
Mexico's Oil Price–Hedging Program

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INTRODUCTION

In 2008, on the brink of the worst financial crisis in decades, West Texas Intermediate (WTI) oil prices plummeted from their peak levels above US\$140 per barrel to about US\$40 in less than six months. For commodity-exporting countries like Mexico, for which oil revenues represent a substantial portion of total government income, a drop in oil prices of that magnitude could have compromised the public balances of the government and destabilized the economy. However, as it had done on several occasions in the past, Mexico had implemented an oil-hedging program, precisely to buy insurance against an adverse scenario such as the one that it eventually faced. The profits generated by the hedge proved to be a key compensating source of income for the government and greatly contributed to the stabilization of the domestic financial markets in Mexico. In fact, at some point during the crisis, the marked-to-market value of the program was close to \$10 billion, an amount that was made public to anchor expectations with regard to the strength of Mexico's public finances and balance of payments.

BACKGROUND

Oil Industry in Mexico

The oil industry has been extremely important for the Mexican economy over the years. In the 1980s, oil represented more than half of total exports. Nevertheless, the structural reforms implemented during the last decades, particularly those in relation to the negotiation of the North American Free Trade Agreement (NAFTA) with the United States and Canada, greatly reduced the dependency of the Mexican economy on oil exports (Figures 15.1 and 15.2). Indeed, NAFTA has largely benefited the non-oil sector, which has expanded vigorously. As a result, today's oil price movements do not represent a major source of

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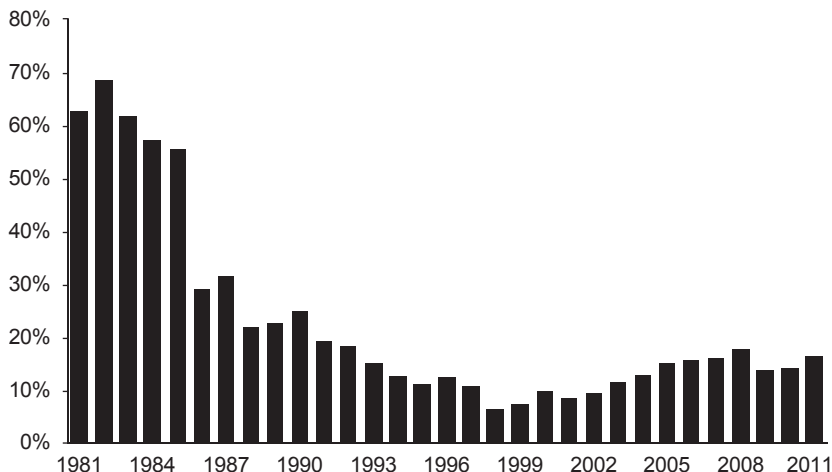


Figure 15.1 Mexico: Oil Exports as a Share of Total Exports

Source: Banco de México.

Note: 2011 data are as of September 2011.

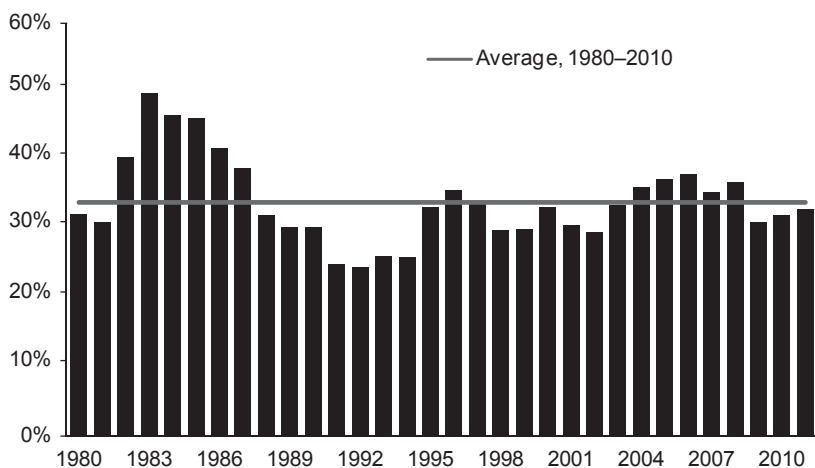


Figure 15.2 Mexico: Oil-Related Revenues as a Share of Total Public Sector Revenues

Source: Banco de México.

vulnerability to the balance of payments. Nonetheless, in spite of several tax reforms, public finances are still highly dependent on oil-related revenues, representing more than 30 percent of total government income.

Oil Income Stabilization Fund

To reduce the vulnerabilities posed by such dependence, the Mexican government has implemented several oil-hedging programs since the 1990s and also constituted an Oil Income Stabilization Fund (Fondo de Estabilización de los Ingresos Petroleros, or FEIP) in 2000.

TABLE 15.1

Oil Income Stabilization Fund	
Source of funds	Use of funds
Contributions of federal government	Coverage of budget gaps
Fraction of oil income surplus	Payment of the hedging instruments
Profit/loss from hedging instruments	Administrative expenses
Financial return	

Source: Oil Income Stabilization Fund.

The FEIP is a public trust created by the Undersecretary of Finance and Public Credit under direct orders from the Ministry of Finance. Its objective is to reduce the effects on public finances and the economy that result from a gap between the actual oil revenues and those established in the Federal Income Law. This might be the result of either a decline in oil prices and production volume or an extreme movement in the peso-dollar exchange rate.¹

The trust was initially funded by contributions from the federal government and grew significantly until 2008 with the windfalls of the oil industry as energy prices reached historically high levels. Nonetheless, as the financial crisis deepened, the capital of the fund was used to compensate for budget gaps and helped to cover expenses of programs authorized in the federal budget of the following fiscal years. Table 15.1 describes in more detail the source and use of FEIP funds.

Although the FEIP has served its main purpose, it is important to recognize that its size and scope are limited when compared to other countries' stabilization funds. In fact, the small size of the FEIP, relative to the size of the Mexican economy and the importance of the oil industry in Mexico, argues in favor of an oil-hedging program to self-insure against adverse movements in oil prices (Figure 15.3).

OIL-HEDGING PROGRAM

Governance Structure

The oil-hedging program is executed through the FEIP. The fund's operation is the responsibility of a technical committee formed by officials from the Ministry of Finance. Among its responsibilities, the committee decides whether an oil price-hedging program will be implemented, and if so, it also defines the amount of resources that would be available to purchase the hedging instruments.

An oil price-hedging subcommittee that groups technical experts from the Ministry of Finance, the Mexican State Oil Company (Petróleos Mexicanos, or PEMEX), the Ministry of Energy, and the Central Bank of Mexico (Banco de México) determines the characteristics of the hedging instruments to be used and coordinates the execution of the hedge itself. Banco de México, being the financial agent of the federal government and building on its infrastructure and expertise in regard to international financial markets, is directly responsible for the hedge's actual implementation.

¹ Objectives of the FEIP were published in the *Mexican Official Journal* in May 2007.

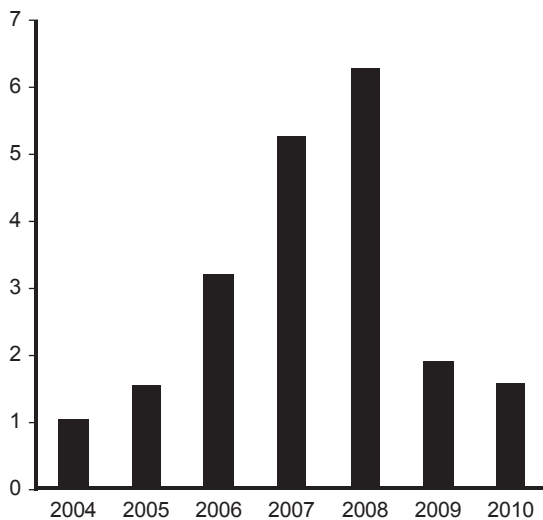


Figure 15.3 Mexico: Oil Income Stabilization Fund (Year-end balance, billions of U.S. dollars)

Source: Ministry of Finance.

Banco de México—Participation in the Oil-Hedging Program

There are various reasons that explain why Banco de México has executed the hedging program on behalf of the Mexican government. First and foremost, the central bank has the experience and infrastructure to actively participate in international financial markets, mainly as a result of its responsibility to invest the country's international reserves. This infrastructure includes not only information technology and operational capabilities, but also a highly skilled staff that has a thorough understanding of the functioning of financial markets. Throughout the years, Banco de México has gained experience in its investment of the international reserve portfolio, in addition to other hedging programs it has implemented on behalf of the government in other asset classes such as interest rate and foreign exchange products. This has given the bank a comparative advantage relative to other government agencies. Furthermore, the bank has more experience in selecting counterparties and in setting up the legal framework for the hedging program.

From an execution standpoint, having a flexible approach to minimize the impact of the program in the financial markets has proven to be very important. Therefore, the bank's staff has developed a framework to optimize the execution of the hedging strategies, mainly by trading under good liquidity conditions and by being patient and staying away from the markets in unfavorable circumstances (i.e., a sudden increase in implied volatilities of the put options). Finally, Banco de México has probably the strongest governance structure among public institutions in Mexico, which guarantees that the execution of the program is carried out with transparency and efficiency.

BOX 15.1 Important Steps before the Execution of the Hedging Program

Selection of Counterparties

The execution of the hedging program is challenging, so particular attention must be placed on selecting counterparties and on avoiding any potential impact of their execution on the hedging program's cost.

The process of selecting counterparties usually starts with a comprehensive analysis of the daily market coverage of potential counterparties by the central bank's operations staff. Several institutions are important participants in the commodities markets, but their clients' coverage, including their daily market commentaries, research, strategy, and comments on specific markets, is still an important factor in dictating which institutions are leaders in the market and thus will be considered for the execution of the hedging program. Given that the program involves transacting complex financial derivatives, it is also important to understand the intermediaries' valuation methodologies, modeling techniques, and risk-hedging strategies. In doing so, Banco de México gets a clearer picture of which institutions have an in-depth knowledge of the hedging vehicles that will be traded and on their strategies to absorb risk or transfer it to other market participants. Having a full understanding of the counterparties' trading platforms is also relevant because a deeper infrastructure may give institutions the ability to manage risk more efficiently and become more competitive (leaders in the commodities markets have large financial platforms and large physical trading capabilities).

Assessing the ability of the institution to warehouse risk and to be competitive on a consistent basis is more complicated and usually requires a direct and open dialogue with the firms, preferably at a higher level in the organization. The fact that the hedging program might be implemented on a continuous basis is important because it lines up the incentives for counterparties to be consistent in service and pricing if they want to be considered for the execution of the program in the years ahead.

Setting Up the Legal Framework

The definition of legal contracts to engage in the hedging program is also indispensable. Banco de México's activities with its counterparties are governed by an International Securities Dealers Association (ISDA) agreement. One of the main objectives of having ISDA contracts is to reduce the credit risk by establishing collateral management policies. Other important benefits include having legal certainty on what could constitute a credit event or an event of default and what would be the legal proceedings to follow under such circumstances.

Execution of the Oil-Hedging Program

The objective of the oil price-hedging program is to hedge the value of Mexican oil exports at a price that is consistent with the one determined in the federal budget law for any given fiscal year.

The program has evolved significantly during the last years as new markets have developed and liquidity conditions have improved. Taking advantage of these structural changes, the Mexican oil price-hedging program has also

TABLE 15.2

Characteristics of a Possible Hedging Strategy	
Instrument	Put options
Type of option	Asian
Underlying asset	Maya
Payoff	Difference between the strike price and the average closing price of the underlying asset during a 12-month period
Settlement	Term settlement (at the end of the 12-month period)

Source: Banco de México.

evolved to better suit the needs of the Mexican government. For example, the hedge is now more precise and less subject to a breakdown in the correlations of the different types of crude reference prices in the market. Nevertheless, there are still significant challenges in terms of execution and price discovery. A thorough explanation of one of the hedging strategies used in recent years is given in Table 15.2.

Options

As previously mentioned, the execution of the oil-hedging program has evolved throughout the years. Nonetheless, the one characteristic that has remained constant is the use of *put options* as the main vehicle for hedging. The rationale behind using options is simple. Options cover the risk of a decline in oil prices while keeping the benefits if prices increase (see Figure 15.4).

Asian Term Options

Asian options have recently been a preferred alternative, because the Mexican government needs to hedge the price of its oil exports throughout the year and not only at a particular expiration date (as would be the case with European or American options). The payoff of an Asian term option is determined by the difference between the strike price and the average price of the underlying asset

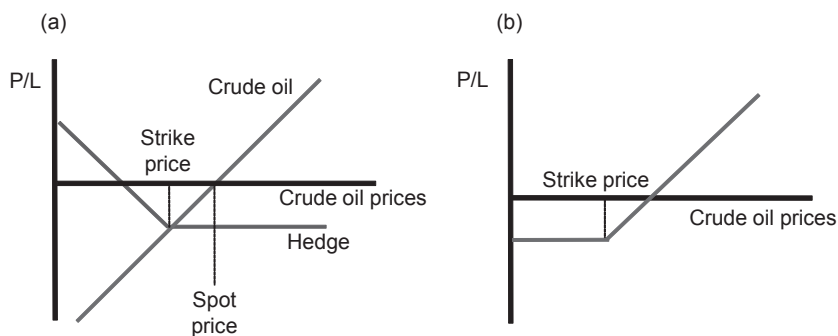


Figure 15.4 Hedging Strategy

Source: Banco de México.

Note: Graph (a) reflects both the put option structure and the long exposure to oil prices. Graph (b) represents the final exposure to oil prices once considered the hedge. P/L: profit/loss.

over a predetermined period of time. Asian term options are particularly useful because the volume of the Mexican exports is stable (Figure 15.5), and they better match the average price at which oil exports are sold. Figure 15.6 exemplifies the benefits of Asian term options. In an oil price scenario, such as the one described in this figure, a European put option would not be exercised at

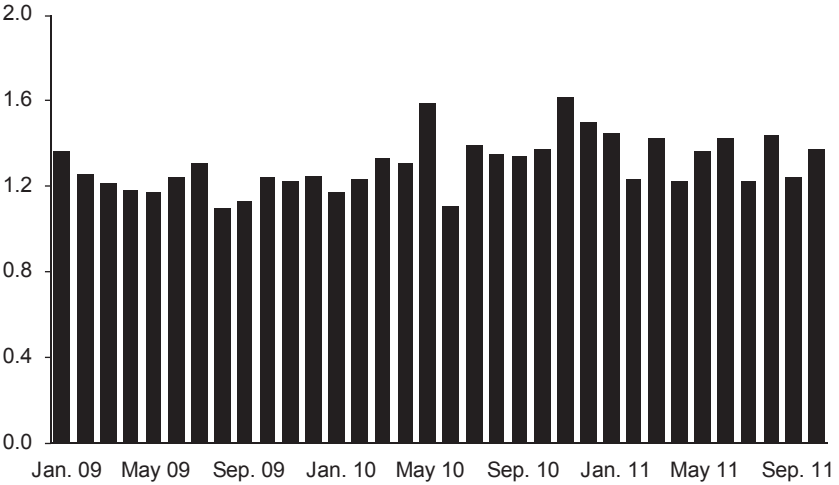


Figure 15.5 Mexico: Monthly Oil Exports (*Millions of barrels per day*)

Source: Banco de México.

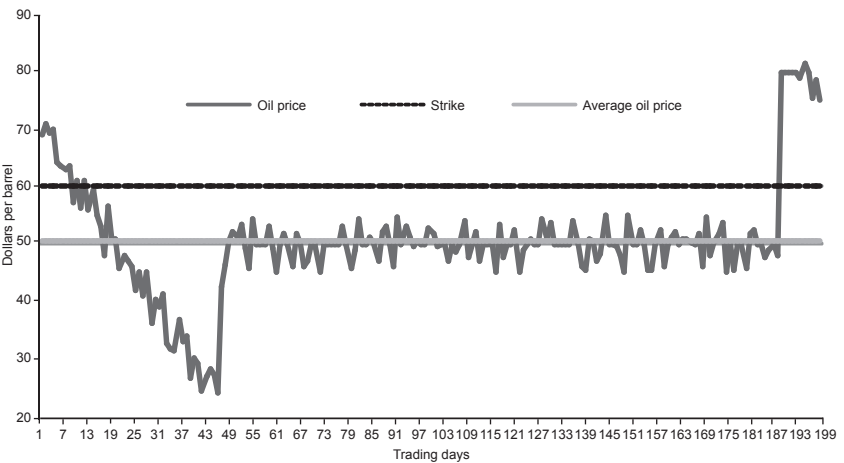


Figure 15.6 Oil Price Scenario and Strike Price

Source: Banco de México.

TABLE 15.3

Option Cost Comparison for a One-Year WTI \$87.50 Strike Put		
Option type	Premium offer (\$/bbl)	Payoff
Asian term settled	\$4.18	One cashflow: Strike versus the arithmetic average of the daily first nearby WTI settlement prices during the term
European term settled	\$5.21	One cashflow: Strike versus the settlement price of the respective WTI future on expiration date
Asian monthly	\$5.61	Twelve cashflows: Strike versus the arithmetic average of the daily first nearby WTI settlement prices during the respective calendar month of the term
European monthly settled	\$8.31	Twelve cashflows: Strike versus the monthly settlement price of the respective WTI future on expiration date

Source: Authors' compilation.

Note: As of December 13, 2011. Indicative prices provided by a leading institution in the commodities markets; WTI: West Texas Intermediate. Reference spot price: US\$100.14 per barrel. The strike (US\$87.50 per barrel) was set to exemplify the cost of an Asian term settled put option with a 25 delta.

a profit, because oil prices would end up above the strike price at the end of the hedging period (despite the fact that during the life of the option oil prices were below the strike). In contrast, an Asian term option would settle at a profit, because the average oil price during the period is below the strike price, and would therefore fully compensate for the foregone revenue resulting from a lower average oil price.

Because of their averaging feature, Asian term options also have a lower implied volatility and consequently are usually less costly than American or European options. Furthermore, a one-year term option is less expensive than a strip of 12 monthly Asian term options (see Table 15.3).

Underlying Asset

The Mexican crude oil basket is composed of three crudes: Maya, Olmeca, and Isthmus. The first one is a heavy and sour crude, whereas the other two are lighter and sweeter, like WTI or Brent. Recently, Maya production has represented more than 80 percent of total production in Mexico.

WTI and Brent crudes are probably the most important benchmarks, and therefore, the financial derivatives referenced to these crudes are the most liquid and easiest to trade. Nonetheless, the Mexican crudes have different properties (from an energy and chemical perspective) than those of WTI or Brent, and consequently, the prices between the former and the latter can vary significantly.

One of the most important challenges of the oil price–hedging subcommittee is to weigh the costs and benefits of hedging the Mexican crude oil basket to minimize the basis risk (the risk of hedging the Mexican oil basket using WTI or Brent derivatives) at the expense of trading less liquid and less transparent derivatives against those of hedging using WTI or Brent as underlying assets at the expense of having a larger basis risk.

BOX 15.2 Selecting the Underlying Asset

West Texas Intermediate (WTI) is the most important benchmark in the crude oil market in the American continent. As such, financial derivatives with this crude as underlying are also more liquid. Nonetheless, WTI derivatives have significant drawbacks.

- Movements in WTI prices are subject to local conditions in addition to global fundamental factors. The distribution center for WTI is Cushing, Oklahoma, a location far from coasts and with limited storage capacity. Hence, a sudden buildup/drawdown of inventories can have a significant impact on pricing.
- The liquidity of WTI futures contracts, as well as the inclusion of these in broader commodity-indexed investment vehicles, has triggered a large participation of short-term investors in the WTI market. Consequently, WTI prices are also more susceptible to short-term fluctuations that affect WTI's value relative to other crudes.

These inconveniences complicate the use of WTI derivatives to execute the hedging program. Using Brent might partially alleviate these inconveniences, but, in any case, basis risk can still be significant. Figures 15.7 and 15.8 illustrate that despite having a high correlation, the price differentials between WTI, Brent, and Maya can vary significantly through time. This was particularly obvious in 2011 when the price differentials among these three crudes were particularly high and unstable from any historical perspective.

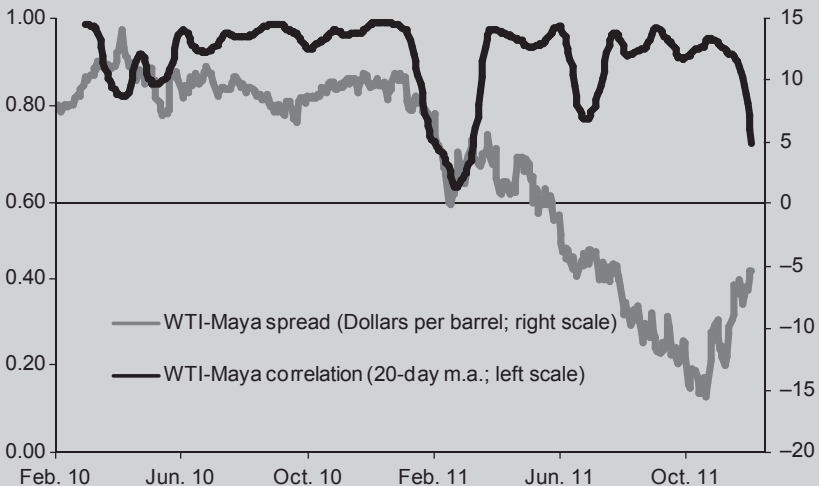
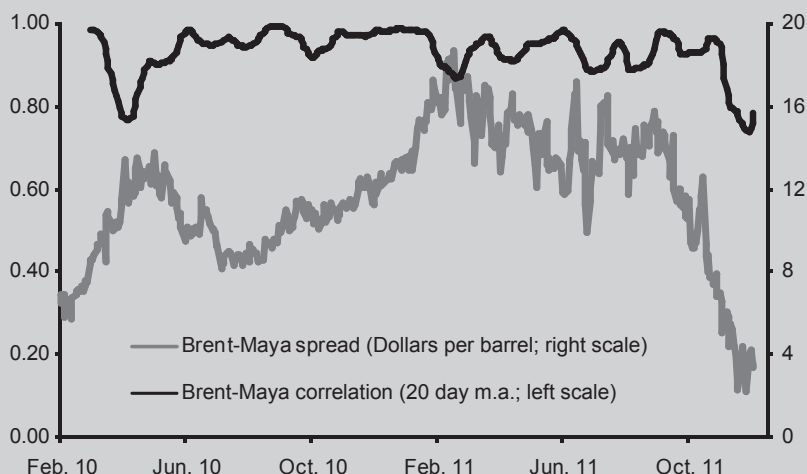


Figure 15.7 WTI-Maya Spread and Monthly Correlation

Sources: Banco de México; Bloomberg; and Platts.

Note: m.a.: moving average; WTI: West Texas Intermediate.

(continued)

BOX 15.2 Selecting the Underlying Asset (continued)**Figure 15.8** Brent-Maya Spread and Monthly Correlation

Sources: Banco de México; Bloomberg; and Platts.

Note: m.a.: moving average.

Strike Price of the Maya Put Option

The strike price of the option is determined in such a way that it hedges the oil reference price determined in the federal budget law for the next fiscal year. This reference price is determined from the average of the following components:²

1. Average of
 - The arithmetic average of the monthly international prices for the Mexican Export Mix during the preceding 10 years.
 - The average of New York Mercantile Exchange (NYMEX) WTI future prices for at least 3 years forward, adjusted by the differential with the Mexican Export Mix.
2. 0.84 percent of the average of NYMEX WTI futures for the period that is being budgeted, adjusted by the differential with the Mexican Export Mix.

Usually, the strike price has been such that the put option to be purchased during the hedging program is an out-of-the-money (OTM) option, with a price sensitivity (delta) to the price of the underlying asset between 10 and 25 percent. This OTM feature has helped in meeting the program's objective to hedge against extreme adverse scenarios, as well as in reducing the cost of the program (Table 15.4).

²The formula for the oil reference price is established in Article 31 of the Federal Law of Budget and Fiscal Accountability.

TABLE 15.4

Cost of WTI Put Options at Different Strike Prices		
Strike	Delta	Premium
100	46.45	\$11.18
90	24.72	\$6.56
80	12.70	\$3.54
70	5.89	\$1.65

Source: Authors' compilation.

Note: As of December 14, 2011. Strike and premium in dollars per barrel, delta in percentage. Reference spot price: US\$94.95 per barrel.

Pricing of the Maya Put Option

As mentioned earlier, using Maya put options eliminates basis risk. However, the execution is more complicated given that there is no observable, screen-based market for Maya crude, as opposed to WTI or Brent.

The commercial branch of PEMEX, PMI, prices Maya in the international markets using an algebraic formula that includes the price of West Texas Sour crude, fuel oil, Light Louisiana Sweet crude, Dated Brent, and an adjustment factor K .³ In other words, Maya can be seen as a bundle of different energy products, and consequently, the value of a Maya put option is approximated by the cost of hedging such a bundle (Figure 15.9). However, some of these components may not have a tradable forward market, so financial institutions have to define

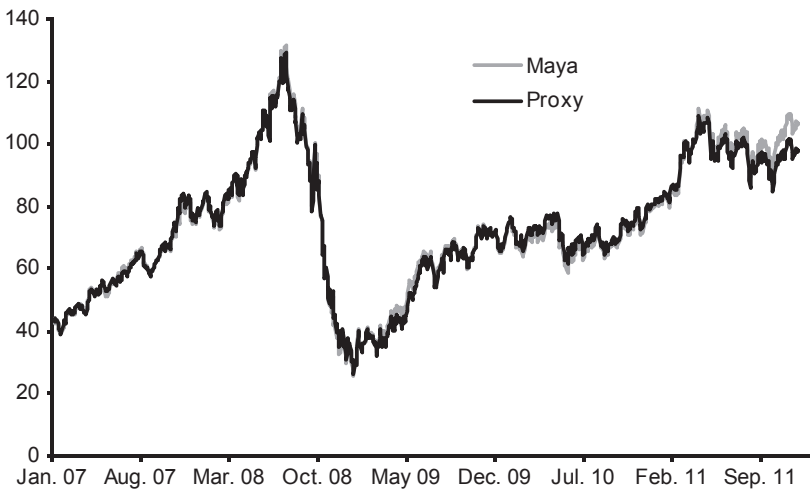


Figure 15.9 Proxy of Maya (Dollars per barrel)

Sources: Banco de México; Bloomberg.

Note: Maya = 38% WTI + 47% fuel oil + 17% Dated Brent - 4.98.

³The actual formula for pricing Maya crude is 0.40 (West Texas Sour crude + Fuel Oil No. 6 with a 3 percent sulfur content) + 0.10 (Light Louisiana Sweet crude + Dated Brent crude) + K .

their own methodologies to determine a Maya forward curve, to estimate the implied volatility of the Maya price, and to hedge their risks. Hence, the assessment of the value of the put option can vary significantly, which makes the price discovery process particularly challenging.

In fact, the pricing discrepancies among different counterparties can be significant, mainly under conditions of risk aversion and extreme volatility. Given these pricing difficulties, it is essential to have a good understanding of pricing models to determine which are the main drivers of the value of the option, as well as to trade with different institutions as a means of fostering competition to reduce the cost of the hedging program.

Execution of the Hedging Program

The execution of the hedging program is a complicated and time-consuming process that requires the full attention of a dedicated team. The objective is to minimize the cost of the hedging program; therefore, minimizing its visibility is extremely important. In doing so, the central bank also reduces the impact of its hedging activities on financial markets.

The program starts with a comprehensive analysis of the developments in the energy markets by Banco de México and the Ministry of Finance. In this process, staff from both institutions try to identify market trends, analyze new hedging vehicles or strategies, and determine the precise moment at which the put options must be purchased. A detailed analysis of the capabilities and potential price competitiveness of counterparties must be completed at this stage. This market intelligence effort is important and sets the stage for a smooth execution.

The purchase of the hedging vehicles requires a flexible hedging strategy to adapt the program to market conditions. It is the staff of Banco de México who decide the speed at which the hedging program is implemented. Sometimes, conditions in the market are such that speeding up the program might be convenient; in other circumstances, it might be preferable to adopt a more conservative approach. During the execution phase, having constant communication with counterparties is essential. Most often, these institutions have a good assessment of the liquidity and depth of the markets and can therefore offer insightful information for determining the timing, pace, and scale of the execution. The flexibility of the hedging program has allowed Banco de México to trade under favorable market conditions, including episodes of lower implied volatility and higher liquidity, thus reducing the program's overall cost.

The actual trading of the put options by Banco de México is done in a very transparent manner. The trade is executed with the most competitive institution (lowest price). The transparency with which the hedging program is conducted, together with the strong governance structures of the Oil Income Stabilization Fund and Banco de México (as the program's executing agent), has been essential for satisfying the information requirements of the auditing institutions of the Mexican government.

The execution of the hedging program carries important challenges. In fact, the execution has become more complex, not only because of extreme market conditions, but also because some of the particularities of the hedging program were made public in 2009.⁴ Press reports on the hedging program have become more frequent, and keeping the program confidential has become difficult. Most of these media reports include inaccurate information about the Mexican hedging activities, but nevertheless, they can have a negative impact on market conditions.

Collateral Management

Following the execution, the bank has to manage the collateral associated with the put options. The objective is to minimize counterparties' credit risk through strict collateral and margin requirements. Such collateral management involves daily margin calls to account for the daily mark-to-market of the hedging program. In other words, if the value of the option increases, Banco de México requires additional collateral from its counterparties; in contrast, if the value of the option decreases, the central bank returns collateral in an amount that reflects the new price of the put option. Some important considerations include the definition of eligible collateral, which is often defined to include only the most liquid fixed-income securities issued by governments with highly rated credit. The definition of a threshold amount to require collateral is also relevant; a zero threshold amount reflects zero tolerance for credit risk. Some institutions might prefer to have a higher threshold amount to avoid the operational complexities of daily margin calls. For Banco de México, the most important aspect of collateral management is to make sure that in the case of a credit event or an event of default by any of the counterparties (as defined in the International Securities Dealers Associations contracts), the bank would be able to sell the collateral to cover any amount due.

Finally, the central bank is also responsible for preparing reports and presentations on the different aspects of the hedging program, including important developments on the commodities markets, the mark-to-market value of the hedging program, activity reports, and collateral position reports, among others. These documents are the official means of communication between the central bank, the oil price–hedging subcommittee, and the Ministry of Finance and also the best alternative for having a transparent record of the activities of the Oil Income Stabilization Fund for auditing-related purposes.

Performance of the Hedging Program

Given that large swings in oil prices can have a significant effect on public policies, it is extremely important to have a hedging program in place. The

⁴The 2009 hedging program was very successful in offsetting the reduction of oil prices. It was also highly publicized.

objective of the program is to compensate for a decrease in government revenues in an adverse scenario for oil prices. Such will be the case if the options end up being in the money. However, if the options end up being out of the money, it implies that oil prices have been higher than the reference price used for the corresponding federal budget. In other words, oil income has been higher than expected.

Therefore, assessing the results of the hedging program using only the return of the hedging instruments would be misleading. There are many indirect benefits that, when factored in, favor its implementation. For instance, the hedging program has been an important element in providing certainty about the ability of Mexico to finance its current account deficit. Such certainty has had positive spillover effects on the performance of financial assets, on foreign direct investment, and more broadly, on economic growth and development. In fact, as mentioned earlier, the 2009 oil-hedging program proved to be a very important factor behind the consolidation of public finances and the resilient performance of Mexican markets in the aftermath of the financial crisis.

FINAL COMMENTS

The oil industry in Mexico is an important source of income for the Mexican government. Hence, the Ministry of Finance established the Oil Income Stabilization Fund in 2000. However, the small size of the fund and its limited scope relative to the size of the economy and to the importance of the oil industry argues in favor of other methods to self-insure against adverse movements in oil prices. One such alternative is the oil price–hedging program.

The objective of the program is to hedge the value of Mexican oil exports at a price that is consistent with the one determined in the federal budget law for the subsequent fiscal year. The hedging strategy is determined by the oil price–hedging subcommittee, which groups experts from the Ministry of Finance, PEMEX, the Ministry of Energy, and Banco de México. The strategy has evolved significantly throughout the years to account for new market developments and is reviewed on a continuous basis to determine the costs and benefits of new hedging vehicles or strategies. Lately, Asian term options on Maya crude have been chosen as the main hedging vehicle because these options essentially eliminate basis risk and allow the Mexican oil exports to be hedged throughout the year and not only at a particular expiration date. It is Banco de México, building on its expertise earned through the investment of its international reserve portfolio and through the execution of other hedging programs on behalf of the Mexican government, that executes the oil-hedging program.

The execution has been challenging but successful. The markets for hedging commodity prices have evolved significantly, becoming more competitive, more liquid, and deeper than before. Furthermore, the Mexican experience shows that the financial and commodities industries have evolved to allow the Mexican

government to hedge using the types of crude that Mexico produces, enhancing the efficiency of the program. Nonetheless, comprehensive reforms to increase the size and scope of the FEIP, and, above all, to diversify the sources of income of the Mexican government to make it less dependent on the oil industry must be a priority in the policymakers' agenda in the years ahead.

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