters are located in Vienna, Austria.

The objective of the organization is " to coordinate and unify the petroleum policies of its Member Countries and ensure the stabilization of oil markets" (OPEC, 2018) which involves the creation of a steady supply of petroleum to the consumers in general and a reasonable return on capital to the producers.

The influence of Saudi Arabia within the organization has been unchallenged. Due to its large crude oil production capacity, Saudi Arabia is the only country having a large excess capacity available to face market interruptions and demand surges. Over the years, Saudi Arabia has softened the impact of critical oil supply interruptions such as during the Iran-Iraq war, the invasion of Kuwait and the Venezuelan crisis of 2003 (AGUILERA, RADETZKI, 2016).

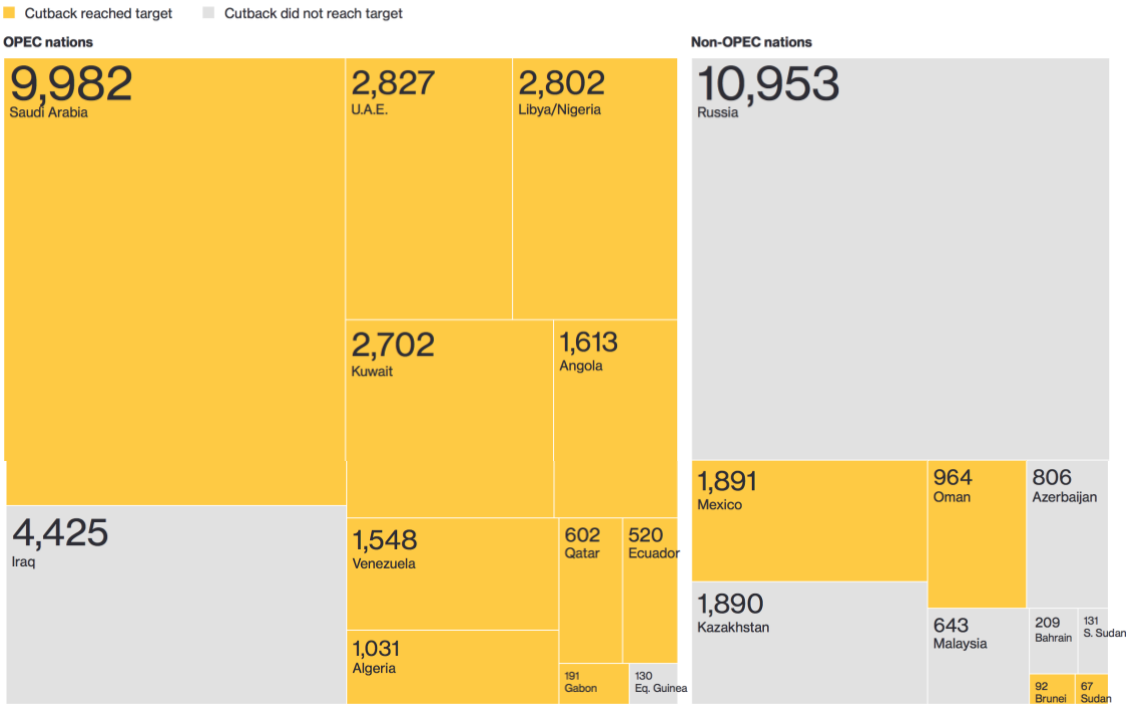
We can understand the importance of stable oil markets for Saudi Arabia due to their dependency on oil. Saudi Arabia's oil policies have always been towards maximization and sustainability which was easy when the country could play a leverage role in the oil sector.

The objective of the OPEC is at stake today due to two main reasons which make Saudi's excess capacity advantage less attractive: the rise of the shale industry and Russia and ARAMCO's IPO.

Back in January 2017, OPEC members and their allies started to cut their production to support the recovery of the oil price. While it is easy for Saudi Arabia to fill the gap in production to meet world demand it is much harder to implement a strategy to cut world production. Most of the OPEC countries have followed through the plan in which 21 countries are attempting to reduce production by almost 1.8 million barrels a day (WINGFIELD, DODGE, SAM, 2018). Figure 3 shows the production in thousands of barrels a day for February 2018. While Saudi Arabia, the UAE, Libya/Nigeria, Kuwait, Angola, Qatar, Ecuador, Algeria, Gabon have met or exceeded the cutback target Iraq and Equatorial Guinea did not meet the requirements. Venezuela has cut back its production notably, reaching the cutback target on an average of 212% since January

2017. However, the cut in Venezuelan production is unintentional and due to an economic crisis.

Figure 3 February 2018 crude oil production (mbbld)



Source: Bloomberg "OPEC Oil Cuts Deepen"

Non-OPEC countries, however, have not been cutting production efficiently. Only Mexico, Oman, Brunei and Sudan have reached the cutback target. On the run to be world's leading producer, Russia did not achieve the cutback targeted by producing 10'953 thousand barrels a day; 12% more than the quantity agreed. Nevertheless, OPEC countries cutbacks were positive. From January 2018 to April 2018 cutbacks averaged 156%. OPEC's allies, however, did not reach the target with an average of 74% over the same period. Altogether, OPEC countries compensated the lack of cutbacks from their allies thanks to the Venezuelan crisis. We see that it takes more than the OPEC countries, and especially Saudi Arabia, to affect prices nowadays. On the other side of the world, the USA has been pumping more oil than ever, undermining OPEC's practices to create a supply shortage (SMITH, 2018). USA's ascendance can explain Russian production as both are competing for the world's leading producer rank.

The second reason lies with Aramco's IPO, explaining OPEC's cutbacks (SMITH, 2018). The IPO was initially planned for earlier this year and has been postponed to 2019. The IPO lead to rethink OPEC oil policy. If listed, the company will have to take into account the interests of investors and will be scrutinized by anti-trust legislation (EL GAMAL,

LAWLER, 2017). In the United States, anti-trust legislation prohibits price-fixing and Aramco could be accused of such if the country follows the OPEC policy of adjusting output to manage price.

The example of Equinor -former Statoil- is a good illustration of the path that Aramco is planning to follow. Equinor has been listed in New York and Oslo since 2001 and owned by the Norwegian government which has a stake of 67%. Since its listing, the company has refrained from joining any international steps related to regulation of oil outputs. Aramco's leaders have met with Equinor to talk over the best approach to restructure Aramco's operations and prepare the IPO (EL GAMAL, LAWLER, 2017).

Saudi Arabia is at the moment still a member of the OPEC but due to those two important points, one could wonder if the OPEC is not about to lose the precious influence of one of their founding member in a foreseeable future.

1.1.3 Comparison to Petroleos Mexicanos (PEMEX)

Petroleos Mexicanos (PEMEX) is the Mexican state-owned oil producing company. The company headquartered in Mexico city is also engaging in the exploration, production, refining and marketing of oil and gas. Pemex operates principally in Mexico, America (North, Central, South) and Europe. In terms of production, Mexico experienced some decrease in production over the years due to a natural decline in matured fields. In 2017, two significant discoveries have been made in Mexico, one offshore by private companies as Mexico changed its fiscal reform in 2013 and one onshore discovered by PEMEX. The latter giving hope for a recovery in PEMEX's production. (PARASKOVA, 2018)

The table below shows the similarities and differences of the two companies. The information and figures were found on PEMEX's and Aramco's official website.

Table 1 Comparison of PEMEX & Aramco

	PEMEX	**Aramco**
Type	State-owned	State-owned
Headquarters	Mexico	Saudi Arabia
Market structure	Monopolistic	Monopolistic

Activity	Exploration, production, refining, marketing	Exploration, production, refining, distribution, marketing
Region	Mexico, America (North, Central, South), Europe	Asia, North America, Europe
OPEC Member	No	Yes
Listed company	No	No - IPO by the end of 2018 for 5%
Oil production 2016	2.154 mmbpd	10.5 mmbpd
Reserves 2016	9.762 billions barrels	260.8 billions barrels
Exports 2016	1'194 thousand barrels	2'799 millions barrels
Type of crude	Maya, Isthmus, Olmeca Heavy crude oil (50%) Medium crude oil (35%) Super light (25%)	Arabian Super light crude oil Light crude oil
Petroleum fiscal regime	Concessionary since 2013	Go-it-alone strategy

Both companies display several similarities; they are state-owned, monopolistic and non-listed. The definition of their activities is similar with the exception of PEMEX not stating distribution as an activity. PEMEX is more active in the West region of the globe with Mexico, America and Aramco in the East region with Asia. Mexico is not an OPEC member, it is however an ally to the OPEC members.

The main difference to highlight for the purpose of the upcoming analysis is the production size; Aramco's production is almost 5 times bigger than PEMEX's which will most likely oblige us to take a different approach to a possible hedging strategy.

In terms of crude oil, Maya crude, which is the most common crude oil produced by PEMEX is a heavy crude (high density) that needs special refineries to be pre-treated.

Isthmus crude oil is a medium crude and Olmeca a light crude oil. Arabian crude oils are mainly of high standards and are considered light and super light crude oil. The Sulphur content in Aramco's crude is also lower than in PEMEX's making it a sweeter type of crude.

The fiscal regimes of each country, i.e. the set of laws, regulations and agreements governing the profits derived from petroleum exploration and production are different as well. Saudi Arabia has a go-it-alone strategy. It means that the country has chosen to develop its domestic resources on its own. The government formulates and finances an investment program which is executed through the National Oil Company, Saudi Aramco. Saudi Aramco exploits their resources base as a mean of supporting the domestic economy and as a tool to sustain the country's supply. This strategy can create an under-investment situation, potentially generating stagnation in growth capacity as well as inability to maintain or increase production capacity. This situation happened to Mexico. who has changed its fiscal model in 2013 for a concessionary regime resulting in a narrow opening on its oil & gas sector for international players. It was made through restrictive terms of risk service contracts. It was an crucial change for Mexico who could not allocate large capital in exploration. Opening the oil market to international players allows opportunities for experimentation and innovation. Norway adopted an hybrid solution of NOC (Equinor) and IOC combined. The fiscal reform (Energy Reform) became a law in August 2014 in Mexico (DANIEL, KEEN, MCPHERSON, 2010)

1.2 Derivatives

Financial products, especially derivatives, are generally perceived negatively by the public opinion, particularly when the word "speculation" is employed. Most of the time, when we see a topic on derivatives in the newspapers, it is associated with tremendous losses and scandals – Enron in 2001, Lehman Brothers 2008. But without them, the industrialized world as we know it could not be absorbed by the financial markets. The origins of are related to the development of commercial operations and they date back to very old times. Interest rate swaps, commodity derivatives and currency structured products which we know today are the offsprings of old business practices (PALANIAPPAN, 2017). Trading was a conventional practice and people were exchanging goods and services before the invention of money. One would barter goods it had in excess for goods it lacked (BURN-CALLANDER, 2014). Non-perishable items such as grains or wine were used as a storing value.

Around 4500 BC, the people of Sumer, a region of ancient Mesopotamia – today's Iraq and Kuwait used clay tablets to represent commodities and recorded delivery dates for traded goods. This practice bears a certain resemblance to futures contracts. (PALANIAPPAN, 2017)

The first example of a derivative transaction was recorded in Aristotle's work around 600 BC, in ancient Greece, by Thales of Miletus who became the world's first olive oil derivatives trader. Thales was challenged by an ancient question "If you are so smart, why aren't you rich?" and so he used his knowledge of astronomy to predict good olive crops in the coming season to become rich. He positioned himself to profit from the rising price of oil; he invested the little money he had to reserve each olive oil press so that he would benefit from its exclusive use during harvest time. When the harvest came, Thales' predictions became fulfilling and, as he had the monopoly over the production of olive oil, he could charge high price for olive oil which was in high demand. The contract he had made with the owner of the press was in substance, no different from today's derivatives. It could have been either an option or a forward depending on the terms. By reserving each olive oil press, Thales gave a deposit which entitled him to the use of the press at harvest time. If it was only a right and not an obligation this transaction could have been called an option. If on the other hand, he would have had to pay for the olive oil press at harvest time whether he made a use of it or not, this would have been called a forward. (CHATNANI, 2010)

In the same way, the Athenians used shipping contracts in which they specified the pricing, the type of commodity and its volume as well as a period of time. The practice comes is familiar to forwards contracts. In Medieval Europe, the use of "fair letters" during the Champagne fairs was of a great improvement for trades. They acted like a promise of payment with people buying at one fair and promising to pay at a later one. The Champagne fairs acted like a clearing house settling debits and credits at the end of each day (PALANIAPPAN, 2017).

As demonstrated through common old practices, the evolution of humanity brought the evolution of the financial world, leading us to the financial products we know today.

1.2.1 Types of instruments

The basic idea of derivatives is that traders, producers or consumers want to insure themselves against a risk. On the other hand the counterparty must be willing to take on that risk. In this context, we can therefore talk about risk transfer; the risk being transferred from the seller to the buyer or vice versa.

Derivatives are financial instruments dealing with assets. Hence, they do not perform by themselves, but according to the asset, called the underlying, from which the price derives. A financial derivative can be very broadly defined as a contract whose value depends on the value of an underlying asset.

We can distinguish two types of underlying:

Commodity underlying	**Financial underlying**
Agricultural, Metals, Energy, …	Publicly traded stock, stock market index, exchange rate

In this paper, we will look at off-balance sheet instruments such as forwards, futures, options and swaps used to manage financial risk on a commodity underlying. Appendix A sums up the four instruments in a table.

1.2.1.1 Forwards

A forward contract is a private agreement between two counterparties, namely the buyer and the seller, to trade an asset on a specified date in the future. The price is fixed at the time of the conclusion of the contract for a delivery in the future. A forward contract is an Over-The-Counter (OTC) traded derivatives with customized terms and features. The downside to such agreement is that one party may fail to honor its commitment and so each party is taking the credit risk of the other counterparty.

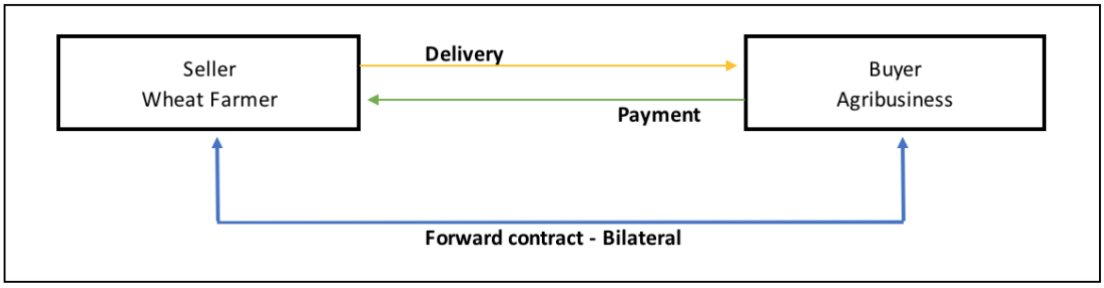
There are two forms of settlement in a forward contract: physically-settled and cash-settled contract. In a physically-settled contract, the seller has to deliver the contract's specified quantity and the buyer has to pay the agreed price. In a cash-settled contract, no asset is delivered. The spot price of the asset at maturity is compared to the contract's price and the party loosing must compensate the party gaining for the difference. If the spot price is higher than the contract price, it means that the contract price is more advantageous for the buyer so the seller has to compensate him. Inversely, if the contract price is higher than the spot price, the buyer has to compensate the seller for the difference.

Forwards are generally settled physically and thus require delivery as illustrated in Figure 4 with the example of a wheat farmer. A common motivation to enter into a forward contract is to hedge an existing market exposure which means reducing the cash flow uncertainty arising from the market exposure. The farmer is concerned about the price of wheat in three months' time, when his crops will be harvested. The farmer is exposed to the risk of declining prices. By entering in a three-month forward contract as a seller,

the farmer can lock-in a price and therefore avoid price fluctuations by securing his cash flow.

The buyer of the forward contract will have the opposite price exposure; he is concerned by the rising price of wheat. It might be an agribusiness which needs wheat as an input in its production and would like to lock-in a price at which it could purchase wheat.

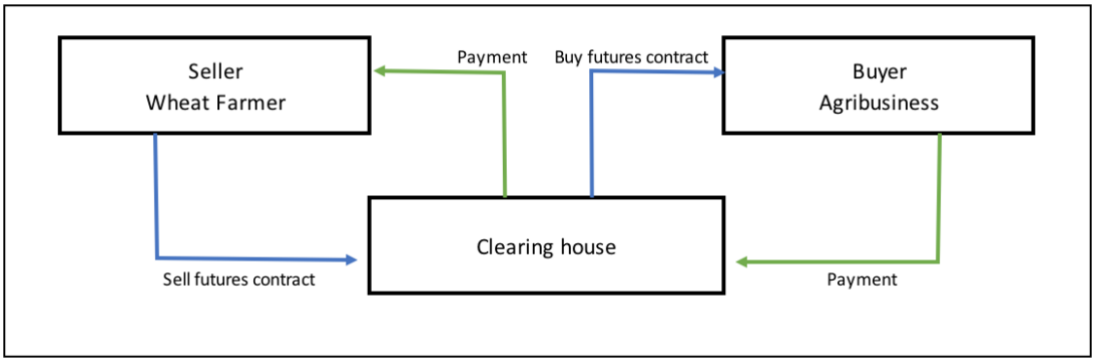
Figure 4 Forward schema



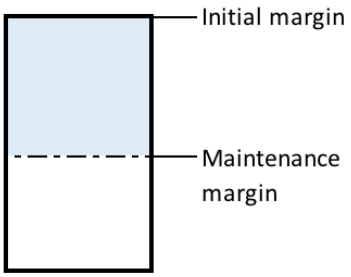
1.2.1.2 Futures

Futures contracts are essentially like forward contracts but standardized and traded on an organized exchange. As seen under the forward section, forward contracts terms are set consensually by the buyer and the seller. In futures contract, the exchange determines all the terms except for the price. The exchange determines the commodity underlying the contract, the quantity of one contract, the delivery date, the grade/minimum quality of the commodity, the delivery point and the currency. Buyers and sellers submit their orders to the exchange and indicate the number of contracts they would like to buy or sell. The exchange then matches the orders. In Figure 5, we clearly see that there is no connection between the buyer and the seller. Orders are made to the organized exchange and payment are made through it as well.

Figure 5 Futures schema



In substance forwards and futures have the same function but the exchange lay important differences.



By its standardization, futures contract generally do not provide a good hedge as customizable forward contracts unless the hedging needs coincide with the terms of the standardized contracts.

Under a forward contract, each party takes on a counterparty risk. In a futures contract, the exchange guarantees performance of the contract, which means that the exchange becomes counterparty to the buyer and to the seller. This makes it less riskier than a forward; a process is called novation process. The exchange takes on the credit risk through the clearing house. The clearing house is therefore the intermediate to all futures transactions.

To guarantee the performance of the contract obligations, the clearing house has a risk management system which requires each party to deposit a margin. The margin resembles to a “good faith” deposit and serves as a collateral.

The minimum level for the initial margin and the maintenance margins are set by the exchange. At the opening of the contract, each party has to deposit an initial margin which usually represents 10% of the contract value in a margin account. As the clearing house completes mark-to-market calculations every day, margin accounts are debited/credited accordingly. If the futures price rises (falls), the buyer has made a paper profit (loss) and the seller a paper loss (profit); the payment of paper profit/loss is made through the margin. If the loss incurred sets the margin account at a level lower than the maintenance margin, the clearing house sends a margin call to the party concerned. The party concerned has to restore the margin account up to the initial margin the same day to keep the position open.

Through futures contracts, the hedger eliminates the risks. But in reality, it is difficult to eliminate all risks. To eliminate all risks, one would need the futures contract to match perfectly with its physical contract: the quantity, the precise date, the underlying, the quality. If we consider the precise date, a futures contract is subject to a delivery period before which the hedging position needs to be closed or else the contract will turn into a physical contract. The position needs to be offset during the trading period, before the expiry, which usually occurs a month prior to the delivery date. This creates a mismatch calendar wise. The hedge cannot cover a specific contract period. All risks can therefore not be eliminated, the hedger will be facing what we call the basis risk. The basis risk is

the difference between the spot price of the asset hedged and the futures price. It is represented by the widening or narrowing of basis from the moment the hedge is put into place until it is closed.

In the eventuality the asset hedged is similar to the one in the futures contract, the basis risk would equal zero at the expiration of the futures contract. During the hedging period, the basis can be either positive or negative. If the basis is positive, meaning that the spot price is higher than the futures price, the market is said to be in backwardation. If the basis is negative, meaning that the spot price is lower than the futures price, the market is said to be in contango.

If however, the asset hedged is different than the underlying of the futures contract, we are in a situation of cross hedging. In a cross hedging situation, the basis will never equal zero, even at the expiration. The basis can be reduced by finding a futures contract which is highly correlated to the asset hedged. High correlation will result in a lower basis and improved hedge effectiveness. It is important to note that the spot price and the futures price are positively correlated. Futures hedging works to bring a zero-zero sum. In a declining market, a producer who is long physical and short futures, would incur a loss on the spot market when selling physical and a gain on futures when buying back futures.

Gains/losses can be made through the basis. When offsetting a hedge, a producer has to go long futures i.e. buy back the same position. If the basis is the same when the hedge is lifted, the producer incurs no gain/loss. However, if the basis is lower, the producer ends up with a higher net price (WISNER, HOFSTRAND, 2015).

1.2.1.3 Swaps

Swaps, like forwards, are OTC contracts. Swaps are effectively portfolios of forwards. In a forward contract, the counterparties commit to a single trade. In a swap, the counterparties commit to multiple trades over several dates in the future. Swaps are financially settled, no physical commodity is delivered. As a bilateral agreement, they are a substitute for futures contracts which allow for a better hedge. They rely on the exchange pricing to define the financial arrangement. The pricing can also be based on trade journal references such as Platts. The attraction of swaps is that basis risk can at times be zero, as OTC contracts can often price against the same price reference as the physical. For example, FOB Gasoil Amsterdam quote against gasoil has a correlation of at 99.9%[1].

[1] Interview with Dougal Poget, Geneva

The counterparty risk of the swap can be transferred to a clearing house. The transaction would then be called a cleared swap. A cleared swap benefits from the intermediation of the clearing house but is not executed on the exchange (THE ICE, 2011).

Most commonly used swaps are interest-rate swaps and currency swaps. Commodity swaps involve the exchange of the difference between a specified fixed price and the actual floating price of a commodity.

Let us consider the case an airline company, which buys kerosene on an ongoing basis. To reduce the risks related to the price, the company could enter in a forward contract for each payment or, to facilitate the transaction, the company could use swaps to hedge the stream of payments. In a swap, the counterparties set the estimated amount, the maturity of the swap, the payment dates, the floating price (market price) and the fixed price.

Figure 6 Swaps schema

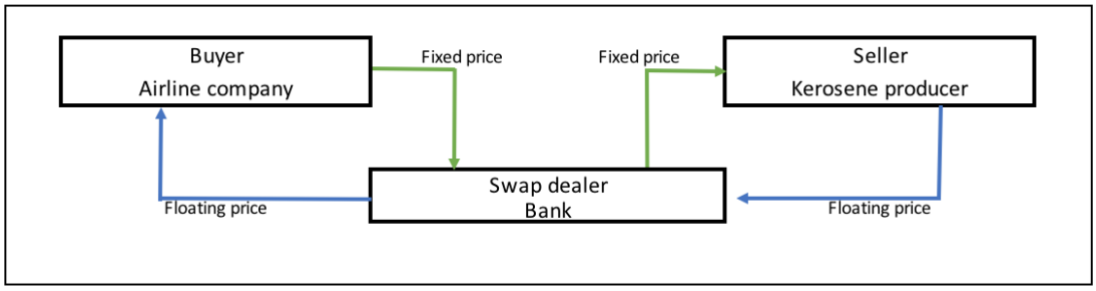


Figure 6 shows the structure of a swap but it does not represent the cash-flows. In reality the difference is calculated between the fixed price and the variable price and only the counterparty owing money to the other makes a payment. The seller of the commodity, is said to be the seller of the swap and therefore pays the floating price; he wants protection against a falling price. The buyer of the commodity however is seeking protection against a rising price and pays a fixed price. When entering into a swap contract, the swap value is zero, which means that there are no cost to enter into the contract. The changes in prices over the time period will drive the swap value negatively or positively.

In a commodity swap, only one party pays the cash settlement at maturity date.

If the fixed price is higher than the floating price, then the buyer has to pay the cash settlement to the seller.

If on the other hand the fixed price is lower than the floating price, the seller has to pay the cash settlement to the buyer.

In the previous section about futures, we defined basis risk and how it influences a hedge with a futures contract. In crude oil markets, there are three primary types of basis risk: locational basis risk, product/quality basis risk and calendar basis risk. Each of these can be hedge with a basis swap. It is very common for producer to enter into basis swaps on quality basis risk for example. It is the perfect combination to eliminates the risks due to the standardization of the futures.

1.2.1.4 Options

An option is also contract between two counterparties and can be OTC or exchange-traded. An option provides a sort of financial insurance. As the name suggests, options are characterized by optionality. The buyer of an option acquires a right to - buy or sell – a determined quantity of a good at a specified time and at a determined price called the strike price. The buyer is also referred to as the holder of the option or is said to be long. The buyer has the right to exercise at any time up to the expiry date under an American option and under a European option the exercise can only take place at the expiry date. To acquire this right, the buyer pays a premium. The seller on the other leg of the contract has the obligation to - buy or sell - under the conditions set, should the buyer exercises his right. In return, he receives the premium. The seller is also called the writer of the option or said to be short.

The value of the premium has two components: the intrinsic value and the time value. The intrinsic value is represents the difference between the market value and the strike price; it can never be negative. The time value is influenced by the residual maturity and the volatility of the commodity. The further the expiration date of the option is, the greater the risk but the greater the flexibility to act. As we get closer to the option's expiry, the temporal value diminishes. On expiry date, the time value equals to zero.

A call option premium will be more expensive if the market price is high, the strike price is low, the residual maturity is long and the volatility is high.

A put option premium will be more expensive if, the market price is low, the strike price is high, the residual maturity is long and the volatility is high.

1.2.1.4.1 Two types of option

Call option:

In this context, the buyer is said to take a long call. His market expectations are bullish; he expects the price of the commodity to increase. To acquire his right to buy the commodity at a certain price in the future, the buyer pays a premium to the seller. The

seller on the other hand, has the obligation to sell the commodity if the option is exercised. The buyer will exercise his option if the market price increases. His potential profit is unlimited (as per the commodity price).

Table 2 Call option similes

	Long call	**Short call**
Market expectations	Increase in price	Decrease in price / No major fluctuation
Buy / Sell	Buy	Sell
Rights & Obligations	Right to buy Obligation to pay the premium	Obligation to sell Right to the premium
Bullish market; price ⬆	Exercise the right	Obligation to sell
Bearish market; price ⬇	No exercise	-
Potential profit	Unlimited	Limited to the premium
Risks	Limited to the premium	Limited if covered Unlimited if uncovered

Put option:

The buyer takes a long put. His market expectations are bearish; he expects the price of the commodity to decrease. Like in the call option, the buyer pays the premium to acquire his right to sell and the seller receives the premium. The buyer will exercise his option if the market price decrease below the strike price. His potential profit is – strike price minus the premium –and his risk is limited to the premium.

Table 3 Put option similes

	Long put	**Short put**
Market expectations	Decrease in price	Increase in price / No major fluctuation
Buy / Sell	Buy	Sell
Rights & Obligations	Right to sell Obligation to pay the premium	Obligation to buy Right to the premium
Bullish market; price ⬆	No exercise	-
Bearish market; price ⬇	Exercise the right	Obligation to buy
Potential profit	Limited to strike price - premium	Limited to the premium
Risks	Limited to the premium	Limited to strike - premium

1.2.1.4.2 Four strategies

Long call

A wheat consumer is concerned that the price of wheat will rise due to a supply shortage caused by dry weather for example. He buys an option:

1 call wheat $300.00 June 2017 $15.00 (American)

It is a long call which allows for the purchase of wheat at $300.00 until June 2017. To acquire this right, he pays $15.00. The buyer makes a profit when the price of wheat is higher than the strike price plus the premium ($300.00+$15.00 = $315.00). The potential profit is said to be unlimited; the higher the market price – the higher the profit. At the expiry, if the price is below $315.00, the buyer will not exercise and his maximum loss is the premium ($15.00).

Long put

A wheat producer is concerned the price of wheat will fall due to over-supply for example. He buys an option:

1 put wheat $300.00 June 2017 $15.00 (American)

It is a long put which allows for the sale of wheat at $300.00 until June 2017. To acquire this right, the buyer pays $15.00. The buyer makes a profit when the market price is below the strike price – the premium ($300.00 - $15.00 = $285.00). As the market price falls, the profit increase. Above $285.00, the buyer makes a loss however limited to the premium.

Short call

A wheat producer is concerned the price of wheat will fall. He sells an option:

1 call wheat $300.00 June 2017 $15.00 (American)

It is a short call which obliges the producer to sell wheat at $300.00 if the option is exercised by the buyer. The producer realizew a benefit if the market price is below the strike price + the premium ($300.00 + $15.00 = $315.00) at the expiry date as the buyer would not exercise under those circumstances. The maximum benefit is the premium ($15.00). In the eventuality the buyer exercise the option, the producer has the obligation to sell wheat at $300.00.

Short put

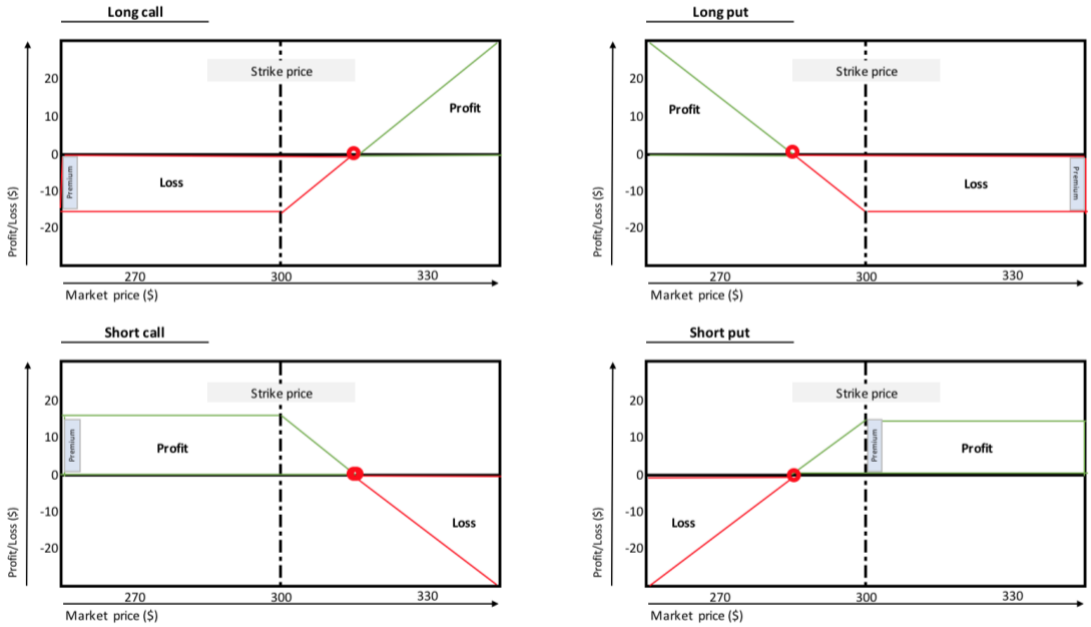
A wheat consumer is concerned the price of wheat will increase. He sells an option:

1 put Wheat $300.00 June 2017 $15.00 (American)

It is a short put which oblige the consumer to buy wheat at $300.00 if the option is exercised by the buyer. The seller's potential profit is limited to the premium and risks are limited to the strike price minus the premium ($300.00 - $15.00 = 285).

Figure 7 shows the options diagram for the four types of strategies described above.

Figure 7 Options diagram



The diagram illustrates the limitation in profit for a long put and a short call; one is limited to the strike price minus the premium and the other one to the premium. The long call offers a possibility of unlimited profit as the latter would rise up with the market price. The riskier option of all is consequently the short call with an unlimited potential loss if the transaction is undertaken uncovered. The others are limited to the premium or to the strike price minus the premium.

Holding a call option therefore provides an insurance to the holder against an increase in the price of the commodity while allowing the holder to take advantage of price decreases. There are thus no real alternative to options, as the other instruments fix a price without providing optionality to act. However, it involves an up-front costs of buying an option (premium) to compensate against the optionality to exercise.

1.2.2 The potential risks

We find three factors which need to be taken into account when evaluating the risks of derivatives usage; leverage, volatility and liquidity.

Leverage is a great “factor” in derivatives instruments which creates a good potential for large gains but it does also leverage a losing position if the market moves in the wrong direction.

Volatility adds up to the leverage effect. If the underlying asset displays high volatility and unexpected price movements, the effects of leverage will amplify the movements under the derivative contracts leading possibly to larger losses.

Volatility accompanies liquidity. If the market is not liquid enough, it makes it harder to exit a position and it therefore increases the risk of the position. Liquidity facilitates the distribution of financial risk to market participants who are more able to bear the risks or are willing to take them on.

2. Analysis

As seen in the derivatives section, derivatives are useful instrument to manage risks. They can be used to hedge an existing market exposure (futures & forwards), to obtain downside protection from an exposure without giving up the upside potential (options) and to transform the nature of an exposure (swaps).

2.1 Research methodology

To undertake the analysis, the resources used are primary and secondary researches. Both researches provided me with quantitative and qualitative data.

For primary research, I used company financial reports to see what were the hedging practices in place, if existing, and to understand the managerial decision taken. Quantitative data was collected from Auditoria Superior de la Federacion, a Mexican government website, the Petroleos Mexicanos, Saudi Aramco's, EOG Resources', BP's, Equinor's as well as the Bank for International Settlements' websites. Some quantitative information was also gathered from secondary resources such as Bloomberg website or platform.

The websites listed above were also used for qualitative data about companies. I have additionally collected information in press articles, principally to gather information about the Hacienda Hedge. Concerning the theoretical aspect of my thesis, I read books and reports.

2.2 Study of derivatives

2.2.1 The market size

Despite the general negative opinion about financial derivatives, financial derivatives are widely used. Derivative markets are often estimated at $1.2 quadrillion at high-end (CHANG, 2017), exchange and OTC combined, however some analysts believe the figure is vastly overstated. Figures in tables below have been retrieved from the Bank for International Settlements to assess the size of the market.

Table 4 and 5 describe the size of the world derivatives market. The first table represents the notional outstanding on standard exchanges. Table 4 only shows futures and options on interest rate and foreign exchange. The Bank for International Settlements did not present any data breakdown per underlying as a result no details were available on commodities contracts as well as no information on the gross market value.

Table 4 Exchange-traded futures and options

In billions of US dollars	Notional outstanding			
	Dec.1998	Dec.2010	Dec.2016	Jul.2017
All derivatives instruments	12'741	62'311	67'245	81'031
Futures				
All markets	8'072	21'249	26'169	33'653
Interest rate	8'040	21'077	25'944	33'372
Foreign exchange	32	172	225	281
Options				
All markets	4'669	41'062	41'076	47'378
Interest rate	4'621	40'918	40'954	47'259
Foreign exchange	49	144	122	119

Source: The Bank for International Settlements

As of July 2017, the notional outstanding was at $81 trillion ($33 trillion in futures and $47 trillion in options). In over two decades, the notional outstanding has quadrupled. From 2010 to 2017, the size of the exchange has increased by 30% and we have had a shift between the use of futures in 1998 and to the use of options. As of 2010, options are the predominantly used instruments. Over the past years, we have been in a situation of sustained trends on all markets (equity, bonds and commodities) which I believe could explain the shift in utilization. Volatility has decreased in most markets which induce that option premiums are less expensive and therefore more attractive.

Table 5 shows the notional outstanding in OTC derivatives market amounting to $459 trillions in July 2017; notional amounts represent the face value of the underlying asset. The gross market value represents $12 trillions. Gross market value is a better indication of the actual risk as it characterizes the total value of outstanding contracts. We can see an increase from 1998 to 2010, from a gross market value of $3 trillions to $12 trillions. In over two decades, OTC derivatives market expanded greatly with swaps representing 80% of the market, followed by options (11%). Lastly, we find commodities contracts separately for the purpose of the thesis. The notional outstanding representing $1.4 trillions; $1’023 billions in forwards and swaps and $378 billions in options. Forwards and swaps amounting to $136 billions in gross market value.

Table 5 Global OTC derivatives market

In billions of US dollars	Notional outstanding				Gross market value			
	Dec.1998	Dec.2010	Dec.2016	Jul.2017	Dec.1998	Dec.2010	Dec.2016	Jul.2017
All derivatives instruments	74'553	519'559	411'343	459'660	3'219	19'738	14'490	12'325
Swaps	50'724	413'909	335'812	375'071	2'244	15'427	11'782	10'023
Forwards and forex swaps	12'063	28'433	37'215	43'871	491	886	1'262	1'044
Curency swaps	2'253	19'271	20'903	22'207	200	1'235	1'447	1'107
Interest rate swaps	36'262	364'377	275'168	306'144	1'509	13'139	8'915	7'683
Equity-linked forward and swaps	146	1'828	2'526	2'849	44	167	158	189
Options	13'034	63'194	46'317	51'858	440	2'243	1'502	1'281
Fx contracts	3'695	10'092	10'478	10'901	96	362	264	179
Interest rate contracts	7'997	49'295	32'226	36'970	152	1'401	924	764
Equity-linked contracts	1'342	3'807	3'613	3'987	192	480	314	338
Commodity contracts	408	2'922	1'350	1'401	43	526	163	136
Forwards and swaps	213	2'011	956	1'023	N/A	N/A	N/A	N/A
Gold	76	230	220	248	N/A	N/A	N/A	N/A
Other precious metals	22	90	34	51	N/A	N/A	N/A	N/A
Other commodities	114	1'691	702	723	N/A	N/A	N/A	N/A
Options	195	911	393	378	N/A	N/A	N/A	N/A
Gold	99	167	134	128	N/A	N/A	N/A	N/A
Other precious metals	28	32	18	16	N/A	N/A	N/A	N/A
Other commodities	69	712	242	234	N/A	N/A	N/A	N/A
Unallocated	10'387	39'534	27'864	31'330	492	1'542	1'043	885

Source: The Bank for International Settlements

As the OTC market involves bilateral agreements, I suspect that the information available are not representative of the actual market size as data is not always available. The figures collected do not come close to the $1.2 quadrillion estimation. I believe calculations were made on the notional amount. OTC and exchange markets combined come to a notional outstanding of $540'690 billions (OTC $459'660 billions + $81'031 billions exchange traded) The result is greater in value than all stock markets combined ($73 trillion) (CHANG, 2017). This amount come close to low-end estimation of $540 trillion as made by analysts. I believe it is more accurate to look at the gross market value. Due to the lack of transparency of the exchange, only OTC gross market is available. However, with a $136 billions of gross market value on commodities contracts only, we can consider that the market is displaying sufficient liquidity

2.2.2 PEMEX & the Hacienda Hedge

The Hacienda Hedge is the largest oil trade made on Wall Street, as stated in Javier Blas's article "Uncovering the Secret History of Wall Street's largest oil trade". Every year since 2008, Mexico hedges a great amount of the country's production. The decision involves a dozen representatives from three Mexican government ministries and Pemex. It is executed through a couple of oil trading desks such as Barclays, Goldman Sachs, Morgan Stanley, Deutsche Bank. PEMEX buys put options which give them the right to sell oil at a predetermined future price. Their outlook on the market is that the price will drop and they want to be insured against it. This type of deal has been a thinking since the 1980s when Mexico was seeking to stabilize its fiscal stance. It was however undertaken for the first time in 1990 after Saddam Hussein invaded Kuwait. The country did not want to suffer another oil crisis like the one in 1985-86 when Saudi Arabia submerged the market by increasing its production and prices plummeted. After that, Mexico did not enter in a hedging program for years until the early 2000s. (BLAS, 2017).

2.2.2.1 Annual reports

In its annual reports, PEMEX recognizes the use of financial derivatives to manage interest rate risk, exchange rate risk as well as commodity price risk for natural gas. Concerning crude oil, the company states in its Notes to the Consolidated Financial Statements 2008;

"Under its fiscal regime, Pemex transfers most of its risk related to crude oil prices to the Mexican Government. As a consequence, Pemex generally does not enter into long-term hedging transactions against fluctuations in crude oil prices. During 2008 and 2007, Pemex did not enter into any crude oil price hedging transactions.".

As a result, no evidence of derivatives practice was found in the annexes on crude oil derivatives for those years. In 2009, the company engages in futures contracts (7.15 MMb) and exchange traded swaps (2.86 MMb). In 2010, they used futures for 4.93 MMb and exchange traded swaps for 0.32 MMb as well as in OTC swaps for 0.55 MMb (PEMEX 2010 Annual report, p. 59). In 2011, PEMEX used the same type of derivatives. Regarding annual report 2012, the derivatives products were classified as non-hedging instruments as they do not qualify to the strict requirements of IAS 39 (PEMEX 2012 Annual report, p. 50). After 2013, there is no annual report available in the publication section on Pemex's website.

As seen in accounting class, under IFRS and US GAAP, derivatives instruments used for hedging purposes are not recorded in the balance sheet. However I read another

note in the annual reports concerning the differentiation in accounting arising from derivatives used in the purpose of trading and hedging. Financial derivatives recognized in the balance sheet were valued at fair value. Changes in the fair value of derivatives held for trading purposes are recorded in the cash flow results and derivatives used as hedge are recorded in the statement of operations using the fair value method. It is not clear what the criteria are for an instrument to be considered as a hedge. In Table 6, we find the reported financial results of PEMEX expressed in USD. The figures from 2008 to 2012 are audited results. The reports starting of 2013 are unaudited and did not mention any distinction between financial instruments used for hedging and trading. The consolidated statement of operations was not available either.

From 2009 to 2012, PEMEX recorded losses 3 years out of 5. Profits were recorded in 2009 and 2010 for respectively $1'124'507 and $1'042'778 thousand. No further information was found in the details of the transactions.

Table 6 Pemex's consolidated results

in thousands US

	2008		2009		2010		2011		2012	
Consolidated Balance Sheet	Assets	Liabilities	Assets	Liabilities	Assets	Liabilities	Assets	Liabilities	Assets	Liabilities
Derivative financial instruments	1'646'137	1'825'623	2'012'292	1'304'735	1'081'552	623'395	832'111	557'358	467'950	349'163
Consolidated statement of cash flow										
Financial instruments	-321'085		-699'674		98'021		122'986		99'245	
Consolidated statement of operations										
Comprehensive financial result										
Interest- Net (includes valuation effects of financial instruments Note 11(viii)	-2'690'302		-2'296'742		-1'661'669		-1'698'075		-2'571'686	
Exchange loss - Net	-5'248'999		1'124'507		1'042'778		-3'040'363		-2'318'804	
Gain on monetary position	-		-		-		-		-	

Unaudited

	2013		2014		2015		2016		2017		Q1 2018	
Consolidated Balance Sheet	Assets	Liabilities	Assets	Liabilities	Assets	Liabilities	Assets	Liabilities	Assets	Liabilities	Assets	Liabilities
Derivative financial instruments	516'000	481'000	106'000	1'186'000	93'000	1'587'000	235'000	1'494'000	1'522'000	897'000	2'325'000	571'000
Consolidated statement of cash flow												
Financial instruments	141'000		1'111'000		570'000		15'000		-843'000		-1'080'000	
Consolidated statement of operations												
Comprehensive financial result												
Interest- Net (includes valuation effects of financial instruments Note 11(viii)	N/A		N/A		N/A		N/A		N/A		N/A	
Exchange loss - Net	N/A		N/A		N/A		N/A		N/A		N/A	
Gain on monetary position	N/A		N/A		N/A		N/A		N/A		N/A	

Source: PEMEX

Some unaudited annexes on the financial reports produced for each quarter starting of 2012 revealed information on crude oil derivatives. The company reported crude oil stock market futures, stock market swaps i.e. cleared and OTC swaps. Appendix B is a composition I have made from the annexes on financial reports starting of 2015. The information found shows the utilisation of swaps and futures from 2015 to the first quarter of 2018. Starting of the second quarter of 2017 only, Pemex has been using options.

However, transactions do not correspond to the world's largest oil trade because of its quantity and no option strategy was recorded before 2017.

The information found is therefore considered as internal practices of PEMEX. From 2012 to 2016, Pemex as a company did not enter in any option contract, failing to predict the drop in price in 2014. It is only when the price started rising again, in the second quarter of 2017, that PEMEX entered into a hedging strategy which included options for $228 million representing 68.7 million barrels as per Appendix B. The hedging program is still on going as per the information gathered for the first quarter of 2018. As seen previously, it comes with no surprise that options are used during high prices to protect against an eventual fall in prices by buying a put option.

From 2008 to 2018, PEMEX is utilizing both markets – spot and futures- and therefore reduces its price risk by being only concerned by the basis risk. The oil market being volatile, limiting the risk to the basis risk is a great way to reduce the financial impact of changing price. The company has also been using swaps. A better way to mitigate risk for PEMEX would have been to enter into a basis swap on top of the futures contracts, in order to mitigate the basis risk.

As a result, no information concerning the largest oil trade on Wall Street was found on PEMEX's annual reports and annexes which explains why the Hacienda Hedge accounts for Mexico's profit. The decisions are not internal to the company and the deals are managed on a governmental level even though it is technically PEMEX's production which is being hedged. It is however notorious that Mexico hedges every year and the information are to be found in the legislature's annual audit; the "Auditoria Superior de la Federacion" (ASF).

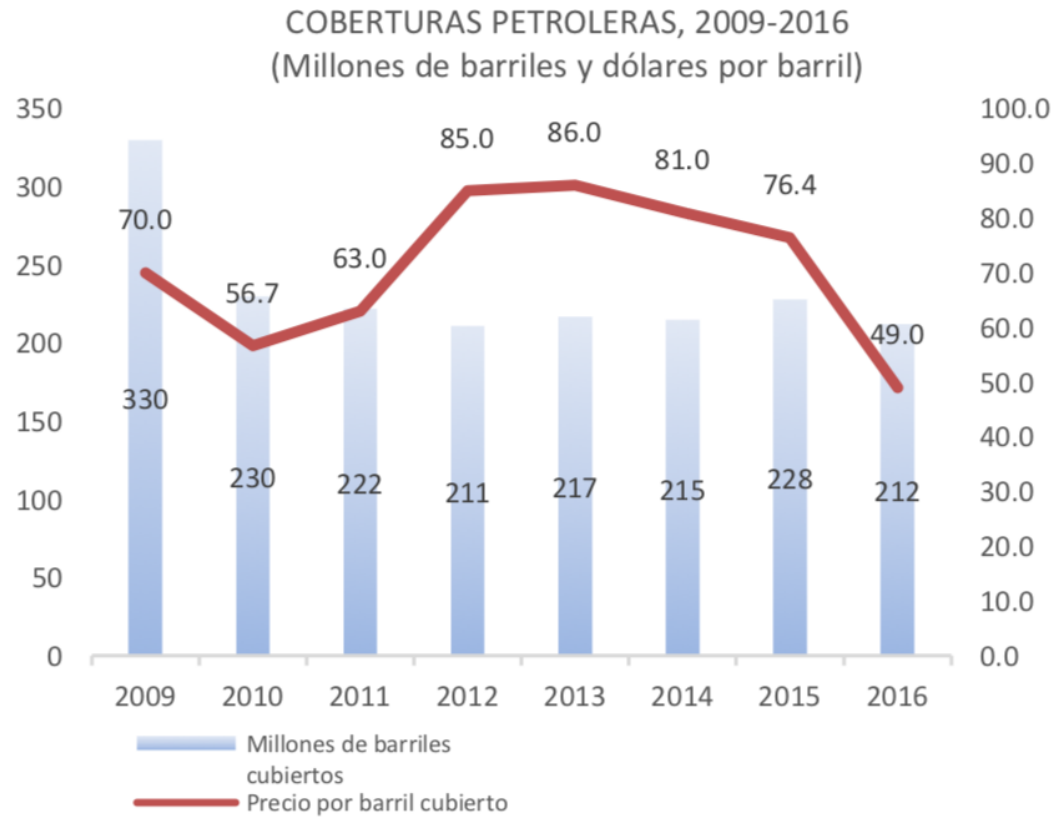
2.2.2.2 Auditoria Superior de la Federacion

In order to better understand the Hacienda Hedge, I looked at the Auditoria Superior de la Federacion (ASF) website in Spanish. Some hedging programs implemented by the country are registered at the ASF. We find information on execution details such as trades date, quantity, cost and even benefits being transferred to the Federal Government.

Figure 8 displays the amount of barrels bought from 2009 to 2016 as part of the Mexican hedging program as well as each deal's average price. The figures correspond to millions of barrels and US dollars per barrel.

On average, the country has hedged 233 millions barrels per year with average prices higher in 2012-2015 when oil prices were relatively high.

Figure 8 Mexican oil hedging 2009-2016



Source: Secretaria de Hacienda y Crédito Público

With daily production decreasing from 2'601 to 2'154 thousand barrels between 2009 and 2016, the hedging program covers on average 24% of the total production with an average of 233 million barrels per hedging program, i.e. per year as per my calculation in Table 7. In 2009, Mexico hedged about 10% more than its average, as prices were reaching $140.00 per barrel. The hedging program is based on Maya crude, so I have calculated the portion of the deal considering only Maya crude oil production. Mexico hedges about 50% of its Maya crude oil production every year. With options, it is not necessary to hedge the entire production, which is fortunate, as the market would not sustain such a large contract size. The contract size is one of the reason Mexico buys its OTC option through a number of investment bank. The biggest hedging programs were set in 2006 and 2008 for 454 and 435 million barrels respectively. This characteristic is key as to discussing the possibility for Saudi Arabia to enter in such program due to the size of its production. Obviously, this calculation of the hedging amount should not take into account the secured sales nor their proper consumption.

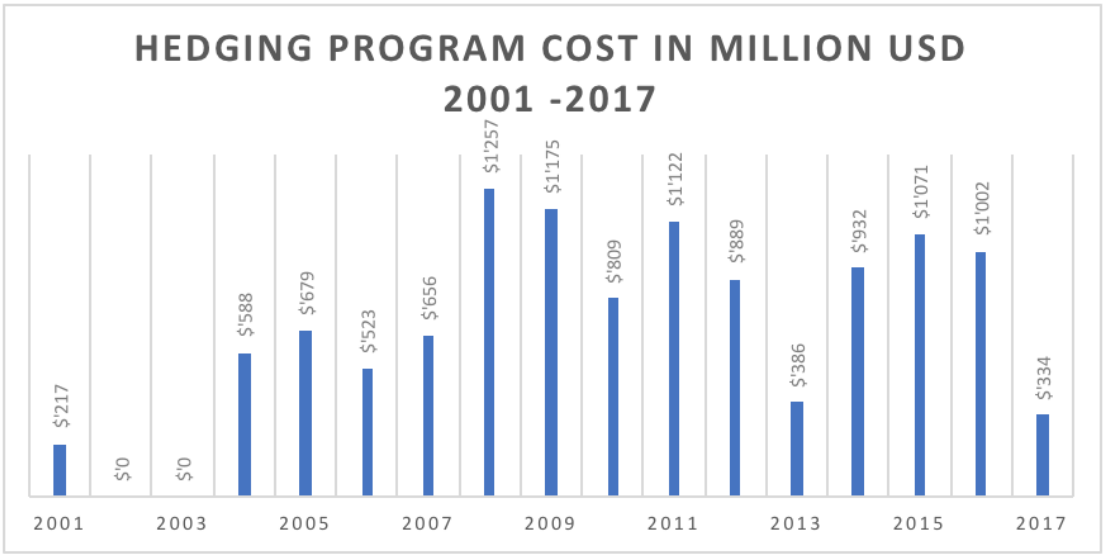
Table 7 Production/Hedging size comparison 2009-2016

	2009	2010	2011	2012	2013	2014	2015	2016
Total Production Thousands barrels / day	2'601	2'577	2'553	2'548	2'522	2'429	2'267	2'154
Total Production Annualized (360 days)(mbbl)	949'365	940'605	931'845	930'020	920'530	886'585	827'455	786'210
Maya Production Thousands barrels / day	1'520	1'464	1'417	1'385	1'365	1'266	1'152	1'103
Maya Production Annualized (360 days)(mbbl)	547'200	527'040	510'120	498'600	491'400	455'760	414'720	397'080
Hedging program Thousands barrels / year	330'000	230'000	222'000	211'000	217'000	215'000	228'000	212'000
% Hedging Program on Total	34.76	24.45	23.82	22.69	23.57	24.25	27.55	26.96
% Hedging Program on Maya	60.31	43.64	43.52	42.32	44.16	47.17	54.98	53.39

Source: PEMEX & Secretaria de Hacienda y Crédito Público

Figure 9 displays the total cost related to the oil hedging program since 2001. The cost has been calculated based on the information found in a report of the "Centro de Estudios de la Finanzas Publicas". As figures were available in million Pesos, I have calculated the cost and the profit in US Dollars by averaging the annual exchange rate published quarterly on the Bureau of the Fiscal Service – US Treasury Department. The calculations are to be found in Appendix C. Hedging costs vary between $217 million and $1'257 millions.

Figure 9 Hedging Program Cost in Million USD 2001-2017



During the 15 years of the hedging program, Mexico has not exercised its option every time and has only made a profit during three years; 2009, 2015 and 2016 as shown in

table 8 below. The revenues generated in 2009, 2015 and 2016 were respectively of $5.0 billion, $6.5 billion and $2.8 billion. The three-year revenues of $14.5 billion minus the cost of the premium of $11.6 billion comes out to a total profit of $2.8 billion. On a year basis, the average profit is $190 million which is an unneglectable amount. I understand that assessing the benefits for Mexico is more complex than simply looking at the difference in costs and revenues.

Table 8 Hedging Program 2001-2017

Coberturas Petroleras 2001 - 2017[1]

Indicadores

Año Aplicación	Cobertura (Millones de barriles)	Precio de Contratación (Dólares por barril)	Costo de la Cobertura (Millones de pesos)	Beneficio (millones de pesos)			Estatus de las Coberturas
				Ingresos por Cobertura	Beneficio Anual	Saldo Acumulado	
2001	200.0	20.5	2,020.6	0.0	-2,020.6	-2,020.6	No ejercida
2002	0.0	0.0	0.0	0.0	0.0	-2,020.6	No hubo
2003	0.0	0.0	0.0	0.0	0.0	-2,020.6	No hubo
2004	n.d.	n.d.	6,649.0	0.0	-6,649.0	-8,669.6	No ejercida
2005	n.d.	n.d.	7,373.0	0.0	-7,373.0	-16,042.6	No ejercida
2006	454.4	n.d.	5,692.0	0.0	-5,692.0	-21,734.6	No ejercida
2007	n.d.	n.d.	7,122.0	0.0	-7,122.0	-28,856.6	No ejercida
2008	435.0	46.8	15,497.0	0.0	-15,497.0	-44,353.6	No ejercida
2009	**330.0**	**70.0**	**15,561.0**	**64,353.1**	**48,792.1**	**4,438.5**	**Ejercida**
2010	230.0	57.0	10,294.0	0.0	-10,294.0	-5,855.5	No ejercida
2011	222.0	63.0	14,421.0	0.0	-14,421.0	-20,276.5	No ejercida
2012	211.0	85.0	11,729.0	0.0	-11,729.0	-32,005.5	No ejercida
2013	217.0	86.0	4,988.0	0.0	-4,988.0	-36,993.5	No ejercida
2014	215.0	81.0	12,686.0	0.0	-12,686.0	-49,679.5	No ejercida
2015	**228.0**	**79.0**	**17,503.0**	**107,512.4**	**90,009.4**	**40,329.9**	**Ejercida**
2016	**212.0**	**49.0**	**19,016.0**	**53,738.0**	**34,722.0**	**75,051.9**	**Ejercida**
2017	250.0	38.0	6,232.0				Vigente
			156,783.6	**225,603.5**	**75,051.9**	**75,051.9**	

Fuente: Elaborado por el CEFP, con información de la ASF y el SHCP.
1/ De 2001 a 2011 con información de la ASF, a partir de 2012 con información de la SHCP.

Source: Centro de Estudios de la Finanzas Publicas (CEFP)

I have retrieved the price of Brent crude oil since 2008 to 2017 to compare each years strike price with low-high-average prices as Maya crude was not available. We note on table 9 that despite low prices going below the strike price in 2008 and 2014, the option was not exercised as the average was higher than the strike price. In 2009, the low price was higher than the one in 2008, but the average was lower than the strike price of 2019. By looking at the years where options were exercised, we observe that the average price needs to be below the strike price for it to represent low price level i.e. a bearish market. It is not sufficient to have prices drop to really low levels and oscillate at higher heights. Indeed, in the Mexican program, the type of option bought seems to be Asian style put options (BLAS, 2017) which compares the strike price to an average price over a certain period rather than one price at the expiration like in European option. Profitable years for Mexico were represented by low oil prices and preceded high oil prices. The 2009 strike price of $70 was set during 2008, when oil price experienced all-time high. From July to

September 2008, prices moved from $143.68 to $93.52. It is hard to say exactly when the put options were bought, but it was certainly during that period of time. The percentage on high and on average I calculated represents the percentage of the strike price on high and average prices from the previous year. In 2009, it means that if based on $143.68, the strike price represents 48.72% of 2008 high price and 78.72% of 2008 average price. $88.92. 48% does not range in the habitual practice, and is biased by the exceptional high oil price. I believe the strike price usually represents between 67% and 78% of the market price. As the premium is influenced by the strike price as well, it would be more expensive for Mexico if the strike price was high compared to the market price at the time of conclusion. I think strike price are more likely to be set around 70% of the market price i.e. based on high prices. Premiums tend to be more expensive when the strike price is high compared to the market price in put options.

Table 9 Brent crude oil price 2008-2017

BRENT CRUDE OIL PRICE							
	LOW	HIGH	AVERAGE		Strike price	% on high	% on average
2008	$34.16	$143.68	$88.92		$46.80	N/A	N/A
2009	$40.18	$78.68	$59.43		$70.00	48.72	78.72
2010	$70.59	$93.08	$81.84		$57.00	72.45	95.91
2011	$93.52	$124.01	$108.77		$63.00	67.68	76.98
2012	$88.69	$127.27	$107.98		$85.00	68.54	78.15
2013	$99.25	$115.20	$107.23		$86.00	67.57	79.64
2014	$55.27	$113.42	$84.35		$81.00	70.31	75.54
2015	$37.36	$65.58	$51.47		$79.00	69.65	93.66
2016	$27.88	$56.09	$41.99		$49.00	74.72	95.20
2017	$45.83	$66.72	$56.28		$38.00	67.75	90.51

Source: Macrotrends

2.2.2.3 The 2008-2009 hedging period

Due to the secrecy of the deal I have not been able to find detailed information about the construction of the Hacienda hedge in 2008-2009. As seen in Table 10, the deal was made through four banks over August and September 2008. Barclays took the biggest part of the deal (220 million barrels) followed by Goldman Sachs (85 million barrels). Deutsche Bank bought 15 million barrels and Morgan Stanley 10 million barrels. As the banks executed the deal, oil prices started falling, reaching an average of less than $55 per barrel in 2009. With an average option price of $70, Mexico was making a great deal.

The annual hedge made by the government is composed of a mix of Maya and Brent; a decade ago the Mexican Government locked in the price of WTI but this practice created issues because of the changing relationship between WTI and Maya. As a result, Brent

considered as a world standard has been chosen to be mixed in the deal with 80-90% of Maya crude oil.

Table 10 Options calculations on Pemex's 2008-2009 deal ($)

	Crude oil type	Market price	Strike price	Difference (Mkt-strike)	Barrels	Total
Barclays	Maya	$53.6421	$66.50	$12.8579	80'000'000	1'028'632'000
	Maya	$53.6421	$69.00	$15.3579	130'000'000	1'996'527'000
	Maya	$53.5707	$69.00	$15.4293	10'000'000	154'293'000
						3'179'452'000
Goldman Sachs	Maya	$53.6421	$66.50	$12.8579	20'000'000	$257'158'000
	Maya	$53.6421	$69.00	$15.3579	55'000'000	$844'684'500
	Brent	$60.0000	$87.00	$27.0000	10'000'000	$270'000'000
						$1'371'842'500
Morgan Stanley	Maya	$53.6421	$66.50	$12.8579	10'000'000	**$128'579'000**
Deutsche Bank	Brent	$60.0000	$87.00	$27.0000	15'000'000	**$405'000'000**
Mexico's profit						**$5'084'873'500**

Source: BLAS Javier – Bloomberg Markets

When the price dropped under the average strike price, PEMEX exercised their option. By the end of December 2009, the four banks had transferred the balance due to Mexico. Mexico's revenue on this deal was $5'084'873'500 ($5 billion).

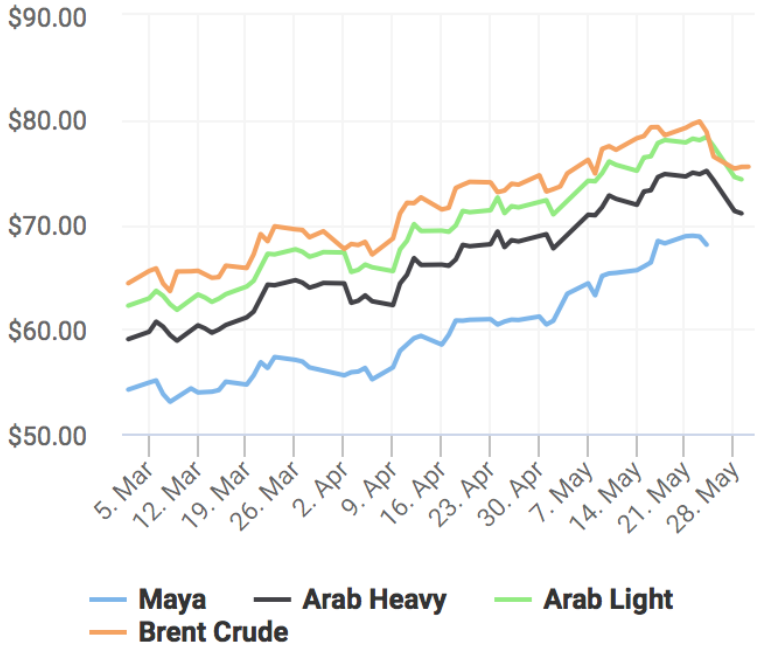
The revenue in the article by Blas Javier for 2009 hedging program was reported in Appendix C to avoid a difference of 223 million dollars. The difference would arise from the exchange rate average calculated in the appendix. The calculations undertaken are of general guidance for the purpose of the thesis. It was therefore not necessary to calculate 2009 revenue.

We note in Table 10 a differential between the strike price of Maya and Brent crude oil. The differential of $18.00 and $20.50 is quite significant (21-24%). The reason for the price difference arises from the difference in quality. Maya crude oil has a 22°API gravity and 3.3 % sulfur (PEMEX, Glossary). API gravity characterized whether the crude oil is light or heavy. At 22°API gravity, Maya crude is a heavy crude. The higher the number, the lighter the crude. We consider crude oil to be light at 30°API gravity (PETROLEUM.CO.UK, 2015). The sulfur content tells us if the crude oil is sweet or sour. The lower the sulfur content, the sweetest the crude oil. A sweet crude oil is easier to refine and safer to extract. Crude oil is considered sour at 0.5% of sulfur content (PETROLEUM.CO.UK, 2015). Maya crude oil is therefore a heavy sour crude oil. As a comparison, Brent crude oil, 38.06°API gravity and 0.37 %. Brent crude oil is a sweet light type. This is the reason why we observe an important differential.

The second reason is locational. Crude oil produced further from market will incur higher transportation costs to get to the market.

In Figure 10, we see that prices of different crude oils move largely in coordination. I have chosen to compare Brent with Arab Light, Arab Heavy and Maya, four different quality of crude oil which illustrates differentials due to quality and location. We can see that Arab light's curve is closer to Brent's. The quality of Arab light being 33.4°API gravity and 1.77 % sulfur (MCKINSEY) making it a light but sour crude oil. Arab heavy is a heavy and sour crude oil (27.4°API gravity and 2.80 % sulfur) like Maya crude oil. Compared to Maya crude oil, Arab heavy is indeed less heavy and less sour, as confirmed by the chart.

Figure 10 Maya-Brent-Arab crude oil differential



Source: Oilprice.com

2.2.2.4 The 2009-2010 hedging period

The size of this hedging was of 230 million barrels at an average option price of $56.69. It was of a duration of five months, going from August 2009 to December 2009. To finance the deal, an amount of Pesos 18'000'000'000 (18 billion) was borrowed from the Fondo de Estabilizacion de los Ingresos Petroleros (FEIP). The cost of the premium was of $5.0827/ barrel and involved a cost of $1'171'669'000 (1.1 billions) representing Pesos 15'554'996'200.

Table 11 displays the type of crude, the number of operation needed to concretize the deal, the amount of barrels expressed in million as well as the premium price, the strike price and the total cost in million dollars and pesos. Strike price in the 2009-2010 hedging

program demonstrated as well a differential of 15% (56.00/66.00*100) between Maya and Brent crude oil. The differential was however much lower than the precedent year for unknown reason. Maya premium per barrel on 110 million barrels and 100 million barrels was different. The difference is related to the bank taking the counterparty. It seems that Goldman Sachs has priced a lower premium ($4.8729) on 110 million barrels than JP Morgan and Barclays Capital ($5.318 per barrel).

Table 11 Options' purchase 2009-2010

COMPRA COBERTURAS PETROLERAS, 2009-2010

Crudo	Operaciones	Millones de barriles asegurados	Prima prom. pagada	Piso asegurado (dpb)	Costo en miles de dólares	Costo en miles de pesos
Maya	21	110	4.8729	56.0	536,019.0	7,044,120.6
Maya	19	100	5.3518	56.0	535,180.0	7,154,629.4
Brent	3	20	5.0235	66.0	100,470.0	1,356,246.2
Total	43	230	5.0827	56.69	1,171,669.0	15,554,996.2

Source: Secretaria de Hacienda y Crédito Publico

The information about the 2009-2010 hedging program give us a greater understanding of the structure of the deal. Table 12 demonstrates the number of transaction required to conclude the program. Three trading desks were involved: Barclays, Goldman Sachs, JP Morgan. The deal was split into 43 transactions; Barclays 16 transactions, Goldman Sachs 24 transactions and JP Morgan 3 transactions. This represents an average of 5'348'837 barrels per transaction. On a five-month period, considering that the banks are open Monday to Friday, we have 100 days on which to split 43 transactions; a transaction would have been executed roughly every second day.

Table 12 Counterparties intervening in 2009-2010 hedging program

CONTRAPARTES QUE INTERVINIERON EN LAS OPERACIONES DE COBERTURA PETROLERA
(Miles de pesos)

Contraparte	Crudo	Millones de barriles asegurados	% de operaciones asignadas por contraparte	Operaciones	Importe en moneda nacional
Barclays Capital	Maya	85	37.0	16	5,744,349.4
Goldman Sachs /J. Aron & Company	Maya	110	47.8	21	7,400,094.5
Goldman Sachs /J. Aron & Company	Brent	20	8.7	3	1,356,246.2
JP Morgan	Maya	15	6.5	3	1,054,306.1
Total		230	100	43	15,554,996.2

FUENTE: Confirmaciones de operaciones de cobertura, proporcionadas por el BANXICO.

Source: Secretaria de Hacienda y Crédito Publico

The 2009-2010 options were not exercised but the structure gives us an idea of the procedure of the deal which could be applied to Saudi Aramco's case. If options were

bought by Aramco, the deal would have to be OTC as well and spread through a number of transactions via multiple investment banks.

2.2.2.5 Fondo de Estabilizacion de los Ingresos Petroleros (FEIP)

The FEIP is a Petroleum Income Stabilization Fund in which the profit issued from the hedging program are transferred. The fund was created 26th April 2001 due to the volatility in petroleum revenues and the uncertainty related to it. In 2009, the $5 billion were transferred to the Federal Government in order to cover the diminution in revenues of the Federal Government due to lower collection of tax revenues, lower oil prices and lower quantity of crude oil extractions. According to the Article 19, section IV, second paragraph of the Federal Budget and Fiscal Responsibility Law, the surplus of income will be allocated until reaching an adequate reserve to face the fall in the Participatory Federal Fundraising, the oil revenue of the Federal Government and PEMEX. I have not found information on the current level of the fund nor the estimated amount of adequate reserve estimated.

The outtake of the Mexican hedging program for the purpose of this thesis is first, the fact that one does not need to hedge all of its production to benefit from hedging. Mexico has been hedging a significant quantity of its production on a year basis. Further analysis would need to be undertaken to estimates the actual profitability of the hedging program on the budget. Does the profits from the hedging program provide enough revenues to the Government? I do not believe so. Options come with non-negligible cost and uncertainty. Over a period of 15 years, the country has exercised their options only three times, which could signify that this type of strategy would not bring stability to Saudi Arabia. To understand why the country buys put option despite the fact that it does not seem profitable, I have looked a bit further and found an interesting explanation. Mexico benefits from the hedging program through its borrowing terms. By hedging through put options, the country is considered to be protected from lower oil prices by its creditors. An analysis has shown that "Mexico's sovereign borrowing costs would be 19 basis points higher in the absence of hedging" (VALENCIA, Unknown publication date). This is where the real benefit of put options resides. Mexico had a public debt of 56,1% of GDP in 2017 (GLOBAL FINANCE, 2018). With a GDP of $1'124.3 billion (GLOBAL FINANCE, 2018), public debt amounts to 630 billions. The savings in term of interest cost could therefore amount to over 1 billion per year.[2] Put options thus allow the country to save on borrowing costs every year.

[2] Interview with Frédéric Ruiz, deputy director of the ISFB, Geneva, 2 June 2018

2.2.3 EOG Resources Inc.

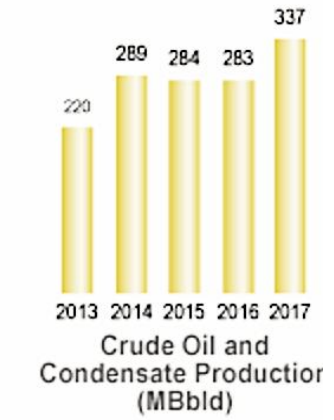
EOG Resources Inc. was founded in 1985 and is active in the exploration, development, production and marketing of crude oil & natural gas. The company works primarily in the major producing basins of the USA as well as in the Republic of Trinidad, the UK, China and Canada.

As of December 2017, the net proven reserves of crude oil amounting 1'313 million barrels of crude oil and condensate reserves. 97% of its reserves are located in the USA, 2% in Trinidad and 1% in international areas.

EOG's business strategy is to maximize the rate of return on interest capital and the company does so by controlling its costs of capital and utilizing advanced technology associated to horizontal drilling and fracking.

Figure 11 shows EOG's crude oil and condensate production from 2013 to 2017. In 2017, the production amounted to 337'000 barrels a day which is much lower level than PEMEX or Aramco. The company's annual report on Form-10K provide us with interesting information on their hedging practices.

Figure 11 EOG's crude oil production 2013 - 2017



Source: EOG Resources

2.2.3.1 Financial derivatives practices

EOG utilizes primarily price swaps, options, swaptions, collars and basis swaps contracts to manage their price risk.

Table 13 reveals EOG derivatives practices of 2013 and 2014. EOG reported a crude oil derivative contract for 2014. According to the explanation given, the derivative contract could be categorized as a swaption. EOG gave the counterparty the option to extend certain current derivative contracts for an additional period of six- or nine-months. By definition, a swaption gives a right to enter at a future date in a swap for a precise period at a fixed price. We notice that the contracts are for a volume in barrels per day ranging between 171'000 and 10'000 barrels.

The 2015 annual report provided no information on derivatives transactions except for these concerning natural gas.

Table 13 EOG Derivatives contracts 2013 - 2014

Annual report 2013

Crude Oil Derivative Contracts		
2014	**Volume (Bbld)**	**Weighted Average Price ($/Bbl)**
January 2014	156'000	96.30
1 February to 31 March	171'000	96.35
1 April to 30 June	161'000	96.33
1 July to 31 December	64'000	95.18

Annual report 2014

Crude Oil Derivative Contracts		
2015	**Volume (Bbld)**	**Weighted Average Price ($/Bbl)**
1 January to 30 June	47'000	91.22
1 July to 31 December	10'000	89.98

Source: EOG Resources

In 2016's annual report, EOG reported two crude oil transactions (Table 14). The first one was a normal contract on a commodity for a period of two weeks (12-30 April) and a quantity of 90'000 barrels a day at an average price of $42.30. Another covered May 1st to June 30th for 128'000 barrels a day at an average price of 42.56. A transaction was recorded for 2017, covering from January 1st to June 30th for a quantity of 35'000 barrels a day at 50.04.

For the second semester of 2016, EOG opted for a crude oil collar. A collar is considered to be an advanced hedging strategy as it combines two options; a long put with a short call. The duration of the collar was from 1st September to the 31st December for a quantity of 70'000 barrels a day. We do not have any information on the premium paid; the structuring of the options can lead to what is called a zero cost collar where by the premium paid in the long put is offset by the premium received in the short call. I believe it was not a zero cost collar. The ceiling price indicates that the strike price of the short call was $54.25 and the floor price indicates that the strike price of the long put was $45.00. If the Index price (WTI) is between the collar range of $54.25 and $45.00, EOG does not incur a hedging gain or loss. However, if the Index price moves above $54.25, EOG has to pay the difference between the ceiling price and the index price. However, if the Index price is below the floor price of 45.00, EOG is entitled to receive the difference between the floor price and the Index price.

Table 14 EOG Derivatives contracts - Annual report 2016

Crude Oil Price Swap Contracts		
2016	**Volume (Bbld)**	**Average Price ($/Bbl)**
12 April to 30 April (closed)	90'000	42.30
1 May to 30 June (closed)	128'000	42.56
2017		
January 2017 (closed)	35'000	50.04
1 February to 30 June	35'000	50.04

Crude Oil Collar Contracts			
2016	**Volume (Bbld)**	**Weighted Average Price ($/Bbl)**	
		Ceiling Price	**Floor Price**
1 September to 31 December (closed)	70'000	54.25	45.00

Source: EOG Resources

The 2017 annual report details on three contracts were found (Table 15). Two were basis swap contracts and one was a crude oil swap.

EOG enters in crude oil basis swaps in order to avoid the differential between prices in Midland/Cushing as well as Gulf Coast/Cushing, Cushing location being related to the NYMEX WTI Futures. The basis risk covered in this context is a locational basis.

In the first case, the weighted average differential price of 1.063 represents the amount of reduction to Cushing, Oklahoma. The swap covers a volume of 15'000 barrels a day running from the 1st February 2018 to the 31st December 2018.

Another swap concerning the same basis risk has already been put in place for 2019 for a quantity of 20'000 barrels a day for a differential of 1.075.

The last one is a swap on crude oil. We can see two closed transactions for 2017 and that the hedge only covered the first 6 months of 2017. There is an open transaction concerning 2018. The open transaction is a swap for a quantity of 37'000 barrels a day, covering January 1st to December 31st 2018. As the natural physical position of EOG is long, its swap position would have to be short. EOG is seeking protection against a fall in the price and is paying a floating price. If at the expiry the average floating price is higher than the fixed price, EOG would have to pay the cash settlement to the buyer. If it is lower, EOG will receive the payment of the cash settlement.

Table 15 EOG Derivatives contracts- Annual report 2017

Midland Differential Basis Swap Contracts		
2018	**Volume (Bbld)**	**Weighted Average Price Differential**
January 2018 (closed)	15'000	1.063
1 February to 31 December	15'000	1.063
2019		
1 January to 31 December	20'000	1.075

Gulf Coast Differential Basis Swap Contracts		
2018	**Volume (Bbld)**	**Weighted Average Price Differential**
January 2018 (closed)	37'000	3.818
1 February to 31 December	37'000	3.818

Crude Oil Price Swap Contracts		
2017	**Volume (Bbld)**	**Weighted Average Price ($/Bbl)**
1 January to 28 February (closed)	35'000	50.04
1 March to 30 June (closed)	30'000	50.05
2018		
1 January to 31 December	37'000	56.48

Source: EOG Resources

EOG practices from 2013 to 2017 have exhibited the utilization of swaps, swaptions, basis swaps as well as collar. Considering the structure of the company it is not surprising to see that the company has chosen the least costly instruments. Shale companies have the incentive to hedge because of their funding structure, they cannot afford a declining revenues. With cheap drilling methods come cheaper financial derivatives. Most of their hedge are conducted on an annual basis, a few of them cover only a 6-month period. Swaps also provide better hedging than futures, as they avoid one of the most common basis risk for oil producers known as calendar basis risk. They do not have margin requirement or initial costs. The collar is a good strategy to avoid the high cost of a premium. Whether the collar is costless or not, if the strategy is well managed, the premium received from the short call could cover a portion of the premium of the long put.

2.2.4 British Petroleum Plc (BP)

BP headquartered in London was founded in 1908 as the Anglo-Persian Oil Company. BP is one of the seven world leading supermajors in oil and gas. The company is an international company with expertise in the exploration, production, refining, marketing, power generation and trading of oil and natural gas. As of 31st December 2017, BP had a crude oil production of 3.6 million barrels per day and proved reserves of 18'441 million barrels (BP, 2018).

2.2.4.1 Annual reports

The analysis undertaken here is a bit different than the previous one as no information was available in terms of contracts specification, which is understandable given the size of the company. The analysis was therefore focusing on the company's oil derivatives size in million dollars and the maturity dates. BP acknowledges using oil options and futures to mitigate price risk. They undertake trading by using OTC contracts in combination with other derivatives contracts. Market exposure is measured using the value-at-risk technique. Trading activity is supported by a limit of $100 million of value-at-risk.

Table 16 displays the assets and liabilities at fair value of derivatives instruments as of the 31st December 2017 and 2016. For 2017, we come to a figure for oil price derivatives of $1'637 million assets and of $1'281 million liabilities, giving us a net value of $356 million. We can see that oil derivatives represent a much smaller chunk than natural gas price derivatives. From 2016, the net value has decreased by $235 million.

Table 16 BP Derivatives instruments at fair value on 31st December 2017- 2016

$ million

	2017		2016	
	Fair value asset	**Fair value liability**	Fair value asset	Fair value liability
Derivatives held for trading				
Currency derivatives	**237**	**(756)**	167	(2,000)
Oil price derivatives	**1,637**	**(1,281)**	1,543	(952)
Natural gas price derivatives	**3,580**	**(2,844)**	3,780	(2,845)
Power price derivatives	**885**	**(693)**	768	(560)
Other derivatives	**115**	**—**	232	—
	6,454	**(5,574)**	6,490	(6,357)
Embedded derivatives				
Commodity price contracts	**—**	**(16)**	—	(50)
Other embedded derivatives	**—**	**(115)**	—	(100)
	—	**(131)**	—	(150)
Cash flow hedges				
Currency forwards, futures and cylinders	**35**	**(35)**	32	(451)
Cross-currency interest rate swaps	**—**	**—**	—	(154)
	35	**(35)**	32	(605)
Fair value hedges				
Currency forwards, futures and swaps	**460**	**(523)**	22	(1,159)
Interest rate swaps	**193**	**(306)**	831	(233)
	653	**(829)**	853	(1,392)
	7,142	**(6,569)**	7,375	(8,504)
Of which – current	**3,032**	**(2,808)**	3,016	(2,991)
– non-current	**4,110**	**(3,761)**	4,359	(5,513)

Source: BP

The assets and liabilities in million dollars presented in Table 17 were classified by maturity. Most of them are held for less than a year. A report on hedging effectiveness and futures contract maturity (RIPPLE & MOOSA, 2005) has highlighted that hedging is more effective by using the near-month contract than a more distant one (6-month). This could suggest that a considerable part of the instruments are futures with short maturity. Short maturity instruments provide a low-risk alternative as well as they provide great market liquidity.

Table 17 BP Derivatives assets and liabilities by maturity

Derivative assets held for trading have the following fair values and maturities.

							$ million 2017
	Less than 1 year	1-2 years	2-3 years	3-4 years	4-5 years	Over 5 years	Total
Currency derivatives	186	31	8	5	3	4	237
Oil price derivatives	1,280	177	99	66	14	1	1,637
Natural gas price derivatives	1,122	609	428	328	288	805	3,580
Power price derivatives	420	188	81	60	38	98	885
Other derivatives	—	—	—	—	—	115	115
	3,008	1,005	616	459	343	1,023	6,454

Derivative liabilities held for trading have the following fair values and maturities.

							$ million 2017
	Less than 1 year	1-2 years	2-3 years	3-4 years	4-5 years	Over 5 years	Total
Currency derivatives	(92)	(232)	(66)	(188)	(99)	(79)	(756)
Oil price derivatives	(1,120)	(118)	(33)	(4)	(6)	—	(1,281)
Natural gas price derivatives	(973)	(410)	(334)	(224)	(194)	(709)	(2,844)
Power price derivatives	(337)	(134)	(63)	(39)	(29)	(91)	(693)
	(2,522)	(894)	(496)	(455)	(328)	(879)	(5,574)

Source: BP

Table 18 represents all the derivative asset and liabilities not only oil contracts which were sorted by hierarchy level. The hierarchy level represents the marketability of the instrument used. As a general guidance, level one accounts for easily marketable instruments such as exchange traded derivatives. Level two represents the OTC financial swaps and the physical commodity contracts. Their valuation is made by using public markets information and quotations provided by brokers. For less liquid markets and long-term contracts, the value is more difficult to establish due to the rarity of the contracts and the unpredictability. Those are characterized by the level three and they are valued using internal methodologies. By looking at the hierarchy level classification, we notice that there are no level 1 derivatives. This comes to dismiss my suggestion on their use of futures derivatives on oil. Due to the classification, it appears to me that BP does not use exchange traded derivatives surprisingly at all despite mentioning their utilization in the annual report. They take on counterparty risks in their contracts. As a result, we find a netting by counterparty in diminution of the fair value. The netting by counterparty is a risk mitigation method.

Table 18 Derivatives assets and liabilities by hierarchy level

$ million

	2017						
	Less than 1 year	1-2 years	2-3 years	3-4 years	4-5 years	Over 5 years	Total
Fair value of derivative assets							
Level 2	3,663	1,003	438	244	140	135	5,623
Level 3	386	258	231	226	211	899	2,211
	4,049	1,261	669	470	351	1,034	7,834
Less: netting by counterparty	(1,041)	(256)	(53)	(11)	(8)	(11)	(1,380)
	3,008	1,005	616	459	343	1,023	6,454
Fair value of derivative liabilities							
Level 2	(3,338)	(953)	(358)	(289)	(163)	(166)	(5,267)
Level 3	(225)	(197)	(191)	(177)	(173)	(724)	(1,687)
	(3,563)	(1,150)	(549)	(466)	(336)	(890)	(6,954)
Less: netting by counterparty	1,041	256	53	11	8	11	1,380
	(2,522)	(894)	(496)	(455)	(328)	(879)	(5,574)
Net fair value	486	111	120	4	15	144	880

Source: BP

OTC contracts are used because they are not standardized. It allows BP to customize and can better fulfill the hedging needs. It is hard to say whether BP is using OTC options, forwards or swaps; as I have not found information on cost such as premium I believe they use forwards and swaps. On short term option contracts, temporal value would be close to 0 as temporal value equals zero at maturity date. A low temporal value means the option has little or almost no time to be profitable, if not already profitable. This involves higher risk taken on. Moreover, options are really to be considered as insurances, and high prices followed by a fall in the market are needed to truly benefit from such instruments. Forwards and swaps however, allows to lock in a price on customized terms without paying high premiums which could potentially go to waste and reduce the overall profitability of the hedging program over the years.

2.2.5 Equinor

Equinor is the new name given to Statoil, the Norwegian oil company as of 2018 Annual General Meeting. The purpose of it was to remove “oil” from their name as the company is shifting its focus to broader energy generation.

The Norwegian state is the majority shareholder of the company for 67%. On top of that we can add the Norwegian national insurance fund for which the ownership interest is of 3%. The rest of its shareholders are private entities.

The daily production of oil and oil equivalent for 2017 amounted to 2’134 millions.

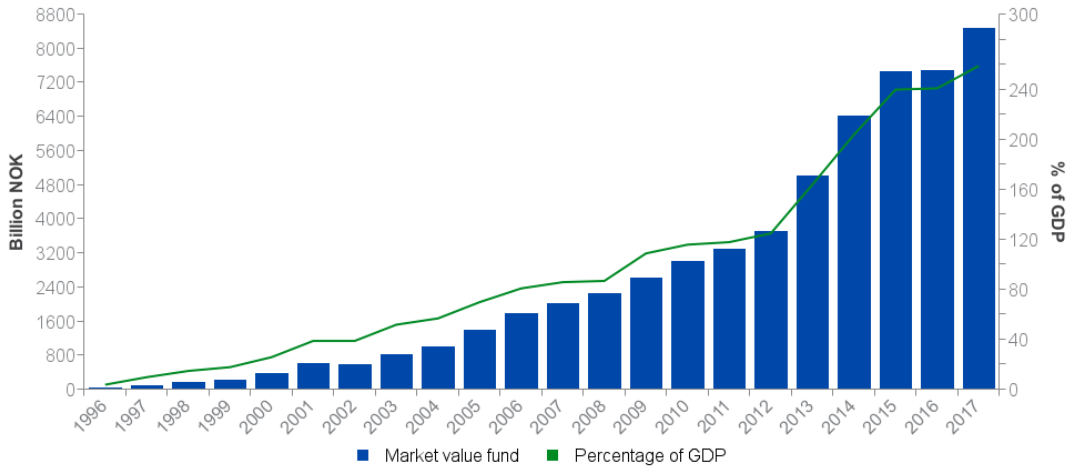
2.2.5.1 Financial derivatives practice

No information were available as to contracts specifications on oil. However the company acknowledges the use of financial derivatives. Equinor uses futures, options, forwards as well as OTC market swaps and contracts for differences related to crude oil/petroleum products. In short, they use the four instruments available. The maturity is usually of less than a year and they are traded on the Inter Continental Exchange (ICE), the New York Mercantile Exchange (NYMEX), the OTC Brent market as well as the swap markets (EQUINOR 2017).

The reason why I have chosen to analyze Equinor is because of the company’s structure; with a mix of state & private ownership the company could in the future be more apparent to Saudi Aramco. With its IPO planned for 2019, Aramco might have a great deal to learn from the former Statoil even if only 5% of the stock is listed, the liberalization of the country might lead to larger public opening in the coming years.

In 1996, Statoil created the “Oljefondet”; the Government Pension Fund of Norway. And every year since, the government transfers its revenue from the company to the fund. The mission of the fund is to build financial wealth for current and futures generations. The market value of the fund is 8’425 billion NOK.

Figure 12 The market value to the Government Pension Fund Global, 1996-2017



Source: The Norges Bank Investment Management

Figure 13 shows us the evolution of the size of the fund in billion NOK as in relation to GDP. Since 2010, the market value of the fund represents more than a 100% of the GDP.

This has been possible through their investments. On a general note, the investment are made in three different asset classes; equities, bonds and global real estate. It represents a mix of 72 countries and 9'146 companies. The fund is well diversified and has generated a 5.9% annual return since the establishment of the Bank Investment Management in 1998. The net annual return after management costs and inflation is 4%.

There is a fiscal rule which stipulates that a 3% share of the fund can be used to fuel the Norwegian economy. Compared to its annual return, it means that the state can finance its economy by not touching its revenues but only the return of the funds.

I believe that there is a structure that Saudi Arabia could learn from. It would however require the partial privatization of the company but with the undergoing liberalization of Saudi Arabia, I do not see at this point in time and with the knowledge available to me why this could not be a viable possibility.

3. Discussion

Findings has shown that despite Aramco being the world's first crude oil producer, there are ways for the company to hedge their production. The analysis covers three different size of companies and presented various instruments available for each category depending on the company's structure and the management preferences. I understand that none come close to Aramco's size especially in terms of oil production but as the Hacienda Hedge and EOG Resources analysis has demonstrated; it is not necessary to hedge the entire production.

Market size, whether on the organized exchange or on the over-the-counter market, has the capacity to take on an unimaginable number of derivatives contracts. There is a significant gap between high-end and low-end estimation which shows that we do not clearly know the value of derivatives market. In my opinion, the high end of $1.2 quadrillion of outstanding notional amount (CHANG, 2017) is overvalued. What is certain is that even considering only low-end estimation, the derivatives markets are bigger than all stock markets combined. Nonetheless, by looking only at the figures retrieved from the Bank for International Settlements (BIS), I do not believe the results are well representative of the actual market size either. Being hard for analysts to evaluate markets, it is even harder for me to do so. From the general idea I have and the figures from the BIS, I think derivatives markets size is not a relevant point for the evaluation of the feasibility of a hedging strategy for Saudi Arabia as the market seems to be important enough in size. A significant question would concern the counterparties; would OPEC's leader find counterparties ?

Due to the importance of Aramco in the oil trading world, one could think that no counterparty would be willing to take the other side of the deal. The reasons are the countless measures undertaken by Saudi Arabia within OPEC to regulate prices throughout the years. Saudi Arabia is named as a price maker or a price swinger. As seen, Saudi Arabia has a large excess capacity which could be used to drive prices down or up by cutting production. I believe that this measure, and in relation to it Saudi's power, is overvalued. Overvalued is perhaps a strong word to define their influence at this time as Saudi Arabia is currently curbing price with cutbacks measure and it is working in their favor but their leverage could be at stake.

Saudi's excess production could potentially be a problem if Aramco wishes to enter into a long put like the Mexican government. It is indeed easy for Saudi Arabia to drive prices down and if holding long put options, the country would have to produce at full capacity

to drive prices down, exercise the option and make great revenues on financial derivatives.

But Aramco's IPO planned for 2019 could void the issue. By listing the company, the company will have to take into account the interests of the investors and be ruled by anti-trust legislation. As said, price-fixing is precluded by anti-trust legislation and Aramco could face strong accusation if entering in price adjustment measures. By floating 5% of the company, Aramco will have to follow the path of Statoil and step back from international measures concerning oil regulation outputs.

Moreover, the oil market has been undergoing a few changes in terms of oil production. One of these changes is the evolution of the shale industry over the last years and the improvement made on horizontal drilling and fracking. USA's oil production has been significantly growing since 2010 and I believe it is not about to slow down any time soon. US companies have different incentives to produce more every day, the structure of the US market is composed by a large number of private companies. Each one of them is driving the production up as they are trying to maximize their investments and repay the banks financing them. Russia as well, has been pumping more oil to keep its market share. The rise of the US/Russian production, supplying the market generously, makes it difficult to influence prices on the way up and to keep them high.

There are two types of derivatives markets available: the exchange and the over-the-counter markets. For a company like Aramco, it is more suitable to undertake transactions in the OTC market. The OTC market would have less impact on spot prices as the contract is private. The company would have to find its counterparties like in the case of the Hacienda. Large counterparties with which to enter into large transactions are investment banks. Investment banks take on risks and off set them on the exchange market via transactions of a smaller quantity. By going OTC through investment banks, Aramco would not have to comply with exchange regulations, i.e. margin requirements. Considering Aramco's production and potential size of the transactions, a margin requirement of 10% would incur an important upfront payment for the company as well as margin calls. In a volatile market such as the oil market, margin calls might freeze substantial amounts of liquidity and challenge the operations of the company.

Another important differences determined by the access point is the counterparty risk. On exchange-traded markets we find futures contracts. Futures contracts are standardized contracts, they do not allow for customization like OTC instruments (forwards, swaps, options). The clearing house - the intermediary of the transaction- takes on the counterparty risk through the process of novation which exists in OTC

contracts. The counterparty risk is hence low in futures contracts in comparison to forwards, non-cleared swaps and OTC options. Options are available on standardized exchange as well. Options will be traded OTC if customization is required. In the Hacienda Hedge, put options were bought OTC as the transaction required a mix of Maya and Brent crude oil. Futures contract being the underlying of an option transaction, it would not be possible to have an option on Maya crude oil because there is no futures contract on Maya crude oil. If Aramco would follow Mexico's path, the company would have to use OTC options as well if they wanted to hedge Arabian crude oil.

Another particularity of the exchange market is liquidity. The standardization allows for the contracts to be traded in an easier manner than customized contracts. However, in real life, the market is liquid on short terms contract, but as we go further in time, there is less volume traded which makes the market illiquid on medium term to long term contract.

Futures contracts display another difference with OTC contracts; basis risk. Basis risk is the price to pay if one choose not to have counterparty risk. Basis is the difference in price between the futures contract which is standardized and the physical contract (spot). With specified maturity dates and quality, futures contracts are not tailored to the need of the hedge and hence bring the risk of not reflecting the reality of the physical contract.

The advantage of futures is the low counterparty risk. It requires though compliance with the exchange regulations and a margin deposit. On top of that, there are brokerage and exchange fees. The price is fixed consequently, price risk is inexistent just as are higher price opportunities.

To benefit from a rise in price, an option contract would be a better choice. By fixing the floor price, Aramco would secure a minimum price and still be able to benefit from higher prices like Mexico. The optionality comes with a premium cost however, which has to be paid at the time of the purchase. With the example of the Hacienda Hedge in mind, options can be very costly. Through the analysis I have undertaken, options at PEMEX were carried out only when oil prices were relatively high. And the Hacienda Hedge has proven to us that a drop in price below the average price is required to benefit from their strategy. Over 15 years, Mexico exercised the options only three times and this demonstrates to me that this instrument does not bring stability. As a result, with the knowledge I have on options, I believe they should be used as a complimentary instruments and not as a unique strategy.

Swaps on the other hand can eliminate basis risk. Just like an OTC contract, a swap contract can be customized and its pricing can be referenced over a physical underlying. The counterparty risk is existent unless the swap is cleared through an exchange. Swaps incur no cost compared to options and futures. They are cash settled, which means that at maturity date one party has to compensate the other in cash and there is no physical settlement possibility. Futures in comparison can be physically settled but most of the time settlement take place through the offsetting of position.

As a result, I would recommend the use of a mix of financial derivatives which is the same practice as the Norwegian oil company. The company does not have a fixed strategy like Mexico. A hedging strategy should change according to the market and because the oil market is volatile, it is best not to put a finger on one single instrument.

Despite the fact that it is indeed possible for Aramco to hedge to some extent, I believe Equinor as a company could be a model to Aramco. Their fund would be an unneglectable practice which could bring serenity to the country. Aramco could change its fiscal regime from a go-it-alone strategy to a hybrid one. A hybrid fiscal regime would allow them to invest less in the innovation and technology and benefit from the International Oil Company resources and knowledge.

There are some limitations to this research paper. The research paper does not consider the Saudis knowledge on the mechanism of financial derivatives as well as their acceptance of such practice. Compliance with Sharia law is also excluded.

Conclusion

My objective was to determine whether or not Saudi Arabia could have its national oil company – Saudi Aramco – hedging its production despite their significant production and their position within the oil industry.

The derivatives market size has shown to be extensively vague; there is a vast range between high-end estimation and low-end but even low-end estimation provides great liquidity. The limitation on the market does not come from the size of the market, but from the amount one invest in without causing distresses on the market. I like to think of it as a pond; if we throw a tiny stone in the pond, we will see its impact but it dissipates in the water and the stone will quickly be covered by the water. If we throw a larger stone, or a rock, the crash on the water is more intense and can have impact on the entire pond. It is the same with markets. The larger the stone, the larger the distress.

Concerning the counterparty taking on the other side of the transaction, as I said, OTC would be a better option in order to avoid disrupting the market. If Aramco was to use the exchange market, the natural structure of the market should be able to take care of it. There are always consumers willing to take the other side or speculators balancing out the market structure. In addition to that, I think the status of Saudi Arabia as a price maker is obsolete due to the escalation of the shale industry and Russia. Finally, the possible reshaping of Saudi's OPEC policy due to the IPO should also be mentioned.

A mix of financial derivatives was recommended. Derivative instruments have a number of similarities and differences making each one of them specific. A hedging strategy to mitigate risk should never be fixed. With oil prices consistently changing, a strategy needs to be flexible to the market. Through the analysis, we have seen that Mexico has a fixed hedging program; every year the country purchases put options. The findings have proven that this strategy has the purpose of reducing borrowing cost on sovereign debt. As a result, the strategy is not the most efficient in terms of price mitigation.

Furthermore, the findings on the Norwegian Oil Company has demonstrated the efficiency of the creation of a pension fund which could be considered by Aramco as a complimentary step to a hedging strategy. It would not mitigate the price risk but it would set the country on a more sustainable path which is exactly what the country is trying to achieve with its Vision 2030 project.

As a conclusion, I trust this research paper has provided my readers with a greater understanding of the financial derivatives in general and in particular those related to the oil market.

Bibliography

AGUILERA, Roberto F., RADETZKI, Marian, 2016. The price of oil, United Kingdom, Editions Cambridge University Press, ISBN 978-1-107-11001-4

Bank for International Settlements, 2018. Exchange traded derivatives statistics. *Bank for International Settlements* [online]. 11 March 2018 [viewed 15.04.2018]. Available from: https://www.bis.org/statistics/extderiv.htm?m=6%7C32%7C616

Bank for International Settlements, 2018. OTC derivatives outstanding. *Bank for International Settlements* [online]. 20 March 2018 [viewed 15.04.2018]. Available from:

https://www.bis.org/statistics/derstats.htm?m=6%7C32%7C71

BLAS, Javier, 2017. Uncovering the secret history of Wall Street's largest oil trade. Bloomberg Markets [online]. 4 April 2017. [viewed 24.10.2017]. Available from: https://www.bloomberg.com/news/features/2017-04-04/uncovering-the-secret-history-of- wall-street-s-largest-oil-trade

BRITISH PETROLEUM PLC, 2018. Annual reporting archive. British Petroleum [online]. [viewed 10.05.2018]. Available from:

https://www.bp.com/en/global/corporate/investors/results-and-reporting/annual-report/annual-reporting-archive.html

BURN-CALLANDER, 2014. The history of money: from barter to bitcoin. The Telegraph [online]. 10 October 2014 [viewed 28.01.2018]. Available from :https://www.telegraph.co.uk/finance/businessclub/money/11174013/The-history-of-money-from-barter-to-bitcoin.html

CENTRO DE ESTUDIOS DE LA FINANZAS PUBLICAS, 2017. Manejo de las Coberturas Petroleras en México [PDF document]. 31.08.2017

CHANG, Sue, 2017. Here's all the money in the world, in one chart. Market Watch [online]. 28 November 2017 [viewed 01.05.2018]. Available from: https://www.marketwatch.com/story/this-is-how-much-money-exists-in-the-entire-world-in-one-chart-2015-12-18

DANIEL, Philip, KEEN Michael, MCPHERSON Charles, 2010. The Taxation of petroleum and minerals: principles, problems and practice, Oxon, Routledge Taylor & Francis Group, ISBN 978-0-203-85108-1

EL GAMAL, Rania, LAWLER , Alex, 2017. Aramco listing reshapes Saudi Arabia's OPEC oil policy. *Reuters* [online]. 28 September 2017 [viewed 20.04.2018]. Available from : https://www.reuters.com/article/us-saudi-aramco-insight/aramco-listing-reshapes-saudi-arabias-opec-oil-policy-idUSKCN1C31H0

EOG Resources, 2018. Overview. EOG Resources [online]. 2018 [viewed 01.05.2018]. Available from: http://www.eogresources.com/about/overview.html

EOG Resources, 2018. Return Focused 2017. EOG Resources [online]. 27 February 2018 [viewed 01.05.2018]. Available from:

http://www.eogresources.com/investors/reports/2017/EOGR_2017_Annual_Report.pdf

EQUINOR, 2017. Annual report and Form 20-F [online] 2017 [viewed 15.05.2018]. Available from : https://www.equinor.com/content/dam/statoil/documents/annual-reports/2017/statoil-annual-report-20f-2017.pdf

FETEHA, Ahmed, 2017. Key figures in Saudi Arabia's 2018 Budget, 2017 Fiscal data. *Bloomberg* [online]. 19 December 2017 [viewed 10.02.2018]. Available from: https://www.bloomberg.com/news/articles/2017-12-19/key-figures-in-saudi-arabia-s-2018-budget-2017-fiscal-data

GEMAN, Hélyette, 2005. Commodities and commodity derivatives, England, Editions John Wiley & Sons Ltd, ISBN 0-470-01218-8

GLOBAL FINANCE, 2018. Mexico GDP and economic data. Global Finance [online]. [viewed 03.05.2018]. Available from: https://www.gfmag.com/global-data/country-data/mexico-gdp-country-report

ICE FUTURES U.S., 2011. Cleared swap contracts The ice [online]. 07 November 2011 [viewed 01.05.2018]. Available from:

https://www.theice.com/publicdocs/futures_us/Cleared_Swaps_FAQ.pdf

JACQUILLAT, Bertrand, SOLNIK, Bruno, PERIGNON, Christophe, 2009. Marchés financiers – Gestion de portefeuille et des risques, 5th Edition. Paris : Dunod, ISBN 978-2-10-052329-0

JOVANOVIC, Slobodan, 2014. Hedging commodities, Great Britain, Editions Harriman House Ltd, ISBN 9780857193193

MERCATUS ENERGY ADVISORS, 2018. An overview of energy basis, basis risk and basis hedging. Mercatus energy advisors. [online]. 15 July 2016. [viewed 10.05.2018]. Available from: https://www.mercatusenergy.com/blog/bid/38368/an-overview-of-energy-basis-basis-risk-and-basis-hedging

NORGES BANK INVESTMENT MANAGEMENT, 2018. Government Pension Fund Global. Norges bank investment management. [online]. 2018[viewed 10.05.2018]. Available from:

OILPRICE.COM., 2018. Oil price charts. Oil price.com [online]. [viewed 26.05.2018]. Available from: https://oilprice.com/oil-price-charts

ORGANIZATION OF PETROLEUM EXPORTING COUNTRIES, 2018. Organization of the Petroleum Exporting Countries [online].[viewed 10.04.2018]. Available from: http://www.opec.org/opec_web/en/

ORGANIZATION OF PETROLEUM EXPORTING COUNTRIES, 2018. Our mission Organization of the Petroleum Exporting Countries [online].[viewed 10.04.2018]. Available from: http://www.opec.org/opec_web/en/about_us/23.htm

ORGANIZATION OF PETROLEUM EXPORTING COUNTRIES, 2017. OPEC Annual Statistical Bulletin 2017 Organization of the Petroleum Exporting Countries [online].[viewed 10.04.2018]. Available from:

http://www.opec.org/opec_web/en/data_graphs/330.htm

PALANIAPPAN, Raja, 2017. A brief history of derivatives. Origin Markets [online]. 14 April 2017 [viewed 28.01.2018]. Available from : https://originmarkets.com/origin-hosts-issuer-roundtable-in-parallel-with-the-25th-annual-euromoney-global-borrowers-conference-3/

PARASKOVA, Tsvetana, 2018.The revival of Mexico's oil industry. Oil Price [online]. 25 January 2018 [viewed 10.05.2018]. Available from : https://oilprice.com/Energy/Crude-Oil/The-Revival-Of-Mexicos-Oil-Industry.html

PETROLEOS MEXICANOS. Glossary [online]. [viewed 26.05.2018]. Available from: http://www.ri.pemex.com/files/content/ACFUZAYEay.F.pdf

PETROLEOS MEXICANOS, 2018. Results Petroleos Mexicanos [online]. [viewed 14.01.2018]. Available from: http://www.pemex.com/en/investors/financial-information/Paginas/results.aspx

PETROLEOS MEXICANOS, 2016. Statistical year book 2016 [online]. [viewed 26.05.2018]. Available from:

http://www.pemex.com/en/investors/publications/Anuario%20Estadstico%20Archivos/STATISTICAL_YEARBOOK_2016_2.pdf

PETROLEUM.CO.UK, 2015. API Gravity. Petroleum.co.uk [online]. 2015 [viewed 26.05.2018]. Available from: http://www.petroleum.co.uk/api

PETROLEUM.CO.UK, 2015. Sweet vs Sour. Petroleum.co.uk [online]. 2015 [viewed 26.05.2018]. Available from: http://www.petroleum.co.uk/sweet-vs-sour

ROGOFF, Kenneth, 2016. What's behind the drop in oil prices?. World Economic Forum [online]. 02 March 2016 [viewed 02.03.2018]. Available from : https://www.weforum.org/agenda/2016/03/what-s-behind-the-drop-in-oil-prices/

SAUDI ARAMCO, 2018. Saudi Aramco [online]. [viewed 20.02.2018]. Available from: http://www.saudiaramco.com/en/home.html

SAUDI ARAMCO, 2016. Annual Review 2016 Saudi Aramco [online]. [viewed 20.02.2018]. Available from:

http://www.saudiaramco.com/content/dam/Publications/annual-review/2016/English-PDFs/2016-AnnualReview-full-EN.pdf

SECRETARIA DE HACIENDA Y CREDITO PUBLICO, 2015. Informe del Resultado de la Fiscalización Superior de la Cuenta Pública 2014. Auditoria Superior de la Federacion [online]. 18 December 2015 [viewed 01.05. 2018]. Available from : https://www.asf.gob.mx/Trans/Informes/IR2014i/Documentos/Auditorias/2014_0092_a.pdf

SECRETARIA DE HACIENDA Y CREDITO PUBLICO, 2011. Informe del Resultado de la Fiscalización Superior de la Cuenta Pública 2009. Auditoria Superior de la Federacion [online]. 01 January 2015 [viewed 01.05. 2018]. Available from : http://www.asf.gob.mx/Trans/Informes/IR2009i/Tomos/Tomo2/2009_0453_a.pdf

SMITH, Grant, 2018. Saudi Arabia is taking a harder line on oil prices. Bloomberg. [online]. 19 February 2018 [viewed 02.03.2018]. Available from :https://www.bloomberg.com/news/articles/2018-02-19/once-opec-s-oil-price-dove-saudi-arabia-takes-a-harder-line

THE WORLD BANK, Unknown publication date. The World Bank [online]. [viewed 03.01.2018]. Available from:

http://www.worldbank.org/en/country/gcc/publication/economic-brief-july-saudi-arabia-2016

THE NORGES BANK INVESTMENT MANAGEMENT, Unknown publication date. *The Norges Bank Investment Management* [online]. [viewed 15.05.2018]. Available from: https://www.nbim.no/en/the-fund/

US DEPARTMENT OF THE TREASURY, 2018. Treasury reporting rates of exchange. Bureau of the fiscal service.[online].17 April 2018 [viewed 31.05.2018]. Available from:https://www.fiscal.treasury.gov/fsreports/rpt/treasRptRateExch/historicalRates.htm

WINGFIELD, Brian, DODGE, Samuel, SAM, Cedric, 2018. OPEC's Troubled Two

Smash Oil Cuts Anew. Bloomberg [online]. 15 February 2018. [viewed 01.05.2018]. Available from: https://www.bloomberg.com/graphics/2017-opec-production-targets/

VALENCIA, Fabian, Unknown publication date. To Hedge or to Self-insure? The Benefits of Mexico's Oil Hedging Program. International Monetary Fund. [online]. [viewed 01.05.2018]. Available from: http://www.imf.org/external/np/blog/dialogo/032618.pdf

WISNER, Robert N, HOFSTRAND, Dom, 2015. Grain Price Hedging Basics [PDF document]. July 2015

WORKMAN, Daniel, 2018. Crude oil exports by country. World's top export [online]. 15 April 2018 [viewed 20.04.2018]. Available from :

http://www.worldstopexports.com/worlds-top-oil-exports-country/

Appendix A: Financial derivatives table

	Forwards	Futures	Options		Swaps
Access point	Over-the-counter (OTC)	Organized exchange	Organized exchange	Over-the-counter (OTC)	Over-the-counter (OTC)
Product specifications	Customizable	Standardized	Standardized	Customizable	Customizable
Margin/collateral	Collateral can be required	Margin requirements usually 10% of the contract value Marked to market	Margin requirements usually 10% of the contract value Marked to market	Collateral can be required	Collateral can be required
Counterparty risk	Depends on counterparty credit rating; potentially high	Low; clearing house acts as an intermediary for all trades	Low; clearing house acts as an intermediary for all trades	Depends on counterparty credit rating;potentially high	Depends on counterparty credit rating; unless cleared
Price	Fixed at conclusion	Fixed by the exchange	Strike price fixed	Strike price fixed	Fixed and variable
Settlment	Physical or Cash on the last day	Rarely delivered Settlment normally take place through offsetting position; ie cash	Cash	Cash	Cash
Liquidity	Lower than exchange	High	High	Lower than exchange	Low
Regulation	No regulation determined	Regulated by the exchange	Regulated by the exchange	No regulation determined	No regulation determined
Tradability	Harder to trade due to customization	Easily traded	Easily traded	Harder to trade due to customization	
Costs	Cost of carry	Brokerage and exchange fees	Premium + brokerage & exchange fees	Premium	No cost
Key risk	Counterparty risk	Basis risk Liquidity risk	Liquidity risk	Counterparty risk	Counterparty risk

Appendix B: PEMEX Derivatives use 2015 - 2018

First quarter 2015

Crude oil and petroleum products derivative financial instruments classified as cash and cash equivalents for accounting purposes due to high liquidity	2014	2015 (MXN million)	Change	2015 (USD million)
Mark to market (MXN million)	**1,950**	**87**	**(1,863)**	**6**
Stock market futures	118	12	(106)	1
Stock market swaps	1,832	76	(1,756)	5
Net volume (MM barrels)	**(8.6)**	**(9.6)**	**(1.0)**	-
Stock market futures	(1.7)	(1.0)	0.7	-
Stock market futures	(6.9)	(8.6)	(1.7)	-

Second quarter 2015

Crude oil and petroleum products derivative financial instruments classified as cash and cash equivalents for accounting purposes due to high liquidity	2014	2015 (MXN million)	Change	2015 (USD million)
Mark to market (MXN million)	**1,950**	**(174)**	**(2,124)**	**(11)**
Stock market futures	118	(39)	(157)	(2)
Stock market swaps	1,832	(136)	(1,968)	(9)
Net volume (MM barrels)	**(8.6)**	**(8.2)**	**0.4**	
Stock market futures	(1.7)	(0.7)	1.0	
Stock market futures	(6.9)	(7.5)	(0.6)	

Third quarter 2015

Crude oil and petroleum products derivative financial instruments classified as cash and cash equivalents for accounting purposes due to high liquidity	2014	2015 (MXN million)	Change	2015 (USD million)
Mark to market (MXN million)	**249.4**	**372.6**	**123.2**	**21.9**
Stock market futures	37.8	8.0	(29.8)	0.5
Stock market swaps	211.6	364.6	152.9	21.4
Net volume (MM barrels)	**(5.4)**	**(7.8)**	**(2.4)**	
Stock market futures	(1.3)	(0.2)	1.2	
Stock market futures	(4.1)	(7.6)	(3.5)	

Fourth quarter 2015

Crude oil and petroleum products derivative financial instruments classified as cash and cash equivalents for accounting purposes due to high liquidity	2014	2015 (MXN million)	Change	2015 (USD million)
Mark to market (MXN million)	**1,950.1**	**326.7**	**(1,623.4)**	**19.0**
Stock market futures	118.1	(8.0)	(126.1)	(0.5)
Stock market swaps	1,832.0	334.7	(1,497.2)	19.5
Net volume (MM barrels)	**(8.6)**	**(6.2)**	**2.4**	
Stock market futures	(1.7)	-	1.7	
Stock market futures	(6.9)	(6.2)	0.7	

First quarter 2016

Crude oil and petroleum products derivative financial instruments classified as cash and cash equivalents for accounting purposes due to high liquidity	2015	2016 (MXN million)	Change	2016 (USD million)
Mark to market (MXN million)	**1,950.1**	**(274.4)**	**(2,224.5)**	**(15.8)**
Stock market futures	118.1	8.0	(110.2)	0.5
Stock market swaps	1,832.0	(282.4)	(2,114.4)	(16.2)
Net volume (MM barrels)	**(8.6)**	**(7.1)**	**1.5**	
Stock market futures	(1.7)	(0.4)	1.3	
Stock market futures	(6.9)	(6.7)	0.2	

Second quarter 2016

Crude oil and petroleum products derivative financial instruments classified as cash and cash equivalents for accounting purposes due to high liquidity	2015	2016 (MXN million)	Change	2016 (USD million)
Mark to market (MXN million)	**(174.3)**	**(394.9)**	**(220.5)**	**(20.9)**
Stock market futures	(38.6)	-	38.6	-
Stock market swaps	(135.7)	(394.9)	(259.1)	(20.9)
Net volume (MM barrels)	**(8.6)**	**(7.1)**	**1.5**	
Stock market futures	(1.7)	(0.4)	1.3	
Stock market futures	(6.9)	(6.7)	0.2	

Third quarter 2016

Crude oil and petroleum products derivative financial instruments classified as cash and cash equivalents for accounting purposes due to high liquidity	2015	2016 (MXN million)	Change	2016 (USD million)
Mark to market (MXN million)	**-**	**-**	**-**	**-**
Stock market futures	-	-	-	-
Stock market swaps	-	-	-	-
Net volume (MM barrels)	**(174.3)**	**(278.0)**	**(103.6)**	
Stock market futures	(38.6)	3.8	42.4	
Stock market futures	(135.7)	(281.8)	(146.1)	

Fourth quarter 2016

Crude oil and petroleum products derivative financial instruments classified as cash and cash equivalents for accounting purposes due to high liquidity	2015	2016 (MXN million)	Change	2016 (USD million)
Mark to market (MXN million)	**327**	**(688)**	**(1,015)**	**(33.3)**
Stock market futures	(8)		8	-
Stock market swaps	335	(688)	(1,023)	(33.3)
Net volume (MM barrels)	**(6.2)**	**(4.1)**	**2.1**	
Stock market futures	-		-	
Stock market futures	(6.2)	(4.1)	2.1	

First quarter 2017

Crude oil and petroleum products derivative financial instruments classified as cash and cash equivalents for accounting purposes due to high liquidity	2016	2017 (MXN million)	Change	2017 (USD million)
Mark to market (MXN million)	**(274.4)**	**169.6**	**444.1**	**9.0**
Stock market futures	8.0	-	(8.0)	-
Stock market swaps	(282.4)	169.6	452.0	9.0
Net volume (MM barrels)	**(7.1)**	**(7.0)**	**0.1**	**N.A.**
Stock market futures	(0.4)	-	0.4	N.A.
Stock market futures	(6.7)	(7.0)	(0.3)	N.A.

Second quarter 2017

Crude oil and petroleum products derivative financial instruments classified as cash and cash equivalents for accounting purposes due to high liquidity	2016	2017 (MXN million)	Change	2017 (USD million)
Mark to market (MXN million)	**(394.9)**	**29.8**	**424.7**	**1.7**
Stock market futures	-	(22.7)	(22.7)	(1.3)
Stock market swaps	(394.9)	52.5	447.3	2.9
Net volume (MM barrels)	(4.6)	(2.3)	2.3	N.A.
Stock market futures	-	(1)	(1)	N.A.
Stock market futures	(4.6)	(1.6)	3.0	N.A.

Crude oil derivative financial instruments				
Mark to market (MXN million)	**-**	**4,081.1**	**4,081.1**	**228**
Crude options	-	4,081.1	4,081.1	**228**
Volume (MM barrels)	-	68.7	68.7	**3.8**
Crude options	-	68.7	68.7	3.8

Third quarter 2017

Crude oil and petroleum products derivative financial instruments classified as cash and cash equivalents for accounting purposes due to high liquidity	2016	2017 (MXN million)	Change	2017 (USD million)
Mark to market (MXN million)	**(278.0)**	**(275.8)**	**2.2**	**(15.2)**
Stock market futures	3.8	(74.2)	(78.0)	(4.1)
Stock market swaps	(281.8)	(201.6)	80.2	(11.1)
Net volume (MM barrels)	(3.7)	(3.1)	0.7	N.A.
Stock market futures	0	(1)	(1)	N.A.
Stock market futures	(3.9)	(2.1)	1.8	N.A.
Crude oil derivative financial instruments				
Mark to market (MXN million)	**-**	**93.5**	**93.5**	**5**
Crude options	-	93.5	93.5	**5**
Volume (MM barrels)	-	184.6	184.6	**10.1**
Crude options	-	184.6	184.6	10.1

Fourth quarter 2017

Crude oil and petroleum products derivative financial instruments classified as cash and cash equivalents for accounting purposes due to high liquidity	2016	2017 (MXN million)	Change	2017 (USD million)
Mark to market (MXN million)	**(688.0)**	**(241.4)**	**446.6**	**(12.2)**
Stock market futures	-	(141.7)	(141.7)	(7.2)
Stock market swaps	(688.0)	(99.7)	588.3	(5.0)
Net volume (MM barrels)	(4.1)	(3.3)	0.7	N.A.
Stock market futures	-	(2)	(2)	N.A.
Stock market futures	(4.1)	(1.3)	2.8	N.A.
Crude oil derivative financial instruments				
Mark to market (MXN million)	**-**	**(5,010.2)**	**(5,010.2)**	**(253)**
Crude options	-	(5,010.2)	(5,010.2)	**(253)**
Volume (MM barrels)	-	153.6	153.6	**7.8**
Crude options	-	153.6	153.6	7.8

First quarter 2018

Crude oil and petroleum products derivative financial instruments classified as cash and cash equivalents for accounting purposes due to high liquidity				
Mark to market (MXN million)	**169.6**	**(83.6)**	**(253.3)**	**(4.6)**
Stock market futures	-	(81.8)	(81.8)	(4.5)
Stock market swaps	169.6	(1.9)	(171.5)	(0.1)
Net volume (MM barrels)	(7.0)	(4.3)	2.7	N.A.
Stock market futures	-	(1)	(1)	N.A.
Stock market futures	(7.0)	(2.8)	4.2	N.A.
Crude oil derivative financial instruments				
Mark to market (MXN million)	**-**	**1,331**	**1,331**	**73**
Crude options	-	1,331	1,331	**73**
Volume (MM barrels)	-	114	114	**6.2**
Crude options	-	114	114	6.2

Source: PEMEX

Appendix C: Mexico's hedging program profit calculation

HEDGING COST 2001-2017			
	MXN	Exchange Rate	USD
2001	2'020'600'000	9.29	$217'502'691
2002	N/A	-	-
2003	N/A	-	-
2004	6'649'000'000	11.30	$588'602'412
2005	7'373'000'000	10.86	$679'194'878
2006	5'692'000'000	10.87	$523'763'515
2007	7'122'000'000	10.85	$656'224'086
2008	15'497'000'000	12.33	$1'257'159'082
2009	15'561'000'000	13.24	$1'175'590'685
2010	10'294'000'000	12.72	$809'324'449
2011	14'421'000'000	12.85	$1'122'060'340
2012	11'729'000'000	13.18	$889'824'561
2013	4'988'000'000	12.91	$386'449'476
2014	12'686'000'000	13.61	$932'125'866
2015	17'503'000'000	16.33	$1'071'568'507
2016	19'016'000'000	18.97	$1'002'662'730
2017	6'232'000'000	18.65	$334'083'843

Total	156'783'600'000	**11'646'137'120**

REVENUES MADE 2009, 2015, 2016			
	MXN	Exchange Rate	USD
2001	Option not exercised	-	$0
2002	Option not exercised	-	$0
2003	Option not exercised	-	$0
2004	Option not exercised	-	$0
2005	Option not exercised	-	$0
2006	Option not exercised	-	$0
2007	Option not exercised	-	$0
2008	Option not exercised	-	$0
2009	64'353'100'000	12.66	$5'084'873'500
2010	Option not exercised	-	$0
2011	Option not exercised	-	$0
2012	Option not exercised	-	$0
2013	Option not exercised	-	$0
2014	Option not exercised	-	$0
2015	107'512'400'000	16.33	$6'582'123'179
2016	53'738'000'000	18.97	$2'833'460'758
2017	N/A	-	$0

Total	225'603'500'000	**14'500'457'436**

Profit	68'819'900'000	**2'854'320'316**

Source: Centro de Estudios de la Finanzas Publicas (CEFP)

EXCHANGE RATE MEXICAN PESOS TO $1.00					
	Q1	Q2	Q3	Q4	AVERAGE
2001	9.680	9.140	9.200	9.140	9.290
2002					
2003					
2004	11.160	11.410	11.380	11.235	11.296
2005	11.091	10.885	10.808	10.638	10.856
2006	10.449	11.280	10.947	10.794	10.868
2007	10.745	10.745	11.027	10.895	10.853
2008	10.689	10.336	13.281	15.002	12.327
2009	13.385	13.138	13.325	13.099	13.237
2010	12.364	12.806	13.207	12.500	12.719
2011	12.120	11.740	13.764	13.785	12.852
2012	12.755	14.110	12.820	13.040	13.181
2013	12.320	13.020	13.200	13.089	12.907
2014	13.250	12.987	13.500	14.702	13.610
2015	15.351	15.679	16.944	17.362	16.334
2016	17.170	18.580	19.460	20.652	18.966
2017	18.709	18.025	18.178	19.704	18.654

Sourrce: Bureau of the Fiscal Service – US Treasury