



# **A Proposed Fuel Price Stabilization Mechanism through the Use of Financial Derivatives**

Juan Antonio Zapata  
Carlos Gabriel Rivas  
Alejandro Melandri

**Inter-American  
Development Bank**

Infrastructure and  
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## 1. Introduction

The price of oil remained relatively stable for much of the 20th century, most notably in the twenty-five years preceding the crisis brought about by the oil-producers' embargo of 1973. After October that year, the price of oil began to show marked volatility, which has lasted until today. Since then, upward and downward trends have been following each other over spaces of a few years, including some sharp year-on-year variations combined with significant short-term fluctuations. Upwards trends in the price of oil, downward corrections in it and the magnitude of fluctuations have become particularly sharp since 2002.

The reasons behind these recent behaviors as well as the long-term prospects for them have triggered a broad debate among hydrocarbon market analysts. Some economists have seen the signs of a bubble in the price of oil, similar to bubbles that have arisen in connection with other assets, which would be facilitated by the deepening of the markets where oil is traded.<sup>1</sup> Other analysts identify real market imbalances (a rapidly increasing demand along with a decline in the production of oilfields under exploitation) that would explain an upward trend in the long term.<sup>2</sup> In any case, structural changes in the real market as well as the facilitation opportunities offered by the financial markets are related to oil price volatility and suggest that scenarios as the ones described will predominate at least in the medium term.

Oil price volatility impacts on the economy of the countries in various ways, both at the macroeconomic level and with regard to the markets of oil refinery by-products, particularly liquid fuel markets. The coexistence of highly volatile prices with strong short-term trends make it difficult for economic actors to distinguish one phenomenon from the other, which creates uncertainty and tension and, consequently, leads to sub-optimal decision making in such contexts.

In many cases, governments have attempted to moderate or neutralize these impacts on the economies through the implementation of several mechanisms, such as direct subsidies,

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<sup>1</sup> John E. Parsons, "Black Gold and Fool's Gold: Speculation in the Oil Futures Market," MIT Center for Energy and Environmental Policy, 2010.

<sup>2</sup> Ramón Espinasa, Inter-American Development Bank, 2010, cited by Parsons.

cross-subsidies and specific price stabilization funds, or by promoting fuel switching in the long run.

The energy balance of many economies in Latin America and the Caribbean is very highly oil-dependent. The Inter-American Development Bank has identified in many of its member countries and interest in analyzing alternatives to moderate hydrocarbon price volatility and its repercussions on the costs for consumers.

This is the context in which this study has been designed, which proposes a discussion of the fundamentals of employing a mechanism based on the use of financial hedging instruments to mitigate the impact of oil price volatility on the cost of oil derivatives. For the purpose of contributing to the consideration of alternatives, the possibility of supplementing these financial instruments with the implementation of price stabilization funds is also examined, in view of some existing experiences with the latter in the region.

The document seeks to support the analysis by modeling the possible results of applying these mechanisms to a regional economy. To this end, the authors received the assistance and collaboration of authorities and officials from the Government of Peru, which made it possible to base the modeling exercise on the behavior of real regional market variables. Furthermore, the study simulates a price stabilization scheme “suggested” for such market aimed at mitigating the volatility of the prices of oil refinery by-products, and quantifies the possible results on the basis of a simplified theoretical simulation.

The purpose of this study is to serve as a basic working paper, the main aim of which is to open a window of interest and support a dialogue on the application of stabilization mechanisms that help discuss specific proposals, analyze regulatory frameworks, and develop models to be applied to the price of oil and its derivatives in the countries of the region.



## Structure of the Study

Oil price volatility impacts on fuel prices, which substantially affects other economic variables. For instance, in the case of Peru, fuel consumption accounts for some 4% of the GDP, for which a fuel price rise of about 25% would have a direct impact<sup>3</sup> of 1% on the GDP. This would cause an equivalent decline in the aggregate demand of the other goods and services,<sup>4</sup> which may take place concomitantly with a strong impact on the general price level. There are numerous oil importing countries faced with the dilemma of either allowing volatility to impact on fuel prices or resorting to mechanisms, if available, to soften its effects, i.e. to cushion or mitigate both price rises and falls. Fuel price increases have social and political effects, and many governments try to avoid them. Therefore, a great number of countries adopt policies aimed at lessening the effects of temporary oil market price increases in order to prevent them from impacting at the domestic level. A study carried out by GTZ on a sample of 175 countries revealed that in 2007 and 2008 about half of them had implemented some sort of subsidy scheme to prevent oil price volatility from immediately hitting the domestic front. Some of the mechanisms used involved price controls, tax cuts, reductions in State-run oil companies' revenues, or fuel stabilization funds. Almost all these instruments bear fiscal costs or affect resource allocation in the oil industry.

This document focuses on the analysis of fuel price stabilization models through the use of financial derivatives, which ensure greater neutrality and have a lesser impact on resource allocation than the other instruments.

These hedging instruments serve as insurance policies against undesired events, such as a commodity price spike (of oil, for instance) in the case of a net oil importing country or a price fall in the case of a net exporter.

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<sup>3</sup> In addition to its direct impact, this brings about other effects, since fuels serve as an input to other manufacturing processes.

<sup>4</sup> In turn, a decline in the aggregate demand may have an adverse impact on employment.

These instruments work similarly as a simple insurance (personal accident, fire, life) policy; a premium is paid to cover a risk, and the insurance amount is collected if this risk occurs. As with any other insurance, premiums increase as events prove more likely to occur.

In the case of an oil importing country, the event involves a price rise above a certain previously fixed threshold or ceiling (exercise or strike price). Any increase above such threshold is offset by the insurance, for which a premium is paid. This mechanism protects the insured party for a given period of time (a month, a quarter, a year) and for the contracted volume; for example total consumption or the expected imports or exports.

Thus, hedging instruments help stabilize fuel prices for consumers during the length of the hedge period, which is an economic policy goal given the impact of the fuel price on the economy. The (premium-indemnity) mechanism can be implemented so as to avoid undesired fiscal effects, such as an increase in public expenditure to keep fuel prices stable (in the case of a net importer) or a decrease in public revenue in the case of a net exporter.

As an alternative to hedging instruments, a stabilization fund can be adopted to partially absorb variations in the international reference price through subsidies or surcharges so that the price paid by consumers falls within a price band. This mechanism should work in the following way: below the lower bound of the band, the price paid by consumers will be higher than the international price and the fund will accumulate a surplus, whereas when above the upper bound, the price paid by consumers will be lower than the international price as a result of the subsidy, and the fund surplus will dwindle down. In practice, the latter (depending on the intensity and duration of the price increase) may result in the depletion of the fund resources.<sup>5</sup>

This document is structured as follows:

- Chapter 2 describes different hedging alternatives available for consumers as well as the purchase of call options in the case of an oil importing country.

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<sup>5</sup> This was the case in Chile, where a rule was adopted to limit withdrawal of resources from the fund when close to depletion.

- Chapter 3 analyzes how to complement stabilization funds with derivatives in the face of different oil price tendencies and volatility scenarios.
- Chapter 4 puts forward some simulations under different scenarios in Peru, estimating the option amounts required to hedge domestic fuel consumption, as well as a stabilization scheme proposal for such country, including its potential effects on consumers, producers and tax authorities.
- Chapter 5 presents a summary as well as the conclusions, describing in detail the major results from the policy alternatives proposed and highlighting the institutional, transparency and communication aspects worth considering.
- The Annex lists the cases observed that make use of these hedging instruments, such as Mexico and some airlines, or where their adoption is under study, as in the new Chilean legislation.

## **2. The Use of Derivatives or Hedges**

This section analyzes the hedging alternatives available for oil consumers, such as futures contracts and the purchase of calls or other type of options.

The call options alternative has been chosen to be developed more thoroughly —i.e. acquiring call options in the case of an oil importing country. The information used for this alternative has been derived from the call options that are traded every day on the New York Mercantile Exchange (NYMEX), where the call option buyer pays a premium to guarantee the right to buy oil on a future date at the price fixed today.

If at the time of exercising the right to buy the agreed quantity the spot price exceeds the strike price, the insured exercises the option and receives an indemnity that is equal to the difference between the spot price and the agreed price (known as exercise or strike price).

Instead, if at such time the spot price is below the strike price, the call option buyer does not exercise the right to buy, having only paid for a premium to hedge against an event that did not take place.

The parties interested in this kind of hedging instrument are those that depend on the commodity concerned, for example large oil consumers or the State on behalf of its consumers.

In the case of an oil importing country, the event against which protection is sought for consumers is a price rise above a certain previously fixed threshold or ceiling (exercise price). Any increase above such threshold would be offset by the insurance, for which a premium is paid. This mechanism protects the insured party for a given period of time (a month, a quarter, a year) and for the contracted volume, for example total oil consumption. The origin of the oil, whether local or international, is irrelevant in this case, since both local and foreign producers receive the international price. Thus, this instrument is neutral in terms of national oil investment decisions. Hedging, therefore, may contribute to oil price stabilization policies, by purchasing instruments against a price rise above the established price threshold in the case of an importer.

As for oil sellers, there is another hedging alternative: *the purchase of put options* by those who wish to guarantee their right to sell oil on a future date at a price agreed today. This alternative can be used by oil exporting countries. In this case, if the strike price exceeds the spot price on the put exercise date, the buyer exercises the right and receives an indemnity that is equal to the difference between the exercise price and the spot price. If the strike price is less than the spot price, the buyer does not exercise the option, and the oil is sold at the spot price. Being an oil exporter, Mexico has resorted to this kind of hedging mechanism by purchasing put options for years, as oil tax revenue accounts for a large share of the federal revenues. Through the adoption of this instrument, Mexico has been able to guarantee the execution of its budget.

## **2.1. Hedging Alternatives for Consumers**

There are several mechanisms available to hedge against the risk of oil price increases.

### **2.1.1. Purchasing Future Contracts**

The easiest way to hedge against an undesired price increase is through a future commodity purchase, whereby the price is fixed for a given period of time (for example, a year). If the price turns out to be higher than the agreed price, the futures buyer gains —or vice versa—, since in this case the buyer has the *right and obligation to buy at the preset or futures price*.

In these transactions, both buyer and seller post a margin with a broker, i.e. make a collateral deposit to ensure fulfillment of obligations in the event that the price on the delivery date either rises or falls vis-à-vis the futures or strike price. If it rises, the broker uses some or all of the collateral every day and may even call the seller for an additional deposit if the funds are considered insufficient to settle the transaction on that date; in the meantime, this price rise is credited to the buyer's account. When the price rises, the seller loses and the buyer gains.

### **2.1.2. Purchasing Call Options**

Another instrument to hedge against price increases is the call option, whereby the buyer acquires the *right* but not the obligation to buy an agreed quantity of a particular commodity for a certain strike price on a future specified date. To have this right, the buyer has to pay a premium. At the option expiration time, if the spot price is higher than the strike price, the buyer exercises the option and receives an indemnity from the seller that amounts to the difference between the spot price and the strike price. The call option seller is obligated to pay the indemnity.

If on the expiration date the spot price is below the strike price, buyers *are not obligated to exercise the option*, because if they need the oil, they would rather buy it on the spot market at the lowest price. The seller is released from the obligation to sell when the buyer does not exercise the option, but keeps the premium paid by the buyer.

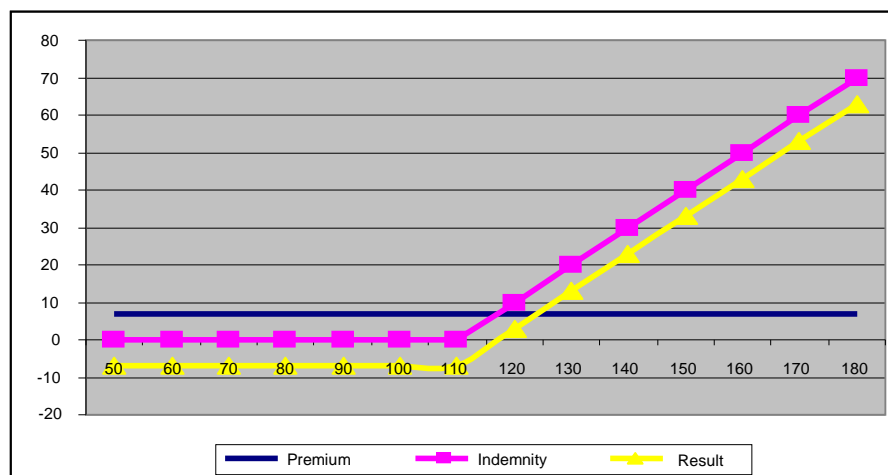
Premiums in oil call options buying and selling operations are determined by supply and demand, and are published on a real time basis on options markets such as NYMEX. Premiums, therefore, are associated with oil price volatility risks.

NYMEX is a regulated market, thus reducing transaction risks and ensuring traders the exercise of their rights independently of their counterparts' financial situation, since sellers are required to post collateral or a "performance bond." It should be noted that option markets do not require any guarantee from buyers since they pay the call or put option premium at the time of concluding the transaction; therefore, sellers do not run any risks.

This situation is illustrated in Figure 1 below: the *Y* axis shows the premium, the indemnity, and the net result vis-à-vis the spot price, which is shown on the *X* axis. The premium has been estimated at US\$7 and the exercise price, at US\$110. The result (yellow line) is the

indemnity minus the premium. The indemnity is positive and it increases when it is above the exercise price; if it is below, it comes down to nil.

**Figure 1. Purchase of Call Options**



Source: Prepared by Zapata and Rivas.

Note: Vertical axis: Premium, indemnity and result in US dollars per barrel. Horizontal axis: US dollar spot price per barrel.

The transaction can be analyzed as follows: if the price is, for example, US\$90, the premium is lost, whereas if the price is US\$150, an indemnity of \$40 (US\$150-US\$110) will be gained, and the net result will amount to US\$33 (US\$40-US\$7) after paying a premium of US\$7.

These instruments are traded on the CME Group electronic trading platform,<sup>6</sup> which publishes information on the transactions taking place in the New York Mercantile Exchange (on the trading floor). The website of this market or electronic trading platform (Table 1) shows all the information available for decision making, e.g. for buying a call where the asset traded is a WTI (Light Sweet Oil West Texas Intermediate) contract (in units of 1,000 barrels), WTI being a grade of crude oil used as benchmark in oil pricing in the USA.

On the upper left corner of the website, we can choose the contract expiration date (month-end close). Immediately to the right there appears a chart (see Figure 2) showing the future WTI price variation followed by the last quote (of the future price), the change vis-à-vis

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<sup>6</sup> We understand this is the main electronic market, though not the only one.

the prior settle, the highest and lowest future price of the month chosen that day, the volume of traded contracts, the high and low price limit of all the series from the time the future concerned is quoted up to the time and date at which the information was provided (the website data have a 10-minute delay and are constantly being updated). Below the date, we can choose the type of option: either American (the option can be exercised at any moment until the expiration date) or European (the option can be exercised only on its expiration date).

Once the type of option is selected, the screen shows the premium cost (under Last) for each strike or exercise price (expressed in cents) and for each kind of contract (call or put), immediately followed by the same kind of information shown on the upper panel for WTI futures.<sup>7</sup>

**Figure 2. WTI as of October 31, 2011, Daily Highs and Lows**



Source: [http://www.cmegroup.com/trading/energy/crude-oil/light-sweet-crude\\_quotes\\_globex\\_options.html?exchange=XNYM&foi=OPT&venue=G&productCd=CLN2&underlyingContract=CL&floorContractCd=CLN2&expMonth=201202](http://www.cmegroup.com/trading/energy/crude-oil/light-sweet-crude_quotes_globex_options.html?exchange=XNYM&foi=OPT&venue=G&productCd=CLN2&underlyingContract=CL&floorContractCd=CLN2&expMonth=201202)

<sup>7</sup> This information is available at [http://www.cmegroup.com/trading/energy/crude-oil/light-sweet-crude\\_quotes\\_globex\\_options.html?exchange=XNYM&foi=OPT&venue=G&productCd=CLN2&underlyingContract=CL&floorContractCd=CLN2&expMonth=201207](http://www.cmegroup.com/trading/energy/crude-oil/light-sweet-crude_quotes_globex_options.html?exchange=XNYM&foi=OPT&venue=G&productCd=CLN2&underlyingContract=CL&floorContractCd=CLN2&expMonth=201207)

**Table 1. Costs of Call and Put Options Expiring in February 2012 as of October 31, 2011**

**Futures Underlier**

Month	Charts	Last	Change	Prior Settle	High	Low	Volume	Hi Lo	Limit	/ Updated
Feb 2012	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/>	92.55	-0.62	93.17	93.40	92.18	1,329	103.17 83.17		7:08:42 AM CT 10/31/2011

[Option Quotes](#) [View Spread Quotes](#)

About this Report Turn Auto-refresh  OFF

Type: American Options Expiration: FEB 2012

Strike Range:

C P  
all  
ut  
s s

Strike Price	Type	Last	Change	Prior Settle	High	Low	Volume	Hi Lo	Limit	/ Updated
9200	CALL	6.83 a	-0.43	7.26	-	6.83 a	0	No 0.01	Limit	6:59:43 AM CT 10/31/2011
9200	PUT	6.28 a	+0.18	6.10	6.41 b	6.28 a	0	No 0.01	Limit	7:00:09 AM CT 10/31/2011
9250	CALL	6.56 b	-0.42	6.98	-	6.55 a	0	No 0.01	Limit	6:59:43 AM CT 10/31/2011
9250	PUT	6.51 a	+0.20	6.31	6.63 b	6.51 a	0	No 0.01	Limit	7:00:12 AM CT 10/31/2011
9300	CALL	6.29 a	-0.41	6.70	-	6.29 a	0	No 0.01	Limit	6:59:43 AM CT 10/31/2011
9300	PUT	6.73 a	+0.20	6.53	6.86 b	6.73 a	0	No 0.01	Limit	7:00:09 AM CT 10/31/2011
9350	CALL	6.03 a	-0.39	6.42	-	6.03 a	0	No 0.01	Limit	6:59:43 AM CT 10/31/2011
9350	PUT	6.96 a	+0.21	6.75	7.10 b	6.96 a	0	No 0.01	Limit	7:00:09 AM CT 10/31/2011
9400	CALL	5.77 a	-0.38	6.15	-	5.77 a	0	No 0.01	Limit	6:59:43 AM CT 10/31/2011
9400	PUT	7.20 a	+0.22	6.98	7.35 b	7.20 a	0	No 0.01	Limit	7:00:12 AM CT 10/31/2011

Source: [http://www.cmegroup.com/trading/energy/crude-oil/light-sweet-crude\\_quotes\\_globex\\_options.html?exchange=XNYM&foi=OPT&venue=G&productCd=CLN2&underlyingContract=CL&floorContractCd=CLN2&expMonth=201202](http://www.cmegroup.com/trading/energy/crude-oil/light-sweet-crude_quotes_globex_options.html?exchange=XNYM&foi=OPT&venue=G&productCd=CLN2&underlyingContract=CL&floorContractCd=CLN2&expMonth=201202)



### 2.1.3. Another Hedging Alternative

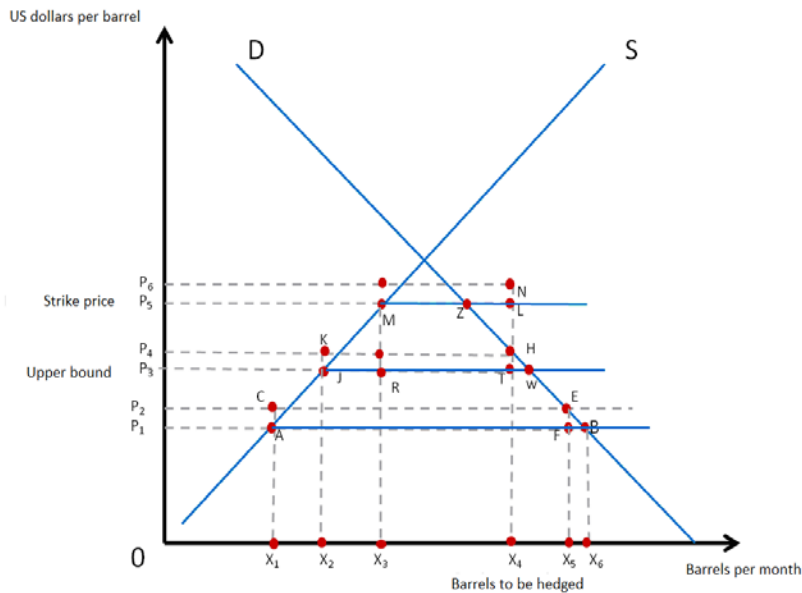
Another common market alternative is a sales agreement between a large consumer and the producer of a commodity whereby a price is fixed for a specified quantity of such commodity to be supplied within a specified period. This is the case of the take-or-pay contracts used in the electricity market of several countries in the region.

## 2.2. Purchasing Call Options: The Case of an Oil Importing Country

The purchase of call options is an alternative for an oil importing country. Figure 3 illustrates how this scheme works. The vertical axis measures the crude oil barrel price, and the horizontal axis tallies the number of barrels per month.

This figure shows the local supply and demand in an oil importing country, where the possibility of buying crude oil in the international market caps its domestic price, thus determining domestic consumption, local production volume, and the amount imported. In this analysis, hedging premiums are assumed to be paid by consumers.

**Figure 3. Supply, Demand and Imports**



Source: Prepared by Zapata and Rivas.

Figure 3 shows an initial situation in which  $P_1$  stands for the international price of oil. In the absence of regulations, local production is  $X_1$ , local consumption is represented by  $X_6$ , and the imports are expressed as  $X_6 - X_1$ .

The introduction of a hedging instrument involves a consumer price increase on account of the payment of the call option premium —namely, the consumer price will rise to  $P_2$ . This price is paid only by consumers, which means that local production remains unchanged, and consumption falls to  $X_5$ ; therefore, imports also drop ( $X_6 - X_5$ ), and new imports are  $X_5 - X_1$ .

The consumers' total expenses amount to:

$$0-X_5-E-P_2$$

and the amount paid for the premium is represented by the following rectangle:

$$P_1-F-E-P_2.$$

Local producers invoice a total of:

$$0-X_1-A-P_1$$

and imports amount to:

$$X_1-X_5-F-A.$$

Furthermore, Figure 3 shows the exercise or strike price,  $P_3$ , which is the ceiling as determined by the hedging policy. In order to have the right to exercise the option of buying oil at this price, a premium equivalent to  $P_2$  minus  $P_1$  has been previously paid. Above this price, buyers will exercise the call option bought at the exercise price,  $P_3$ .

As long as the international price varies between  $P_1$  y  $P_3$ , the scheme works similarly to a free market with a compulsory premium. As long as the spot price does not exceed  $P_3$ , options are not exercised.

Let us assume now that the international price rises to  $P_3$ , precisely to the exercise price. The option is not exercised at this price either, and consumers continue paying the premium, which means that they are faced with price  $P_4$ . As a result of this price rise, the consumption level drops to  $X_4$ , local production rises to  $X_2$  and imports fall to  $X_4-X_2$ .

The consumers' total expenses amount to:

$$0-X_4-H-P_4$$

and the amount paid for the premium is represented by the following rectangle:

$$P_3 - T - H - P_4.$$

Local producers invoice a total of:

$$0 - X_2 - J - P_3$$

while importers invoice the following amount:

$$X_2 - X_4 - T - J.$$

Finally, let us analyze the case in which the option is exercised because the oil price, on the exercise date, exceeds the upper bound of the band,  $P_3$ , and gets to  $P_5$ , for example.

In these circumstances, the fund receives an indemnity, which is transferred to the oil (fuel) market, and is equivalent to the price increase  $P_5 - P_3$  multiplied by the number of barrels purchased  $X_4$ , represented by the rectangle area  $P_3 - T - L - P_5$ .

This indemnity amount makes it possible to subsidize the oil in the local market —i.e. the local price of oil will be  $P_3$  while in the international market it is  $P_5$ .

The subsidy is paid to local and foreign producers so that they can sell oil in the local market at  $P_3$ . Under this scheme, consumers are ensured that their ceiling price of oil is  $P_4$  (i.e.  $P_3$  plus the premium), and the market is supplied with the new local production,  $X_3$ , and the imports  $X_4 - X_3$ .

In this case in which the option is exercised, the hedging manager<sup>8</sup> receives an indemnity for a total amount of:

$$P_3 - T - L - P_5$$

with which it transfers to local producers as indemnity:

$$P_3 - R - M - P_5$$

and as indemnity to importers:

$$R - T - L - M$$

for them to buy the oil at the international price  $P_5$  and sell it at  $P_3$  in the local market.

Consumer total expenses amount to:

---

<sup>8</sup> Hedging could be managed by a stabilization fund or any other governmental agency.

$$0-X_4-H-P_4$$

and the amount paid for the premium is the following rectangle:

$$P_3-T-H-P_4.$$

Local producers invoice a total amount of:

$$0-X_3-M-P_5$$

and importers invoice a total amount of:

$$X_3-X_4-L-M.$$

As can be seen from the case in which the option is exercised, one part of the oil expenses is paid by consumers, while the other is borne by the hedging manager using the indemnity received at the time of exercising the option.

As we can observe, this hedging instrument protects consumers from international oil price increases that exceed the exercise or strike price, i.e. the upper bound determined by the hedging strategy, without affecting local producers at all, who are always paid the international price.

If the international price remains constant at  $P_5$  during a term longer than the one established in the hedging contracts in effect, the mechanism will eventually involve the establishment of new bands, and consumers will have to pay the premium again. Hence, the price they will bear to hedge against even higher increases with a higher exercise price will rise to  $P_6$ .

No fiscal impact will be caused as a result of the mechanism proposed, as the scheme is absolutely revenue neutral to public finances. Imposing an additional cost on consumers (on account of the payment of premiums) would result in a drop in demand depending on its elasticity, as can be seen in Figure 3, when the price rises from  $P_1$  to  $P_2$  and consumption falls from  $X_6$  to  $X_5$ . Only if fuels are subject to other taxes might this produce a fiscal impact.

From a welfare economics perspective, imposing a premium reduces consumers' surplus on the order of  $P_1 - B - E - P_2$  (example in Figure 3). Instead, consumers' surplus increases in the magnitude of  $P_3 - W - Z - P_5$  when indemnity is involved. The comparison of these two magnitudes, which are likely to fluctuate over time, would enable us to assess the policy from

this perspective. If the premiums are “estimated” correctly, the sum of all losses would be similar to the sum of all gains, pointing to the fact that the hedging policy tends to be consumer neutral.

### **3. Comparing Stabilization Funds and Hedging Instruments**

#### **3.1. Introduction**

Stabilization funds allow oil (or fuel) price fluctuations within a previously specified price band. The narrower the band, the greater the use or accumulation of fund resources. In other words, any price volatility not covered by the band is transferred to the fund. Should oil prices exhibit a sustained trend and the upper and lower bounds of the band not be adjusted in a timely manner, the fund resources tend to deplete (in the context of an upward trend) or to increase indefinitely (in the context of a downward trend).

Oil prices can be stabilized through another mechanism, such as a hedging policy. The lower the price defined as a stabilization target through the purchase of a call option, the higher its cost and, consequently, the higher the premiums to be paid because of the hedging policy. In financial terms, a hedging instrument to cover the current or actual (spot) price of a commodity is known as an “at-the-money” option, while a hedging where the strike price is above the current (spot) price (for example, the cap of the band price) is known as an “out-of-the-money” option.

As an example, we present different call option costs for WTI in the New York Mercantile Exchange (NYMEX) as of February 2012. On October 25, 2011, at approximately 1 p.m. (NYT), the at-the-money call option cost was US\$7.26 for a contract giving the right to buy oil at US\$93.50 per barrel, while the cost of the premium came down to US\$3.20 if the exercise price rose to US\$103.00 per barrel (10% above the current price).<sup>9</sup> It is only reasonable that the call option premium should drop as the exercise price rises, since the potential loss expected is lower.

The purchase of a call option enables a net consumer of the commodity to hedge against any increase above the target price of the hedging policy.

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<sup>9</sup> During the time we devoted to writing this paragraph, prices changed more than five times.

If a hedging system is used as the only stabilization mechanism, just a cap (strike or exercise price) is set over the spot (cash) price of the commodity; for example a 12.5% higher than what it was proposed in the Chilean case, for instance. In this situation, a lower-band floor price is not established. If the price drops, consumers reap full benefit, unlike the case in which a fund is involved, since the fund accumulates the difference between the spot price and the lower bound of the band. This policy would be administered by a governmental agency.

Another oil price stabilization alternative may be a combination of a stabilization fund and a hedging policy, which can be administered by a State institution in charge of buying call options and choosing the exercise (preset) price. The payment of the premium may be borne by consumers, the fund, or both. This institution would be responsible for collecting the indemnity when the spot price exceeds the call option exercise or strike price. This indemnity is used to cover the difference between both prices and, thus, buy oil in the market.

### **3.2. An Example of Commodity Price Volatility, with No Price Trend<sup>10</sup>**

Figure 4 shows how *hedging* works in a five-year hypothetical case with no price trend. For this analysis, the spot price is to be understood as the market price, and the consumer price is the spot price plus the premium minus the indemnity.

The average consumer price (Cons Pr, red line) is equal to the average spot price (Spot, blue line), US\$100 in both cases; however, the standard deviation of the consumer price is US\$18.9 vis-à-vis a US\$26.7 spot price.

The hedging policy has managed to reduce volatility. In this hypothetical example, consumer gains amount to nil, proving that the premium was correctly established. Where the spot price exceeds the strike price, the consumer price has a ceiling plus a premium (US\$117 in the Figure). In the other periods (spot price below strike price), the consumer price exceeds the spot price because of the premium.

Consumer price = spot price + premium paid – indemnity (if any).

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<sup>10</sup> Volatility in this period was estimated by using an algorithm creating random numbers with a variance similar to the one implicit in NYMEX call option quotes with a one-year exercise period.

Indemnity = spot price – strike price, if the difference is positive; otherwise, it is 0.

For example, if the spot price is 110, the consumer price will be:

$$110 \text{ (spot)} + 7 \text{ (premium)} - 0 \text{ (indemnity)} = 117 \text{ (consumer price)}.$$

If the spot price is 140, the consumer price will be:

$$140 \text{ (spot)} + 7 \text{ (premium)} - 30 \text{ (indemnity)} = 117 \text{ (consumer price)}.$$

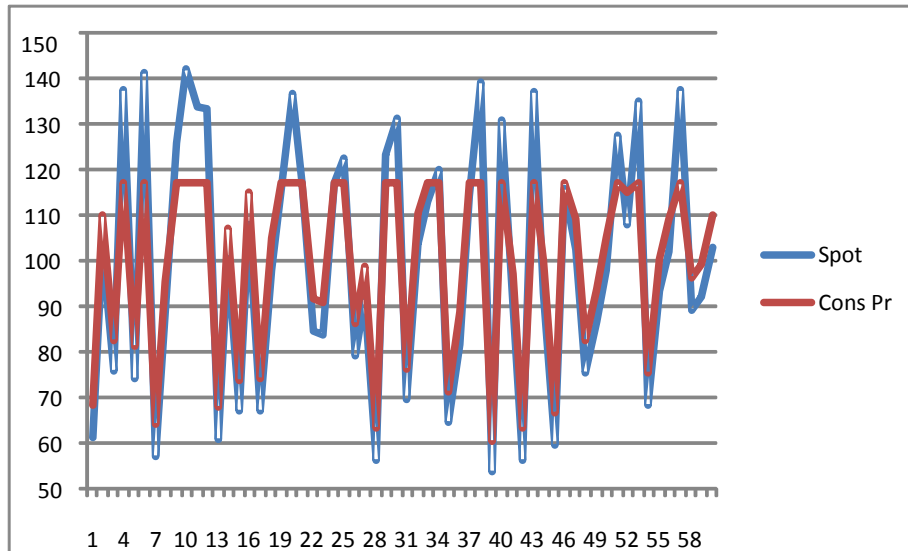
If the spot price is 105, the consumer price will be:

$$105 \text{ (spot)} + 7 \text{ (premium)} - 0 \text{ (indemnity)} = 112 \text{ (consumer price)}.$$

If the spot price is 70, the consumer price will be:

$$70 \text{ (spot)} + 7 \text{ (premium)} - 0 \text{ (indemnity)} = 77 \text{ (consumer price)}.$$

**Figure 4. How Hedging Works in a Five-year Hypothetical Case, with No Commodity Price Trend**



Source: Prepared by Zapata and Rivas.

Note: Vertical axis: Spot and consumer prices in US dollars per barrel. Horizontal axis: Months.

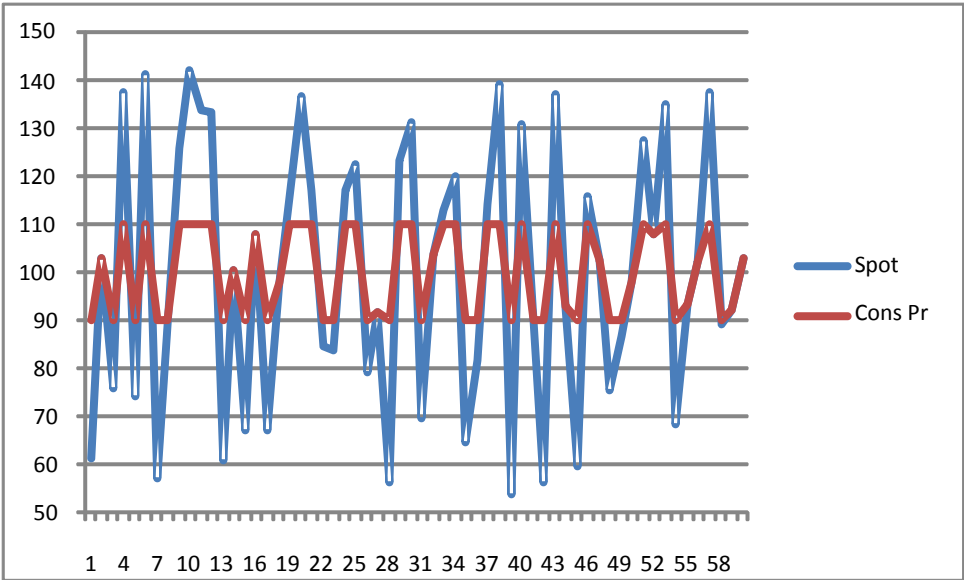
Figure 5 shows the case of a *stabilization fund with no hedging* and a  $\pm$ US\$10 band, in which the spot price behaves just as in the previous case. Again, the consumer net gains are null, as the average consumer price is equivalent to the average spot price. Assets in the fund

accumulate and decline around zero; however, there are periods in which the accumulated assets are negative, indicating the need for funding.

In this case, consumer price volatility is lower than in the example with a call option hedge: US\$9.2 vis-à-vis US\$18.9, respectively.

A price band width can be estimated so that consumer price volatility is identical to the one in the example with a call option hedge. Such estimation enables us to design policies as a result of which consumers bear the same cost in terms of both the average price paid and its volatility.

**Figure 5. How a Stabilization Fund Works without Hedging but with Bands**



Source: Prepared by Zapata and Rivas.

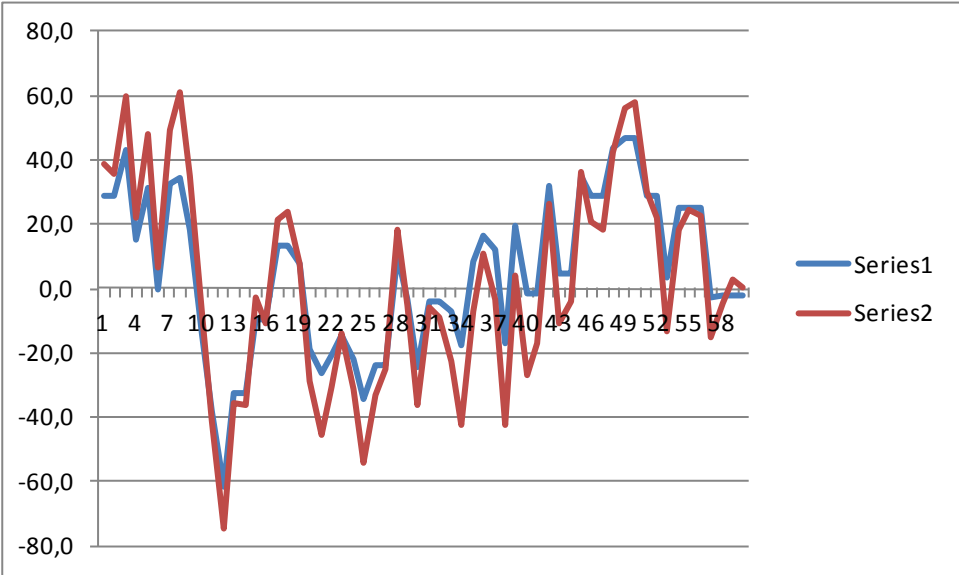
Note: Vertical axis: Spot and consumer prices in US dollars per barrel. Horizontal axis: Months.

It should also be noticed that, in this hypothetical case, bands could be reduced, and at an extreme the average price of the period could be fixed, thus reducing all the price volatility to zero and transferring it entirely to the stocks accumulated in the fund. This is shown in Figure 6, where we assume the greatest volatility in the assets of the fund for the extreme case of a zero band range.



Our preliminary conclusion is that a stabilization fund is more effective in reducing price volatility when the commodity price shows no trend. The only problem lies in collecting resources to finance the fund accumulated results. It should be made clear that if active and passive rates are identical, market access is fluid and administrative costs are irrelevant, then funding the fund should not represent any problem. Bands could also be estimated to cover the financial and administrative costs of the fund.

**Figure 6. Evolution of the Fund Assets under Two Band Assumptions:  $\pm$ US\$10 (Blue Series) and Zero Band (Red Series)**



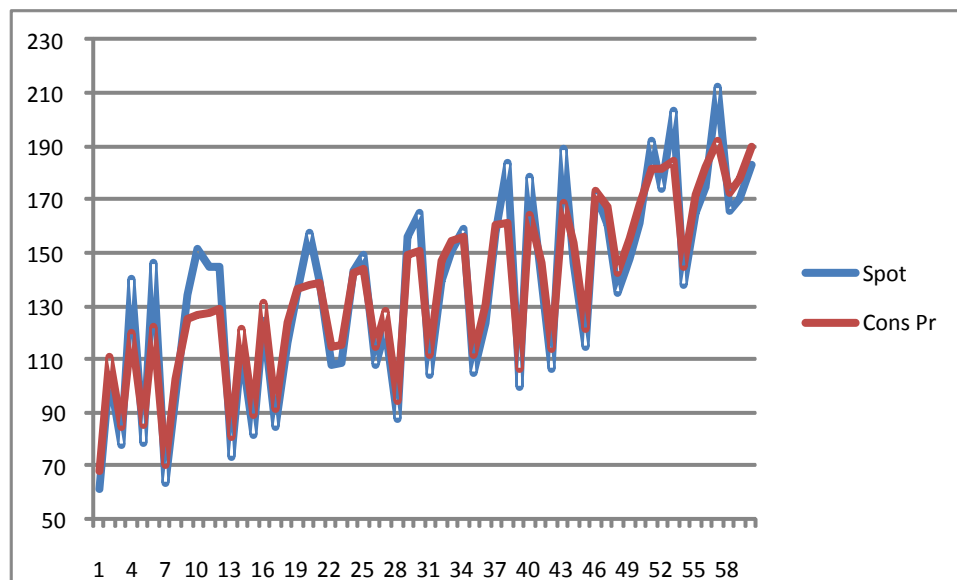
Source: Prepared by Zapata and Rivas.

Note: Vertical axis: US dollars. Horizontal axis: Months.

**3.3. An Example of Commodity Price Volatility, with Price Trend**

Figure 7 illustrates the case of call option *hedges*, in which the commodity price shows the same volatility as in the previous example, but around a positive trend of a cumulative monthly percentage of 1%. If strike prices capture this trend completely, the result for consumers will be exactly the same as in the case without trend. Premiums do not change either as the volatility around the trend is also identical to the previous case.

**Figure 7. Hedging with Call Options, Price Volatility and Trend**



*Source:* Prepared by Zapata and Rivas.

*Note:* Vertical axis: Spot and consumer prices in US dollars per barrel. Horizontal axis: Months.

This also holds in the case of a fund with stabilization bands: the results are identical provided the band magnitude is within a range of US\$20. If the bands are fixed as percentages, the results will be slightly different as the range increases with the trend, which involves a lower accumulation below the minimum price, and vice versa. It should be borne in mind that the broader the band, the lesser the fluctuation of the fund. Figure 7 is identical to Figure 5 with an average price trend of a cumulative 1% per month.

As in the previous case, an average price could be set without bands, which would reduce the consumer price volatility to zero (vis-à-vis the commodity price trend). All the fluctuations would be addressed with the change in the assets of the stabilization fund.

Table 2 shows a summary of the main variables of the two stabilization strategies, i.e. with or without a hedge. In the hypothetical case presented, we observed that, even with a zero band range, the minimum assets of the fund are lower than the premium that would need to be paid for the call option.

**Table 2. Main Variables in the Two Stabilization Strategies, With or Without Hedging**

<b>Hedging with a call option</b>		
Strike price of the call option purchased	110	
Sum insured per year (one US\$100 barrel for 12 months)	1,200	
Annual premium (US\$7 per barrel for 12 months)	84	
Premium (percentage)	7%	
<b>Hedging with a stabilization fund</b>		
Band range	±10	0
Maximum level of fund assets given the volatility of the example	47	61
Minimum level of fund assets given the volatility of the example	-62	-75
Percentage of the sum insured		
Maximum level of the fund assets / sum insured	3.9%	5.1%
Minimum level of the fund assets / sum insured	-5.1%	-6.2%

Source: Prepared by Zapata and Rivas.

We therefore conclude that, where both price volatility and trend are known, a stabilization fund is more effective in balancing the consumer price vis-à-vis the commodity price trend; its financing needs are modest, less than the annual amount of the premium paid, in the example above.

### **3.4. Errors in Estimating Volatility**

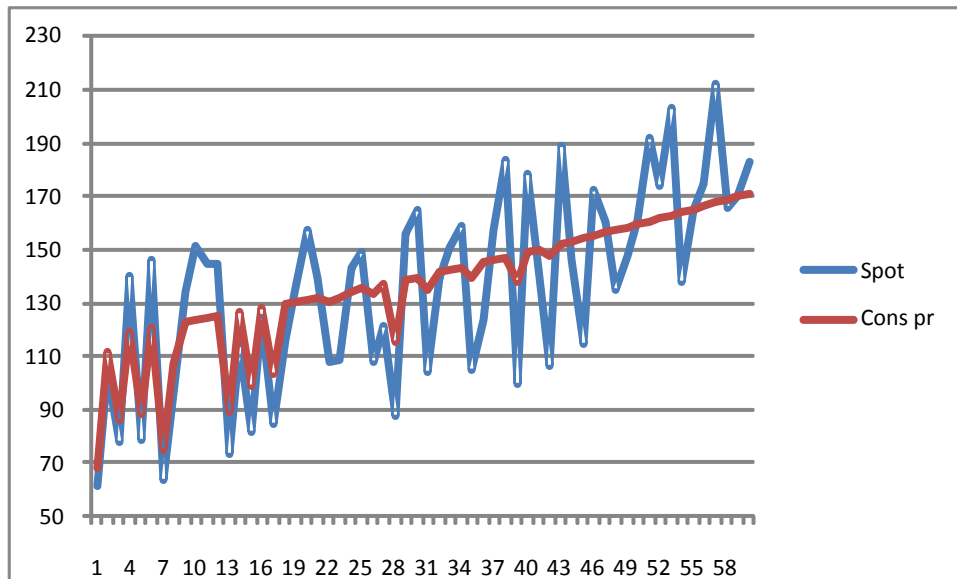
In the case of *hedging* with a call option, an error in the estimation of volatility would bring profits to the seller of the option should the volatility finally realized be lower than the one estimated at the time of entering into the contract.

In the case of the implementation of a *price band policy*, an error in the estimation of volatility may affect the range chosen for the price band and, therefore, may be translated into an equivalent volatility in the fund assets.

### 3.5. Errors in Estimating Trends

In the case of *hedging* with call options, an error in the estimation of a positive price trend will lead to the purchase of premiums with a strike price that does not capture such trend; as a consequence, premiums will rise (if the seller has correctly estimated the price trend). Therefore, we conclude that in this case the estimation error will have no impact, since premiums are set on the basis of the trend and are transferred to the buyer of the options, as can be seen in Figure 8. Here, the strike price is assumed to be US\$110 during the entire period, but premium costs increase following the spot price trend.

**Figure 8. Strike Price at US\$110 during the Entire Period, but Premium Costs Rise Following the Spot Price Trend**



Source: Prepared by Zapata and Rivas.

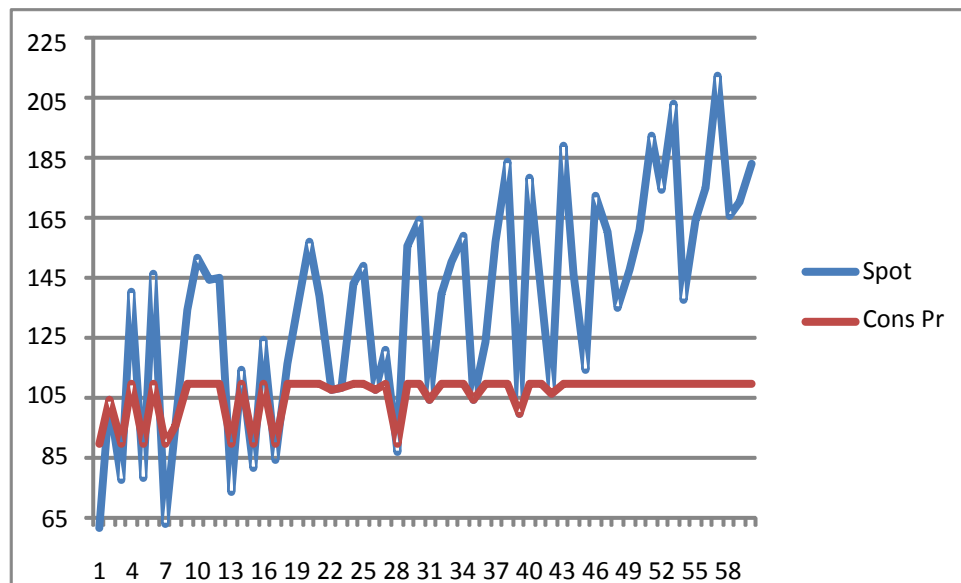
Note: Vertical axis: Spot and consumer prices in US dollars per barrel. Horizontal axis: Months.

Mistakes in estimating the trend will create gains for the seller (losses for the consumer) if the trend is overestimated.

The quotes of hedging premiums can be evaluated by the buyer by estimating both the commodity price volatility and trend implicit in each proposal.

In the case of a *stabilization fund*, a wrong estimation of the positive trend in the price of the commodity will result in the band being maintained as it is without taking the increase in spot prices into account, with the subsequent risk of fund depletion if the situation is not adjusted appropriately and timely. Figure 9 illustrates this case.

**Figure 9. A Stabilization Fund with Positive Commodity Price Trends**



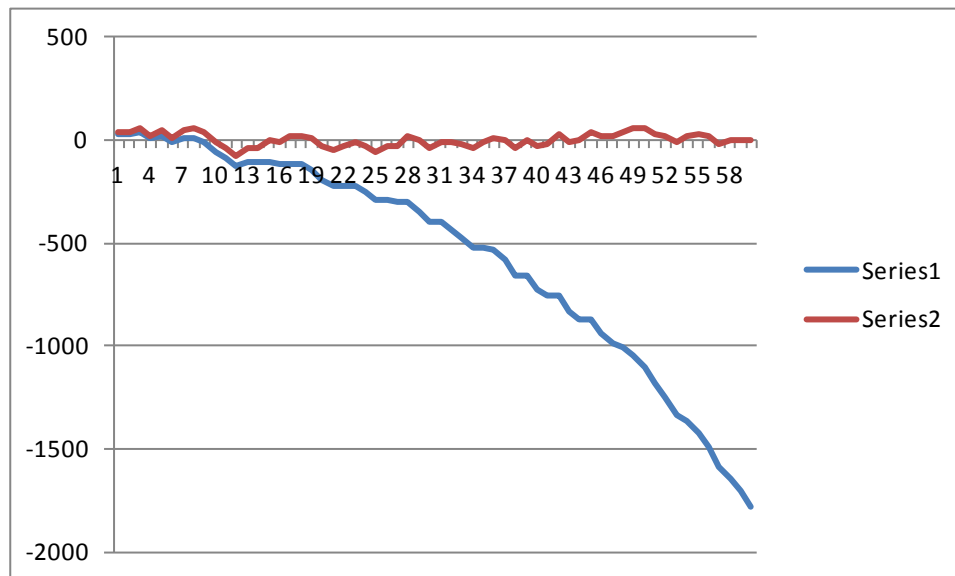
Source: Prepared by Zapata and Rivas.

Note: Vertical axis: Spot and consumer prices in US dollars per barrel. Horizontal axis: Months.

We can see that there is a gap between the consumer price and the spot price. The consumer price remains at 110, whereas the spot price varies following the trend (1% monthly). The “stabilization” obtained involves a significant decline in the fund assets, demanding a radical change in the price stabilization bands.

Figure 10 shows the evolution of the assets with a policy that takes into account the consumer price trend (Series 2, red line) versus a policy that has set the bands without adjusting them by the trend (Series 1, blue line).

**Figure 10. Evolution of the Fund Assets with Errors in Estimating the Spot Price Trend**



*Source:* Prepared by Zapata and Rivas.

*Note:* Vertical axis: Spot and consumer prices in US dollars per barrel. Horizontal axis: Months.

This policy is clearly unsustainable (because the fund must keep a consumer price of US\$110, while paying at the spot value) and must be abandoned with sharp consumer price adjustments or an increasing budget contribution. This situation reflects what happened, for example, with the Chilean stabilization fund when the WTI underwent an increase of 190% between January 2007 and July 2008.

If the price trend is negative, the situation is exactly the opposite, as the result will be an increasing accumulation of assets in the stabilization fund.

Thus, we conclude that in the cases where the price trend is difficult to estimate or predict, the option hedging policy is the most appropriate.

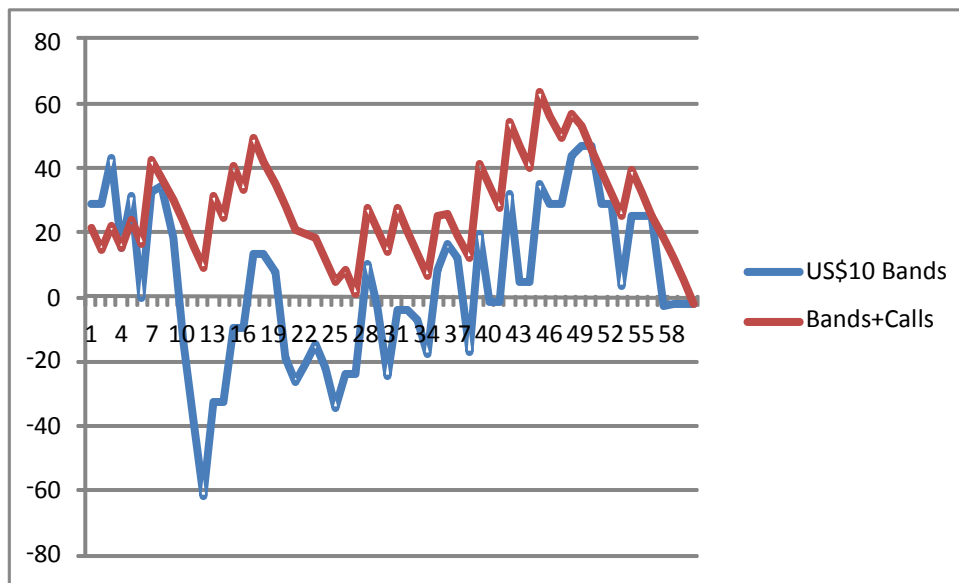
### **3.6. Combining a Stabilization Fund and Hedging**

The loss of the assets is perhaps the main undesirable aspect of the implementation of a stabilization fund. This can be avoided if the fund is supplemented by a hedging policy to restrict such loss. With this complementation of the fund inflows, the premiums paid will be reduced, but the losses will be absorbed by the indemnities. These exercises have assumed that the

premiums are calculated in such a way that the net contribution of the hedging instruments to the fund is null: the sum of the premiums has been assumed to be equal to the sum of the indemnities.

However, supplementing the fund with hedging instruments mitigates its losses, as they are offset by the indemnities, and at the same time sets a limit on the gains resulting from the payment of the premiums. In this way, the possibility of the fund having negative assets is reduced, as can be seen in Figure 11.

**Figure 11. Evolution of the Fund Assets under Two Alternatives: Bands of  $\pm$ US\$10 and the Same Bands Combined with Hedging**



Source: Prepared by Zapata and Rivas.

Note: Vertical axis: Spot and consumer prices in US dollars per barrel. Horizontal axis: Months.

It is to be noted that this kind of policy achieves the same results if errors are committed in estimating trends, provided the bands are adjusted to strike prices that fall within a given percentage of the spot price.

## **4. Simulations: Scenarios for the Peruvian Case**

### **4.1. A Stabilization Fund with Hedging: Rules and Procedure**

For the purpose of assessing how a combination of a price stabilization scheme with hedging instruments would have worked, we have conducted a simulation exercise for the Peruvian case in the September 2004-January 2010 period. This period shows very strong fluctuations in the price of oil (WTI), ranging from a minimum of US\$43 per barrel at the beginning of the period to a maximum of US\$140 per barrel in July 2008 (detailed values are weekly averages).

A stabilization fund combined with hedging was assumed to have been implemented according to the following rules:

- a. The moving average of the WTI price of the 12 previous weeks is estimated every week (throughout approximately 3 months).
- b. Based on this average, a fluctuation band (cap and floor prices) is established.
- c. Subsequently, the band is modified on a weekly basis depending on the moving average of the 12 previous weeks, i.e. the bands that will apply in week 12 + 1 are set depending on the average of the last 12 week prices, as illustrated below:

For example, in week 1, a moving average of the 12 previous weeks is estimated at US\$41.23 per barrel, based on which a band ranging between 51.23 and 31.23 is determined for week 13 (highlighted in yellow).

Similarly, in week 5, for example, an average price (of the 12 previous weeks) is estimated at 42.01, based on which a band ranging between 52.01 and 32.01 is determined for week 17 (highlighted in red).



**Table 3. Methodology for Price Band Determination**

WEEK	MOVING AVERAGE 12 LAST WEEKS	UPPER BOUND	LOWER BOUND
1	<b>41.23</b>		
2	41.41		
3	41.54		
4	41.71		
5	<b>42.01</b>		
6	42.48		
7	43.07		
8	43.76		
9	44.50		
10			
11			
12			
13		<b>51.23</b>	<b>31.23</b>
14		51.41	31.41
15		51.54	31.54
16		51.71	31.71
17		<b>52.01</b>	<b>32.01</b>
18		52.48	32.48
19		53.07	33.07
20		53.76	33.76
21		54.50	34.50

Source: Prepared by the authors based on data from the General Directorate of Hydrocarbons, Ministry of Energy and Mining, Peru.

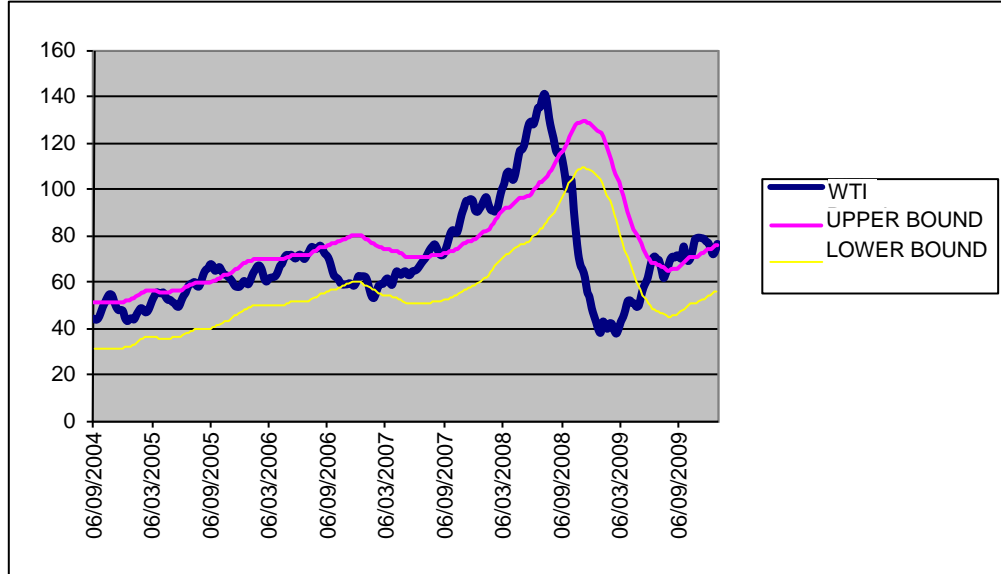
Every week, then, a band that will apply in 12 weeks' time is determined. The cap or upper bound is the value at which we have to buy the call option to hedge against any loss if the spot price exceeds this upper bound on the exercise date (in 12 weeks' time with respect to the decision-making time). For example, in week 5 of Table 3 a hedge is to be purchased at a strike price of 52.01 for week 17. If in week 17 the spot price happens to be higher than 52.01, the option is exercised and profits are made. Should the opposite occur, the option is not exercised and the result in week 17 on account of this transaction (concluded in week 5) is null; it should

*be borne in mind that the premium was already paid in week 5 (the time at which the outflow from the fund took place) as the call option cost.* This procedure will continue throughout the life of the fund: every week, a premium is paid that grants a right in 12 weeks' time. This weekly procedure has been chosen only for illustrative purposes, although it has the advantage of reducing the amounts of the premiums paid each time (since only weekly consumptions are hedged), while creating incentives for the permanent monitoring of the system without imposing a procedural overburden as would be the case if premiums were to be monitored daily.

Figure 12 presents the evolution of the fluctuation band for the period considered. We can see that the 12-week moving average system proves to work relatively smoothly until mid-2007, when there is an increase in the spot price trend. From then onwards until the price reaches a peak of US\$140 per barrel (July 2008), the upper bound is always below the spot price. If the moving average system were quarterly, the new trend would not be captured. It should be noticed that if the moving averages had been annual, the gap between the upper bound and the spot price would have been wider. The shorter the time period used to determine the moving average (the basis for setting the band), the smaller the gap between the band and the spot price. Unfortunately, the flipside of this is that the consumer price—which is precisely what we intend to stabilize—will fluctuate more.

Similarly, if the call option at the cap of the price band were bought in less than 12 weeks' time, the premium paid would be lower, but the price fluctuation would be greater.

**Figure 12. A Fluctuation Band Based on Moving Averages along 12 Weeks**



Source: Prepared by Zapata and Rivas.

Note: Vertical axis: Spot and consumer prices in US dollars per barrel. Horizontal axis: Months.

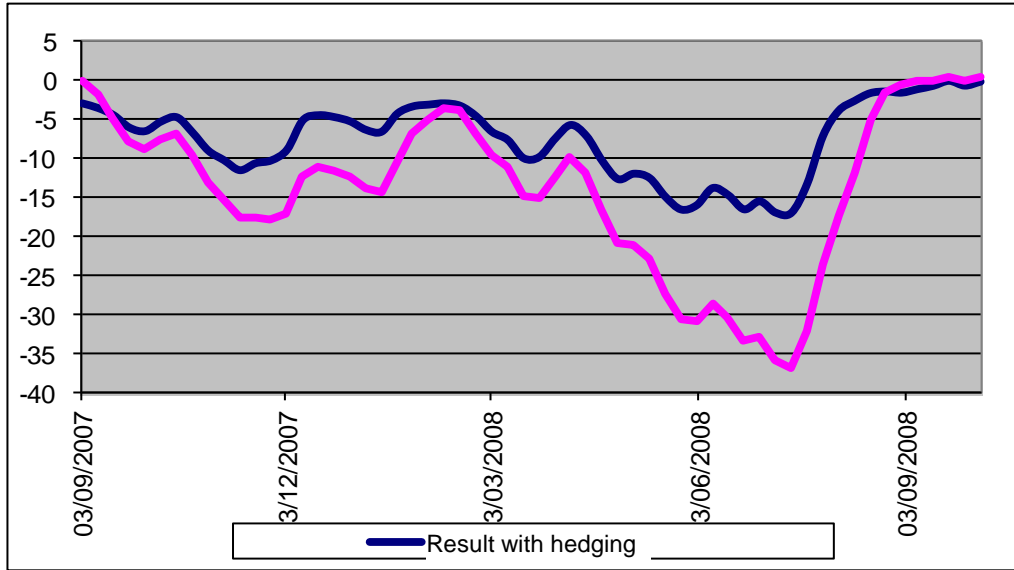
When the spot price decreases, a gap —this time, of an opposite sign— will reappear between the spot price and the upper bound, which will now exceed the spot price until the trend becomes positive again.

#### **4.2. Comparing Stabilization Funds With and Without Hedging**

With each change in trends, the assets in a stabilization fund begin to decline (positive trend change) or accumulate (negative trend change), as shown in Figure 13. The blue line presents the results (assets variation) of a fund with hedging, whereas the pink line shows the evolution of a “traditional” fund (without hedging). The period chosen to show the price trend change is from mid-2007 to mid-2008.

The fund with hedging exhibits better results, as it undergoes less loss because options are exercised. At the same time, however, premiums become more expensive (this aspect will be analyzed more thoroughly in Figure 16) on account of the gap between the spot price and the upper bound *at the decision-making time*. Let us bear in mind that the decision is made in week 1 (payment of the premium), and the indemnity for exercising the call option (if it is convenient) is received in week 13. Hedging has made it possible to mitigate loss.

**Figure 13. Loss Mitigation through Hedging**

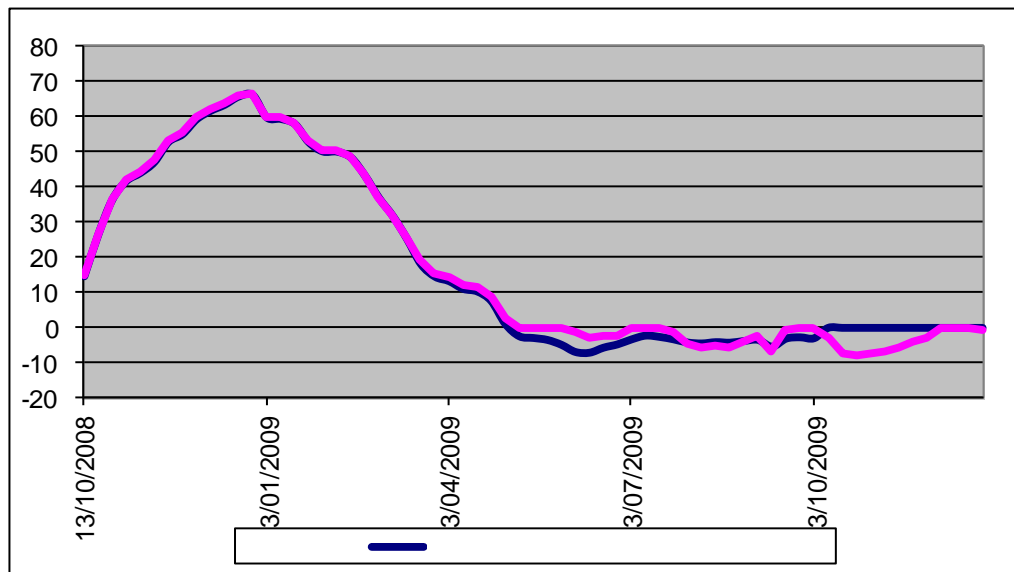


Source: Prepared by Zapata and Rivas.

Note: Vertical axis: Spot and consumer prices in US dollars per barrel. Horizontal axis: Months.

Figure 14 shows the immediately following period in which a new change in the trend direction takes place; this time, the change is negative. The differences between the two alternatives, i.e. fund with hedging (blue line) and traditional fund (pink line), are almost unnoticeable. This is because the inflow derived from the mechanism whereby consumers pay when the spot price is below the lower bound is highly significant vis-à-vis the outflow resulting from the payment of the premiums, which represent a negligible amount because hedging is bought at strike prices (equal to the cap of the band) well above the spot price at the time of making the decision.

**Figure 14. Results of the Alternative Funds (With and Without Hedging) in the Face of a Negative Change in the Oil Price Trend**



Source: Prepared by Zapata and Rivas.

Note: Vertical axis: Spot and consumer prices in US dollars per barrel Horizontal axis: Months.

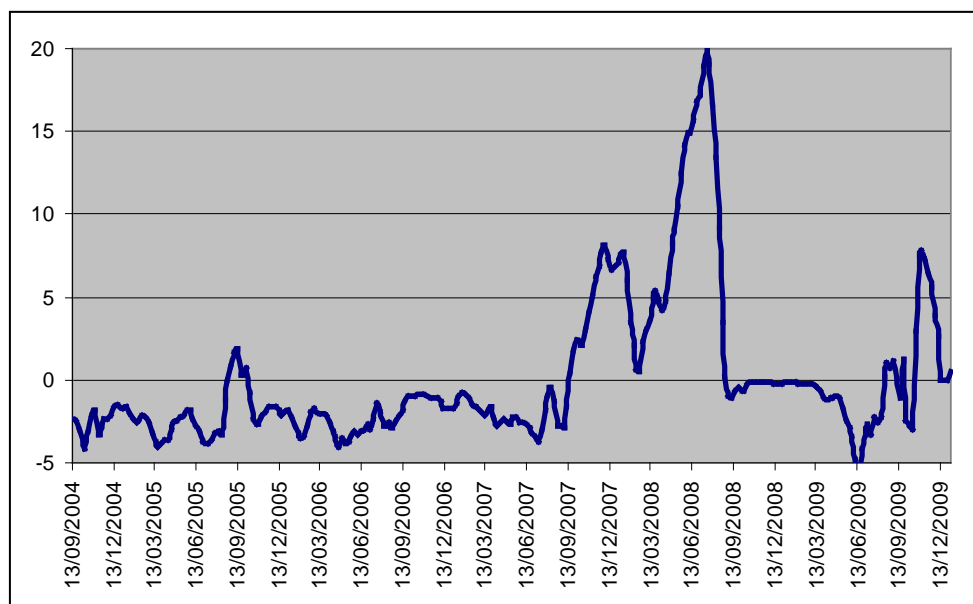
Thus, we conclude that the differences between these two fund alternatives (with and without hedging) are shown primarily when there is a positive change in the oil price trend, where the spot price is higher than the upper bound of the price stabilization band. In the face of this situation, the difference between the two prices is covered with the indemnities in the case of the fund with hedging, while under the other alternative (fund without hedging), the gap is bridged with resources from the fund.

On the contrary, when there is a negative change in the trend, the differences between both alternatives are almost canceled out, since the premiums paid (to hedge against a price well above the spot price) are insignificant and, additionally, options are not exercised precisely because the strike price (the cap) is above the spot price on the exercise date.

Figure 15 shows the difference in the results of both fund alternatives (result of fund with hedging minus result of fund without hedging). It should be underscored that this difference is nothing but: *Premiums paid (negative value) plus indemnities (positive if the spot price is higher than the strike price, or null in the opposite case).*

At the first stage (up to mid-2006, when the change in the trend takes place), the difference in results is negative, indicating that the fund with hedging has incurred losses derived from the payment of premiums and that indemnities resulting from the exercise of the options are almost nonexistent. In the period of the trend change (from mid-2006 to mid-2007), options are exercised and the difference of results becomes positive for the fund with hedging. Later on, differences are canceled out (premiums are very “cheap” because hedging prices are “exorbitant”) until September 2009. In the last sub-period analyzed, we find mixed results: net payment of premiums and collection of indemnities.

**Figure 15. Differences between the Two Fund Alternatives (With and Without Hedging)**



*Source:* Prepared by Zapata and Rivas.

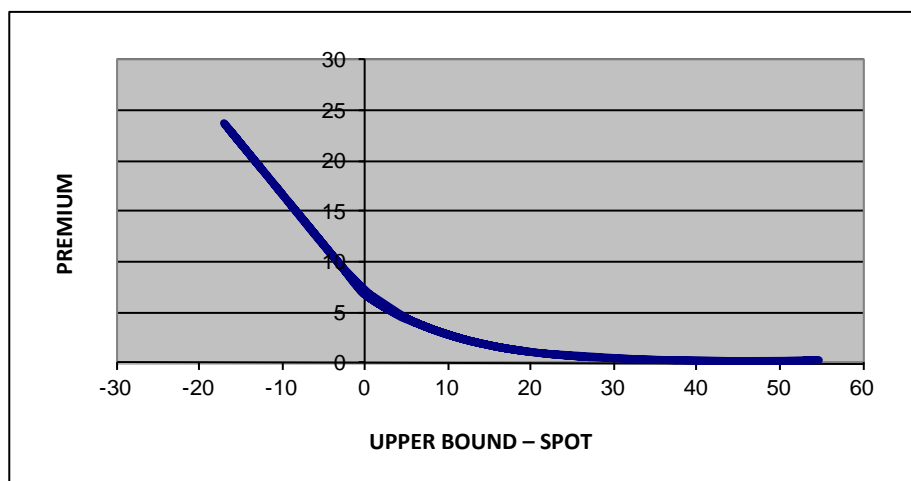
*Note:* Vertical axis: Spot and consumer prices in US dollars per barrel. Horizontal axis: Months.

The cost of a premium is determined by the following factors:

- The difference between the spot price and the strike price;
- The volatility of the underlying asset; and
- The time elapsed between the date of the purchase of the option and the exercise date.

If volatility prevails and all hedges are purchased three months in advance, the cost of the premiums will only be determined by the difference between the spot price and the strike price, as can be seen in Figure 16.

**Figure 16. Cost of the Premium (Y Axis) Based on the Difference between the Upper Bound (Strike Price) and the Spot Price at the Decision-Making Time**



*Source:* Prepared by authors based on data from [http://www.cmegroup.com/trading/energy/crude-oil/light-sweet-crude\\_quotes\\_globex\\_options.html?exchange=XNYM&foi=OPT&venue=G&productCd=CLN2&underlyingContract=CL&floorContractCd=CLN2&expMonth=201202](http://www.cmegroup.com/trading/energy/crude-oil/light-sweet-crude_quotes_globex_options.html?exchange=XNYM&foi=OPT&venue=G&productCd=CLN2&underlyingContract=CL&floorContractCd=CLN2&expMonth=201202)

*Note:* Vertical axis: US dollars. Horizontal axis: US dollars.

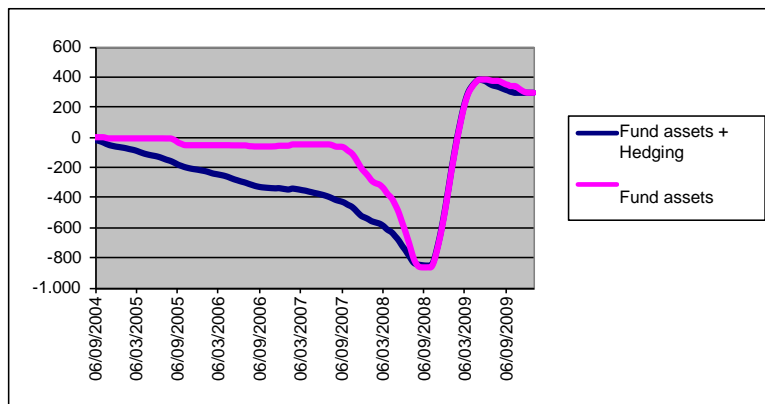
This figure reveals that if the difference between the spot price and the exercise price is null (at the time of making a decision), the premium cost is US\$6.7 per contract (of one barrel) giving the right to buy at such strike price in three months' time. If the strike price is US\$50 above the spot price (at the time of making a decision), the premium cost will be almost null — US\$0.2—, a reasonable situation as this event is very unlikely to occur. If the difference is negative, i.e. the strike price is lower than the spot price (at the time of making a decision), the premium cost increases by exactly such a difference: if the cost at a difference of 0 is \$6.7, the cost at a difference of -10 will be US\$16.7 = US\$6.7 (risk pricing at a strike price equal to the spot price) + US\$10, which is the difference between the strike price and the spot price (what we would gain if we exercised the option immediately).

In the simulation, we use market data of three-month option premiums at different strike prices. It is important to stress that such data match the current volatility of the underlying asset

rather than the volatility that may have occurred in the period under study. Unfortunately, we cannot reconstruct the premiums in force in that period, for which this simulation should be taken exclusively as an example illustrating how a fund with hedging works. The only difference with reality is the actual cost of the premiums, since indemnities are the same. In this simulation, we have proportionally adjusted the premiums so that the total amount paid along the period should equal the indemnities, with the purpose of turning the hedging mechanism neutral. On the contrary, with actual data, both accumulated gains and losses could have been realized throughout the period. But it should be stated that decisions are made in the present with an impact on the future; therefore, no conclusion about the implementation of a fund with hedging would possibly be drawn on the basis of permanent gains (or losses).

Figure 17 illustrates the difference in the evolution of assets under the two fund alternatives presented —with hedging (blue line) and without hedging (pink line). In the end, the assets of both funds are the same, precisely because we have assumed the total premiums to be identical to the total indemnities. From the beginning to September 2008, the assets of both funds are negative and declining. The assets of the hedged fund are less than those of the “traditional” fund up to September 2008, when the assets are equalized and subsequently evolve in a similar fashion. Between September 2007 and September 2008, the decline in the assets of the traditional fund is more pronounced than in the case of the hedged fund because in the latter indemnities cover the losses that occur when the spot price rises above the cap of the band.

**Figure 17. Evolution of the Funds With or Without Hedging**



Source: Prepared by Zapata and Rivas.

Note: Vertical axis: Spot and consumer prices in US dollars per barrel. Horizontal axis: Months.

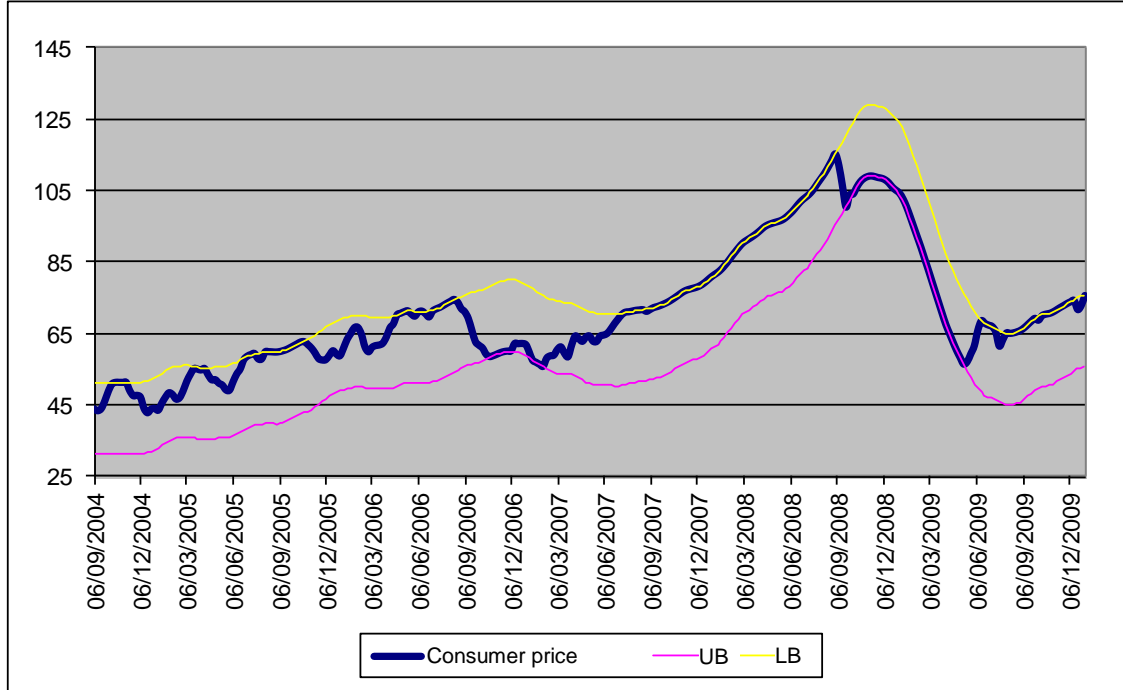


This figure encourages a brief reflection: if the fund had been assessed, for instance, in September 2007 (three years after its implementation), it would have been possible to conclude that hedging was expensive and only involved net outflows of funds (which can also be seen in Figure 15 in terms of flows). Therefore, this could have given rise to strong pressures to put an end to hedging immediately before it became necessary!

*Hedging is an insurance and, in this regard, cannot be assessed in terms of losses and gains (this is precisely why we made them canceled out in the simulation) but in terms of the mitigation of the risk against which we seek protection. (One cannot feel happy at having crashed a car recently insured, but one cannot be unhappy either for never having had a collision and always having paid the insurance.) The hedging mechanism mitigates risk as opposed to its alternative, but such mitigation will obviously cost money.*

Figure 18 shows the result of this stabilization policy in terms of consumer price fluctuations. A standard deviation of US\$17.5 —equivalent to 80% of the WTI standard deviation— is observed in the consumer price throughout the entire period; in the sub-period of greatest volatility initiated in July 2007, the standard deviation of the consumer price decreases to US\$16.3, equivalent to only 62% of the WTI standard deviation for the same period.

**Figure 18. Consumer Price Evolution under the Stabilization Policy**



*Source:* Prepared by authors based on data from the General Directorate of Hydrocarbons, Ministry of Energy and Mining, Peru.

*Note:* Vertical axis: US dollars per barrel. Horizontal axis: Date.

The consumer price evolution is the same under the two alternatives studied, with and without hedging. As already mentioned, the difference lies in risk mitigation in the face of very sharp positive changes in the underlying asset trend.

Table 4 presents a summary of the procedure used for two extreme situations: the case in which exercising the option involves paying the highest premium of the series, and the one in which the premium is almost negligible because the exercise price is well above the spot price. The decision in the first case is made on April 21, 2008, whereas in the second case the decision is made on October 13, 2008.

The premium cost (line 8 of the table below) is, in the first case, US\$10.23 because of the negative difference (line 7) between the cap or upper bound of the band and the -7.68 spot price; in the second case, the premium cost amounts to only US\$0.25 as the strike price is higher than the spot price by US\$33.29.

At the time of exercising the option, the difference between the spot price and the cap of the band (line 12) is US\$36.70 in the first case and -US\$86.55 in the second. The band policy implies that there will be an outflow of precisely US\$36.70 from the fund in the first case and an inflow of US\$86.55 in the second (lines 13 and 14, respectively).

As the band policy is combined with hedging, the option to hedge against loss is exercised in the first case and there is an inflow amounting to US\$36.70 on account of the indemnity paid by the call option seller (line 15).

The result of the fund (line 17) in the first case is 0, whereas in the second case is US\$66.55; however, this is not the final cash flow result (line 19) of the week, since the three-month premiums have to be paid again (line 18).

In the case of a fund without hedging, the indemnity would not have been collected on the exercise date and the premium would not have been paid three months in advance.

**Table 4. Summary of the Procedure for Two Extreme Situations**

1	Date on which a decision is made	21/04/2008	13/10/2008
2	Moving average of the last three months	94.32	114.29
3	Upper bound of the band (= strike price)	104.32	124.29
4	Lower bound of the band	84.32	104.29
5	Date of band validity (3 months after the date of the decision)	From July 14 to July 20, 2008	From January 5 to January 11, 2009
6	Spot price at the time of the decision	112.00	91.00
7	Upper bound – Spot price at the time of the decision	-7.68	33.29
8	Premium cost	10.23	0.25
9	Comments	As the upper bound of the band is lower than the spot price, the premium is deemed “expensive.” <sup>11</sup>	As the upper bound of the band is well above the spot price, the premium is deemed “cheap.”
10	Strike date week	14/07/2008	05/01/2009
11	Spot price on the strike date	141.02	37.74
12	Spot price on the strike date – Upper bound of the band	36.70	-86.55
13	Fund outflow (Spot price – Upper bound of the band)	-36.70	
14	Fund inflow (Lower bound of the band – Spot price)		66.55
15	Indemnity	36.70	0.00
16	Comments	The option to hedge against the loss is exercised.	The option is not exercised because the exercise price is higher than the spot price.
17	Result of the hedged fund on the strike date	0.00	66.55
18	Payment of premiums on the strike date (to hedge in three months’ time)	-16.82	-0.16
19	Final result of the fund	-16.82	66.39

Source: Prepared by Zapata and Rivas.

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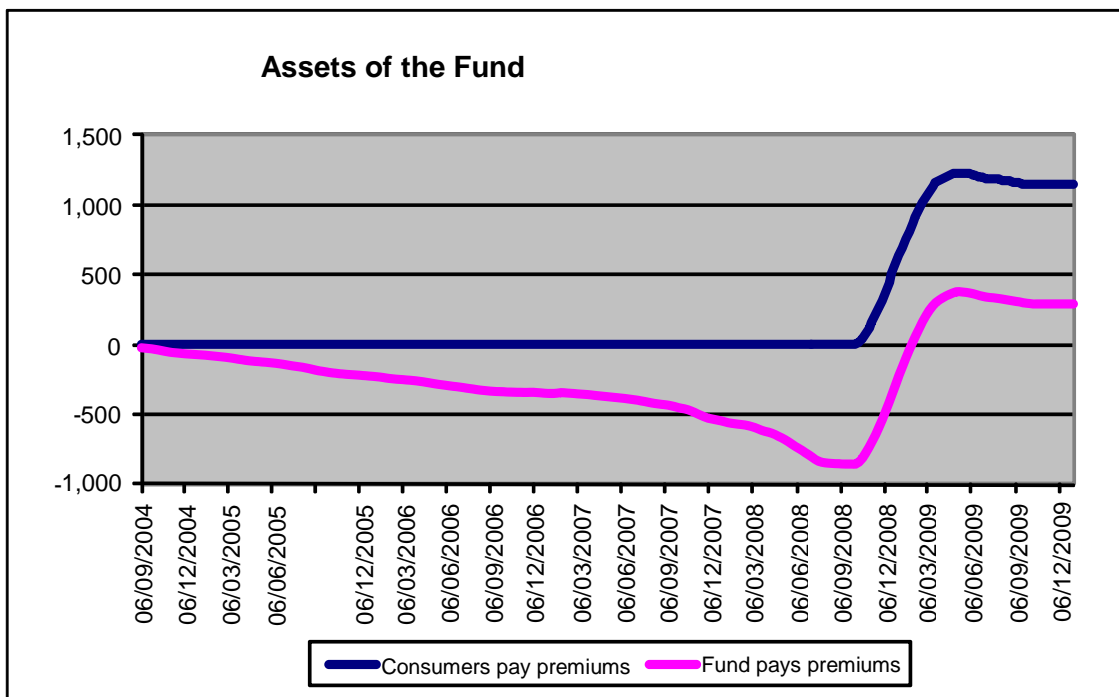
<sup>11</sup> This is equivalent to insuring a car with a smashed up fender; the insurer will charge the usual premium plus the cost of repair at the time of entering into the contract.

### 4.3. Effects of the Fund Assets

For the purpose of analyzing the effects of the assets of the fund, two situations are compared: consumers pay premiums until the fund accumulates assets, on the one hand, and the fund pays premiums, on the other. The period considered is September 2004-January 2010.

Figure 19 shows the evolution of the fund assets under these two alternatives: consumers pay premiums until the fund accumulates assets (blue line), and the fund pays the premiums (red line).

**Figure 19. Evolution of the Fund Assets With and Without Premium Payment by Consumers**



Source: Prepared by Zapata and Rivas.

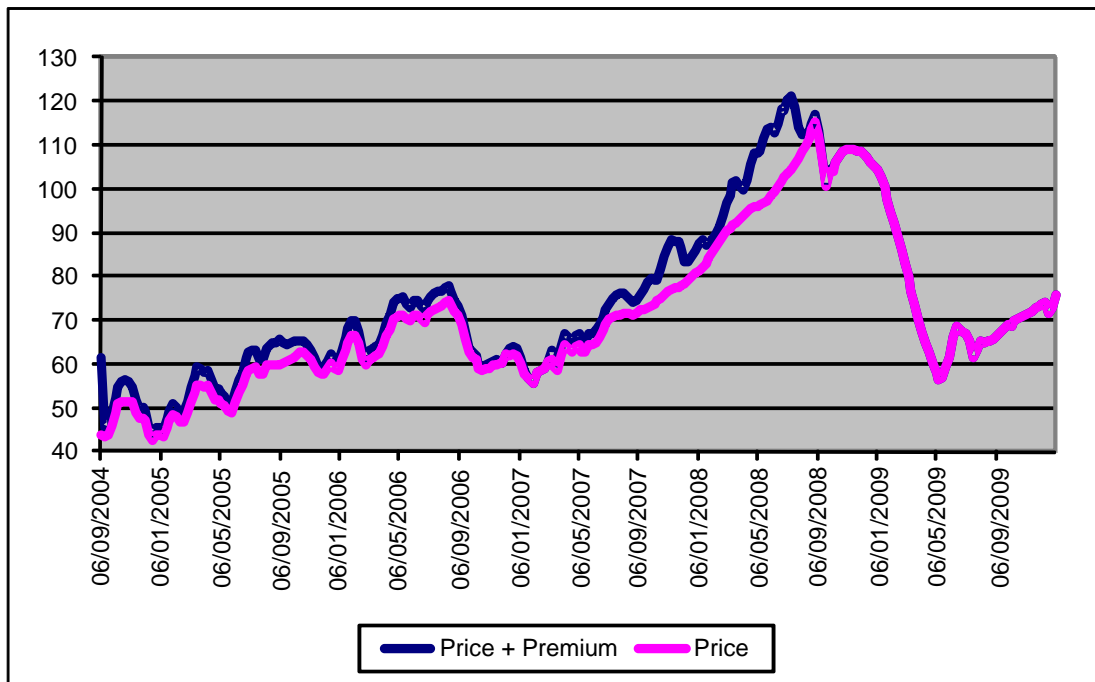
Note: Vertical axis: Spot and consumer prices in US dollars per barrel. Horizontal axis: Months.

The capitalization of the fund begins when it makes a first charge on consumers, which occurs at the time the spot price is below the price-band floor, but also from this moment the fund begins to pay the premiums. Under this alternative (blue line), *consumers finance the generation of the fund assets*. Naturally, these assets can be depleted if premiums are paid for a

sufficiently long period, but once the assets become exhausted, consumers start paying the premiums again.

Figure 20 shows the evolution of the consumer price under these two alternatives. As mentioned above, a standard deviation of the consumer price equivalent to 80% of the WTI standard deviation is observed in the first case for the whole period, while in the sub-period of higher volatility, beginning in July 2007, the standard deviation of the consumer price is reduced to only 62% of the WTI standard deviation for the same period. When consumers pay the premiums, these percentages slightly rise to 86% and 69%, respectively. This alternative eradicates the risk of erosion of the fund assets: the accumulation of assets in it may create the risk of their appropriation by the Government, although this risk is not inherent in this type of fund but in all kinds of funds.

**Figure 20. Evolution of the Consumer Price With and Without Premium Payment by Consumers**



Source: Prepared by Zapata and Rivas.

Note: Vertical axis: Spot consumer prices in US dollars per barrel. Horizontal axis: Months.

#### 4.4. The Costs of Hedging Fuel Consumption

So far, we have described an example solely taking into account the evolution of WTI prices, but for the purposes of engaging in a realistic exercise about the Peruvian case, we must consider that the policy objective is to *protect consumers against fluctuations in the price of the fuels they actually use*. In this case, the call options to be purchased must be effective to this end, which can only be achieved to the extent that there is a well-defined and stable correlation between the prices of the fuels used (diesel fuel, liquefied petroleum gas, gasoline, etc.) and the price of WTI.

It should be noted that although the price of fuels is made up of other components besides the price of oil, the main variable accounting for fuel price fluctuations is the price of oil. For this reason, we have not taken into consideration any possible variations in refining, transportation or distribution costs. This analytical strategy becomes more significant as it takes into account the fact that oil prices are established in a much broader and more transparent market than the other components.

To determine the Q quantity of oil barrels to be hedged by contracts in the WTI options market,<sup>12</sup> the rule described below must be applied:

The US dollar value of domestic consumption of a given fuel will be called C:

$$1) \quad C = p \cdot q$$

where p is the international price of this fuel (import parity price) and q stands for the quantity of domestically consumed fuel.

A change in the value of C vis-à-vis a change in the price of WTI oil (W), assuming that the fuel quantities remain constant over a relatively short period of time —e.g. three months—, may be expressed as follows:

$$2) \quad dC = q \cdot (\partial p / \partial W) \cdot dW$$

where dC is the change in the US dollar value of consumption and  $(\partial p / \partial W)$  is the derivative of the fuel price with respect to the WTI price.

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<sup>12</sup> Even though there are derivatives markets for specific fuels, the WTI market is the deepest and highest volume market, which ensures an adequate level of competition and transparency in the determination of prices.

Expression 2) may be rewritten as follows:

$$3) \quad dC = (C/W).\beta.dW$$

where  $\beta$  is the fuel price elasticity in relation to the WTI price, that is:

$$\beta = (\partial p / \partial W).(W/p)$$

Let us suppose that we have purchased hedging instruments for an amount equivalent to Q barrels of WTI. Note that our intention is precisely to determine the “proper” amount of Q for our hedge in the WTI options market to be really effective in covering domestic fuel price fluctuation risks. For the sake of simplicity, let us also assume that we have paid a premium to hedge against a dW increase in WTI. Consequently, the indemnity (I) that we will be paid at the time when the WTI price increases will be as follows:

$$4) \quad I = Q.dW$$

Our goal is that this indemnity should cover the rise in the domestic cost of the fuel (dC), for which we must equate 3) and 4):

$$5) \quad dC = I, \text{ or alternatively:}$$

$$6) \quad (C/W).\beta.dW = Q.dW$$

On the basis of expression 6), we solve for Q:

$$7) \quad Q = (C/W).\beta$$

Expression 7) determines the necessary quantity of barrels to be covered to get a proper hedge. C/W is the domestic consumption amount expressed in barrels of WTI, and  $\beta$  is interpreted as the correction factor that accounts for the fuel price elasticity. Clearly, if  $\beta = 1$ , the amount of the hedging instruments to be purchased is equivalent to the domestic consumption expressed in barrels of WTI.

Table 5 shows the US dollar values of domestic consumption,  $\beta$ , the t-statistic value, and the adjusted R2.



**Table 5. Consumption, Fuel Elasticities, and Statistics**

Fuel	Annual Consumption (August 2010-July 2011) in million US\$	Beta	t-Statistic	Adjusted R2
LPG	789	0.67	27.91	0.74
G-97 (97-octane gasoline)	76	0.80	40.54	0.86
G-95 (95-octane gasoline)	92	0.80	41.49	0.86
G-90 (90-octane gasoline)	394	0.83	44.88	0.88
G-84 (84-octane gasoline)	380	0.85	43.20	0.87
DIESEL 2 (Number 2 diesel fuel)	1	0.82	55.15	0.92
PI 6 (Number 6 fuel oil)	113	0.91	37.67	0.84
PI 500 (Fuel oil 500)	244	0.93	33.42	0.80
Diesel B2 (Number 2 diesel fuel blended with 2% biodiesel)	1,330			
Diesel B2 S-50 (Number 2 diesel fuel blended with 2% biodiesel and containing up to 50 ppm sulfur)	318			
Diesel B5 (Number 2 diesel fuel blended with 5% biodiesel)	1,799			
Diesel B5 S-50 (Number 2 diesel fuel blended with 5% biodiesel and containing up to 50 ppm sulfur)	579			
Gasohol 98 (98-octane gasoline blended with 7,8% denatured anhydrous ethanol)	0			
Gasohol 97 (97-octane gasoline blended with 7,8% denatured anhydrous ethanol)	4			
Gasohol 95 (95-octane gasoline blended with 7,8% denatured anhydrous ethanol)	15			
Gasohol 90 (90-octane gasoline blended with 7,8% denatured anhydrous ethanol)	134			
Gasohol 84 (84-octane gasoline blended with 7,8% denatured anhydrous ethanol)	166			
Turbo A1 (an aviation fuel)	269			
Total in million US\$	6,703			
Total in million barrels of WTI at a price of US\$98.31 each (6,703/98.31)	68.2			
Monthly equivalent in million barrels of WTI (68.2/12)	5.7			

Source: Prepared by the authors based on data from the General Directorate of Hydrocarbons, Ministry of Energy and Mining, Peru.

Table 5 shows that the computed elasticities are less than one and statistically significant. Elasticities less than unity occur when the cost of the transformation process is independent from the WTI cost and, consequently, a variation in the final price is less than the variation in the commodity cost, given an independent transformation process cost.

We have estimated that the total annual consumption in terms of barrels of WTI (penultimate column in the table) is equivalent to 68.2 million at the current WTI price (US\$98.31 per barrel). In monthly terms, the consumption of fuels in Peru is 5.7 million barrels of WTI.

Table 6 presents a first estimation of the costs of hedging assuming that these instruments are purchased at a strike price of US\$108 per barrel and that all the elasticities are equal to unity. This is a maximum estimation, as we can see that in those cases in which we were able to estimate the elasticities, these turned out to be less than one, which implies (according to expression 7) that the amounts to be hedged are reduced in direct proportion to the price-WTI elasticity.

**Table 6. Hedging Costs: Call Options**

<b>Hedging Costs at US\$108 per Barrel</b>			
	<b>Premium in US\$ per Barrel</b>	<b>Contracts in Million Barrels</b>	<b>Cost in Million US\$</b>
	<b>1</b>	<b>2</b>	<b>3= 1x2</b>
January 2012	0.12	5.7	0.7
February 2012	1.26	5.7	7.2
March 2012	2.56	5.7	14.5
April 2012	3.71	5.7	21.1

*Source:* Prepared by the authors based on data from [http://www.cmegroup.com/trading/energy/crude-oil/light-sweet-crude\\_quotes\\_globex\\_options.html?exchange=XNYM&foi=OPT&venue=G&productCd=CLN2&underlyingContract=CL&floorContractCd=CLN2&expMonth=201202](http://www.cmegroup.com/trading/energy/crude-oil/light-sweet-crude_quotes_globex_options.html?exchange=XNYM&foi=OPT&venue=G&productCd=CLN2&underlyingContract=CL&floorContractCd=CLN2&expMonth=201202)

The amount accumulated in the first three months (12 weeks) is US\$22.4 million, which is equivalent to 0.014% of the GDP. This is a one-time expenditure made at the time the stabilization policy is first implemented.

In this regard, if the alternative under which the premiums are borne by consumers were chosen, they would be charged the hedging fee for week 13 at the inception of this mechanism, the fee for week 14 would be charged the following week, and so on. Therefore, the first 12 weeks would remain unhedged. During this initial period, the Government can choose among the following alternatives:

- Keep the current Peruvian fund as it is, without hedging fees during the first 12 weeks, and charge consumers the weekly premium at the time of inception to hedge the fund from week 13 on.
- Make an initial contribution equal to the premium amount for the first 12 weeks, and at this same time start to charge consumers to hedge week 13.
- Charge consumers all the premiums for the first 12 weeks together with the fee for week 13, and from then on apply the usual weekly charging mechanism to hedge the subsequent weeks. Undoubtedly, this alternative would be politically unviable.

In the fourth month, the hedging cost is US\$21.1 million, which is equivalent to 0.014% of the GDP each month, or US\$253.2 million (0.16% of the GDP) a year, as long as the hedging cost remains relatively stable (i.e. hedges are acquired at US\$10 above the spot price).

Table 7 shows the hedging cost for a period of one year where hedges are purchased from the beginning; in this case, the total cost amounts to US\$350.2 million, i.e. 0.23% of the GDP. The increase in the cost with respect to the previous case is explained by the fact that hedges are acquired for longer periods.

**Table 7. Hedging Costs for a One-Year Period**

<b>Hedging Cost at US\$108 per Barrel</b>			
<b>2012</b>	<b>Premium in US\$ per Barrel</b>	<b>Contracts in Million Barrels</b>	<b>Cost in Million US\$</b>
January	0.12	5.7	0.7
February	1.26	5.7	7.2
March	2.56	5.7	14.5
April	3.71	5.7	21.1
May	4.75	5.7	27.0
June	5.59	5.7	31.8
July	6.17	5.7	35.1
August	6.72	5.7	38.2
September	7.15	5.7	40.6
October	7.60	5.7	43.2
November	7.94	5.7	45.1
December	8.06	5.7	45.8
<b>Total</b>		<b>68.2</b>	<b>350.2</b>

*Source:* Prepared by the authors based on data from [http://www.cmegroup.com/trading/energy/crude-oil/light-sweet-crude\\_quotes\\_globex\\_options.html?exchange=XNYM&foi=OPT&venue=G&productCd=CLN2&underlyingContract=CL&floorContractCd=CLN2&expMonth=201202](http://www.cmegroup.com/trading/energy/crude-oil/light-sweet-crude_quotes_globex_options.html?exchange=XNYM&foi=OPT&venue=G&productCd=CLN2&underlyingContract=CL&floorContractCd=CLN2&expMonth=201202)

Note also that the premium rises from US\$0.12 per barrel in January to US\$8.06 in December, which simply reflects the expected uncertainty or volatility regarding the price of the WTI as the time horizon expands.

The incremental cost of assuring the price 12 months ahead instead of only four months in advance amounts to US\$24.7 million each month: US\$45.8 (the 12-month premium cost) minus US\$21.1 (the 4-month premium cost), which equals US\$296.4 million in one year (1.9% of the GDP). This simply illustrates the fact that the longer the target stabilization period, the higher the cost.

It might be the case that a Government is not willing to charge premiums from consumers in excess of US\$250.3 million. This would help keep the 4-month hedging policy in place for one financial year only if the premiums remain relatively stable (around US\$3.71 per barrel in the example of Table 7). Should the premiums increase due to higher oil price volatility, the Government will have to reduce the length of the hedge period to three months, for instance. Maintaining the original hedge period will demand an increase in the consumer price on account of higher premiums. Clearly, this phenomenon becomes accentuated in the case of a 12-month hedging policy, not only because the 12-month premium cost is higher but also because the premiums may experience a greater increase owing to a higher volatility in the oil price.

#### **4.5. Possible Alternatives for the Peruvian Stabilization Scheme and their Effects**

This document analyzes the different policy alternatives concerning fuel price stabilization and presents how hedging in its various forms operates, a traditional stabilization fund, a comparison between a fund and hedging, a combination of a fund and hedging, the effect of volatility and the oil price trend in each case, the financing of hedging premiums borne by the fund or the consumers or a combination of both, etc.

In short, the possible combinations of stabilization policies may be summarized as follows:

- Fuel price stabilization fund
- Hedging policy
- Fund/hedging combination:
  - o Premiums paid by the fund
  - o Premiums paid by consumers

As a corollary to all this analysis, we suggest that Peru should implement a price stabilization scheme combined with a hedging policy with premiums paid by consumers.

Below we describe how this scheme would operate.

A State institution, whether a Secretariat of some already existing Ministry or a new agency created for this purpose, would be in charge of the mechanism. Premium payments would be borne by consumers on a weekly basis and administered by such institution. At the same time, this institution would be responsible for defining the oil price band for the fund, purchasing call options and selecting the exercise or strike price (the preset cap price), and collecting the indemnities in line with the rules and procedure described in Section 4.1.

The hedging fund would be a self-sustaining mechanism with the following operations, i.e. inflows and outflows: the premiums paid by consumers when buying fuel would be accrued to the fund, which would turn into outflows when call options are purchased. Other inflows arise when the spot price exceeds the strike price (the preset cap price), which originates the collection of an indemnity that is credited to the fund to offset the price difference. Furthermore, the fund may have other inflows when the spot price is below the lower bound (the price paid by consumers plus the premium).

It is worth noting that consumers would pay fuel prices between the lower and the upper bounds plus the premium, except in two situations in which the fund would pay the premium.

These situations that are additional to the procedure defined in Section 4.1 are the following:

- When the international price is below the floor price of the band paid by consumers in addition to the premium, the fund accumulates resources. However, if this situation were to continue over a considerable period of time (which should not be the case if the price bands are calculated in an appropriate manner to capture oil price volatility), a rule would apply (as a release device if the band is not appropriately adjusted) setting a resource accumulation limit for the fund. Thus, when the fund accumulates a given amount of resources, this rule would allow the difference between the international price and the lower bound of the band to be used to subsidize part of the premiums paid by consumers.
- On the other hand, when the international price is above the floor price of the band, an indemnity resulting from the hedging purchased would be collected, although in the event of an unexpected shock, the premiums paid by consumers may considerably rise. In this

case, the resources accumulated in the fund would be used to pay a portion of the value of such expensive premiums.

The effects on the main stakeholders in this scheme would be as explained below.

*Consumers* would pay smoothed-out fuel prices (values ranging between the bounds of the band plus the premium), i.e. prices with less volatility than the market.

As for local *producers*, this scheme does not distort the relative international prices at all; therefore, resource allocation is the same as it would be in a free price mechanism. As regards the effect on *public finance*, the scheme is revenue neutral to the tax authorities, since it was precisely designed bearing such purpose in mind. There is an exception when the mechanism is first implemented and, as explained in Section 4.4 above, one alternative is that the State should make an initial contribution equal to the premium amount for the first 12 weeks, or else that the fund currently in place in Peru should be the stabilization instrument during these initial 12 weeks.

## 5. Summary and Conclusions

Futures and markets have been an issue of concern throughout history. Thales of Miletus, 600 years B.C., was one of the precursors of futures operations. In his work *Politics*, Aristotle mentions that the first of the Seven Sages of Greece, Thales of Miletus (624 B.C.-547 B.C.), after predicting a large crop of olives thanks to his knowledge of astronomy, purchased all the olive presses in Miletus and Chios while it was still winter. When the harvest season began, he hired them out, which helped him amass a big fortune, proving other philosophers that they can be rich if they choose to, although their ambition is quite different.

Today hedging instruments are appropriate insurance mechanisms to cover against undesired events, such as rises in petroleum prices in the case of a net importing country.

These mechanisms are simple: a premium is paid to cover the risk and the insurance or indemnity is collected if the undesired event or loss takes place. As in the case of any other insurance, the premium is raised when the probability of loss increases, when the sum insured is higher, when the coverage period is longer, and when the risk covered is more distant in time.

These instruments are traded, for example, on the CME Group electronic platform, which publishes information on the transactions taking place in the New York Mercantile Exchange (on the trading floor). The website of this market or electronic trading platform (Table 1) shows all the information available for decision making, e.g. for buying a call where the asset traded is a WTI (Light Sweet Oil West Texas Intermediate) contract (in units of 1,000 barrels), WTI being a grade of crude oil used as benchmark in oil pricing in the USA.

We have analyzed the case of an oil importing country that uses call options as a hedge. These options are traded daily on the New York Mercantile Exchange (NYMEX), where the buyer of the insurance pays a premium to guarantee his/her right to purchase oil on a future date at a price arranged today. If, on the date when the buyer exercises the right to buy the agreed quantity, the spot price is higher than the strike price, the insured receives an indemnity payment equal to the difference between the spot price and the strike price. Conversely, if on that date the spot price is lower than the strike price, the right to buy is not exercised, and the insured has simply paid a premium for an event that did not take place. Legislation has been passed to implement this mechanism in Chile at a future time.



On the other hand, Mexico already has experience with this type of hedging against a drop in the price of oil through the purchase of put options, as it is an oil producer and exporting country where oil fiscal revenue accounts for a very high percentage —40% approximately— of the federal government's revenue, and wants to assure the execution of its budget. Oil price is a key variable in the federal budget, and there is a moving average procedure to estimate it, the methodology of which is established under the Federal Budget and Treasury Accountability Law (*Ley Federal de Presupuesto y Responsabilidad Hacendaria*). Now, if Mexico sells oil at a lower price, the federal budget must be adjusted, and it is to avoid this that the country takes out a hedging strategy, and has paid an annual insurance premium of about US\$1 million in the last three-year period. Actually, the goal of the Mexican position in oil put options is to assure the budget rather than the price of oil. After all, the put option strike or exercise price to purchase is determined by the Congress when approving the Budget Law.

Coming back to the case of importing countries, hedging instruments may supplement the operation of a stabilization fund that works within a price band.

In the case of a fund without hedging, if the international price falls below the lower bound of the band, the fund accumulates a surplus, whereas when the international price is above the upper bound, the resources of the fund decrease. In practice, the latter situation may lead — depending on the duration and extent of the price rise— to the depletion of the fund resources and the need for greater fiscal resources.

It is precisely for this reason that hedging instruments, supplemented by the fund, may contribute positively to the fuel price stabilization policy, by acquiring hedges for protection against the strike price rising above the upper bound of the band. In this way, fiscal resources are not affected and, because of the hedging strategy, an indemnity for the difference between prices is received.

In practice, the use of a fund without hedging requires tax revenue contributions more than once; this is why Chile put an end to its oil stabilization fund and is moving forward to establish a call option insurance system.

## **Stabilization Funds**

Stabilization funds allow oil (or fuel) price fluctuations to occur within a previously specified price band. The narrower the price band, the greater the use or accumulation of fund resources. In other words, any price volatility not covered by the price band is transferred to the fund. Should oil prices exhibit a sustained trend and the upper and lower bounds of the band not be adjusted in a timely manner, the fund resources tend to deplete (in the context of an upward trend) or to increase indefinitely (in the context of a downward trend).

It should be underscored that in the face of a sustained trend in the commodity price, any mechanism in place can only have a temporary stabilization impact unless hedging contracts have been entered into on a very long-term basis, which is not common practice in the hedge markets, where at present significant hedging transactions are conducted only for periods of up to one year.

## **Hedging Policy, Volatility, and Trends in Relation to the Stabilization Fund**

The greater the volume to be hedged through price stabilization, the higher the cost of hedging, i.e. the more expensive the total premiums to be paid on account of the hedging policy.

When the fund mechanism, including the price band, is fully replaced by a hedging system, only a cap (strike or exercise price) with respect to the spot (cash) price of the commodity is set, such as 12.5% in the Chilean case, for instance.

If hedging fully replaces the stabilization fund, a lower-band floor price is not established. If the price drops, the new scheme allows consumers to reap full benefit, unlike a fund, which restricts such benefit to the lower bound of the band and accumulates a surplus.

Consequently, hedging through the purchase of a call option maintains only a fixed upper price for the term of the contract. The commodity price fluctuates freely below the strike price.

Where both price volatility and trend are known, a stabilization fund is effective in balancing the consumer price vis-à-vis the commodity price trend; its financing needs may be modest and even less than the annual amount of the premium paid, as already explained in Chapter 3.

In the case of hedging with a call option, an error in the estimation of volatility would bring profits to the seller of the option should the volatility finally realized be lower than the one estimated at the time of entering into the contract; on the contrary, an underestimation of the volatility by the seller of the option would result in a loss for the seller and a benefit for the buyer.

In the case of the implementation of a price band policy, an error in the estimation of volatility may affect the range chosen for the price band and, therefore, may be translated into an equivalent volatility in the fund assets.

In the case of hedging with call options, an error in the estimation of a positive price trend will lead to the purchase of premiums with a strike price that does not capture such trend; as a consequence, premiums will rise (if the seller has correctly estimated the price trend). Therefore, we conclude that in this case the estimation error will have no impact, since premiums are set on the basis of the trend and are transferred to the buyer of the options.

In the case of a stabilization fund, a wrong estimation of the positive trend in the price of the commodity will result in the band being maintained as it is without taking the increase in spot prices into account, and hence the fund assets will decline, which will eventually call for a sharp change in the price stabilization band. If the price trend is negative, the situation is exactly the opposite, as the result will be an increasing accumulation of assets in the stabilization fund.

Thus, we conclude that in the cases where the price trend is difficult to estimate or predict, the option hedging policy is the most appropriate. Note that the high variability of the price of oil makes the possibility of predicting or estimating its trend—or, in other words, of distinguishing whether an increase (or reduction) is permanent or temporary—very unlikely.

### **Combining a Stabilization Fund and a Hedging Policy**

The loss of the assets is perhaps the main undesirable aspect of the implementation of a stabilization fund. This can be avoided if the fund is supplemented by a hedging policy to restrict such loss. With this complementation of the fund inflows, the premiums paid will be reduced, but the losses will be absorbed by the indemnities. If the premiums are calculated correctly, the net contribution of the hedging instruments to the fund is null, as the sum of the premiums is equal to the sum of the indemnities.

Should there only be a hedging strategy in place, inflows would be as follows: i) the amounts received to finance the premiums, which are wholly paid to the seller of the options; and ii) the indemnities, which will be wholly distributed among the consumers.

Supplementing the fund with hedging instruments mitigates its losses, as they are offset by the indemnities, and at the same time sets a limit on the gains resulting from the payment of the premiums. In this way, the possibility of the fund having negative assets is reduced.

For the purpose of assessing how a price stabilization scheme combined with hedging instruments would have performed, we have conducted a simulation exercise for the Peruvian case in the September 2004-January 2010 period. This period shows very strong fluctuations in the price of oil (WTI), ranging from a minimum of US\$43 per barrel at the beginning of the period to a maximum of US\$140 per barrel in July 2008.

In the simulated case, the fund operates on the basis of a 12-week moving average system as an element for setting the price band for the next three months. In the case of the period analyzed, the quarterly moving average system does not serve to correctly capture the observed price trend changes. The shorter the time period used to determine the moving average (the basis for setting the band), the smaller the gap between the band and the spot price. Unfortunately, the flipside of this is that the consumer price—which is precisely what we intend to stabilize—will fluctuate more, bringing about a trade-off between the cost of the premiums and volatility. It is important to recognize that the choice of a strike price must be made with the aim of reducing the effects of oil price shocks but also taking into account the costs associated with such choice, which increase according to the time horizon intended to be hedged.

Every time there is a change in the price trend, the stabilization fund starts to lose (positive trend change) or gain (negative trend change) assets, and we have proved that hedging helps mitigate losses.

The differences between the two alternative funds (with and without hedging) become particularly evident when there is a positive change in the oil price trend, since in this case the options are exercised, which mitigates the losses of the fund that result from an indemnity to consumers for the payment made when the spot price is above the upper bound of the band. Instead, when there is a negative price trend change, such differences become null because the

premiums paid (to hedge against prices well above the spot price) are not significant and, also, the options are not exercised precisely because the strike price (the upper bound) is above the spot price on the expiration date.

In the simulated case, from the beginning to September 2008, the assets of both funds are negative and declining. The assets of the hedged fund are less than those of the “traditional” fund up to September 2008, when the assets are equalized and subsequently evolve in a similar fashion. Between September 2007 and September 2008, the decline in the assets of the traditional fund is more pronounced than in the case of the hedged fund because in the latter indemnities cover the losses that occur when the spot price rises above the cap of the band. This situation leads us to ponder the following: if the fund had been assessed, for instance, in September 2007 (three years after its implementation), it would have been possible to conclude that hedging was expensive and only involved net outflows of funds and, therefore, this could have given rise to strong pressures to put an end to hedging immediately before it became necessary.

The simulated policy shows that stabilization in terms of consumer price fluctuations was effective, as the volatility of this price was reduced. The evolution of the consumer price is the same under the two alternatives analyzed, i.e. with and without hedging; the difference between them lies in the mitigation of risks when there are very marked positive changes in the price trend of the underlying asset.

### **The Costs of Hedging Fuel Consumption**

We have estimated, for the Peruvian case, the amount of call options to cover domestic fuel consumption based on the quantity of fuel consumed between August 2010 and July 2011.

The annual fuel consumption in this period amounted to US\$6,703 million (4.3% of the GDP), which is equivalent to 68.2 million barrels of WTI (at a price of US\$98.31 per barrel). In monthly terms, fuel consumption in Peru amounts to US\$558.6 million, which is equivalent to 5.7 million barrels of WTI. We have assumed that the hedging instruments are written at a strike price of US\$108 a barrel to protect against the estimated monthly consumption. The premium amount accumulated in the first three months is US\$22.4 million (accounting for approximately

4% of the spot price), which is equivalent to 0.014% of the GDP. This is a one-time expenditure made at the time the stabilization policy is first implemented.

From the fourth month on, the hedging cost is US\$21.1 million, which is equivalent to 0.014% of the GDP each month, or US\$253 million (0.16% of the GDP) a year, as long as the hedging cost remains relatively stable (i.e. hedges are acquired at US\$10 above the spot price).<sup>13</sup>

This premium amount accounts for 3.8% of the annual fuel consumption; as a consequence, in the early years of operation of the scheme up to the capitalization of the fund, consumer prices would be marked up by about 4% to support the payment of premiums.

This is the estimation of the stabilization system annual cost when “fully operational,” that is writing hedging instruments every month (or week) three months (or 12 weeks) in advance.

We believe that a mechanism with these characteristics is feasible from both the premium-cost perspective and the technical implementation standpoint. However, the implementation strategy must take into account important “political economy” obstacles.

### **A Possible Stabilization Scheme Suggested for Peru**

The scheme suggested for Peru is a stabilization fund combined with a hedging policy, where premiums are paid by consumers.

A State institution, whether a Secretariat of some already existing Ministry or a new agency created for this purpose, would be in charge of the mechanism. Premium payments would be borne by consumers on a weekly basis and administered by such institution. At the same time, this institution would be responsible for defining the oil price band for the fund, purchasing call options and selecting the exercise or strike price (the preset cap price), and collecting the indemnities in line with the rules and procedure described in Section 4.1.

Consumers would pay fuel prices between the lower and the upper bounds plus the premium. However, if the international price were below the floor price of the band and if this

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<sup>13</sup> Should hedging instruments be purchased for a whole year period, the total cost is, from the onset, US\$350.2 million, i.e. 0.23% of GDP. This increase in the cost with respect to the previous case is explained by the fact that hedges are acquired for longer periods.

situation were to continue over a considerable period of time, a rule would apply (as a release devise if the band is not appropriately adjusted) setting a resource accumulation limit for the fund. Thus, when the fund accumulates a given amount of resources, this rule would allow the difference between the international price and the lower bound of the band to be used to subsidize part of the premiums paid by consumers. On the other hand, when the international price is above the floor price of the band, an indemnity resulting from the hedging purchased would be collected, although in the event of an unexpected shock, the premiums paid by consumers may considerably rise. In this case, the resources accumulated in the fund would be used to pay a portion of the value of such expensive premiums.

The effects on the main stakeholders would be as follows. *Consumers* would pay less volatile fuel prices than those obtained in the market. As for local *producers*, as the relative international prices are not distorted, resource allocation is the same as it would be in a free price mechanism. Finally, the scheme is revenue neutral to the tax authorities, as they do not incur any expenses or receive any revenue as a result of this mechanism (there is an exception when the mechanism is first implemented).

### **Important Aspects: Institutional, Transparency and Communication Issues**

The political costs of using these hedging instruments may be very high for government leaders. For example, how could politicians explain that instead of improving a road, they are going to use the money to purchase call options at the New York Mercantile Exchange to hedge against any rise in the price of oil?

Furthermore, how could they explain that a premium equivalent to 4% of the price of oil has been paid with revenue collected from a tax on consumption in the context of a contract that is not exercised because the price of oil has fallen? As we have seen in the simulation exercise concerning the Peruvian case, it may happen that premiums are paid for long periods of time (two years or more) without the options being exercised, which may give rise to a simple question: why have we “spent” US\$253 million a year for two years? The answer calls for a clear dissemination of the notion of insurance.

The proposal made includes an insurance against variations in the price of oil, which is the most significant component of the price of fuels, but does not provide for an insurance

against variations in the US dollar exchange rate. This is an important issue, as fluctuations of fuel prices in the local currency as a result of changes in the exchange rate, which will not be subject to any stabilization policy, may lead to political conflict. Therefore, *good dissemination in society of the policy being implemented*, of what it includes and what it leaves out, is of the essence. The stabilization policy proposed does not cover variations in the US dollar since these changes affect not only the fuel market but all the other markets as well, and if fuel prices are stabilized as a consequence of changes in the US dollar exchange rate, the prices in all the other markets should also be stabilized.

These hedging policies involve an important political risk because gains are regarded as normal and losses raise suspicion of corruption, even if no “losses” in the strict sense of the word occur in the case of a hedging strategy. Since what must be regularly paid is a premium, it may happen that these payments continue over long periods of time in which no indemnity whatsoever is collected, and suspicion be cast on the mechanism adopted. In the long term, any insurance is expensive and it is possible that the sum of the premiums paid exceeds the amount of the indemnities. This is why it is necessary to design *a highly transparent institutional framework* that automatically operates according to an accepted law so that citizens are convinced that this kind of insurance is good for consumers and for economic stability.



## **ANNEX: Cases Observed**

### **1- The Case of Mexico**

This document analyzes the case of Mexico, an important oil exporting country that, for a number of years, has combined an Oil Revenue Stabilization Fund (*Fondo de Estabilización de los Ingresos Petroleros* – FEIP) with a hedging mechanism involving the purchase of put options on the oil exported.

Fiscal revenue from oil accounts for 40% of the federal budget receipts. Oil is exploited by PEMEX, a State-owned company.

The fiscal revenue from oil that is used to finance the Expenditure Budget is forecast using a formula approved under the Federal Budget and Treasury Accountability Law (*Ley Federal de Presupuesto y Responsabilidad Hacendaria*) of 2006. This formula is the arithmetic mean of two components, one of them based on the last 10-year historical price series and the other one based on the NYMEX futures prices. These are estimated using an average of historical prices (the moving average of the last 10 years) and the average of futures prices (the WTI moving average for the following three years, due to its equivalence to the Mexican export crude oil blend).

Under the above-mentioned law, the difference between the budget price and the actual export price is allocated to FEIP, which accumulates funds when the international price is higher than the budget price, and loses funds when the international price is lower than the budget price. From 2009 onwards, Mexico has strengthened FEIP through the use of hedging, buying put options with resources from the fund.

Thus, Mexico guarantees the right to sell at a strike price that is equal to the budget price, and gets protection with an insurance against lower international market prices that, in other circumstances, would have forced the country to deplete FEIP and make adjustments to the budget.

If the international price were higher than the strike price, Mexico does not exercise the option, sells at the highest price, and accumulates the difference in FEIP. If the international price were lower than the budget price, the country exercises the put and sells its oil at the budget

price. The put options are charged against FEIP,<sup>14</sup> and the Bank of Mexico is responsible for finding the highest bidders.

With these mechanisms, Mexico has managed to mitigate the effects of oil export price volatility and execute its federal budget. Due to its administration of the oil export hedges, the Mexican Secretariat of Finance has become a policy case that in 2009 received the award for the most innovative or creative use of derivatives, which is granted by *Futures & Options World*, a magazine specialized in global derivatives. The Secretary of Finance informed that as a result of the 2009 hedges, Mexico made more than US\$5 billion by hedging the US\$50 price per barrel of its exportable production.

Tanks to this mechanism, Mexico has ensured that it will not incur a deficit in the budget approved by Congress.

In 2010, Mexico purchased put options at US\$57 per barrel for an US\$1,172 million amount.

In 2011, the country acquired put options for an amount of US\$812 million to hedge 222 million barrels at US\$63 per barrel of the Mexican blend, the budget price being US\$65.90. In this way, if the price is lower than US\$63, Mexico exercises the option and sells at US\$63; if the price is higher than US\$63, the country does not exercise the option; and if the international price ranges from US\$63 to US\$65.90, FEIP pays the difference, thus allowing the budget to be executed. Finally, if the price is higher than US\$65.90, the surplus is credited to FEIP.

## **2- The Case of Chile<sup>15</sup>**

The other case is that of the Chilean law recently enacted by Congress that became effective in March 2011. This law creates a mechanism for protection against variations in the international price of fuels called the Fuel Taxpayer Protection System against International Fuel Price

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<sup>14</sup> The FEIP operating rules are detailed in the *Official Gazette* of May 31, 2007. [http://www.apartados.hacienda.gob.mx/presupuesto/temas/lineamientos/otras\\_disposiciones/reglas\\_operacion\\_fondo\\_estabilizacion\\_petroleo.pdf](http://www.apartados.hacienda.gob.mx/presupuesto/temas/lineamientos/otras_disposiciones/reglas_operacion_fondo_estabilizacion_petroleo.pdf)

<sup>15</sup> “Historia de la Ley 20.493: ‘Crea un nuevo sistema de protección al contribuyente ante las variaciones en los precios internacionales de los combustibles.’” *Official Gazette*, February 14, 2011, Library of the National Congress of Chile.

Variations (*Sistema de Protección al Contribuyente del Impuesto específico a los Combustibles – SIPCO*).

## **2.1 Before March 2011**

The Oil Price Stabilization Fund (*Fondo de Estabilización de Precios del Petróleo – FEPP*) was created in 1991 by Law 19,030 and modified in May 2000 under Law 19,681. This fund was initially established for five products: automotive gasoline, diesel fuel, kerosene, liquefied gas, and fuel oils. Since it was reformed in 2000, FEPP has had very limited funds available for several years.

In September 2005, the Fuel Price Stabilization Fund (*Fondo de Estabilización de Precios de los Combustibles – FEPC*) was created by Law 20,063 to respond to the rise in the price of petroleum oil and its derivatives resulting from the effects of hurricane Katrina on the Gulf Coast of the United States (a territory associated with crude oil extraction and refining activities). FEPP came to cover fuel oils only, while FEPC covers automotive gasoline, diesel fuel, and liquefied gas. The latter fund was supposed to operate until June 30, 2006, but its operation was extended until June 30, 2007 by Law 20,115 and, subsequently, until 2010 by Law 20,197.

The aim of these funds was to stabilize fuel prices by establishing tax credits or taxes in order to avoid any significant variation in final consumer prices. The Ministry of Energy set the parity prices of the crude oil-based fuels provided for in the laws governing FEPP and FEPC on the basis of weekly reports submitted by the National Energy Commission (CNE, its acronym in Spanish). The reference prices were determined to establish the price band and the operating rules of the funds.

These funds evolved and improved over time in terms of the conditions under which they apply (eliminating arbitrariness), the determination of the weekly prices using previously devised and published formulas, the enhancement of the reference price determination models (taking into account WTI crude oil spot and futures prices), the use of appropriate formulas to avoid depletion of the funds, and the creation of sub-funds for each product to avoid cross-subsidies, among others.

The funds, however, have represented a considerable cost to the State and society, amounting to some US\$2,344<sup>16</sup> (2000-2009 subsidies), and their performance has been modest in terms of their price stabilization goal, as some of these changes have been permanent.

The problem with these funds is that they do not distinguish among beneficiaries based on their income. A general subsidy for gasoline is established, which is regressive, as liquefied gas or kerosene consumption is more important to lower-income families. Furthermore, they benefit the owners of consuming entities who are capable of protecting themselves against price fluctuations since they have access to hedging instruments offered by private third parties.

In this connection, the funds have created an undesired effect: they have reduced the private demand for hedging instruments, thus holding off the development of the Chilean hedge market.

By virtue of these problems, Chile has been making further progress with stabilization mechanisms with a view to continuing to improve over time through planning ahead.

## **2.2 As From March 2011**

FEPC expired in 2010, and FEPP is still operational and covers only domestic kerosene, along with SIPCO.

In February 2011, the Fuel Taxpayer Protection System against International Fuel Price Variations (*Sistema de Protección al Contribuyente del Impuesto específico a los Combustibles ante las Variaciones en los Precios Internacionales de los Combustibles – SIPCO*) was created by Law 20,493. As from March 2011, the new system based on the variable tax concept started to be applied instead of a fund.

The debate that took place before the bill that would become Law 20,493 was passed included an insurance system to hedge against price rises in the global market, which will enter into force when the Ministry of Finance so decides. The SIPCO will evolve into an insurance system that would use hedging tools.

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<sup>16</sup> According to data from the Library of the National Congress of Chile.

## SIPCO

The Fuel Taxpayer Protection System against International Fuel Price Variations is intended to establish a mechanism to protect against variations in the international price of fuels, whereby the variable component of the excise tax on fuels (*Impuesto Específico a los Combustibles* – IEC) is added to or subtracted from the base component, taking into account the variation in fuel prices, so that the price paid by consumers is kept within the price band. In other words, the variable component of IEC falls when the international price rises and the other way round. Thus, consumers do not pay any increase in international fuel prices since they are compensated with a decrease in the IEC rate (which operates as a subsidy), whereas if such prices fall, they pay a higher IEC rate (which in this case operates as a tax).

SIPCO applies to automotive gasoline, diesel fuel, liquefied petroleum gas for vehicle use, and compressed natural gas for vehicle use.

The variable component can be negative or positive, and is determined on the basis of the difference between the import parity price and the upper and lower bounds of the reference price band for each fuel. This band is established as  $\pm 12.5\%$  of the intermediate reference price.

$$\text{Parity price} \times (1 + \text{VAT}) + \text{IEC}_{\text{base}} + \text{IEC}_{\text{variable}}$$

Where:

- $\text{IEC} = \text{IEC}_{\text{base}} + \text{IEC}_{\text{variable}}$
- $\text{IEC}_{\text{base}} = 6 \text{ UTM/m}^3$  for gasoline;  $1.5 \text{ UTM/m}^3$  for diesel fuel
- $\text{IEC}_{\text{variable}} =$  a tax or a credit if the parity price falls outside the  $\pm 12.5\%$  price band.

Note: UTM stands for *Unidad Tributaria Mensual* (monthly tax unit).

SIPCO does not offer protection to all fuel consumers, but to those that pay the excise tax and to small and medium enterprises. Large fuel-consuming companies that get a 100% excise tax rebate are not covered by the system, as they have financial and other resources to hedge against volatility.

SIPCO is financed by taxes and subsidies and not through a fund, i.e. it is similar to a fund but it does not become exhausted. It is worth noting that this mechanism is designed to absorb variations in the international price of oil but not in the exchange rate.

An example in this regard is the significant depreciation of the Chilean currency in the last week of September 2011. This rise in the US dollar price was not covered by the system and, thus, consumer prices of fuels increased regardless of the US dollar price of oil. This situation sparked public debate and discussion.

As already mentioned, SIPCO is due to be replaced by the Taxpayer Insurance against Fuel Price Variations (*Seguro de Protección del Contribuyente ante Variaciones en los Precios de Combustibles* – SEPCO).

### **Stages Leading to the Implementation of SEPCO**

SIPCO will be operational throughout 2012 or longer while SEPCO is being established. In a second phase, when SEPCO is already operating, the variable component of the excise tax will be calculated in the basis of the premiums of and indemnities from the insurance contracts entered into by the Ministry of Finance abroad.

Using these kinds of instruments may give rise to difficulties at the beginning. Consequently, the Government does not rule out the possibility that SIPCO may operate for more than a year owing to the complex initial steps towards the first call for bids on insurance.

- 1) The first stage of SEPCO consists in launching a call for tenders for a study to design a specialized unit within the purview of the Ministry.
- 2) The Government shall hire appropriate personnel to lead and staff such unit.
- 3) Design the master insurance contracts.
- 4) Prequalify the potential bidders, which shall be oil producers and investment banks specialized in commodities.
- 5) Reach a consensus on the details of the master contract with each of the potential bidders.
- 6) Announce the first call for bids; every month one call for tenders shall be held for each type of fuel.

## SEPCO

The Taxpayer Insurance against Fuel Price Variations (*Seguro de Protección del Contribuyente ante Variaciones en los Precios de Combustibles* – SEPCO) is a mechanism designed to hedge Chilean consumers, through the purchase of call options in the international market, against a sharp and unexpected rise in the international price of oil ranging from a base price to 12.5% above the fuel reference price.<sup>17</sup> If the price rises above 12.5% (the cap of the band), the right to purchase is exercised, paying the premium minus an indemnity (for the difference between the reference price plus 12.5% and the spot price). This indemnity would be applied as a negative, variable excise tax that would lower the price to meet the upper bound of the band. Conversely, if the price falls below the floor of the band, the option is not exercised, and only a premium has been paid for the insurance.

In the bill, premiums are restricted to a maximum of 4% of the price.<sup>18</sup>

$$\text{Parity price} \times (1 + \text{VAT}) + (\text{IECbase} + \text{IECvariable})$$

Where:

- IECvariable =
  - Premium - indemnity. If the spot price exceeds the average price of the last three months by more than 12.5%, such excess gives rise to an indemnity.
  - Otherwise, premium.

The cost of the insurance is equal to the premium minus the indemnities. It has been established that large consumers will not be covered by the SEPCO insurance, as they have financial and other resources to get insurance coverage themselves.

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<sup>17</sup> The mechanism will also use a band of 12.5% above or below the established reference price.

<sup>18</sup> This data is based on simulation results. For an actual change in excess of 4% of the premium to occur, sharp situations or variations vis-à-vis the conditions under which the prices are set should take place, which is not estimated to happen.

The advantage of an insurance system is that it results in a longer adjustment period, a more competitive balance among fuels, and higher levels of financial development than stabilization funds. Furthermore, it is a stabilization mechanism without any fiscal costs, as the cost of insurance is added to the price of the product.

In this connection, with the implementation of the system, should large fluctuations result in price rises, the cost is not borne by individuals or the State, but by external insurance companies, as the project transfers the risk to third-party insurers.

The methodology associated with SEPCO will be as follows:

- The Ministry of Finance takes out, ahead of time, a call option to buy oil in the foreign market at the price of the upper bound of the band.
- Every month, hedging instruments are purchased for three months ahead, which means that the price for the next quarter is hedged at all times. When the covered month arrives, the spot price is compared against the average price of the last three months. If the spot price exceeds this average by more than 12.5%, such excess gives rise to an indemnity.
- When the prearranged price is exceeded in the futures market, the possibility of buying at the cap price provided for opens up immediately. It is not necessary to make a put option, because if the price falls, the country derives benefit, and the only loss is the cost of the insurance premium.

One of the advantages of the design of this system is that a predefined methodology is followed, and investment decisions that may put it at risk are not left in the hands of politicians, since the system does not include the purchase of put options.



## A Comparison among FEPC, FEPP and SIPCO

<p>Fuel Price Stabilization Fund FEPC Created in 2005; expired in 2010</p>	<p>Oil Price Stabilization Fund FEPP Created in 1991; modified in 2000 and 2005</p>	<p>Taxpayer Protection System against International Fuel Price Variations SIPCO Created in March 2011</p>
<p><u>Four products:</u></p> <ul style="list-style-type: none"> <li>Automotive gasoline</li> <li>Diesel fuel</li> <li>Domestic kerosene</li> <li>Liquefied gas</li> </ul> <p><u>A single fund</u> for the four products</p>	<p><u>One product:</u></p> <ul style="list-style-type: none"> <li>Fuel oils. As from the creation of SIPCO, fuel oils were replaced by domestic kerosene.</li> </ul> <p>A sub-fund per product. (Initially there were five sub-funds; at present, there is only one for domestic kerosene.)</p>	<p><u>Four products:</u></p> <ul style="list-style-type: none"> <li>Automotive gasoline</li> <li>Diesel fuel</li> <li>Liquefied petroleum gas for vehicle use</li> <li>Compressed natural gas</li> </ul> <p><i>It does not rely on a fund</i>, but operates modifying the excise tax on fuels.</p>
<p><u>Price band:</u></p> <p>±5% above the intermediate reference price</p>	<p><u>Price band:</u></p> <p>±12.75% above the intermediate reference price</p>	<p><u>Price band:</u></p> <p>±12,75% above the intermediate reference price</p>
<p><u>Parity price:</u></p> <p>Each product is observed on a weekly basis in three different markets, and the lowest parity of the week is taken as the relevant import parity price. The observable markets are the Gulf Coast of the United States, the East Coast of the United States, and Mont Belvieu.</p>	<p><u>Parity price:</u></p> <p>Each product is observed in a single relevant market to estimate its import parity price.</p> <p>The relevant market is the Gulf Coast of the United States.</p>	<p><u>Parity price:</u></p> <p>Each product is observed on a weekly basis in one or two relevant markets to determine the respective parity. The observable markets are the Gulf Coast of the United States or the average of the Gulf Coast of the United States and New York.</p>

<p style="text-align: center;"><b>Fuel Price Stabilization Fund FEPC</b> Created in 2005; expired in 2010</p>	<p style="text-align: center;"><b>Oil Price Stabilization Fund FEPP</b> Created in 1991; modified in 2000 and 2005</p>	<p style="text-align: center;"><b>Taxpayer Protection System against International Fuel Price Variations SIPCO</b> Created in March 2011</p>
<p><u>Reference price:</u></p> <p>The WTI (West Texas Intermediate) price + the refining differential for each product</p> <p>WTI price = 50% historical average prices (26 weeks for gasoline, kerosene and diesel fuel, and nine weeks for liquefied gas) + 50% future average prices (five months for all products)</p> <p>Refining differential = backward moving average: 26 weeks for gasoline, and nine weeks for kerosene, diesel fuel and liquefied gas</p>	<p><u>Reference price:</u></p> <p>40% historical price (two years) + 25% long-term forecast price (up to 10 years for each product)</p> <p>The calculated intermediate reference prices cannot differ from the average of the parity prices observed during one year by more than 20%.</p>	<p><u>Reference price:</u></p> <p>The WTI (West Texas Intermediate) price + the refining differential for each product</p> <p>WTI crude oil price = WTI crude oil historical price (30 weeks) + WTI crude oil futures price (futures market, six months). The authorities weight the futures prices within a 0%-50% range. Refining differential = moving average of the prices of each fuel, 30 weeks backwards.</p>
<p><u>Operating mechanism:</u></p> <ul style="list-style-type: none"> <li>• If the lowest reference price is higher than the parity price, a tax is imposed on the product, the amount of which per cubic meter sold or imported, as appropriate, is equal to the difference between both prices.</li> <li>• If the parity price exceeds the highest reference price, a tax credit equal to the difference between both prices is granted per cubic meter sold or imported, as appropriate.</li> </ul> <p>It is worth noting that this tax credit may be reduced in the event that the projected fund inflows and outflows are higher than its balance as</p>	<p><u>Operating mechanism:</u></p> <ul style="list-style-type: none"> <li>• If the parity price is higher than the highest reference price, a subsidy amounting to 100% of the difference between these prices is granted, provided that the Product Specific Available Fund (<i>Fondo Especifico Disponible del Producto</i> – FEDP) is higher than or equal to the estimated use of this fund for the next 12 weeks. Otherwise, a percentage equal to the result of dividing FEDP by the estimated use of it for the next 12 weeks is granted. This method prevents the specific funds from becoming depleted. Under the former law, there was a fixed subsidy equal to 100% of the difference between the parity price and the</li> </ul>	<p><u>Operating mechanism:</u></p> <ul style="list-style-type: none"> <li>• If the lowest reference price is higher than the parity price for a given fuel, an excise tax will be imposed on this fuel, the amount of which per cubic meter will be equal to the difference between both prices. In this case, the variable component of this excise tax will be equal to the tax value and will be added to the base component.</li> <li>• If the parity price exceeds the highest reference price, a tax credit will be granted for an amount per cubic meter equal to the difference between both prices. In this case, the variable component of the excise tax will be equal to the absolute value of such</li> </ul>

<p>Fuel Price Stabilization Fund FEPC Created in 2005; expired in 2010</p>	<p>Oil Price Stabilization Fund FEPP Created in 1991; modified in 2000 and 2005</p>	<p>Taxpayer Protection System against International Fuel Price Variations SIPCO Created in March 2011</p>
<p>estimated by the CNE. This adjustment is thus necessary for the projected fund not to become exhausted in the time horizon provided for under Law 20,063, and may be different for each fuel based on its forecast impact on the use of the fund.</p>	<p>highest reference price.</p> <ul style="list-style-type: none"> <li>• If the parity price is lower than the lowest reference price, a tax equal to 100% of the difference between these prices is accrued to the fund, provided that the difference between the Product Specific Objective Fund (<i>Fondo Objetivo Especifico del Producto</i> – FOEP) and its FEDP is greater than or equal to the estimated increase of the fund for the next 12 weeks. Otherwise, a percentage equal to the result of dividing the difference between FOEP and FEDP by the estimated increase of the latter fund for the next 12 weeks is granted. This method prevents the specific funds from over-accumulating assets. Under the former law, there was a fixed tax equal to 60% of the difference between the lowest reference price and the parity price.</li> </ul>	<p>difference and this value will be subtracted from the base component.</p> <p>The variable component is determined as the difference between the parity price and the upper or lower bound, depending on whether such price is above or below the price band. In the case of compressed natural gas, the variable component is the same as the one determined for liquefied petroleum gas for vehicle use multiplied by a 1.5195 factor.</p> <p>The total credit forecast, i.e. the sum of credits and taxes for the following 16 weeks, must not exceed 50 percent of the balance of the Fuel Price Stabilization Fund as of June 30, 2010. The General Treasury informed that this amount is equal to US\$180,736,228.88.</p>

Sources: First two columns: Prepared by the authors based on reports from the Chilean National Energy Commission dated January 2010. Third column: Prepared by the authors based on “Historia de la Ley 20.493: ‘Crea un nuevo sistema de protección al contribuyente ante las variaciones en los precios internacionales de los combustibles.’” *Official Gazette*, February 14, 2011, Library of the National Congress of Chile.

### **3- Airlines and Fuel Price Hedging**

A third case of great interest in respect of fuel hedging is that of airlines, a sector in which hedging mechanisms have become extremely important. In the 2000s, their use has proved to be very positive for many companies. To understand this process, some issues must be taken into account:

1. First, we must consider that the cost of fuel is a significant portion of aircraft operating costs. Even at times when fuel prices were not very high, they have accounted for between 10% and 15% of the operational costs of most airlines, but in times of high prices, these percentages have ranged between 35% and 50%. Despite their efforts, in 2008 the airlines were unable to increase airfares or sufficiently reduce their operational costs to offset such increases.
2. Second, owing to the large number of actors in the airline market, there is heavy competition among the different companies. This is why airlines find it hard to raise the price of tickets as airplane fuel prices rise, because it will result in a reduced number of passengers, who will choose to fly other airlines that pass on a lesser portion of the fuel price increase to their customers.
3. Finally, there is seasonality in the passenger transport market, which makes it more difficult to cover such costs in the low season. A rise in fuel prices in this season brings about an even more complex situation for airlines.

For these reasons, in the last decade some airlines have begun to use financial mechanisms to hedge against unexpected run-ups in the price of oil, which allowed them to reduce fuel costs by US\$1 per gallon in the best cases and, thus, improve their competitiveness and gain market share vis-à-vis other airlines that do not resort to such hedging mechanisms.

This has been the case with Southwest Airlines. Thanks to the use of a variety of financial instruments, it is the airline with lower actual fuel expenses, which has enabled it to rank among the largest air carriers and to have a positive balance when its competitors reported losses. Southwest Airlines started to use hedging instruments in 1994, locking in prices for 20% to 30% of its expected fuel needs three to six months in advance. This situation changed in 1998, when Southwest began to lock in the prices paid for larger amounts of fuel, which by the end of

the 2000s accounted for 80%-90% of its expected needs. Through the hedging mechanism, the airline realized US\$4 billion savings in its fuel costs in one decade, ranking fourth among US airlines.

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### Annex: Cases Observed

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