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Oil Price Instability, Hedging, and an Oil Stabilization Fund

The Case of Venezuela

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Venezuela could use market-based risk management instruments to reduce short-run risk on oil prices and to complement an oil stabilization fund. Using such instruments would decrease the probability that the stabilization fund would run out of funds, and the fund could be significantly smaller.

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International Trade Division
and
Europe and Central Asia/Middle East
and North Africa Regions Technical Department
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Summary findings

The Venezuelan government and PDVSA (Venezuela's state oil companies) are both exposed to oil price instability. Given the existing tax structure, PDVSA has a higher exposure than the government, especially when prices drop below \$18–20 a barrel.

Claessens and Varangis show that the volatility of prices for crude oil is higher (but not significantly) than the volatility of prices for refined oil products. And both prices are highly correlated. So, there is not much strength to the argument that Venezuela, being now mainly an exporter of refined products, faces less volatility than when it was exporting mainly crude oil.

The basis risk for hedging Venezuelan crude oil was found to be higher than for other crudes of comparable quality in the region. One explanation could be the pricing policies Venezuela follows, which leads Venezuelan crude oil prices to deviate for long periods from international prices. The basis risk in Venezuelan refined products is much lower and at acceptable levels for doing risk management.

The issue of liquidity in the hedging markets is crucial, as Venezuela is a major oil producer. Oil futures and options markets are liquid, but the liquidity is concentrated in contracts for periods of less than a year.

For products, the liquidity is concentrated in the nearest 4–5 months. So, for short-term hedges (6–9 months ahead), there is sufficient liquidity for Venezuela to hedge a substantial part of its exports. For longer-term hedges, the over-the-counter market is the more appropriate vehicle. In either case, it will not usually be the case that all production or exports should be hedge

Claessens and Varangis also examined the issue of an oil stabilization fund. For an oil stabilization fund to be effective, several preconditions must be met. Most notably: oil prices should not follow a random walk; financial markets are incomplete; and there are large adjustment costs. These conditions do likely apply in Venezuela.

Venezuela's best strategy would be to remove as much short-term oil price risk as possible by using short-dated hedging instruments (such as futures, options, or short-dated swaps) and to also do some longer term hedging (using mainly over-the-counter options and long-dated swaps). They also find that an oil stabilization fund should be complemented by using market-based risk management tools. The oil stabilization fund could then be used to manage any remaining interperiod oil price risk to the extent considered necessary.

This paper — a joint product of the International Trade Division, International Economics Department, and the Finance and Private Sector Development Group, Europe and Central Asia/Middle East and North Africa Regions Technical Department — is part of a larger effort in the Bank to study how developing countries can better manage commodity price risk. Copies of this paper are available free from the World Bank, 1818 H Street NW, Washington DC 20433. Please contact Dawn Gustafson, room S7-044, extension 33714 (52 pages). April 1994.

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**OIL PRICE INSTABILITY, HEDGING AND AN OIL STABILIZATION FUND: THE
CASE OF VENEZUELA**

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SUMMARY

Both the Venezuelan government and PDVSA--Venezuela's state oil companies--are quite exposed to oil price instability. Given the existing oil tax structure, PDVSA has a higher exposure than the government, particularly when prices are below \$18-20 per barrel.

Our analysis shows that the volatility of crude oil prices is higher, but not significantly, than the volatility of refined oil product prices and both prices are highly correlated. Thus the argument that Venezuela, being now mainly a refined products exporter, faces less volatility than when it was exporting mainly crude oil is not very strong.

The basis risk for hedging Venezuelan crude oil was found to be higher than for other crudes of comparable quality in the region. One explanation could be the pricing policies followed by Venezuela. The basis risk in Venezuelan products is much lower and at acceptable levels for doing risk management.

The issue of liquidity in the hedging markets is crucial as Venezuela is a large oil producer. Oil futures/options markets are liquid but the liquidity is concentrated in contracts with a period of less than year. For products, the liquidity is concentrated in the nearest 4-5 months. Thus, for short-term hedges (six-nine months ahead) there is sufficient liquidity for Venezuela to hedge a substantial part of its exports. For longer-term hedges, the over-the-counter market is the more appropriate avenue to use. In either case it will not usually be the case that all production or exports should be hedged.

We also examined the issue of an oil stabilization fund (OSF). For an OSF to be effective, several pre-conditions need to be met; some of these are not met in the case of Venezuela. The most notable conditions which do not exist are the absence of a random walk in oil prices, incompleteness of financial markets, and the existence of large adjustment costs.¹

We conclude that the best strategy for Venezuela to follow is to remove as much short-term oil price risk as possible through use of short-dated hedging instruments (such as futures/options/short-dated swaps) as well as to do some longer-term hedging (using mainly over-the-counter options and long-dated swaps). We also find that an OSF should be complemented by the use of market-based risk management tools. The OSF could then be used to manage any remaining interperiod oil price risk to the extent considered necessary.

¹Incompleteness of financial markets means that not every contingency (time, type) is covered by a financial contract.

1. INTRODUCTION ²

Much of Venezuela's economic management during the last two decades has focussed on how to accommodate to changes in the international oil market. The particular choice of economic policy instruments and institutional practices has resulted in the poor management of oil resources with flow-on effects to the economy, reflected in the high variability of savings and investments (Edwards, 1992).

In 1992, Venezuela received about 80% of its merchandise export revenues and 80% of government revenues from oil-related activities. This dependence on oil exports has to a large extent determined the economic policies implemented in Venezuela. Forecasts of oil prices are crucial in projecting fiscal revenues in preparing the government budget each year. Under the current system, the budget office depends on the oil company, PDVSA, for forecasts of oil prices and other relevant data, such as production and export volumes. Under the taxation rules variations of projected tax payment are settled at the end of the year.³ Export volumes are much less uncertain and more stable than prices. Daily developments in the oil market directly influence the fiscal agencies' expenditure commitments. Politically stronger ministers usually find it easier than others to commit funds beyond their original budget when oil prices seem high. This makes it difficult to control public expenditures even after the budget has been voted

²The authors wish to thank Ron Duncan, Mayra Zermeno, Ramon Espinasa, and Mudassar Imran for valuable comments.

³Income taxes are paid by PDVSA each quarter based on oil price projections made at the beginning of the year for each quarter. At the end of the year, a reconciliation using the actual year's price determines whether PDVSA makes additional income tax payments to the government. During the period 1980-89, predicted oil export revenues were about 7% lower than actual oil export revenues.

by Congress. On the monetary side, monetization of the oil revenues, in the absence of effective domestic sterilization instruments, is a major source of (price) instability.

The issue of oil price uncertainty and its effects on the Venezuelan economy has been studied extensively. Noteworthy studies are those of Hausmann and Powell (1990) and Hausmann *et al.* (1991) which describe the main concerns and the costs imposed on the Venezuelan economy due to the necessary adjustments. In the Hausmann *et al.* (1991) study, a stabilization fund is proposed to "smooth-out" the effects of oil price volatility on the Venezuelan economy. A stabilization fund along these lines is currently under consideration by the Venezuelan government.

What has yet to be examined for Venezuela is the possibility of using financial instruments to "smooth out" oil price volatility. These instruments can be substitutes for an oil stabilization fund (OSF) or, as we shall see later in the paper, could complement it. Experience with commodity stabilization funds (CSFs) has shown that few have worked well and many have failed. This is to be expected because of the time series properties of commodity prices. Price swings are too large, too long-lived and too uncertain to be smoothed by any reasonably-sized CSF. The necessary accumulation of reserves during booms has to be very large, and is therefore very expensive and, most probably, politically unacceptable. Correspondingly, drawings from the fund in times of price slumps tend to be very large and with uncertain dates of replenishment (Deaton, 1992).

Financial instruments can achieve efficient hedging of oil price exposures and may hold the following advantages over non-market schemes (such as a stabilization fund): 1) they are more efficient, because they are more economical in using monetary and physical resources; 2) they are able to shift price risk externally; 3) they provide longer term price assurance; 4) they provide market-based expectations of future prices; and 5) they are less likely to introduce economic distortions because they are market-based.

Because they are in principle more efficient, financial instruments could provide an attractive alternative to an OSF in the case of Venezuela. To date, Venezuela has not used financial risk management instruments on any significant scale. Some reasons put forward as to why Venezuela has not used financial instruments for hedging purposes are: first, PDVSA has diversified its export basket from mainly selling crude oil to mainly selling refined products and, as a result, it faces less volatility as product prices are less volatile than crude oil prices. Second, because of quality differences and the pricing policies pursued, the basis risk between futures prices and Venezuelan spot crude oil prices is high. Third, there is too little liquidity in international financial markets given the size of Venezuela's oil exports. Fourth, financial instruments are assumed to be costly. Finally, there is the question of who should be using the financial instruments for hedging purposes: the government or PDVSA? These issues, as well as further discussion on an OSF and how market-based financial instruments can complement an OSF, are analyzed in detail in this paper. In general, we find little support for the arguments made as to why financial instruments cannot be used effectively. We conclude that market-based risk management tools could and should be used by Venezuela.

The structure of the paper is as follows: Section 2 analyzes the allocation of oil price risk within Venezuela. Section 3 analyzes in detail the claims that petroleum product prices are less volatile than crude oil, that products offer price diversification, and that the basis risk is too high and there is too little liquidity in the oil derivatives markets. Section 4 analyses the necessary requirements for the establishment of an OSF, and the rules under which an OSF, if deemed necessary, should operate. The section also outlines how an OSF can be complemented with financial instruments. Section 5 discusses the institutional arrangements for hedging and section 6 presents the conclusions.

2. ALLOCATION OF OIL PRICE RISK IN VENEZUELA: GOVERNMENT AND PDVSA

In recent years, the petroleum sector has accounted for about 23% of GDP; however, inclusion of its indirect contributions (spillover effects to other sectors) brings its share up to two-thirds of the GDP. Between 1982 and 1988 oil-related revenues (mainly PDVSA's taxes and royalties) accounted for an average of 67.3% of total government revenues. In 1991 the share of oil-related revenues rose to 78.5%. These statistics indicate the high exposure of the

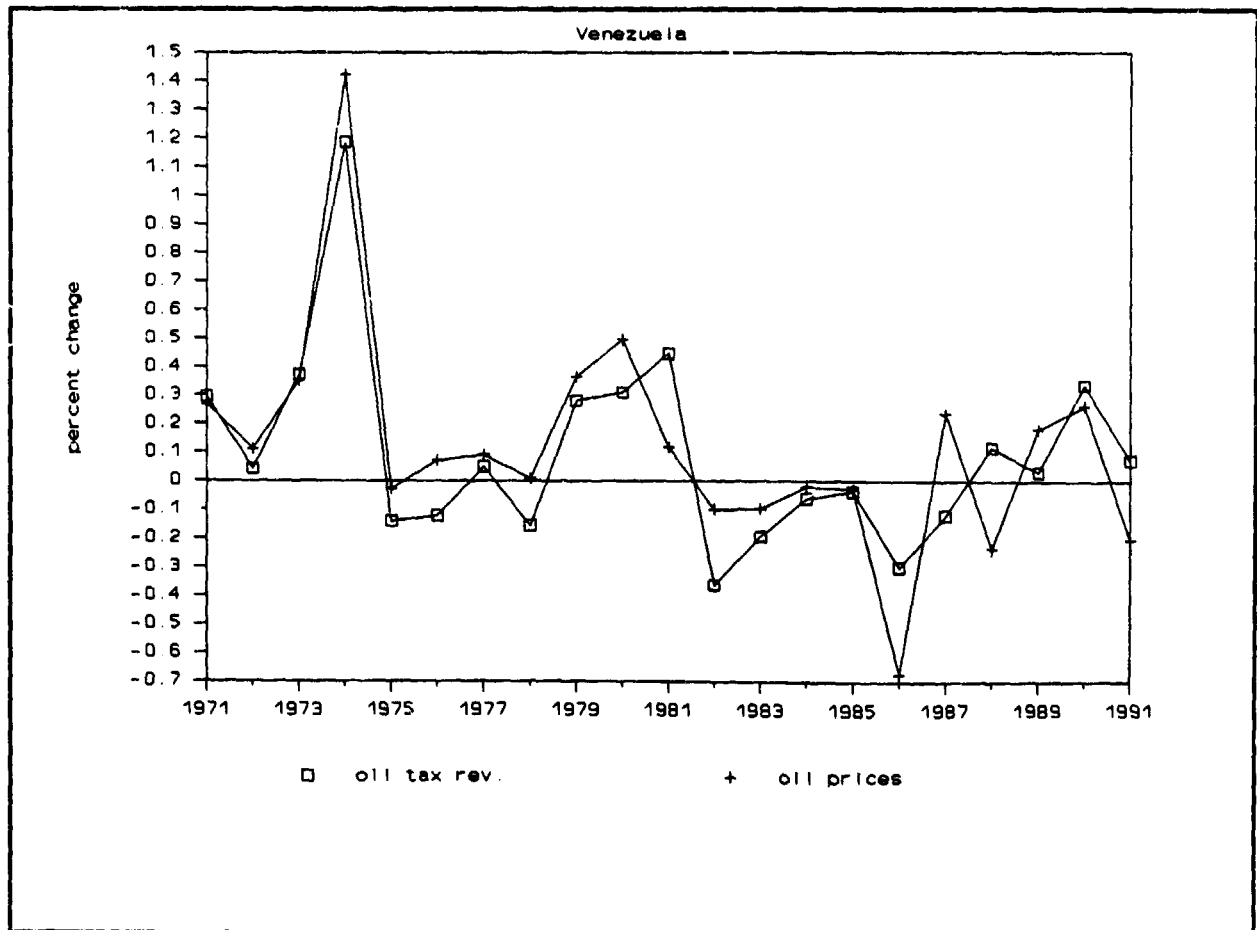


Figure 1

government of Venezuela (GOV) to oil prices. Figure 1 shows the high correlation between GOV's oil fiscal revenues and petroleum prices.⁴ Regression analysis for the period 1970-91 finds that about 94% of the volatility in the GOV's oil fiscal revenues can be attributed to volatility in oil prices. Also, oil price volatility explains about 74% of the volatility in total government revenues.⁵ Furthermore, a 10% change in oil prices translates into a 7% change in the GOV's oil fiscal revenues. In terms of total government revenues (oil and non-oil), a 10% change in oil prices brings about a 6.1% change in total government revenues.

The two main items contributing to the GOV's oil fiscal revenues (and total GOV revenues) are income taxes and royalties paid by PDVSA. The income tax is calculated as follows. (a) the oil export revenue is multiplied by a factor of 1.2 and to that domestic sales are added to arrive at gross sales; (b) from the gross sales are deducted: operating costs (including depreciation), the so called legal contribution (aporte legal), royalty payments, and 10% of the gross profits before taxes; (c) the remainder, (a) minus the reductions in (b), is taxed at a rate of 67%. Proceeds from PDVSA's income taxes accounted for 59% of GOV's total revenues and 74% of GOV's oil tax revenues in 1991.

In addition, in 1991 royalties accounted for about 20% of GOV's revenues and 26% of GOV's oil tax revenues. Taken together, the royalty and the income tax account for a little over

⁴GOV oil fiscal revenues is the sum of oil tax revenues and royalties.

⁵Over the period 1974-91 the volatility of total government revenues was estimated to be 27.6%, while that of oil-related revenues was 28.3%. The volatility of government revenues is thus significant. Such volatility makes the carrying through of government plans extremely difficult. Volatility is defined as the standard deviation of the relevant variable in first difference form.

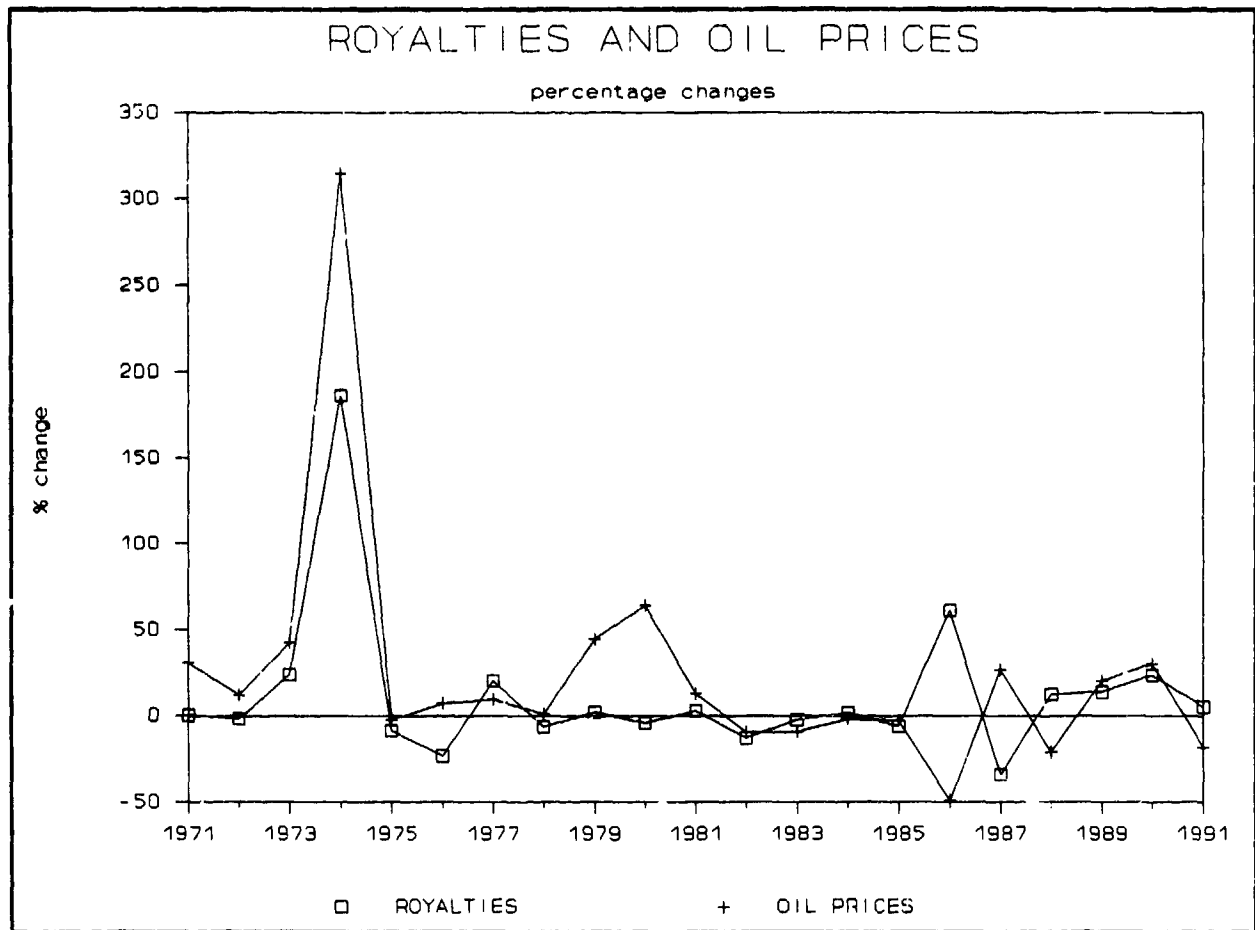


Figure 2

80% of revenues from PDVSA. The royalty is one-sixth of the gross oil revenue which is the product of total production times world oil prices. According to this formula, royalty revenues should closely correlate with world oil prices. Statistical analysis showed that they do not. Figure 2 plots royalties and world oil prices, showing royalties not to be responsive to world oil price changes, particularly during the period 1977-85. For most of the years during the period 1971-91 the percentage changes in royalties have been below the percentage changes in world oil prices. Regression analysis also showed that world oil prices explain only 23% of the volatility in royalties and that a 10% change in world oil prices is translated into a 3.6% change

in royalties. Thus, historically, royalties have not been very responsive to world oil price changes. One reason could be that the oil price used to calculate the royalty has been determined with some discretion by the Ministry of Energy and Mines.

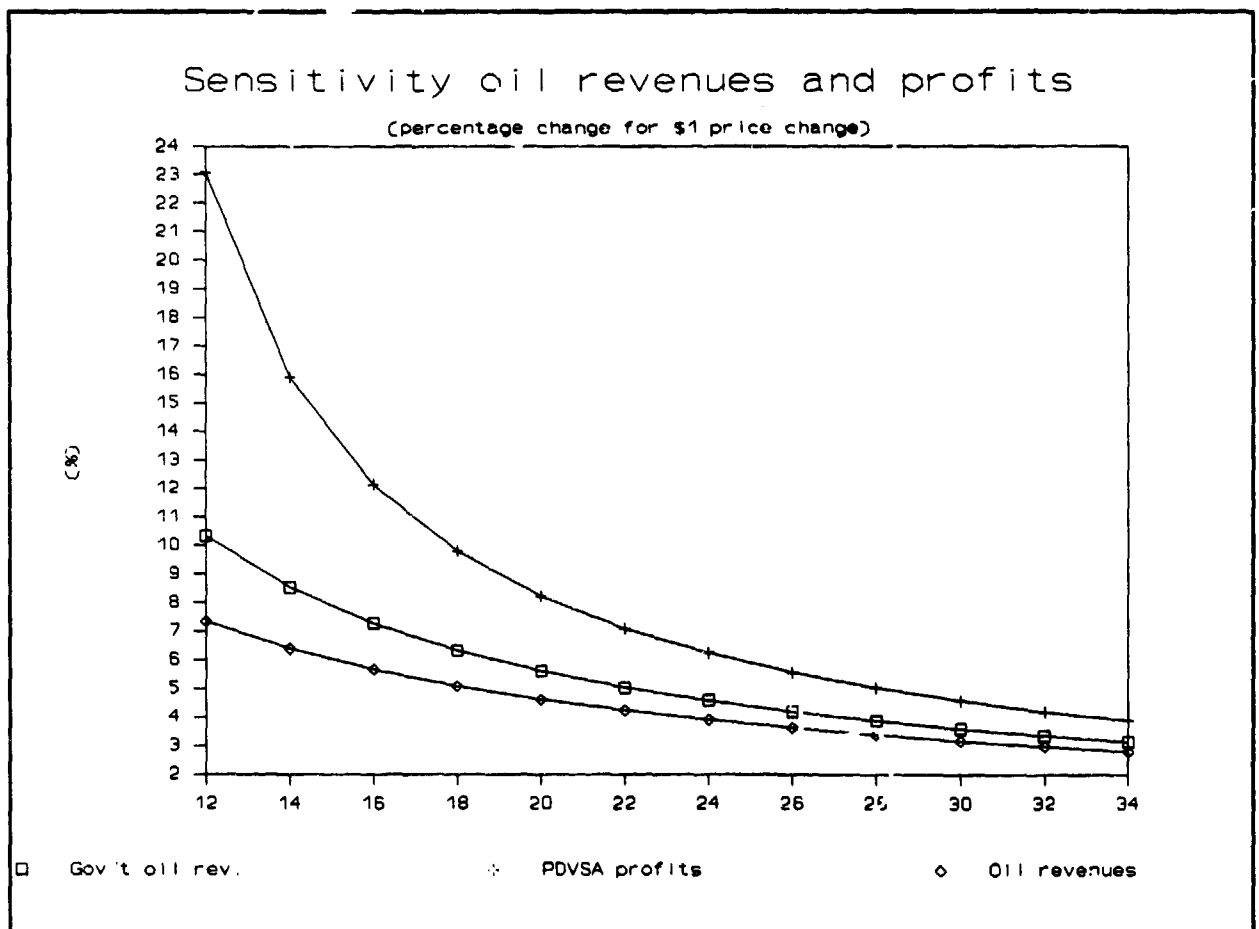


Figure 3a

Figure 3a shows the sensitivity of gross oil export revenues, GOV's oil fiscal revenues, and PDVSA's after tax profits per barrel to different levels of the oil price.⁶ At low prices, the sensitivity of GOV's oil tax returns is much lower--about 13 percentage points--than the sensitivity of PDVSA's after tax profits per barrel. This is because at low oil prices the percentage of the royalty--which is not very responsive to oil prices--in the GOV's oil fiscal revenues is high.⁷ As prices increase and the share of royalty payments in total oil tax revenues drops, the sensitivity of GOV oil fiscal revenues to oil prices is close to that of PDVSA's. Particularly in the case of a low price, royalty payments provide a kind of hedge for the GOV as payments are not very sensitive to oil price changes. If royalty payments become more sensitive to oil prices, PDVSA's exposure becomes somewhat closer to the government's exposure.⁸ Even then, PDVSA has a higher exposure than the government because of the role of production costs. PDVSA incurs costs of production that we assumed to be fixed at any oil price level. That is, PDVSA is incurring the same cost of production whether oil prices are US\$15 per barrel or US\$30 per barrel. Thus, at low oil prices the percentage of costs in PDVSA's gross revenues is high, causing PDVSA's after tax profit per barrel to be more sensitive at low world oil prices.

⁶Sensitivity refers to the percentage change in the total dollar amounts of PDVSA's net income, government revenues and gross oil revenues following a \$1 oil price change. The results are based on the current tax regime.

⁷Based on the regression analysis for the period 1971-91, we assumed that a 10% change in oil prices corresponds to a 3.6% change in royalties.

⁸If royalties responded completely to world oil price movements, at low world prices the difference in the sensitivity between the GOV's oil fiscal revenues and PDVSA's after-tax profits drops from about 13% to about 8%.

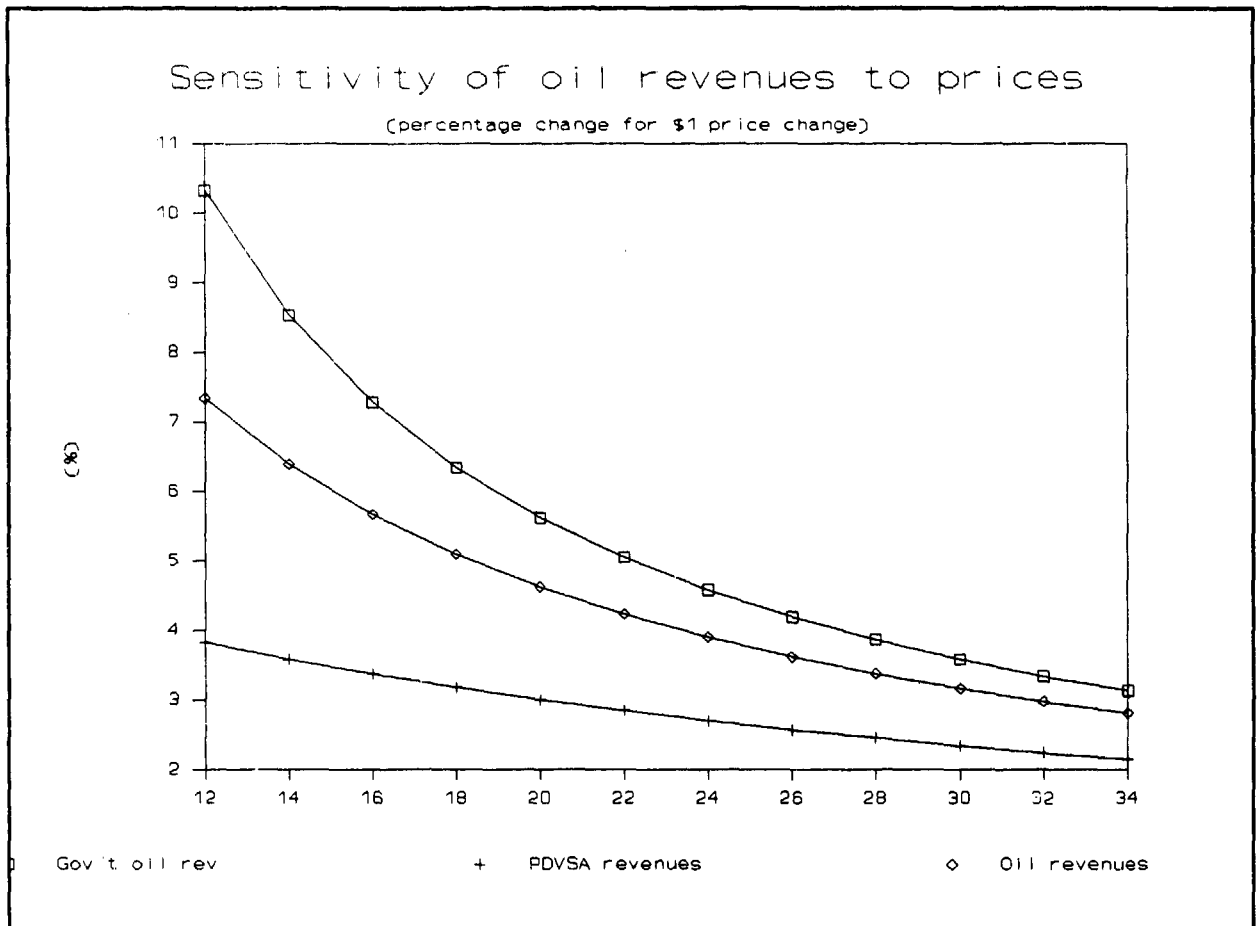


Figure 3b

Figure (3b) compares PDVSA's after tax revenues per barrel exposure with government's oil fiscal revenue exposure. In this case PDVSA's after tax revenues (total revenues minus taxes and royalties) exposure is less than the government's oil fiscal revenue exposure. Sensitivity analysis showed that PDVSA's after-tax revenues are about 7% less sensitive to changes in oil prices than the government's oil fiscal revenues (see Figure 3b).

The present oil tax system thus exposes PDVSA (after taxes) to a higher degree of risk to oil prices than the government (oil fiscal revenues). As oil prices rise, net profits per barrel rise more than proportionally; and as oil prices fall, after tax profits per barrel fall more than proportionally. For example, in 1990 when oil prices (precio paquete de exportacion) increased by about 20% (and production by 14%), this led to a 70% increase in PDVSA's net income (in dollars) and to a 40% increase in the government's oil fiscal revenues (in dollars).

Figures 3a and 3b also shows that total oil revenues (exports plus domestic sales) are less sensitive to oil price changes than either the GOV's oil fiscal revenues or PDVSA's after tax revenues per barrel. This is because the GOV's oil taxes are levied on gross profits (revenues minus costs), where costs are kept constant at all price levels.

PDVSA's subsidiaries abroad operate on what is called a "net back" basis.⁹ That is, PDVSA guarantees them a profit margin (as a percentage of the profits) and the rest is absorbed by PDVSA. Thus PDVSA assumes most of the oil price risk faced by the subsidiaries with the latter being exposed only to changes in the profit margins. The subsidiaries exposure is through the conversion of the percentage profit margin to the dollar (or other currency) profit margin. (It is reported that the subsidiaries use hedging instruments to cover the exposure associated with their profit margins.)

⁹PDVSA's subsidiaries abroad are: in the United States, CITGO (100%) and UNO-VEN (50%); and in Europe, AB NYNAS (50%) and RUHR OEL (50%). All of these companies operate refineries. In addition, PDVSA has leased the ISLA REFINERIA refinery in Curacao and operates storage facilities in the Bahamas (BAPROVEN) and Antilles (BONAIRE).

In "Netback" schemes, the original supplier/producer is essentially exposed to all the transfer price "risk" while the buyers are insulated against risks due to price volatility. The seller, therefore does not know the price he will eventually receive. In other pricing schemes such as "built-up" or "add-on" schemes, the supplier/producer is to some extent insulated against "risk" between the wellhead/port and the point-of-consumption because these costs are added on the production costs (either actual or expected), and thus reflected in consumer prices.¹⁰

¹⁰We owe the implications of "netback" schemes on price risk allocation to Mr. Mudassar Imran.

3. VOLATILITY OF CRUDE OIL AND PRODUCTS PRICES, BASIS RISK, AND LIQUIDITY

A. Volatility of Crude Oil vis-a-vis Products

During the past 15 years PDVSA has been transformed from an exporter of mainly crude oil to an exporter of mainly refined products. In 1976, out of a total production of 2.3 million barrels per day, PDVSA refined domestically 43.4% and exported about two-thirds of the refined output. The remaining 56.6% of production was exported as crude oil. In 1991, out of a total production of 2.5 million barrels per day, PDVSA refined domestically 43.1% and again exported about two-thirds of the refined output. Of the remaining production, 38.7% was refined and sold abroad by PDVSA's subsidiaries. Thus only 18.2% of total production was sold as crude oil.

One of the reasons given for PDVSA's shift to refined product exports was to achieve a reduction in the price volatility faced by PDVSA. This would be so if product prices are less volatile than crude oil prices and/or have a low correlation with oil prices. However, based on the estimated coefficients of variation, the price volatility of crude oil prices is not significantly higher than the price volatility of diesel and gasoline for the period 1970-90 as well as the sub-period 1980-90¹¹ (see Table 1).

¹¹The coefficients of variation were calculated on annual data. Monthly data of product prices tend to show seasonality, which could raise the estimated volatility. Seasonal adjustments would be necessary if monthly data were used.

Table 1: Coefficients of Variation for Crude Oil and Products (%)

	1970-1990	1980-1990
Crude Oil	59.1	31.1
Gasoline	55.7	27.0
Diesel	55.4	28.0

Source: International Trade Division, The World Bank.

We also examined the volatility of refined products and crude oil using weekly data for the period 1988 to 1990. The volatility was calculated for the whole period and for a sub-period which excluded the 1990-91 Gulf War. This was done because a number of analysts have claimed that the volatility of products, and in particular jet fuel, increased significantly more during the Gulf War than it did for crude oil. Table 2 shows that for both the total period and for the subperiod, crude oil volatility was above product volatility but not significantly (except for gasoline). This result holds whether we consider Gulf Coast/N.Y. or MARAVEN's prices for the refined products (MARAVEN is one of the three principal operating subsidiaries of PDVSA).

Table 2: Volatility of Crude Oil and Products Prices: Weekly Data (%)

	1988-90	1988-90 (excluding the Gulf War)
Gasoline	14.64	10.79
Diesel	17.28	12.09
Diesel (MARAVEN)	16.43	13.03
Jet fuel	19.96	12.93
Jet fuel (MARAVEN)	19.39	14.02
Fuel oil	18.08	15.25
Fuel oil (MARAVEN)	17.50	13.84
Crude (Tia Juana)	20.81	15.06
Crude (Bonny Light)	20.11	13.69

Source: International Trade Division, The World Bank.

Notes: Gasoline, regular unleaded gasoline (87), Gulf Coast; Diesel, Gulf Coast and MARAVEN; Jet Fuel, Gulf Coast and MARAVEN; Fuel Oil, 2.2% sulfur, New York and 2.8% sulfur, MARAVEN. Source of raw price data: Platt's.

If prices of the products are not closely correlated to the price of crude, then even if the volatilities between the products and crude are not significantly different, the overall volatility of PDVSA's export basket may drop. To see this, let us view the measure of the overall volatility of PDVSA's export basket. This is equal to:

$$Var(B) = \sum_{i=1}^n W_i^2 Var(P_i) + 2 \sum_{l=1}^n \sum_{j=1}^n W_l W_j COV(P_l P_j)$$

where VAR (π) is the variance of the export basket, n is equal to the number of refined products plus crude oil, P_i is the price of the ith product or crude oil, W_i is the weight (share) of the ith product or crude oil in the export basket and COV signifies the covariance. As an illustration, let us assume that all variances are equal, all covariances (or correlations) are zero and we have five products (including crude) with equal shares (0.2) in the export basket. It can easily be seen that then the volatility of the overall export basket would be 20% (or one fifth) of the volatility of crude oil alone. Thus, the covariances play an important role in the determination of the magnitude of the volatility of the overall basket.

Table 3 shows the correlation coefficients between major refined products and crude oil for the period 1981-1991. The correlations are high enough (except for bunker) to make it unlikely that the overall volatility of an export basket consisting mainly of products, will be

significantly lower than the volatility of an export basket consisting mainly of crude oil.¹² Diversification into refined products has led to the reduction of the overall volatility of export and tax revenues. However, this reduction was not found to be statistically significant. We also calculated the volatility of the 1976 and 1991 export baskets of PDVSA, based on an estimate of the weights (shares) for each of the products plus crude oil. The volatility of this basket was 28.3% for the 1991 export basket and 32.3% for the 1976 export basket over the period 1981-1991 (compared to 31.1% for crude oil only). This shows that volatility declined somewhat with the diversification of exports away from crude oil to products, but not significantly.

Table 3: Correlation Between Crude Oil and Products (%)

	1981-91
Crude oil	100.00
Residual oil (low sulfur)	95.8
Residual oil (high sulfur)	94.6
Gasoline	96.8
Diesel	97.4
LPG	79.1
Bunker	62.8

Source: International Trade Division, The World Bank.

B. Basis Risk

One important reason why one may not want to use established futures/options markets

¹²Using monthly data for the period 1988-90, the correlation coefficients were found to be somewhat lower, ranging from 75% to 85%. But these correlations using monthly data are still high enough not to expect a statistically significant reduction in the overall volatility of a diversified oil export basket compared to exporting crude only.

for a commodity is the existence of basis risk.¹³ In the case of Venezuelan crude oils, high basis risk could be expected because of the quality differential between Venezuelan crudes and West Texas Intermediate (on which the futures contract in New York is based) and because a price formula is used to set the prices of Venezuelan crudes.

Table 4 shows the basis risk of some Latin American crudes and Brent against West Texas Intermediate (WTI) crude for the period January 1986 to December 1990. The WTI crude was chosen as the standard of comparison because the crude oil futures contract in New York (NYMEX) is based on WTI. Alternatively, Brent could have been chosen as the London (IPE) crude oil futures contract is based on Brent. The results show that the Venezuelan crudes do have high basis risk. Basis risk was also computed for different subperiods for Lagotreco and Tia Juana Light (August 1988 to December 1990 and October 1988 to December 1990 respectively). These sub-periods were selected because prices showed more responsiveness to world oil prices (as reflected by WTI and Brent) for these periods than for the overall period. During these subperiods, the basis risk for both Lagotreco and Tia Juana Light was significantly reduced compared to that for the overall period. However, even during these sub-periods, the basis risk was somewhat high.¹⁴

¹³Basis risk refers to the divergence between the movements (changes) in the price of a commodity and the movements (changes) in the price of underlying futures contract. It is measured as $1-R^2$ from the regression of changes in the commodity price on the changes in the futures price (for that or another grade or commodity).

¹⁴Basis risk is considered to be high when it exceeds 15-20%.

Table 4: Basis Risk for Latin American Crudes and Brent, 1986-1990

Crude	Country	Basis Risk (%)
Istmo	Mexico	12
Oriente	Ecuador	22
Cano Limon	Colombia	15
Lagotreco	Venezuela	31
Lagotreco <u>1/</u>	Venezuela	22
Tia Juana Light <u>2/</u>	Venezuela	35
Tia Juana Light	Venezuela	27
Bachaquero	Venezuela	40
Brent	United Kingdom	11

1/ Regression results for the sub-period August 1988 to December 1990.

2/ Regression results for the sub-period October 1988 to December 1990.

Source: Claessens and Varangis (1991).

The quality of Venezuelan crudes is different from that of WTI and Brent crudes; this difference is due to the differences in API gravity and sulfur content (see Table 5). However, the qualities of the Mexican, Colombian and Ecuadorian crudes are quite similar to the Venezuelan crudes. Thus, if quality were the only difference, we would expect basis risk

Table 5: Quality Characteristics of Selected Crude Oils

	API	% Sulfur	Vanadium
Brent	38.2	0.3	0
WTI	39.0	0.4	0
Venezuela (average)	28.4	1.5	+
Mexico (average)	27.4	2.4	+
Colombia (Cano Limon)	29.4	0.5	NA
Ecuador (Orito)	29.9	0.75	NA

Source: PDVSA, ECOPETROL.

Note: Tia Juanna Light has 31° API, Bachaquero 17° API and Lagotreco 30° API, and Lagotreco 30° API.

for the Venezuelan crudes to be close to that of the other Latin American crudes.¹⁵ Even if one considers Mexican crudes to be of inferior quality to the Venezuelan crudes, the argument does not change. If Mexican crude prices move closeby in line with the N.Y. oil futures contract prices then Venezuelan crude prices should be expected to do at least the same based on the quality argument only. That is because Venezuelan crudes are of higher quality than the Mexican crudes and relatively closer in quality to WTI, the underlying crude for the N.Y. oil futures contract.

Another, more likely reason why Tia Juana Light and Lagotreco have a relatively high basis risk is that Venezuelan crudes are priced on the basis of formulae that "smooth-out" price fluctuations. These formulae use long-run moving averages of spot prices. While the largest part of the price-setting formulae is based on the Platt's, the "smoothing-out" of short-term price fluctuation can cause deviations between Venezuela and other crude prices over some periods. Both the Ecuadorian and the Venezuelan crudes exhibited higher basis risk than the Mexican and Colombia crudes. Given that both Ecuador and Venezuela were OPEC members during the sample period, the higher basis risk may also be due to the fact that their crude oil pricing was affected by OPEC pricing policies.

¹⁵The only exception is Bachaquero which is a very heavy crude (17° API) and we would not expect WTI to be a good hedge for that crude. Indeed, Khafji (Neutral Zone), a similar although lighter crude than Bachaquero, was found to have high basis risk (26%) against WTI. See further Claessens and Varangis (1991).

Even though the basis risk for the Venezuelan crudes was found to be relatively high, it does not mean that there is no scope for hedging. Even with a basis risk of 30%, the use of futures contracts will reduce the volatility associated with oil prices by 70% (100-30%) over short-run periods (one to three months). For longer-term hedges, the reduction in volatility will be somewhat less, but no less than 62% (Claessens and Varangis, 1991).

While basis risk was not formally analyzed for the refined products due to the lack of data, an indication of the basis risk can be obtained from seeing how closely cash prices of refined product from Venezuela and international market prices for these products (as expressed in the New York market) move together. Regression analysis for monthly data for 1990 shows that changes in the New York spot fuel oil price and the WTI crude price explain about 78% and 67%, respectively, of the changes in MARAVEN's fuel oil prices. For the same time period, changes in the New York spot diesel price explain about 84% of the changes in MARAVEN's diesel oil prices. Also, 82% of the changes in MARAVEN's gasoline prices are explained by New York gasoline prices.

Doing the same regression analysis for gasoline, but using weekly data instead of monthly data, we find that the correlation between gasoline spot price changes in New York and in MARAVEN changes significantly. Using weekly data for 1989 and 1990, the changes in the New York gasoline spot price explain less than 10% of MARAVEN's gasoline spot price changes. If, instead, the New York gasoline spot price change lagged one week is used, about 50% of MARAVEN's gasoline spot price changes can be explained. With regards to fuel oil,

using weekly data for 1989 and 1990, changes in New York's fuel oil prices explain only 4% of MARAVEN's changes in fuel oil prices. However, if we include the changes in N.Y. prices lagged two weeks, New York fuel oil prices explain 61% of the volatility in MARAVEN's weekly fuel oil prices. For diesel, we compared MARAVEN's diesel prices with Gulf Coast diesel prices. Gulf Coast diesel price volatility explains 18% of MARAVEN's diesel price volatility and 45% if we include price changes lagged two weeks. For jet fuel, Gulf Coast price movements explain 15% of MARAVEN's prices and 45% if we include price changes lagged two weeks.

Comparing the weekly with the monthly results, the following observations can be made: first, MARAVEN's product (gasoline, diesel, fuel oil, and jet fuel) prices do not respond to market changes (as reflected by New York and Gulf Coast prices) on a week to week basis but when prices are aggregated over a month they are closely related to New York and Gulf Coast price movements. Second, the fact that the lagged New York and Gulf Coast product price movements influence MARAVEN's product price movements more than current prices reflects some inefficiencies in the way MARAVEN prices its products. Observations of the price data reveal that MARAVEN keeps its product prices fixed for a long time, sometimes for up to eight to twelve weeks.¹⁶

¹⁶For example, between the 4th and 12th week of 1989 MARAVEN's gasoline price was fixed at \$20.06/bbl. Meanwhile, the New York gasoline price fluctuated between \$21.71/bbl and \$25.07/bbl. Similarly, in 1990, between the 20th and 32nd week MARAVEN's price was unchanged at \$26.15/bbl, with the New York gasoline price fluctuating between \$24.96/bbl and \$37.07/bbl.

On balance, these findings imply that, at least for fuel oil, diesel and gasoline, basis risk is likely to be small provided MARAVEN removes some of the inefficiencies in its current pricing system. That is, MARAVEN's product prices should be allowed to become more responsive to product prices in the international markets. However, this judgement should be supported by a formal analysis of the basis risk involving futures price data for heating oil, WTI, and gasoline instead of New York spot prices, and doing the analysis over a longer time period. Heating oil futures contracts are typically used to hedge diesel and (in combination with gasoline futures contracts) some "cracked" fuel oil prices. For hedging "uncracked" fuel oil, the WTI or Brent crude oil futures contracts are usually used.¹⁷

C. Liquidity

Currently, the futures/options market for crude oil is the most liquid amongst all commodity markets. More crude oil is traded daily on the NYMEX (the light, sweet crude oil futures contract based on the WTI crude) than the total world production of crude oil (about 65-80 million barrels in futures versus 60 million barrels of physical).¹⁸ Options on NYMEX's oil futures contracts account for about 25-30 million barrels or half of world crude oil production. In addition, Brent crude oil futures contracts traded at IPE have a daily trading volume of about 40-50 million barrels, and options on these contracts account for 5-7 million

¹⁷A more appropriate crude oil contract to hedge fuel oil could be the sour crude contract. However, NYMEX's and SIMEX's sour crude contracts do not yet have adequate liquidity.

¹⁸Liquidity has expanded rapidly. In 1989 and 1990, the average daily NYMEX crude oil futures contract trading volume was 55 million barrels and 63.4 million barrels respectively, compared to 22 million barrels in 1986.

barrels in daily trades. Thus, in New York and London, roughly twice the world's physical crude oil daily production is traded in futures and about one-half in options.¹⁹

The daily futures trading volume of heating oil (used to hedge diesel, jet fuel and fuel oil) is currently about 1 billion gallons; and there is about 50 million gallons of trades in options. Gasoline's daily futures and options trading volumes on NYMEX are some 800 million gallons and 150 million gallons, respectively. Since 1988, daily trading volumes in futures and options for heating oil have increased by over 50% and they have more than doubled for gasoline.

Measured in terms of open interest (the number of futures/options contracts outstanding at any moment), most of the liquidity on the NYMEX is concentrated in the short-run. While as of March 1993 the maturities of crude oil futures contracts extend beyond December 1995, the most liquidly-traded contracts are concentrated in the nearest nine to ten months. That is, about 75% of the open interest is concentrated in the first nine months. For Brent crude, most (up to 90%) of the open interest is concentrated in the first four to five months. The same holds true for NYMEX's heating oil and gasoline futures contracts (78% and 90% of the open interest, respectively). In options, most of the interest is also concentrated in short-term maturities.

¹⁹We do not count two other crude oil contracts, NYMEX's sour crude and SIMEX's Dubai, as they are not very liquid at present.

An additional source of market liquidity can be the over-the-counter market (OCM). This market includes options and swaps and covers periods longer than those covered by the futures/options traded at the exchanges. For example, it is not uncommon to be able to enter an oil price swap extending to seven or even ten years. Because the OCM market is relatively new and because it is not as tightly monitored as the exchanges, we do not have good evidence of the degree of liquidity. However, there are indications that this market is growing rapidly.

Several developing countries have used the OCM oil market in recent years for hedging purposes. During the Gulf War, the OCM was used by Brazil, Chile, and Mexico, mainly for short-dated swaps and options.

Summarizing, the following can be said regarding liquidity:

- (i) For short-term hedges, say up to six-nine months, the existing futures/options contracts provide considerable liquidity. Of course, on a single day or even over the course of one week, there is not enough liquidity to cover all of Venezuela's exports for six months (roughly 380 million barrels); but nobody would advocate Venezuela placing such a hedge over such a short period of time. During the Gulf War, Mexico hedged six month's worth of exports, roughly 250 million barrels, and did so by spreading the sale and purchase of futures, options, OCM options and short-dated swaps over a period of two months. Placing large hedges gradually overcomes any liquidity problem, and because doing so "locks-in" prices over several trading days rather than on a single trading day, it achieves a smoother price path.

- (ii) For longer-term hedges, i.e., more than a year, the use of exchange-traded futures/options contracts can only provide very limited coverage. Currently, all the open interest in crude oil futures contracts of more than a year is about equal to two month's of Venezuela's oil exports. For refined products, longer-term futures/options hedges can provide even less coverage. But, liquidity for longer-term hedges can be enhanced by using the OCM. The liquidity of the OCM can be assessed by approaching various brokerage firms or banks. It should be noted that in the case of longer-term hedges, the access and terms of using the OCM will depend on the perception in international financial markets regarding Venezuela's creditworthiness.
- (iii) There are few instances where hedging all the commodity price exposure is advisable. In most cases, partial hedges covering a fraction of the exposure are carried out. The fraction of the exposure covered is determined by an analysis of the existing market circumstances, the amount of risk that is acceptable, the cost of hedging, the possible offset between price and quantity fluctuations as well as other circumstances specific to the company's or the government's interest.

4. OIL STABILIZATION FUND

A. **Conditions for the Establishment of a Government Oil Stabilization Fund**

From an analytical point of view, there are certain conditions and empirical relationships that are required to hold in order to make the establishment of an oil stabilization fund (OSF) economically and financially attractive.²⁰ The following five are necessary conditions which need to hold jointly:

1. Hedging against oil price instability by transferring risk abroad is impossible or suboptimal. The reasons can be incomplete international financial markets (in futures, options, and oil-linked loans and bonds and other (OTC) instruments to insure against oil price variability), or (domestic) restrictions on the ability of companies and individuals to access international financial markets.
2. Access to international credit markets is imperfect for creditworthiness reasons. A pro-cyclical foreign lending pattern may exist which reduces available lending to sub-optimal levels, possibly to zero, during periods of low oil price.
3. The government's objective function includes intertemporal government expenditure smoothing, i.e., the government attempts to save revenue perceived as transitory while spending revenue anticipated as permanent.

²⁰This section draws on notes by Schmidt-Hebbel (1992).

4. The private sector cannot or is not able to offset (completely) any changes in the level and variability of the government's consumption or saving through its own consumption or saving.
5. The government's main revenue uncertainty stems from oil price instability.

However, these conditions are not sufficient. In addition, establishing an OSF requires either:

6. Oil prices do not follow a random walk or other martingale process. Prices are stationary, allowing the government to distinguish between transitory and permanent shocks; or,
7. The government's objective function includes adjustment (or political-economy) costs when adjusting spending. As a result, the government will prefer to avoid changing or scaling back programs in order to minimize macroeconomic or sectoral disruptions or alienation of constituencies and voters.

Do these conditions hold in Venezuela? Conditions 1-3 are typically mentioned when justifying the establishment of an OSF for Venezuela. Conditions 2 and 3 are reasonably

realistic conditions for Venezuela, but condition 1 is questionable.²¹ For short-term oil hedging, it has been shown in Section 3 that the market is available and suitable for Venezuela. Margin requirements assure that credit risk is not an issue, and, in principle, make these instruments available to Venezuela at very low cost. We have shown above that oil futures can remove up to 85% of the oil price risk for horizons of one to two months ahead and up to 81% for somewhat longer horizons. Because these hedging instruments have short maturities, however, they provide less hedging value over longer periods—even with rolling over of the hedges.²² Use of longer-dated instruments would thus be desirable. The market for longer-term commodity hedging instruments, i.e., oil swaps and oil-linked loans and bonds, has developed quite rapidly in recent years. Longer-term hedging instruments involve credit risk, however, and may thus be incompletely available to Venezuela (as its access to international credit markets is imperfect) or at less attractive terms. Nevertheless, some long-term hedging should be possible.

Condition 4 in part arises from the imperfect access of private corporations and citizens in Venezuela to foreign finance (due to creditworthiness), preventing them from offsetting public savings and expenditure decisions (even though the occurrence of capital flight needs to be

²¹With regards to condition 3, Deaton (1992) argues that cases where commodity booms or slumps are obviously temporary are far from typical. Also, shocks that could or should have been considered as temporary, as in the late 1970s for coffee and cocoa, were perceived as rather permanent by many analysts and producing countries.

²²The problem with rolling-over coverage based on short-term maturing instruments is that this usually implies a large exposure in these instruments. This can imply the possibility of large margin calls and/or large option premiums, as well as large exposures to basis risks, making the instruments less attractive for foreign exchange constrained countries.

considered here too).²³ In addition, imperfect domestic financial markets (such as the lack of a long-term bond market) may contribute to the inability of the private sector to offset public actions.

As was shown above, condition 5 (oil price volatility being the largest source of GOV revenue variability) is a realistic assumption for Venezuela. Moreover, the government has taken most of the oil price risks (looking forward, this will change somewhat as a result of the new tax formula which will pass more risk to PDVSA).

It is difficult to argue that condition 6 or 7 holds. It has proved difficult to reject the random-walk hypothesis assumed by condition 6 for most oil prices (and many other commodities)--at least in the short-term.²⁴ Tests of the main Venezuelan oil price, Tia Juana Light (31⁰), confirm that non-stationarity in levels cannot be rejected.²⁵ Even where the pure random-walk hypothesis is rejected, the evidence suggests that the commodity-price time series

²³There is a high correlation between the oil price and the level of capital flight, $R^2 = 0.67$. Higher oil prices allowed more capital flight and was the rational savings response of the private sector to the lack of savings by the public sector.

²⁴See further Arrau and Claessens (1992) for copper and oil prices, Basch and Engel (1992) for copper prices, Morales (1992) for tin prices, and Hausmann *et al.* (1992) for Venezuelan oil revenues. The random walk hypothesis is consistent with efficient arbitrage in financial and commodity markets when rational expectations prevail.

²⁵Augmented Dickey-Fuller (ADF) tests with 1, 4 and 52 lags, and using a constant or a constant and a time trend applied to weekly data (4/1983-7/1991), indicate rejection of stationarity for the nominal price level (the ADF-test with 4 lags and a constant and a time trend can only be rejected at the 10% level). Over longer periods and using monthly data (e.g., 1/1970 - 6/1989), price stationarity can also be rejected (both with a constant and a time trend and with a constant only).

process is not quickly mean reverting.²⁶ Deaton and Laroque (1992) show that most commodity prices do revert eventually to their mean, but only very slowly, with an average reversal time measured in years, not months. Arrau and Claessens (1992) even find **positive** autocorrelation in the first differences of monthly oil prices, indicating no mean reversion in the short run, but instead the opposite. On balance, there is thus no convincing evidence that oil prices display the quick mean-reverting behavior required to make use of an OSF rational.

If the GOV bears some adjustment or other costs when changing its expenditure programs (condition 7), an OSF could be useful in smoothing government expenditures. This motivation underlies the recommendations made by Hausmann et al. (1991, 1993), and also those by Basch and Engel (1992).²⁷ In general, these are more politically-oriented explanations and have less appeal from an economic point of view.

Finally, an OSF has often been justified on the grounds that such a fund provides positive externalities, such as an increase in overall confidence, which justifies keeping a large amount of low-yielding foreign assets even when the country is credit-constrained. Part of this improved

²⁶Williams and Wright (1991), Deaton and Laroque (1992), and Trivedi (1991) reject the random walk as they find that there is more linear and nonlinear dependence in the first difference of most commodity prices than is consistent with the random walk hypothesis. Part of this behavior can be explained by the competitive storage model, which indicates that price jumps due to "stock-outs" lead to skewed price distributions and nonlinear, serial dependence.

²⁷An OSF could be also motivated by other benefits including reduction in: (a) public pressures to quickly spend revenues increases, (b) spending which takes on a life of its own and cannot be reversed, and (c) spending which is inefficient. These considerations may make sense in some institutional contexts but should not be taken as a generally valid feature of GOV policy.

confidence could come from stabilization of the real exchange rate, which may benefit other sectors of the economy when there are costs of adjustment (see also Gilbert, 1992, and Cuddington, 1989). However, these adjustment costs alone cannot be a sufficient reason to establish an OSF when the private sector can hedge against these changes itself. This justification thus relies on the lack of access of the private sector to external hedging instruments, something which cannot be taken for granted (as the existence of capital flight shows), or can be due to imperfectly functioning domestic financial markets, something which requires policy changes directed at improving these markets.

B. Policy Implications

This section develops the implications of various policy options GOV has in coping with oil price uncertainty. It assumes, for the purposes of argument, that the main concern of the GOV is that variability in expenditures leads to real exchange rate and output variability; and that the GOV has an advantage over the private sector in hedging against oil price risks. The following implications are then derived.

- o **Diversification.** International risk diversification should be encouraged. To some extent this can be done through **production and export diversification** in the oil sector. However, the benefits from doing this are limited for a number of reasons; 1) other oil sector activities, e.g., moving down stream, have a positive correlation between net profits and the oil price; 2) activity diversification takes a long time to achieve; and 3) establishment of new activities can be counter to Venezuela's long-run comparative

advantage.²⁸ The first-best policy is to allow and encourage oil risk hedging operations in international financial markets.²⁹ Short-term, market-based, commodity risk management instruments--futures and options--are the best possibility here, complemented with longer-term hedging tools to the extent available to Venezuela.

- o **Oil Stabilization Fund.** The effectiveness of an OSF requires a large number of conditions to hold simultaneously. As discussed above, it is not very likely that this is the case. As a second best solution, an OSF may still be pursued, however. Any OSF will still provide some smoothing benefits, even though not necessarily in the most cost-effective way, especially when compared to market-based hedging techniques.

²⁸It is sometimes argued that, to cope with export price instability, economic diversification should be encouraged by taxing existing commodity production or exports and subsidizing other, more stable, production or export sectors. This is a faulty policy prescription, leading to an inefficient resource allocation (Hausmann *et al.* 1993). Once commodity risk management has been put in place to deal with oil revenue risk, and oil project evaluation has considered the riskiness of expected returns, no additional policies need to be put into place to achieve economic diversification.

²⁹ This is a corollary of the finding that the benefits from portfolio diversification and risk sharing may dominate the gains from accessing foreign saving when the capital account is opened (Ganson, 1992).

C. Optimal Spending Rules and the Design of an Oil Stabilization Fund

In principle, government spending should be determined on the basis of economic efficiency criteria. Investment as well as transfer payment decision should be derived from an analysis of expected future costs and benefits and using appropriate discounting methods. This implies that spending rules should, to some extent, be independent of the behavior of fiscal revenues over time. Only to the extent that a permanent change in future expected revenue occurs, should (projected) spending be adjusted.

Taking this approach will in itself already imply a significant reduction in overall macro-instability as the government will reduce the variability units spending. Any variability in revenues over time is then simply saved (or dissaved).

An OSF can aid in this process by separating the spending decisions more formally from fiscal revenues. If the GOV were to decide to move forward with an OSF, in spite of the arguments made earlier against the economic and financial soundness of such a decision, then ideally the OSF should feature three properties:

- Accumulation of reserves should be based on a forward-looking revenue (or price) projection, rather than a backward-looking revenue (or price) rule. Backward-looking price schemes have seldom worked in practice because of the long time it takes for commodity prices to return to their long-run equilibrium. Long before prices revert to their mean, the fund will either have run out of money or have accumulated large amounts of reserves (which will lead to political

pressures to spend them). The best forward-looking prices available are the prices set in the futures and other oil-derivative markets. They are efficient predictors of future spot prices (see Kaminsky and Kumar (1990)). Currently, futures go out about three years, but by supplementing them with the forward prices implicit in oil swaps, market forecasts up to ten years can be derived. The GOV should therefore use these implicit long-run price forecasts in setting the withdrawal and savings rules for the fund (as well as in setting parameters in its annual budget exercise).

- The design of an OSF should be directly related to the stochastic behavior of oil revenues and GOV objectives. This implies that the size of the fund should depend on: a) the stochastic properties of uncertain revenues or oil prices or the magnitude of the adjustment costs paid by the GOV when changing or down-scaling its spending programs; and b) the degree of intertemporal smoothing the GOV wants to attain.
- The rules should operate on the **stock** of reserves in the OSF, and not on the annual accumulation of reserves. Consequently, the rules should be defined in terms of an optimal stock level (given price expectations) and annual deposits and withdrawals will follow from that optimal stock level.

There have been several papers written in recent years on the optimal design of commodity stabilization funds (CSFs), each of them consistent with the three properties mentioned above. The best summary on the design of CSFs is probably Deaton (1992) who argues that, because commodity prices exhibit only slow mean-reversion, either a CSF would have to be irrationally large to be effective in smoothing revenues or the country would need to have ample access to foreign borrowing opportunities. A large CSF is for domestic political reasons not feasible--it is too much subject to spending pressure from domestic constituencies--and sovereign risk prohibits the necessary access to foreign borrowing. As a small CSF is not effective, Deaton argues that there is little scope for countries to stabilize their domestic consumption levels through a CSF or through borrowing in the international capital markets.³⁰

In the next section we investigate an example of a simple OSF complemented with market-based hedging instruments. The OSF used for the simulations does not have the ideal properties described here, but it still could be instrumental in achieving more macroeconomic stability. As a second best solution, such an opinion--complementing an OSF with market-based hedging instrument--may be worth pursuing by the Government of Venezuela.

³⁰Other studies on this subject are as follows: Hausmann and Powell (1992) assume a random walk process for oil prices (which would imply that no fund would be necessary as price would not revert to a mean). However, they justify the creation of a fund on adjustment costs in the economy. A more stable real exchange rate would prevent these adjustment costs. The fund would have to be large, however, to reduce the exchange rate volatility over an extended period. Basch and Engel (1991) combine the predictions of a large-scale copper model with the policy functions derived by Deaton (1991) in his optimal model for the case when income is assumed stationary. They thus introduce an inconsistency in that they derive the saving/withdrawal policy functions independent of the price process. Arrau and Claessens (1992) estimate the oil price process and use the Deaton 1991 model to determine the optimal saving rules consistent with the estimated price process.

E. Complementing an OSF with Market-Based Hedging

To the extent that an OSF or general revenue stabilization fund is desired, it can be usefully complemented by market-based risk management tools. One possibility is to use market-based instruments such as options to hedge against the occurrence of price spikes or sharp drops. Given the presence of fat tails in the oil price distribution (see Figure 4) it may be efficient to hedge using market-based instruments (especially instruments designed to remove the effects of spikes, such as options) instead of holding low-yielding assets in reserves. To the extent desired, the OSF could be used to manage any remaining interperiod risk or more general government revenues risk.

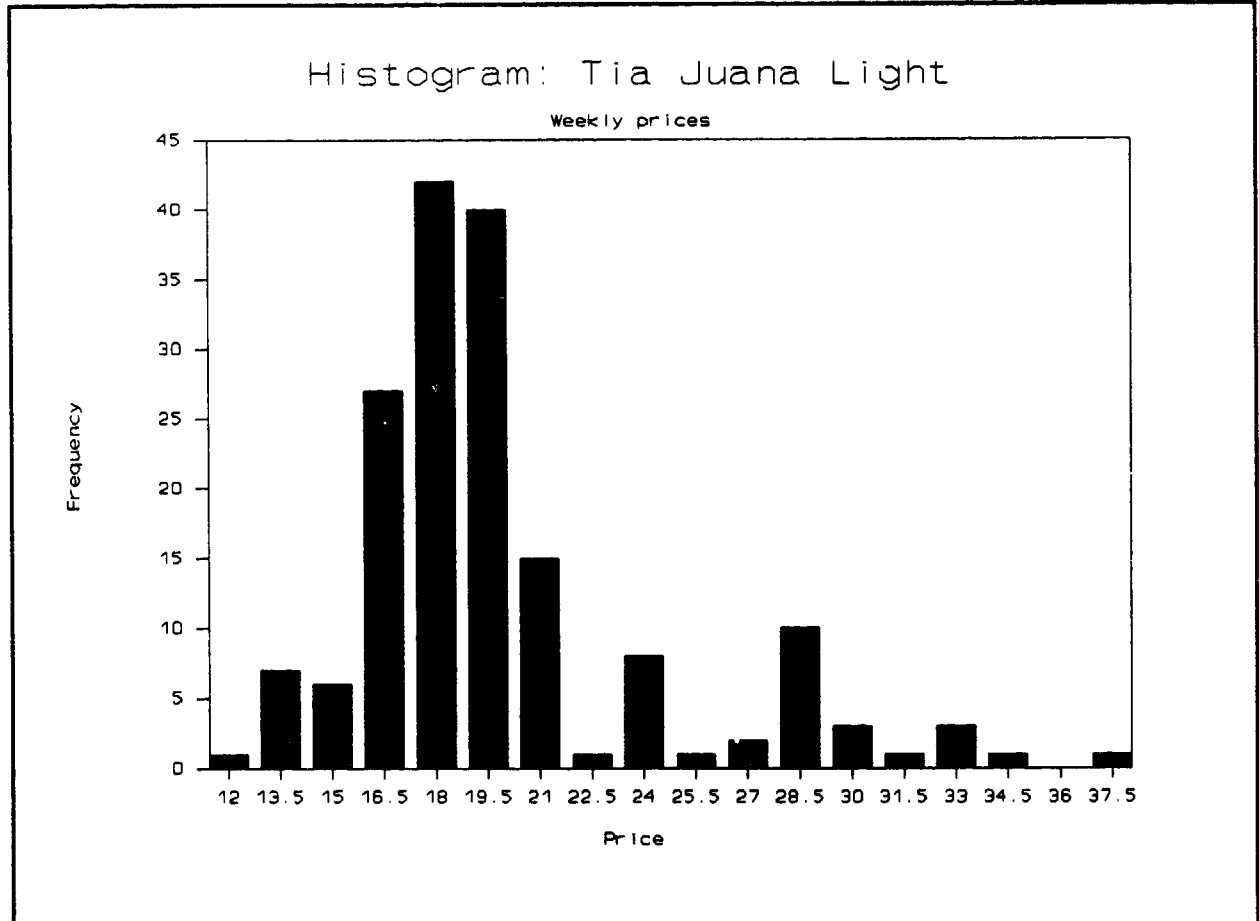


Figure 4: Price Histogram: 1983-1991

We evaluated such a strategy for the 1987-1991 period (see also Larson and Coleman (1991) who use this methodology for agricultural commodities). The strategy simulated was as follows: in early 1987, the GOV buys a series of put options with strike prices set at an oil price of \$20 and expiring over the next five months. The GOV also sells call options at strike prices of \$24 for the next five months, provided calls with a strike price of \$24/barrel are traded (during most of this period they were not traded). Once the "collar" is in place, GOV rolls forward the hedge every day by buying the next day's five-month maturity \$20 put and selling the next day's five-month maturity \$24 call (if available). Consequently, the GOV will always have covered the next five months of its exports with a lower bound, which is financed by selling an upper bound. Figure 5 shows the bands and the periods when the put and call options were exercised.

Depending on movements in the spot price during the period the option hedge is in place, GOV will either exercise the put options at the various maturity dates, or be required to provide the necessary funds when the calls are exercised, or do nothing when the price remains within the band of \$20 to \$24. We simulated this option strategy until just before the Gulf war, August 1990--implying that the GOV would have bought the last option on March 1, 1990, five months before.

We use daily option prices obtained from NYMEX (settlement prices), eliminating those for which the outstanding interest (number of contracts bought or sold) is zero (when no prices are available for the exercise prices of interest, \$20 and \$24, we estimate the options premiums

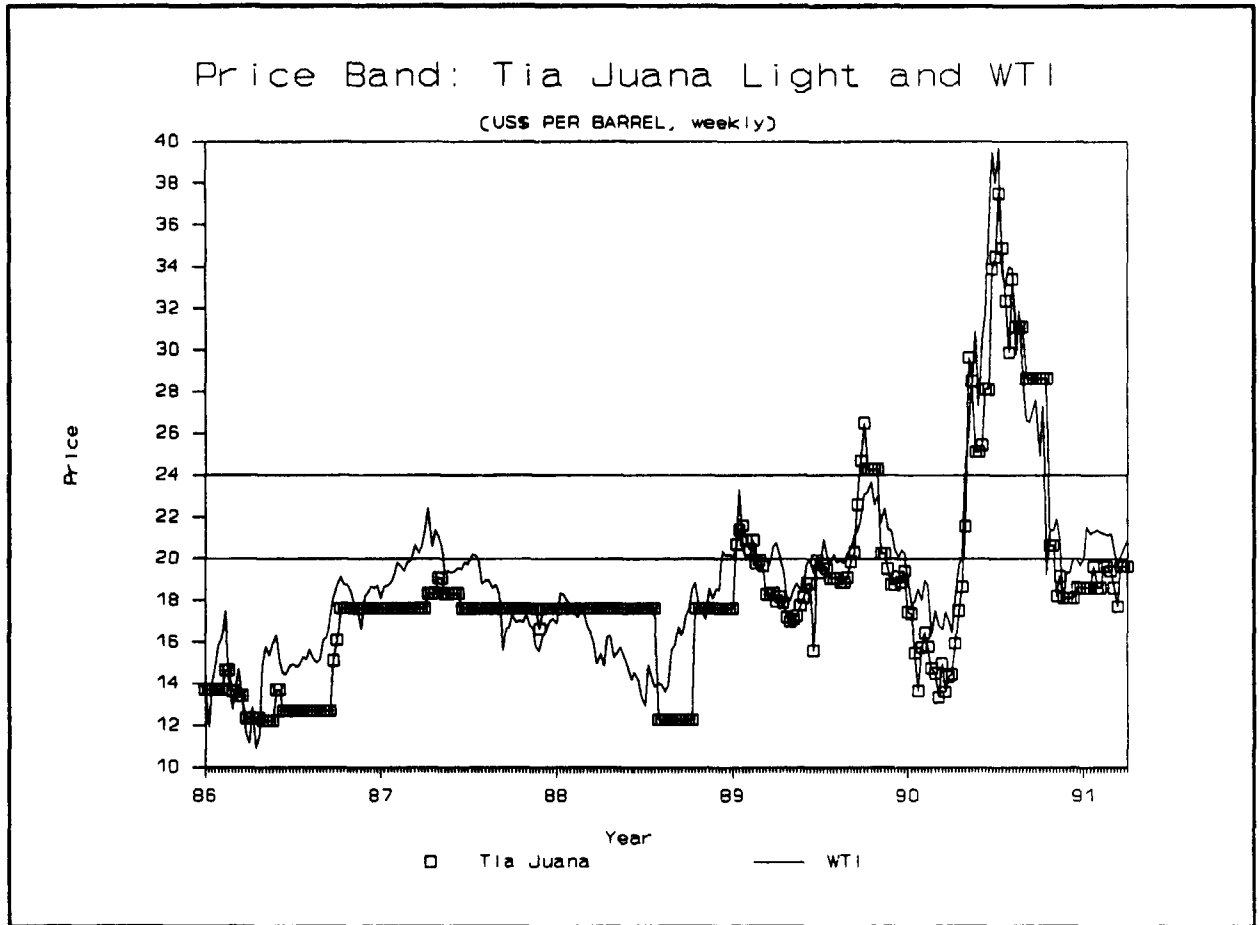


Figure 5: Price Band

using Black's model, the futures prices on that date, and the estimate of the volatility of oil prices implied by the option premiums on contracts which are quoted on that day). We use the spot WTI-price obtained from DRI on a weekly basis.³¹ For the period 1/1/87 - 7/31/90 the results are as follows: buying daily over the period 1/1/87 - 3/1/90 the five-month-out \$20 put option costs on average \$2.07/barrel. Only a limited amount of \$24 calls were available, which cost on average \$0.26/barrel. Over the period 1/1/87 - 8/1/90 the put options were exercised

³¹As shown earlier, the WTI price correlates closely with the Venezuelan spot price in recent periods. However, before 1989 the Tia Juana price did not follow WTI as closely (see Figure 5).

by GOV during the periods of low oil prices, resulting in price protection equal on average to \$1.77/barrel. The cost of exercising the call options was very limited, only \$0.03/barrel. On net the strategy resulted in a \$0.04/barrel gain. Individual year results are shown in Table 6.

Since the WTI price behaved differently over this period from the Tia Juana price--the Tia Juana price was fixed for several periods--we also simulated the same hedging strategy using the Tia Juana price (see Table 7). Since in more recent times the Tia Juana price has followed the WTI price closely, and can be expected to continue to do so, the WTI results are more relevant.

The results for the Tia Juana price may appear to be better. This is in part due, however, to the fact that Tia Juana trades on average about \$0.92/barrel below WTI. As a result the put options were more beneficial, leading to an overall gain of \$0.6/barrel. This is misleading, however, since the options are exercisable on the WTI-price, and on not the Tia Juana prices. Consequently, the cash gains would not have been realized to the extent indicated here. Table 6 is thus the more relevant comparison.

The results depend heavily on whether or not the Gulf war period is included. If we extend the hedging period from 1/1/87 through 2/1/91, the net result is a loss of \$0.98/barrel for WTI and \$0.34/barrel for Tia Juana (the results are in the last row of the Tables). The put option still provides a net gain, but the call strategy results in a loss as the calls sold before the Gulf war were exercised at a high price.

Table 6: Option Strategy: WTI-price
(dollars per barrel)

	Put: Costs	Put: Gains	Call: Sales	Call: Costs	Net
1987	\$1.183	\$0.978	\$0.250	\$0.000	\$0.05
1988	\$2.970	\$4.055	\$0.049	\$0.000	\$1.13
1989	\$1.785	\$0.610	\$0.100	\$0.000	\$-1.18
1990 (whole year)	\$0.978	\$0.668	\$1.708	\$3.029	\$-1.63
1991 (until March)	\$2.572	\$0.386	\$1.224	\$0.382	\$-1.34
All Years: Excluding Gulf War	\$2.068	\$1.771	\$0.260	\$0.003	\$0.040
All Years: Including Gulf War	\$1.917	\$1.542	\$0.218	\$0.821	\$-0.978

Table 7: Option Strategy: Tia Juana Price
(dollars per barrel)

	Put: Costs	Put: Gains	Call: Sales	Call: Costs	Net
1987	\$1.183	\$2.294	\$0.250	\$0.000	\$1.36
1988	\$2.970	\$3.222	\$0.049	\$0.000	\$0.973
1989	\$1.785	\$1.647	\$0.100	\$0.001	\$-0.04
1990 (whole year)	\$0.978	\$1.568	\$1.708	\$2.573	\$-0.28
1991 (until March)	\$2.572	\$0.9245	\$1.224	\$1.260	\$-1.68
All Years: Excluding Gulf War	\$2.068	\$2.440	\$0.260	\$0.025	\$0.607
All Years: Including Gulf War	\$1.917	\$2.118	\$0.218	\$0.758	\$-0.339

We also simulated other options strategies, including one in which a band around the futures prices for the six-month ahead period was created (the band thus varied over time). The results were similar.

F. Complementarity Between the Fund and Options Strategy

The simulations have shown that options can be useful in stabilizing Venezuelan oil prices. The options are effective in removing the impact of sharp price drops at the cost of slightly lower revenues at times when prices rise sharply. The net upfront financing costs of this particular options' strategy was about \$1.81 per barrel (\$2.060 for the puts minus \$0.260 for the calls). This compares to an average overall gain of about \$0.38 per barrel (for the WTI-hedge, Table 6). As the length of the hedge horizon was five months, the rate of return on the upfront financing was on average high, 4.4% ($\$0.04/\181×2) which compares favorably to the possible return on holding assets in an OSF (presumably the risk-free rate of return).

The complementarity between an OSF and an options strategy can be further illustrated by investigating what would happen if a fund were implemented and operated under a set of rules, and this fund were combined with an options strategy. Since we have not analyzed the optimal rules for an OSF for Venezuela, we build for this exercise some simple rules for an OSF. The exact rules we use are set out in Table 8. These rules were inspired and are similar, but not quite, to those used by Oman (see Annex I). The major differences between the rules used in this paper and Oman's rules are that the Oman fund does not stipulate the rules for

withdrawals and the rules for fund accumulation during certain oil prices (above \$22 per barrel).³²

Table 8: Rules of the Fund

Prices	Withdrawal (%)	Deposit (%)
$P < \$10$	50	
$\$10 < P < \12	25	
$\$12 < P < \14	10	
$\$14 < P < \16	7.5	
$\$16 < P < \18	0	
$\$18 < P < \20		7.5
$\$20 < P < \22		10
$\$22 < P < \25		25
$\$25 < P$		50

Note that these rules are ad-hoc, and certainly not consistent with the requirements for the optimal rules outlined above. Using these rules now for the period 1987-1991 leads to a slightly more stabilized price (see Figure 6). The standard deviation of the price with the fund only is 3.55, somewhat less than the standard deviation of TJLIGHT without a fund (4.53). However, including the options strategy (the fund is then only in operation in the \$20 to \$24 price band) leads to an even more stable price with the standard deviation only 1.26. The options strategy allows Venezuela to do away with much of the required withdrawals from and deposits in the fund. This can also be seen from Figure 7 which plots the (weekly) deposits

³²Because of these differences, it is hard to compare our simulations with the actual working of the Oman fund.

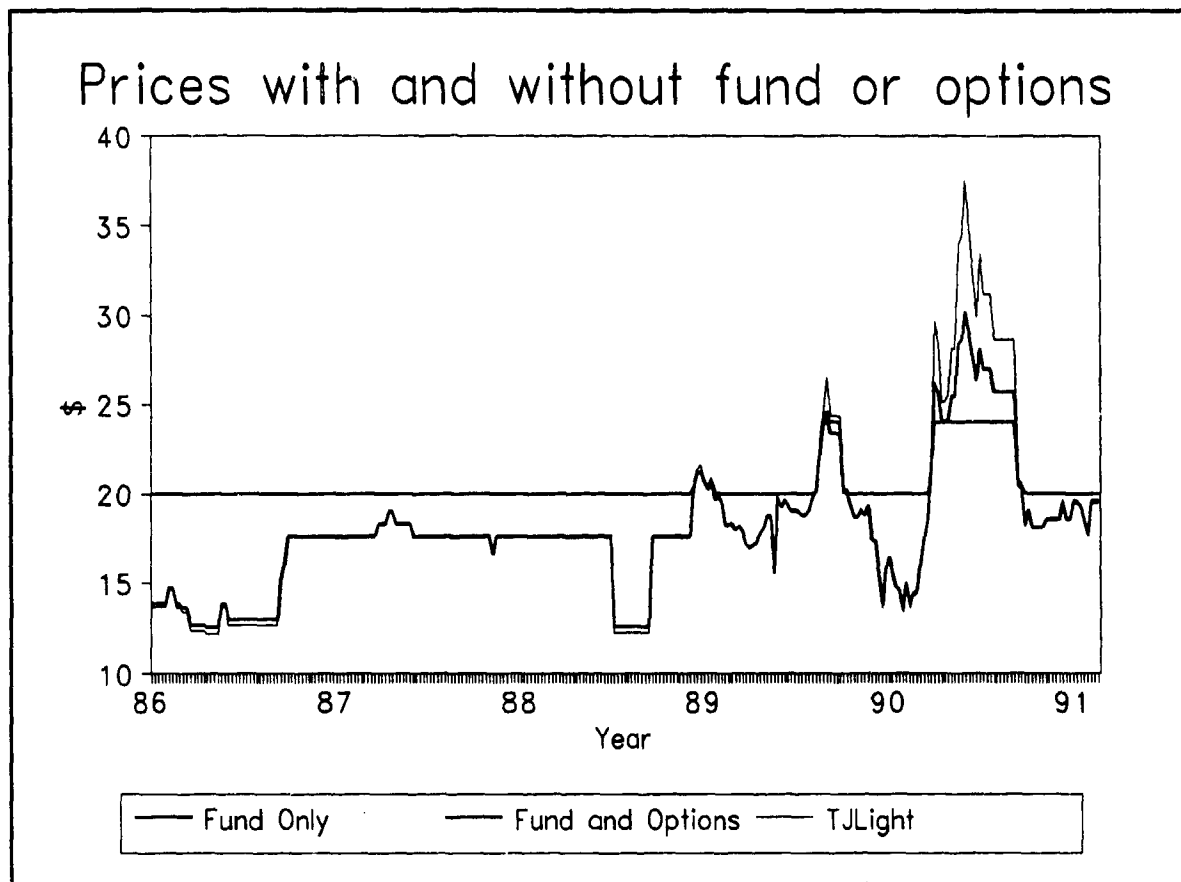


Figure 6: Price with and without fund or options

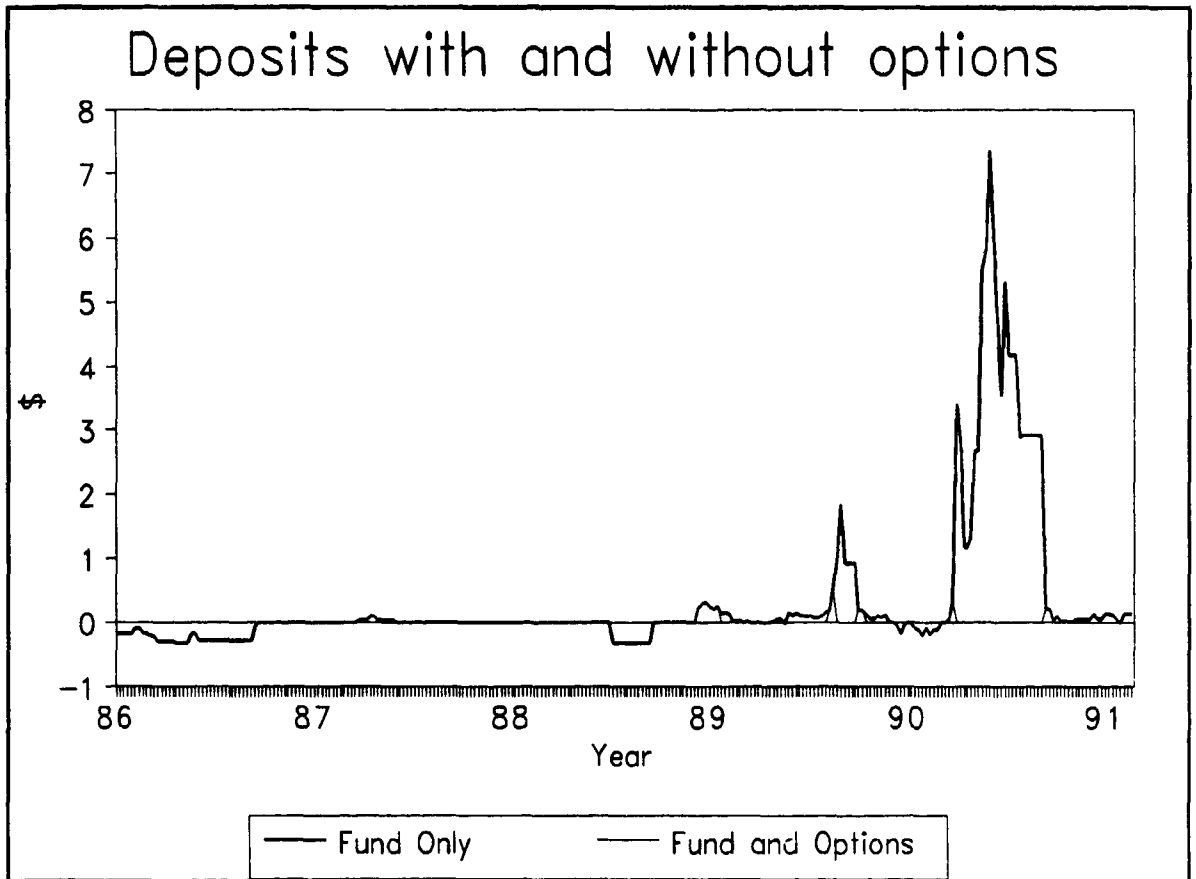


Figure 7: Deposits with and without Options

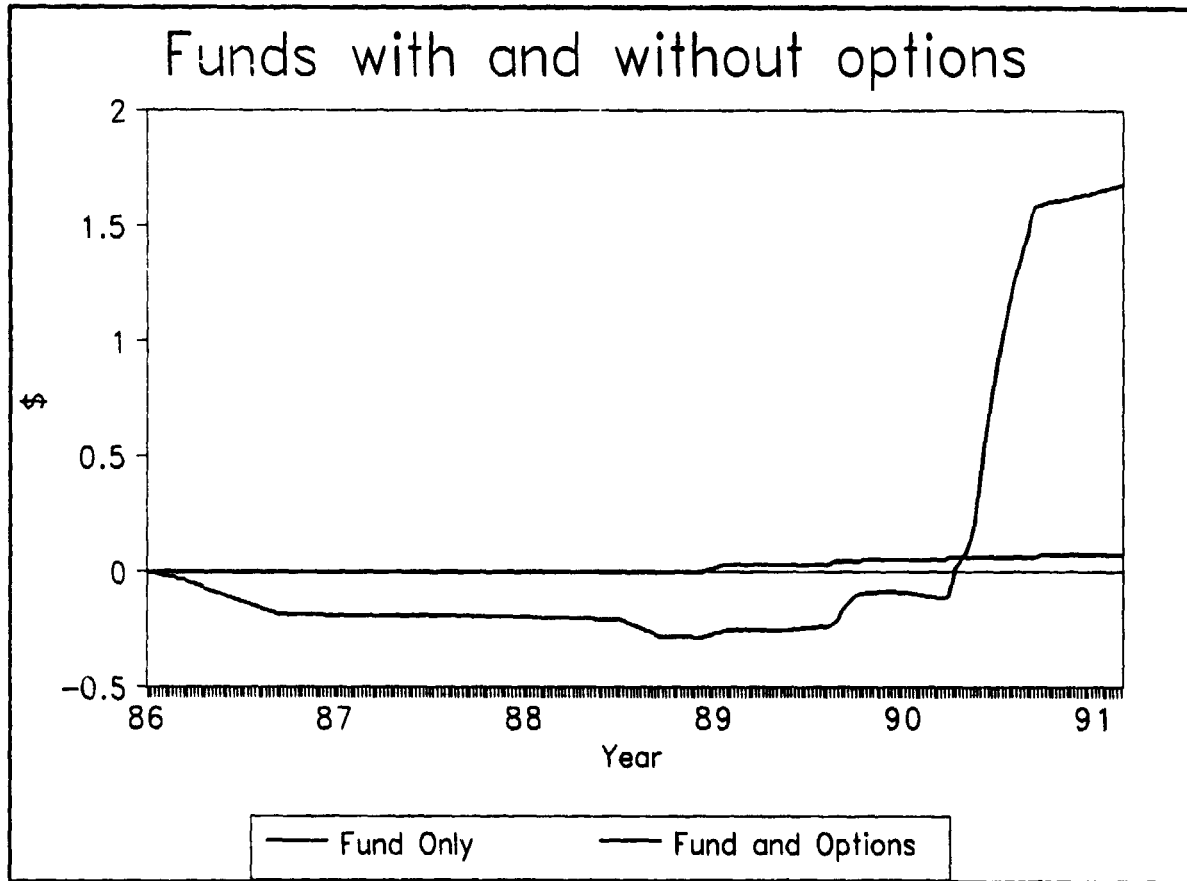


Figure 8: Fund with and without options, dollars per barrel.

which are much less with a fund when the options hedging strategy is used. In exchange, of course, the options strategy required that Venezuela pays for puts, but as we showed above, these puts are to some extent financed by calls.

The main advantage of combining the OSF with an options strategy is that it avoids the large rundowns and accumulations of an OSF. Figure 8 shows the size of the fund under a OSF only and under a combined OSF/options strategy (expressed in dollars per barrel). As can be seen, the fund is much more stable under the combined strategy than under the fund-only strategy. Excluding the period of the Gulf War, the fund under the combined strategy varies

only between \$0 and \$0.05 per barrel exported (with a standard deviation of 0.018), while using the fund-only strategy leads to a consistently negative fund, which reaches a lowest value of -\$0.28 cents (with a standard deviation of 0.069). Thus, under the combined strategy the fund takes on much less extreme values. This is particularly clear once we include the Gulf War period. The standard deviation for the fund without the options strategy increases to 0.58, while with the options strategy the fund has only a standard deviation of 0.03. This shows that the combined strategy has appeal from an economic point of view. Whenever the fund reached a large negative values it would require large borrowings which is presently not feasible for Venezuela. From a political point of view, there are some advantages to a combined strategy too. The option strategy involves using the discipline of international markets to reduce volatility and is thus better shielded from political pressures than a (large) fund kept under the control of the government. Whenever the fund reached large positive values, there would be strong political pressures to divert the fund to other expenditures.

5. WHO SHOULD HEDGE?

There really is no clear-cut answer to the question of whether the GOV or PDVSA should hedge. Who should hedge depends on the specific country and company circumstances. Usually, when it comes to hedging, the entity in the best position to carry out the hedges is the one that handles the physical trade. In the case of Venezuela this is PDVSA. The entity that handles the physical trade has better information regarding production, dates of shipping the exports, long-term plans for exports, and developments in the world oil market. There is already an infrastructure in place that follows developments in the world oil markets, makes analyses and projections and runs the physical operations. In addition, it is our understanding

that in the case of Venezuela, PDVSA can implement a hedging program without formal approval from the Congress. On the other hand, if the government was to implement such a program, it would need specific approval from the Congress. However, if PDVSA is to execute the hedges, the government needs to be involved in the design of the hedging strategy to be pursued. Ideally, a committee should be formed, consisting of staff from different ministries (such as planning and finance), the Central Bank and PDVSA that would meet periodically to review the performance of the existing hedging strategy and, if necessary, propose modifications. The day-to-day execution of hedges would fall to PDVSA.

However, it is not uncommon to find a government ministry or a central bank implementing a risk management program and executing hedges. During the Gulf War, the Ministries of Finance and the Central Banks in Chile, El Salvador, and Mexico executed the oil risk hedging. More recently, the Central Bank of Ecuador is reportedly hedging the crude oil price risk affecting the government's revenues.

6. CONCLUSIONS

Our analysis has shown that both the GOV and PDVSA are exposed to oil price volatility. Oil price volatility is responsible for a large part of the volatility of GOV's total (oil and non-oil) revenues. Under the current oil tax system, PDVSA's exposure increases as oil prices fall.

Comparisons of price volatility estimates show that crude oil price volatility is higher than refined product price volatility, but not by much. Also, as product prices are closely correlated with crude oil prices, diversification into down-stream activities provides little risk reduction. Regarding the issue of basis risk, Venezuelan crude oils have a relatively high basis risk vis-a-vis WTI as compared to other, similar quality Latin American crudes. This relatively high basis risk is mainly attributed to the pricing policies for Venezuelan crudes. While a thorough evaluation of the basis risk in refined products was not pursued, preliminary analysis indicates that it is not high. To the extent basis risk exists, it may be due to Venezuela's inefficiencies in pricing these products.

The analysis raises concerns regarding the establishment of an OSF. It was argued that international financial markets are not as incomplete as perceived. In addition, the random walk hypothesis for oil prices cannot be easily challenged based on recent empirical work. Finally, adjustment costs deriving from price/revenue instability cannot alone be a sufficient reason to establish an OSF when the private sector can hedge. A justification based on adjustment costs relies on the lack of access of the private sector to external hedging instruments, something which cannot be taken for granted as the existence of capital flight shows.

As a short-term hedging tool, market-based instruments perform equally well or better than an OSF in removing short-period volatility, and at lower costs. The best strategy for Venezuela to follow is to remove as much short-period commodity price risk as possible through short-dated instruments as well as--to the extent possible--using longer-term hedging tools. The analysis also shows that an OSF or a government revenue stabilization fund could be complemented by market-based risk management tools. The OSF could then be used to manage any remaining interperiod risk or more general government revenue risk. It should be noted, however, that the use of market-based hedging instruments will not necessarily render the OSF immortal; but it should generate benefits to the government by extending the probable life of the OSF (Larson and Coleman, 1991).

ANNEX I: THE OMAN CONTINGENCY FUND

The Oman Contingency Fund (OCF) operates under the following rules:

- If oil prices range between \$18 and \$20 per barrel, 7.5% of net oil revenues will be deposited in the fund.
- If oil prices range between \$20 and \$22 per barrel, 10% of the additional net oil revenues will be deposited.
- If oil prices are above \$22 per barrel, additional deposits (unspecified) will be required.
- If oil prices are above \$25 per barrel, all additional oil revenues will be transferred to the State General Reserve Fund.
- Withdrawals of the two funds are unspecified with respect to the oil prices, but are determined (up to a limit) by the government for deficit financing. Furthermore, withdrawals are subject to approval by the Council of Ministers.

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