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MANAGING PETROLEUM FISCAL DEPENDENCE
Lessons from Venezuela and Mexico

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Executive Summary

The dominance of the petroleum sector in the economy of many petroleum-exporting states and nations results in the dependence of state and national government budgets on petroleum revenues. The consequences of petroleum fiscal dependence are many and varied. This paper focuses on the implications of oil price volatility for government budgets. The volatility of commodity prices makes estimation of fiscal revenue, and hence project planning, difficult in commodity-exporting states and nations.

In the case of petroleum, the difficulty is exacerbated by extremely high taxes on oil production and the sheer size of the industry. The combination of royalties, severance taxes, and corporate taxes on oil companies results in most of the substantial value of oil produced ending up in the hands of governments. As a result, most governments in oil-exporting regions are far more exposed to oil-price fluctuations than are the companies they tax. Moreover, the magnitude of this exposure is large compared to both total fiscal revenues and expenditures.

Despite the fact that petroleum fiscal dependence and exposure to oil-price fluctuations are central facts of life in many areas, very little fiscal hedging has been undertaken by governments in oil-exporting regions, Mexico and Texas being the best-known exceptions. The paucity of fiscal risk management is surprising not only in theory, but also in light of related experience. There are numerous examples of hedging by oil-importing countries, states, and municipalities in order to protect the energy costs in their budgets. State producers of other commodities, most notably gold and cocoa, have been far more apt to hedge their revenues from exports than have national oil producers. Many private oil and gas producers routinely hedge part of their revenue.

Rather than seek the *causes* behind governments not taking actions that appear to be in their own interest, this paper examines the *impacts* of the absence of risk management to protect the government budget. A central point of the paper is that accurate forecasting of future commodity prices and exports is a substitute for risk management in commodity-exporting states. In other words, if government forecasters can accurately predict petroleum fiscal revenue, then risk management can be of little benefit.

The ability to forecast revenue is an empirical question, which we examine in a case study of Venezuela, an OPEC member that fit the description above. After reviewing the dependence of the country on petroleum for export revenue, as well as the severe fluctuations experienced in government revenue and

spending, we tackle the forecasting question by examining the country's annual budget each year from the time of the first oil shock to the mid 1990s. We compare each country's *ex ante* budget projections of petroleum fiscal revenue, total fiscal revenue, and total expenditure with their *ex post* realizations.

We find that the ability of the government to predict its fiscal revenue is poor, despite the fact that the forecasts we examine are short-term, for only a year, or a year and a few months, into the future. Furthermore, we find that a large part of windfalls (unanticipated revenue increases) are spent in the year they are received, rather than being saved for use in periods of fiscal shortfalls (unanticipated revenue declines). As a result, shortfalls typically result in unplanned decreases in fiscal expenditures, presumably associated with cuts in projects and social programs.

Petroleum fiscal dependence is more difficult to manage in the budget than, e.g., dependence on wheat. Volatility makes forecasting future petroleum fiscal revenue more difficult than revenue from the sale of other commodities. Because of the size of the industry in oil-exporting states, the consequences of failure to forecast future oil revenue accurately, or to protect fiscal expenditure through risk management, are far graver for petroleum than for other commodities. We conclude that these countries would benefit from undertaking a fiscal risk management program.

I. FISCAL REVENUE STABILIZATION: BACKGROUND AND ISSUES

A. Introduction

This paper examines question of stabilization of government revenue in oil-exporting countries. Seven striking facts motivate our inquiry.

1. The economies of many oil-exporting countries and provinces are heavily dependent on the fortunes of the petroleum sector. Latin American countries in this category include Ecuador, Mexico, Trinidad, and Venezuela. Elsewhere, the Arabian/Persian Gulf countries almost all derive more than 80 percent of their export income from petroleum. Several African countries (Algeria, Angola, Cameroon, Congo, Gabon, Libya and Nigeria) derive much of their export income from petroleum.

2. Governments of oil-exporting countries and provinces receive the bulk of their revenue through collection of petroleum severance taxes (taxes imposed on crude oil and natural gas at the extraction point) and royalties, and income taxes on the petroleum industry.

3. The petroleum industry in many oil-exporting countries is dominated by a state-owned enterprise. These enterprises typically have a virtual monopoly (e.g., Petróleos Méxicanos, Petróleos de Venezuela, Petroecuador) over petroleum production and sales, which means that government is dependent on the portion oil revenue that is not taxed, as well as the part that is. Even in cases where the state enterprise faces competition (e.g., Statoil), it still dominates the industry, leaving the government heavily exposed to oil-price movements.

4. Government budgets in these countries are constrained by the level of oil prices. Thus planning, whether for the annual budget cycle, or longer-term development strategy, depends critically on the ability of government and oil-industry officials to forecast future oil prices over the planning horizon.

5. Oil prices have been quite volatile for a quarter of a century, and show little prospect for a return to the stability of the cartel era, when production was controlled by the international majors and the Texas Railroad Commission

6. The volatility of oil prices can make accurate forecasting of oil revenue difficult to impossible.

7. High tax rates on both state-owned and private oil companies often leave oil-exporting governments more exposed to oil-price fluctuations than the oil companies they tax. Despite the enormous magnitude of this exposure, and the potential of derivatives contracts for hedging it, these governments' use of derivatives to reduce price risk is very limited. For example, in 1991 only 1.6 percent of reportable

open interest in NYMEX crude-oil futures contracts was attributed to developing countries, almost all of it from Latin America.[1]

B. Approach

This study examines the dependence of government revenue and spending in major oil-exporting countries, using Venezuela as a case-study. It examines in detail the relationships between forecast oil revenue, actual oil revenue, forecast government spending, and actual government spending, in order to assess the role of oil-price volatility in the budgetary and planning process. This analysis requires collection and analysis of fiscal and planning documents from national sources.

C. Alternative Solutions

Governments have a limited range of options in limiting the exposure of their budgets to fluctuations in the oil market.[2] Privatization of state-owned petroleum enterprises (SOEs), or sale of their assets, has been suggested as a way of reducing government dependence on oil (see Hausmann, Powell, and Rigobón 1993), and some petroleum SOEs in oil exporting countries have been partially or totally privatized (e.g., Petro Canada and YPF in Argentina). As long as oil production is a highly taxed activity, however, governments will depend on oil revenues irrespective of the presence or absence of petroleum SOE.

Diversification of the national economy is another means of reducing dependence on petroleum, but this strategy is slow, costly, and prone to temptation to invest in uneconomic projects and industries. The list of such projects is long, and spread over numerous oil-exporting states. Successful diversification must be based on some resource advantage, such as abundant labor in Indonesia. The very success of the natural-resource sector of the economy tends to result in appreciation of a country's real exchange rate, putting other sectors of the economy at a disadvantage in international competition (see Benjamin, Devarajan, and Weiner 1989).

Stabilization funds are a third possibility, based on a simple idea -- save some of the petroleum revenue when oil prices are higher than expected; invest the capital, and draw down some of it when prices are lower than expected. Even though revenues cannot be stabilized, budget expenditures can be.[3]

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[1]See Claessens and Varangis (1995). Small traders (those falling below a certain threshold) need not report their open interest.

[2]For more detail, see Hausmann, Powell, and Rigobón (1993).

[3]These should not be confused with the idea of a "commodity stabilization fund," designed to manipulate commodity prices themselves thorough buffer stocks.

Such stabilization funds have been set up in a number of oil-exporting states, but few have served to stabilize budget expenditures. The Alaska Permanent Fund pays out a lump-sum to all state citizens, depending on the performance of its investments, not on state oil revenues.[4] The Venezuela FIV has been used to subsidize other industries. Only the Kuwait Fund for Future Generations has actually helped smooth government budgets, but in the case of Kuwait, the loss of oil revenue was due to the Iraqi invasion, rather than a fall in oil prices. The Fund helped pay the country's bills during and after the Gulf Crisis.

In practice, it appears that the pressures to use unanticipated oil windfalls for politically-attractive projects, for indirect subsidies or direct dividend payments to citizens, are too strong to allow a stabilization fund to function properly. Moreover, theoretical research has shown that under most conditions, stabilization funds are inefficient means to smooth revenues (see Claessens and Varangis 1994).

The final alternative, risk management, is the only feasible way to protect government revenues and allow effective planning to be undertaken. Such risk management can take several forms, including hedging through futures and options on organized exchanges, use of over-the-counter instruments such as swaps, and issuance of commodity-linked debt, which effectively allows governments to borrow at low rates when commodity prices are low, and pay higher rates if commodity prices rise (when they should be most able to do so).

Should governments and state organizations hedge their income? Modern finance theory has demonstrated that in the absence of transactions costs, publicly-held firms cannot add value by hedging. What matters for firm value is systematic risk, i.e., the risk that investors cannot eliminate through holding a diversified asset portfolio. When transactions costs (particularly those arising from asymmetric information) make outside borrowing a more expensive source of capital than retained earnings, and income fluctuations make outside borrowing necessary, then hedging can add value to publicly-held firms.[5]

Because governments and state organizations are not publicly held, their "investors" (the residents of the state) cannot "sell their shares," and thus cannot hold a diversified portfolio. Thus, the argument that hedging is valuable is stronger for state organizations than for private firms. The argument is even stronger for governments than state enterprises, because of political pressure to spend windfalls. Enterprises, whether private or state-owned, can make effective use of windfalls. For governments, the temptation to use windfalls to buy political support has proven irresistible.

II. **OIL-PRICE VOLATILITY AND EXPORTER-GOVERNMENT BUDGETS**

[4]On the Alaska Permanent Fund, see Brown and Thomas (1994).

[5]See Froot, Scharfstein, and Stein (1993) for more details.

A. Introduction

For the exercise of analyzing the effect of oil price volatility on government budgets, we focus on Venezuela. The choice was based on several criteria: OPEC membership, importance in the world oil market, upstream dominance of a national oil company, reliance on oil for export revenue, reliance on oil revenues to fund the government budget, and absence of risk management programs to protect the government's oil revenue. This section presents some comparative economic data on Venezuela's dependence on petroleum.

1. Exports

Dependence on petroleum for export revenue is summarized in Table 1. The effects of oil-market fluctuations on export revenue in these countries are most easily seen in the following graphs. Because oil moving in international trade is always priced in US dollars (even when the United States is neither the exporter nor the importer), the graphs present the export data in US dollars, as well as in national currency, adjusted for inflation[6] using the GDP deflator.

Figures 1A and B show exports for Venezuela from the early 1970s through the early 1990s in current dollars and constant (1985) bolivars respectively. The graphs highlight three key facts.

•First, the oil industry accounted for virtually all of Venezuelan exports in the 1970s and 1980s, and continues to account for over 70 percent of the total.

•Second, Venezuela's petroleum exports fluctuate widely. In real terms, exports have varied by a factor of about two-and-a-half, from around 60 billion[7] 1985 bolivars in the early 1970s to over 150 billion in 1990. During this period, the volume of Venezuelan oil exports changed very gradually. Hence, the variability of petroleum exports is caused by fluctuations in oil prices. Indeed, the price spikes associated with the 1973-1974, 1979-1980, and 1990-1991 supply disruptions are easily seen in the graphs.

•Third, petroleum and non-petroleum exports do not move countercyclically, so that the fluctuations in total exports, and hence Venezuela's ability to earn foreign currency, can be traced directly to oil-price volatility.

2. Government Revenues and Expenditures

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[6]High inflation in many oil-exporting countries makes adjustment for inflation necessary for presentation purposes.

[7]In this paper 1 billion = 1000 million, 1 trillion = 1000 billion.

Oil-export revenue is the chief source of funds for the Venezuelan budget.[8] Thus the fluctuations in oil exports discussed above should result in variability of government revenue. This variability can be seen in Figure 2. The oil shocks of 1973-74 and 1979-80 resulted in windfalls to the Venezuelan government; in real terms (panel B) government revenue rose two-and-a-half times from 1970 to 1974, declined by about 20 percent in the late 1970s, then reached

[8]Domestic petroleum sales are typically subsidized, often heavily, and represent a use, rather than a source, of government funds.

Table 1

PETROLEUM EXPORTS AS PERCENTAGE OF TOTAL EXPORTS

	VENEZUELA
1970	75%
1971	92%
1972	90%
1973	NA
1974	95%
1975	95%
1976	94%
1977	95%
1978	95%
1979	95%
1980	91%
1981	89%
1982	94%
1983	99%
1984	93%
1985	90%
1986	83%
1987	86%
1988	80%
1989	75%
1990	80%
1991	81%
1992	79%
1993	75%

Sources: International Finance Statistics YearBook, 1993.
World tables, 1994.
IFS, May 1995

Figure 1A

PETROLEUM AND TOTAL EXPORTS (US$)

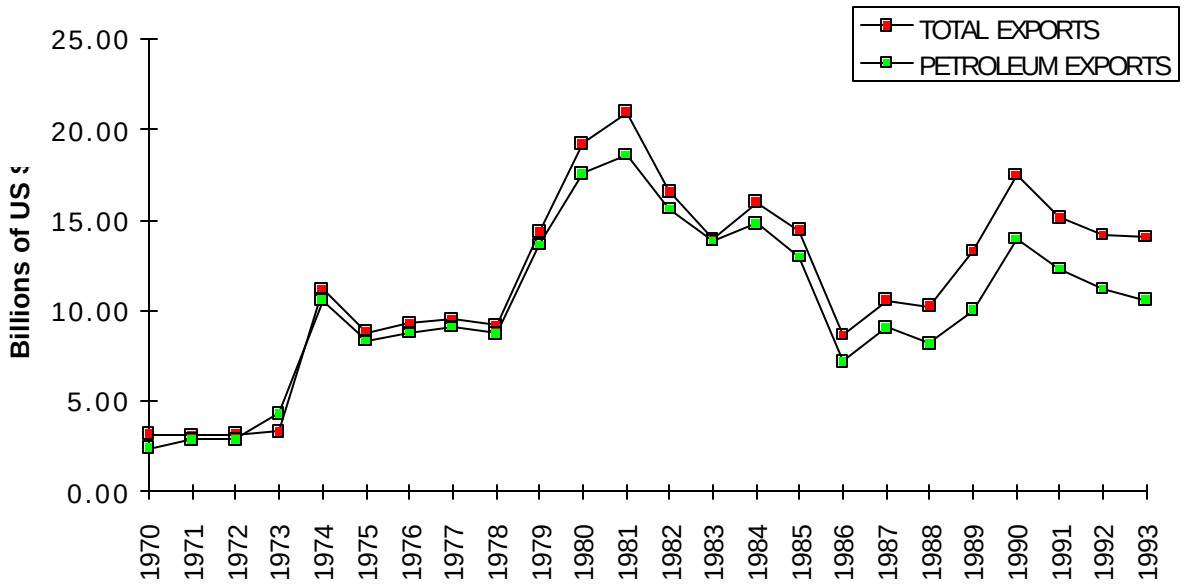


Figure 1B

REAL PETROLEUM AND TOTAL EXPORTS

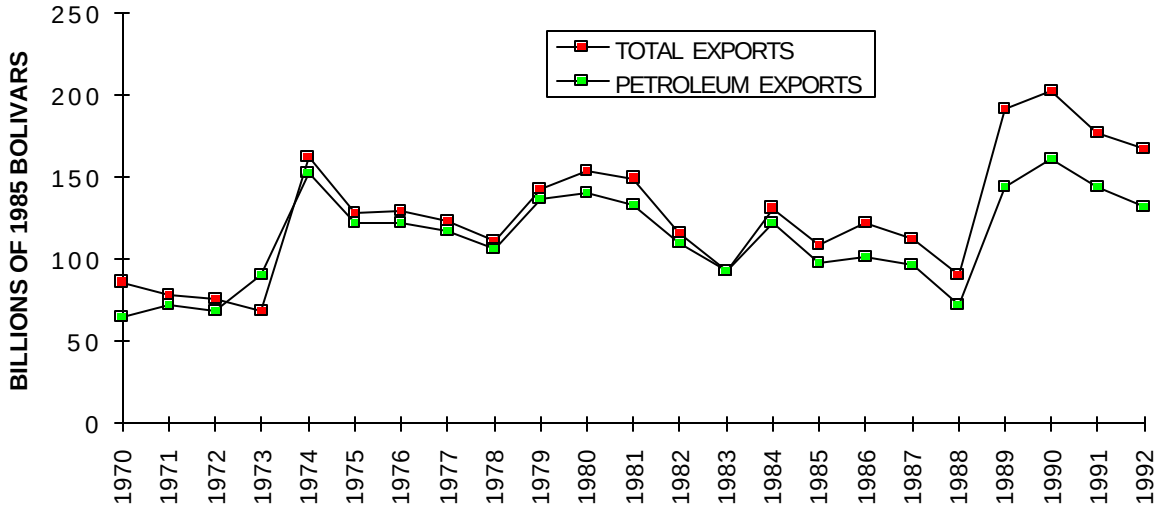


Figure 2A

GOVERNMENT REVENUES AND EXPENDITURES (US$)

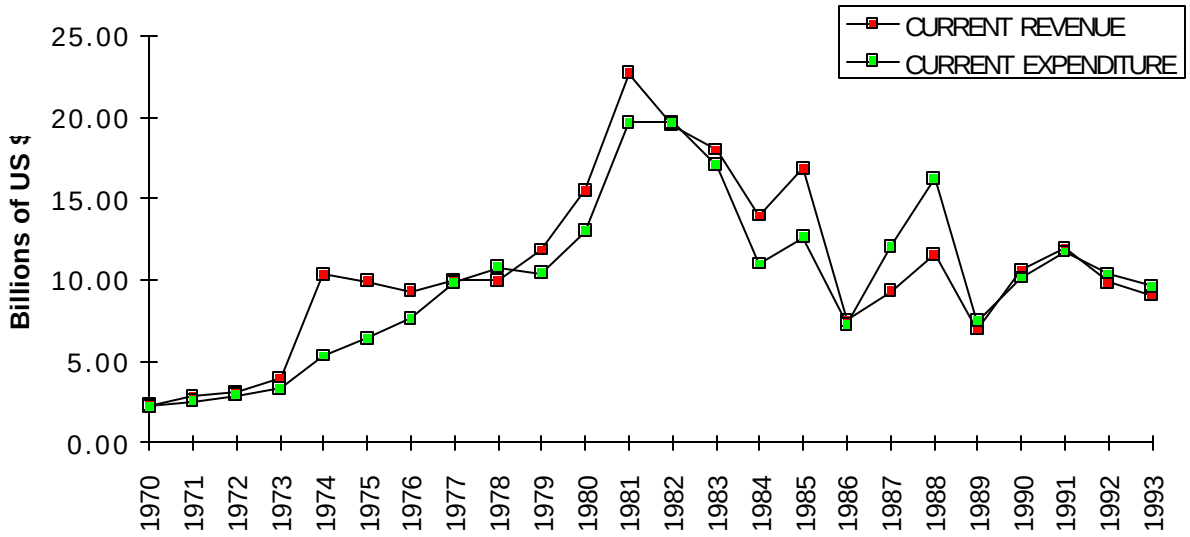
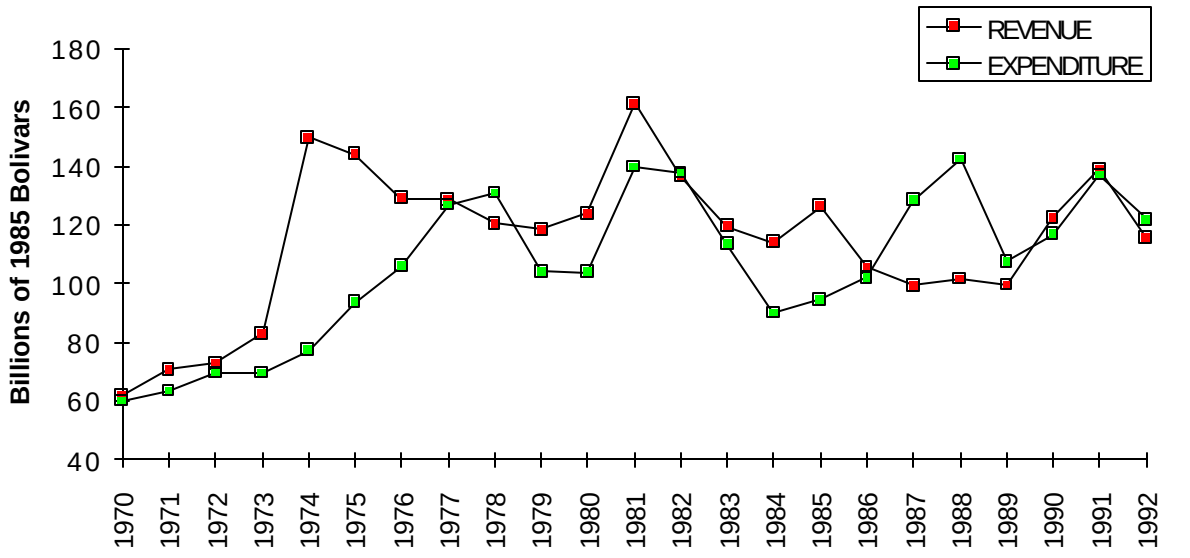


Figure 2B

REAL GOVERNMENT REVENUES AND EXPENDITURES



an all-time high in 1981. Recent revenues have been about 25 percent below this high in real bolivars, and less than half of this high in dollar terms (panel A).

As mentioned in the introduction, one way for governments to manage oil-price risk is through saving and investing windfalls, and using the proceeds of these windfalls to cover shortfalls associated with oil-price crashes. The figure demonstrates that this did not occur in Venezuela. Instead, government spending followed revenues up. By 1978, spending had more than doubled *in real terms* from 1970 levels, and more than ate up all of the windfall of the first energy crisis.

The second oil crisis provided the government another windfall, and spending again increased, from just over $10 billion in 1978 to just under $20 billion in 1981 and 1982. When oil revenue plunged in the mid-1980s, government spending had to be cut very sharply (spending fell from over 130 billion 1985 bolivars in 1982 to less than 100 billion in 1984 through 1986), causing great economic hardship.

In the 1990s the Venezuelan economy was one of the few in South America to perform poorly. Government revenue in real terms continued to be lower than the levels attained in the 1970s and early 1980s. The country continues to experience economic and social problems.

B. The Oil Sector and the Government Budget[9]

In order to assess the impact of oil-price fluctuations on government revenues and spending, we examined the budget process. When the bulk of the government budget is obtained from petroleum, oil-price forecasts are critical to planning government revenue collection and spending. If governments or state oil companies could accurately forecast future oil prices, even in times of volatility, then the argument for risk management to protect the budget would be greatly weakened. Knowing that oil prices next year will be substantially lower than this year would enable governments and state oil companies to plan to reduce their expenditures accordingly.

To investigate this issue we obtained annual budget figures for each year, focusing on forecasts for the coming year for oil revenue, total revenue, and total expenditure. We compare the forecasts made *ex ante* with what actually happened, examining the deviations of *ex post* oil revenue and total revenue from their projected values.[10] We then proceed to analyze the *effects* of unexpected windfalls and shortfalls on government spending.

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[9]See Rodriguez (1991), Boué (1993), Salazar-Carillo (1994), and World Bank (1995) for studies of the Venezuelan economy that cover public finance. All budget figures used here are for the central government. State enterprises, including PDVSA, are not included. Thus, petroleum fiscal revenue is measured as payments received by the central government from PDVSA, in the form of income taxes, royalties, foreign-exchange subsidies, and miscellaneous fees, rather than PDVSA profits. Petroleum fiscal revenue figures do not include retail taxes on petroleum products.

[10]The budget figures in this section are all based on Venezuelan sources, and are not necessarily comparable with the previous section's figures, which have been standardized by the International Monetary Fund. Accounting

Each year the administration sets out its proposed budget, including revenue forecasts and the budget's underlying rationale, for congressional authorization in a document issued by the Budget Office, entitled Exposicion de Motivos del Proyecto de Ley de Presupuesto [Exposition of the Draft Budget Bill].[11] The budget bill is typically approved with only minor changes.

We obtained copies of the Exposicion for as many years as we could find, and extracted forecasts of the relevant variables.[12] Until the early 1990s, the Exposicion for each year usually was published in October of the previous year, so that forecasts for each year were based on data available through August or September of the previous year. We were also able to locate several volumes of Bases Preliminares del Plan Operativo Anual[13] [Preliminary Basis for the Annual Operating Budget], which until the early 1990s was published in June with preliminary budget forecasts for the following year. Since the early 1990s, the Exposicion has appeared in June (with forecasts based on data available through February or March), and the Bases Preliminares is no longer published.

The forecast of government fiscal revenue from the petroleum industry (Petróleos de Venezuela and its operating companies) requires a projection of industry profits. PDVSA profits, equal to revenue less operating costs, are taxed at a rate of about 65 percent, but the calculation of revenue for fiscal purposes is based on tax-reference prices higher than actual market prices, a holdover from the multinational oil era. When a royalty of about 16 percent is included, the effective tax rate exceeds 85 percent.

Almost all of PDVSA's revenue comes from exports of crude oil and petroleum products. The key variables for forecasting revenue are 1) the average price of crude oil and products exported, 2) the volume of exports, and 3) the bolivar/dollar exchange rate, since exports are in dollars. Petroleum risk management can help only with the first variable, so it can be useful only if oil prices are harder to predict than export volumes and exchange rates.

The forecasts of crude oil and petroleum product prices, as well as production and export volumes, on which the government budget is based are made by PDVSA, and then reviewed by the Ministry of Energy and Mines before being passed along to the Budget Office.[14] Figure 3 compares average actual

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conventions differ among countries, as do methods of consolidation, and definitions of "on-budget" and "off-budget" expenditure categories.

[11]Translations are indicated in square brackets. Our objective is to convey the meaning of the original, and thus our version may differ from literal or official translations. Documents published in Spanish as well as English are referenced here by their English titles.

[12]We are especially grateful to Carlos Molina and Angel Ruocco for help in providing access to Venezuelan budget documents.

[13]The title has varied slightly since the Bases Preliminares began publication in 1979.

[14]Information is based on Claessens and Varangis (1994), and conversations with PDVSA and government officials.

with forecasted tax-reference prices for exports of Venezuelan crude oil and products. Figure 4 does the same for market prices.

Figure 3

FORECAST vs. ACTUAL TAX-REFERENCE PRICES

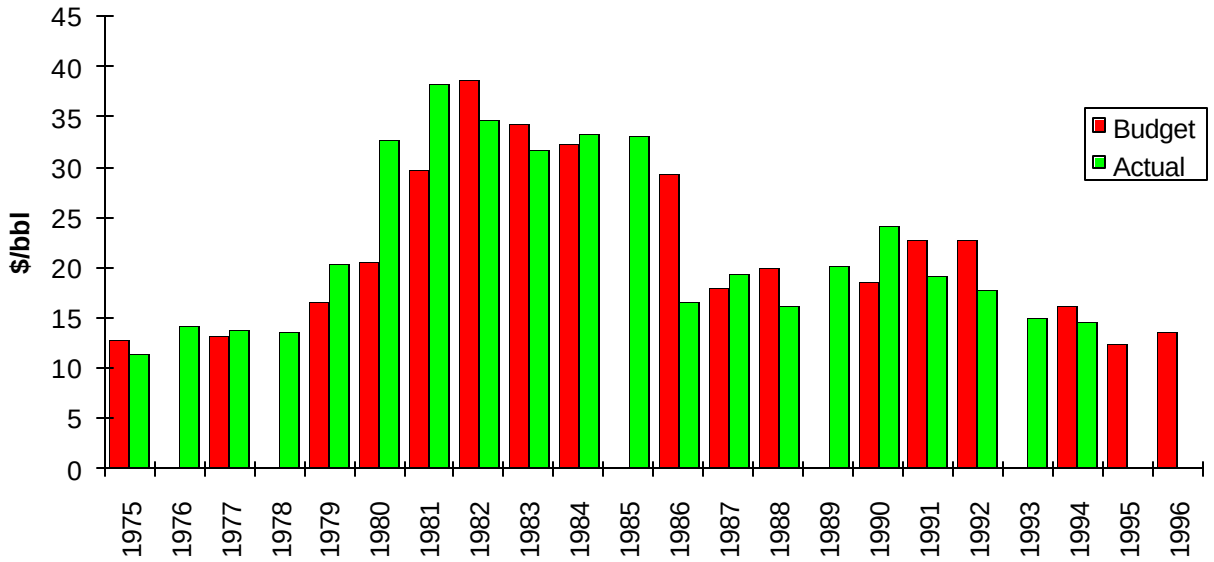
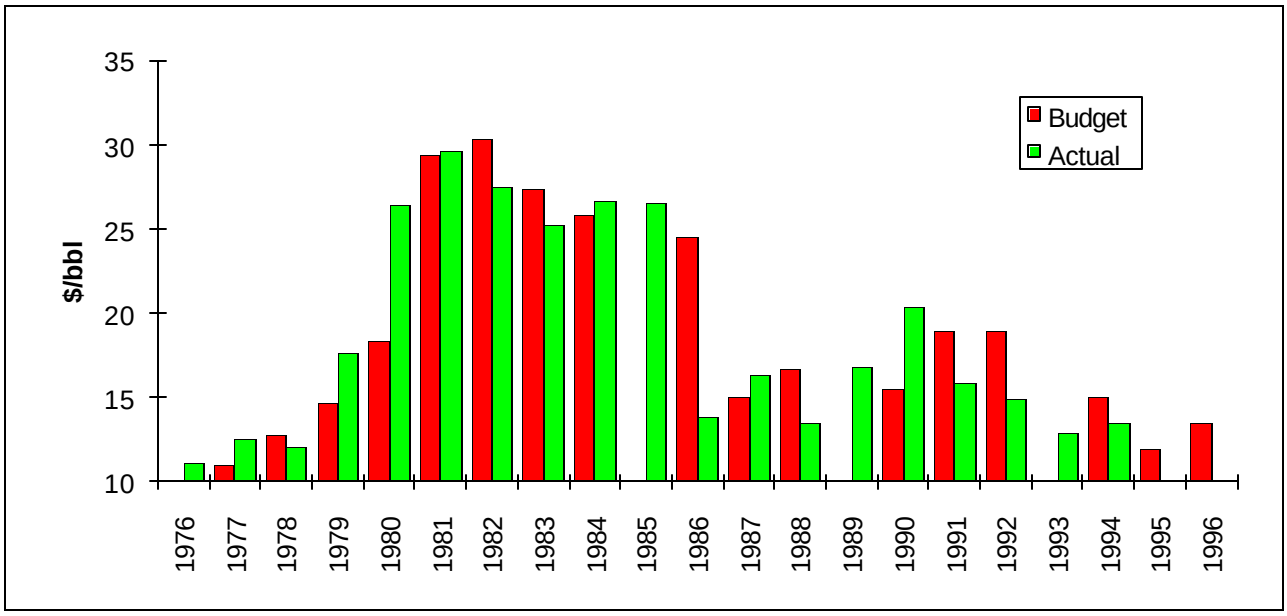


Figure 4

FORECAST vs. ACTUAL MARKET PRICES



The figures reveal that oil price forecasts are often far off the mark. In all but two years for which data are available, the forecast was off by more than $1 per barrel. The average absolute error[15] in predicting tax-reference prices for the 17 years for which we have both forecast and actual data was more than $4 per barrel. The largest error was in 1986, when the predicted price was $29.40 per barrel and the actual price was $16.67 per barrel. Even if the crisis years of 1979, 1980, 1986, and 1990 are excluded, the average error was $2.75 per barrel, equal to roughly 20 percent of the entire value of Venezuelan oil exports.

Forecasts of market prices were similarly inaccurate. The average absolute error was about $3.75 per barrel; even excluding the crisis years, the average error was $2.80 per barrel. The poor quality of the forecasts is not due to ineptitude on the part of PDVSA or the energy ministry; other forecasters have not fared better (see Lynch 1994). The extreme volatility of prices during the post-1973 era has made accurate forecasting impossible.

In contrast, forecasts of oil export volume are very accurate. As can be seen in Table 2, differences between predicted and actual export volumes have been quite small. Even the longer-term forecasts made in the five-year national plans have come close to actual values several years later. Similarly, exchange-rate forecasts have been accurate until the 1990s. In both cases, the reason for accuracy is clear. Venezuelan exports and production (see Table 3) have changed only gradually over the last two decades, making them easy to predict. Until the economic problems of the 1990s, the bolivar was likewise relatively stable against the dollar (see Table 4).

Because exchange rates and oil-export volumes are predicted relatively accurately, the ability to predict oil prices thus translates directly into ability to predict total fiscal revenue, and therefore to plan

[15]This section discusses magnitudes of forecast errors. Statistical tests are performed in the section entitled Regression Analysis below.

government expenditures. Figure 5 compares forecast with actual fiscal revenue arising in the Venezuelan petroleum sector. For each year for which data are available, the table presents in real terms (1985 bolivars) the preliminary revenue estimate published in Bases Preliminares del Plan Operativo Anual, the estimate included in the budget submitted to the congress (published in Exposicion), and actual revenues arising in the petroleum sector.

The figure reveals two striking facts. first, actual petroleum fiscal revenue has been quite unstable. Revenue exceeded 100 million (1985) bolivars in four of the 20 years, when oil prices were high. In contrast, revenue was less than 80 million bolivars in 11 years, and less than 60 million in 4 of those years. Petroleum fiscal revenue declined by a factor of nearly three between 1981 and 1986.

Second, petroleum fiscal revenue is difficult to forecast. In most years, forecasted revenue was substantially above or below actual revenue. Over the 15-year period for which we have data on predicted and actual petroleum fiscal revenue in real terms, the average forecast error was about 20 million 1985 bolivars, over 25 percent of the average petroleum fiscal revenue of about 75 million 1985 bolivars.

Table 2

FORECAST vs. ACTUAL OIL EXPORT VOLUME

Unit: mmbd — Export Volume

	Predicted National Plan	Predicted BP	Predicted Exposicion	Revised BP	Revised Exposicion	Actual
1973						3.15
1974						2.77
1975						2.07
1976	1.80		1.94			2.156
1977	1.82		1.91			1.987
1978	1.90					1.963
1979	1.87		1.99			2.099
1980	1.84					1.864
1981						1.759
1982		1.79	1.79			1.554
1983			1.6			1.5
1984			1.475		1.5	1.52
1985	1.502		1.5		1.35	1.37
1986	1.551		1.41	1.46	1.47	1.51
1987	1.596	1.59	1.59	1.52	1.49	1.52
1988	1.642	1.52	1.52			1.65
1989				1.6	1.61	1.63

1990		1.63	1.67		1.92	1.88
1991			1.9		2.02	2.132
1992			1.95			2.066
1993					2.001	2.251
1994			2.1		2.304	2.317
1995			2.48		2.387	
1996			2.45			

Sources: Bases Preliminares del Plan Operativo Anual, Venezuela, various years.
Exposicion de Motivo del proyecto de ley de presupuesto, various years.
V Plan de la Nacion, 1975-1980, VII Plan de la Nacion, 1984-1988.
From 1976 to 1983, Actual: Diez anos de la industria petrolera. 1991-92: World Bank

Table 3

FORECAST vs. ACTUAL PETROLEUM PRODUCTION

Unit: mmbd

Production of crude oil + condensate + LPG

	Predicted National Plan	Predicted BP	Predicted Exposicion	Revised BP	Revised Exposicion	Actual
1973						3.37
1974						2.98
1975	2.34		2.82			2.35
1976	2		2.2			2.3
1977	2.1		2.2			2.23
1978	2.2				2.1	2.23
1979	2.2		2.36			2.43
1980	2.2	2.27				2.23
1981						2.16
1982		2.22	2.15			1.95
1983			2.02			1.85
1984			1.87		1.81	1.86
1985			1.8		1.73	1.75
1986			1.73	1.88	1.87	1.88
1987		1.97	2.01	1.78	1.87	1.82
1988		1.9	1.095			2
1989				1.9	1.93	2.02
1990		1.98	2.05		2.23	2.25
1991			2.3		2.4	2.42
1992			2.35			2.36
1993					2.409	2.57
1994			2.58		2.68	2.72
1995			2.83		2.79	
1996			2.94			

Sources: Bases Preliminares del Plan Operativo Anual, Venezuela, various years.
Exposicion de Motivo del proyecto de ley de presupuesto, various years.
VII Plan de la Nacion, 1984-1988. Note: World Bank for years 1982.83.91.92, actual.

Table 4

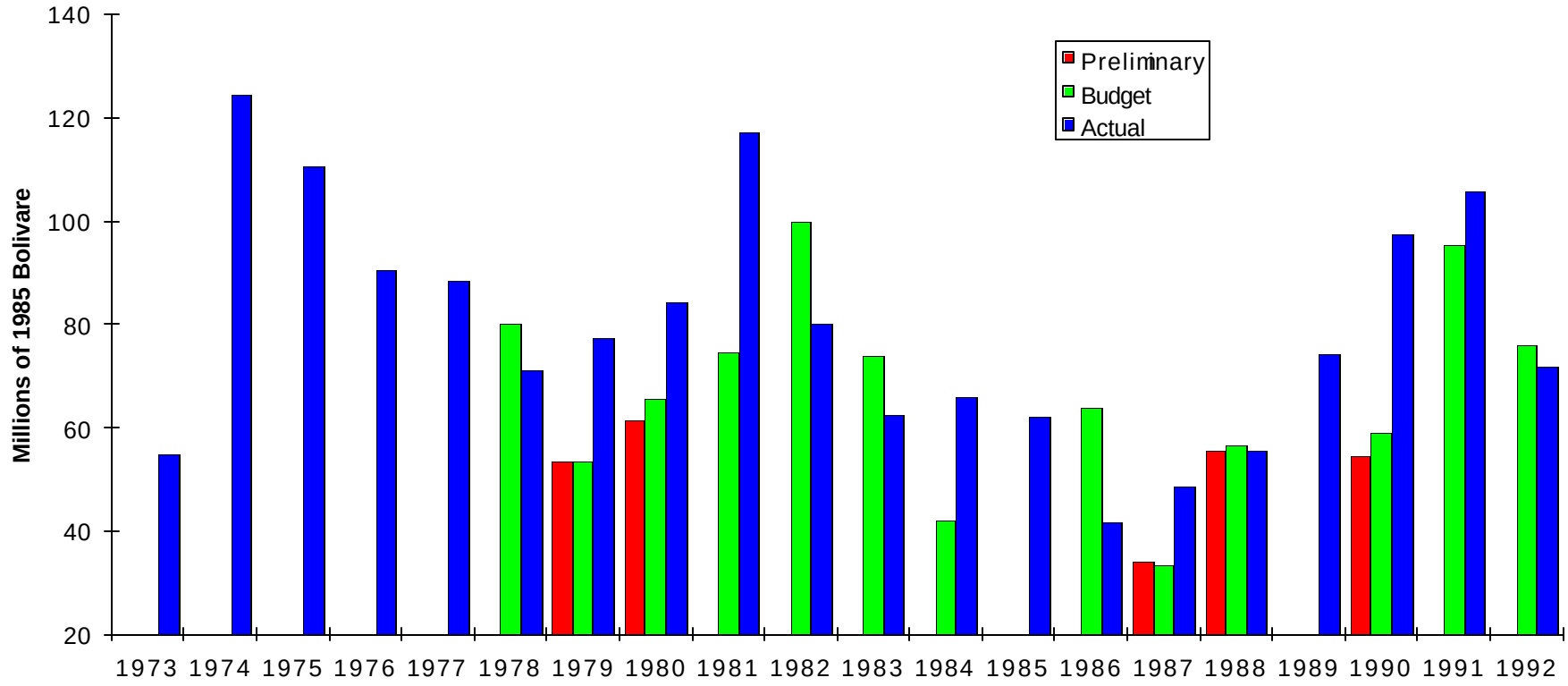
FORECAST vs. ACTUAL U.S. $ EXCHANGE RATE (Bs/$)

	Predicted BP	Predicted Exposicion	Revised BP	Revised Exposicion	Actual
1973					4.28
1974					4.28
1975					4.28
1976					4.28
1977					4.28
1978					4.28
1979					4.28
1980					4.28
1981					4.28
1982					4.28
1983					4.203
1984					5.76
1985				5.99	5.99
1986		7.49	7.49	7.49	7.49
1987	7.5	7.49	11	10.96	11.1
1988	14.5	14.49			14.5
1989			33.14	33.31	34.7
1990	38	38		46.2	48.2
1991		50		56	56.96
1992		56			68.5
1993				83	92.3
1994		108.9		118	153.96
1995		124.09		170	
1996		180			

Sources: Bases Preliminares del Plan Operativo Anual, Venezuela, various years.
Exposicion de Motivo del proyecto de ley de presupuesto, various years.

Figure 5

FORECAST vs. ACTUAL PETROLEUM FISCAL REVENUE



A comparison of predicted and actual total fiscal revenue is shown in Figure 6. As can be seen in the figure, the forecast errors of petroleum and non-petroleum fiscal revenue do not tend to be offsetting, so that the pattern of forecast errors in petroleum fiscal revenue carry over into total fiscal revenue. Fiscal spending is as difficult to predict as fiscal revenue, as shown in Figure 7. Actual spending has exceeded forecasts in all but three of the years for which we have data.

The discussion and data above provide a sense of the difficulty in planning for the annual budget cycle. Designing the national five-year development plan requires forecasts of petroleum income over a substantially longer period, and thus is much more difficult. Figure 8 provides a comparison of actual petroleum export revenue (the basis of almost all of the tax paid by PDVSA) each year with two forecasts. The budget forecast is made the previous year, while the forecast in the national plan is made 1-4 years earlier.

The V Plan covered the years 1976-1980, immediately following the nationalization of the petroleum industry. Given the unexpected nature of the Iranian oil shock, it is not surprising that the plan grossly underpredicted petroleum exports near the end of the period. The VI Plan, covering the period 1981-1985, overforecasted revenues, as did the VII plan, covering 1984-1988, as the 1986 price collapse could not be foreseen. The VIII Plan, covering 1989-1994, underpredicted revenues in the first part of the period, and overpredicted them in the second. The current plan, issued in 1995, does not attempt to predict petroleum revenues, and thus can talk about spending plans only in general terms.[16]

Figure 6

FORECAST vs. ACTUAL TOTAL FISCAL REVENUE

[16] Plan data come from Venezuela, Oficina Central de Coordinación y Planificación (CORDIPLAN) (1976, 1981, 1984, 1990) and discussions with government officials.

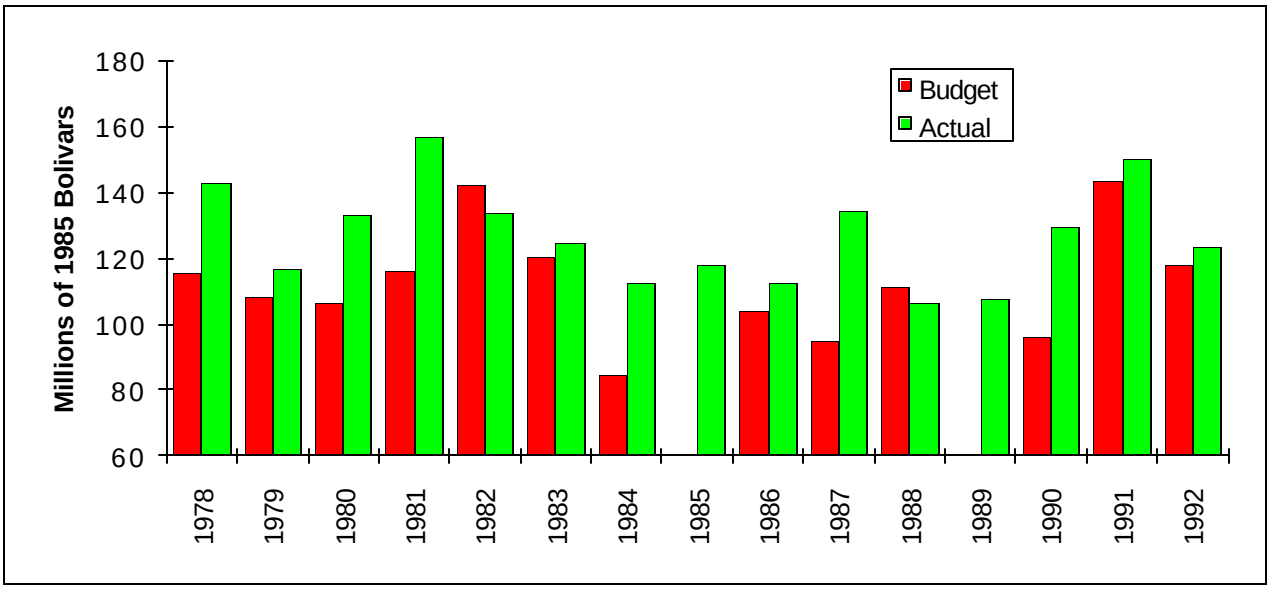


Figure 7

FORECAST vs. ACTUAL GOVERNMENT SPENDING

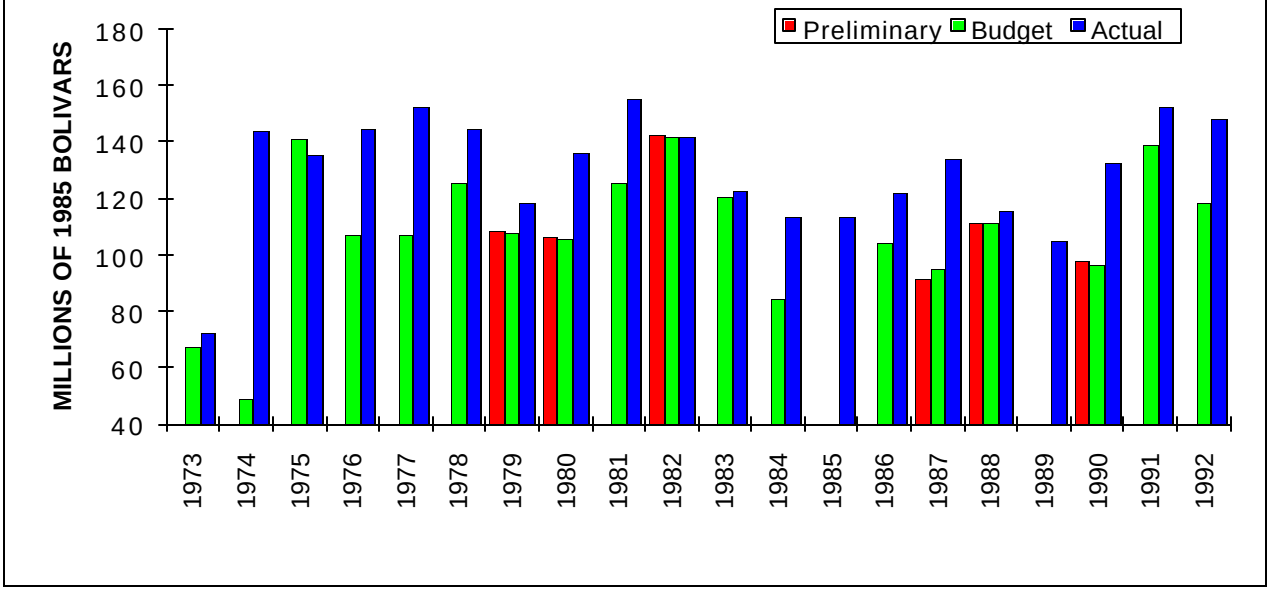
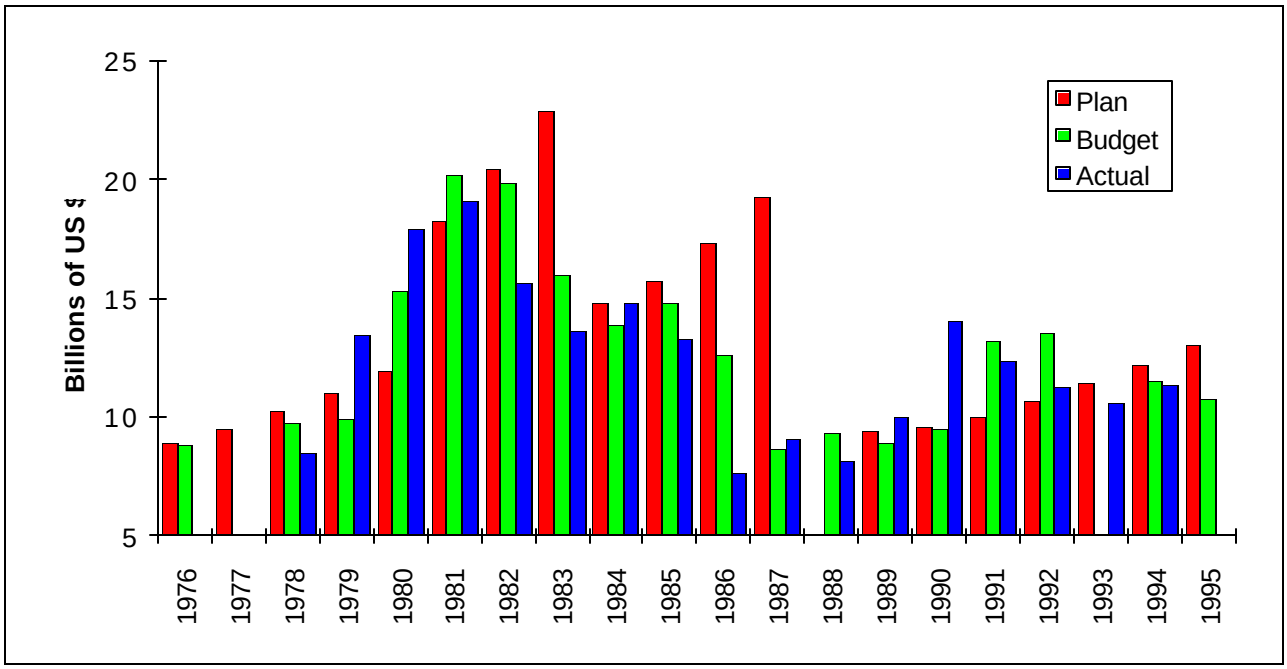


Figure 8

FORECAST vs. ACTUAL PETROLEUM EXPORTS



C. Regression Analysis[17]

This section presents a statistical analysis of the ability of the government to predict revenues and expenditures, and of the relationship between actual revenues and spending. In order to make statements about these relationships with confidence, a formal analysis is necessary. In order to investigate these issues, we performed two groups of regressions. The first examines forecast ability, and is of the form:

$$\text{actual budget item} = a + b\ \text{predicted budget item} + e$$

where the items are as above: petroleum fiscal revenue, total fiscal revenue and fiscal spending, and prices. The slope of the regression line (b) and the intercept (a) are coefficients to be estimated. The error term is labeled e.

If forecasts are unbiased (i.e., correct on average), then $a = 0$, and $b = 1$, so that the actual items will differ from the predicted items only by the forecast error, e. Of course, a forecast can be unbiased and still inaccurate, greatly overestimating the budget in some years, and underestimating it in others. The more accurate the forecast, the smaller the standard error of the estimate.

The second regression examines the relationship between revenue and expenditure:

$$\text{fiscal expenditure} = c + d\ \text{fiscal revenue} + e'$$

[17]This section is considerably more technical than the rest of the document.

If governments spend all of the revenue they receive, then $c = 0$, and $d = 1$, so that expenditure and revenue will differ only by the error term, e'.

Before performing the regressions, we converted all the data (except oil prices) to logarithmic form, in order to be able to interpret the coefficients as elasticities, and took first differences, in order to avoid problems of non-stationarity. Thus the actual regressions run are of the form:

$$\%\Delta \text{ actual budget item} = a + b\ \%\Delta \text{ predicted budget item} + e$$

$$\%\Delta \text{ fiscal expenditure} = c + d\ \%\Delta \text{ fiscal revenue} + e'$$

where $\%\Delta$ indicates the percentage change from the previous year's value.

Table 5 presents the regression results. Starting with the forecast-ability regressions (panel A), none of the intercept (a) estimates is significantly different from zero at the 95 percent confidence level, and all of the slope estimates are less than one, although none is significantly less than one at the 95 percent level.[18]
The implication is that year-to-year percentage changes in petroleum and total fiscal revenue, as well as expenditure, are less than the changes predicted in the budget. Since budgets usually predict an increase in revenue and expenditure from the previous year, the result indicates that on average, these increases are smaller than expected.

Table 5: REGRESSION RESULTS

a. forecast ability

$$\%\Delta \text{ actual budget item} = a + b\ \%\Delta \text{ predicted budget item} + e$$

	a		b	
Venezuela				
tax-reference price	0.23	(2.30)	0.16	(0.40)
market price	0.15	(1.76)	0.18	(0.38)

[18]We follow the statistical convention of accepting a result if we can be 95 percent confident that it is true.

petroleum fiscal revenue	0.15 (0.16)	0.42 (0.33)
total fiscal revenue	0.00 (0.11)	0.94* (0.31)
total spending	0.02 (0.65)	0.95* (0.25)

b. relationships between fiscal revenue and expenditure

$$\%\Delta \text{ fiscal spending} = c + d \; \%\Delta \text{ fiscal revenue} + e'$$

	c	d
Venezuela		
petroleum fiscal revenue	0.12 (0.06)	0.53*^ (0.10)
total fiscal revenue	0.04 (0.02)	0.88* (0.06)

Notes: standard errors in parentheses
price changes are in absolute ($/barrel), rather than percentage form
* indicates an estimate different from zero at the five percent level
^ indicates a slope estimate different from one at the five percent level

In other words, our best estimate is that the forecasts contain a systematic bias toward overoptimistic projections of future revenue and expenditure. For example, a budget prediction of a 10 percent increase in oil revenue is, on average, associated with an actual increase of only 4.2 percent. However, the limited sample size (19 years) makes our estimates very imprecise, and we are therefore not able to reject the hypothesis of unbiased forecasts for any of the budget items. In the case of price forecasts, both the slope and intercept are insignificantly different from zero for both Venezuelan average tax-reference prices and market prices, indicating that predicted changes in these prices are unrelated to actual price changes.

Turning next to the relationship between revenues and expenditures, the B panel of the table indicates that roughly half of increases in petroleum fiscal revenue are spent in the year they are collected. Venezuela spent all of its fiscal revenue increases.

III. CASE STUDY OF HEDGING BY AN OIL-EXPORTER: MEXICO

A. Introduction

Although risk management is undertaken by exporting-country governments and state organizations for some commodities, e.g., cocoa (see Claessens and Varangis 1991), and gold (see Verleger 1993), the petroleum sector is characterized largely by an absence of such activity. Hedging by national oil companies in petroleum-exporting countries is limited primarily to industrialized countries, e.g., Petro Canada and Statoil. This section presents a brief case-study of the experience of Mexico, as well as mentioning a few other examples in passing.

B. Mexico

1. Budget Hedging

Mexico pioneered risk management techniques among oil-exporting countries with its Petrobonos [Petroleum Bonds] in 1977.[19] Petrobono holders received a quarterly coupon payment of 12.66 percent (10 percent after Mexican taxes). Repayment of the bond's principal at maturity (three years) was linked to the price of Mexican oil (based on the average export price for the month preceding the maturity date). Petrobonos allowed the Mexican government to borrow at lower rates (which lenders were willing to receive because they participated in any oil price increase), and to pay back more only when it was receiving more revenue from higher oil prices. The Mexican government raised funds for petroleum development with five successful Petrobono issues in the 1970s and 1980s.

The best-known example of use of derivatives for risk management by an oil-exporting-country central bank is that of the Banco de Mexico. The Mexican Finance Ministry designed a hedging program to protect revenues for the state budget during the Gulf Crisis. During this period petroleum accounted for about 35 percent of government revenue, a much lower level than in many oil-exporting states

From November 1990 to February 1991, the central bank entered into futures, options, and swap contracts to ensure an export price of $17 per barrel, the price assumed in Mexico's 1991 budget. About 120 million barrels for delivery in the first half of 1991 were hedged through the sale of futures, purchase of put options, and taking the fixed-price side of short-term (up to one year) swaps. The hedges covered about half of Mexican exports of 1.3 million barrels/day. The trades were spread over several weeks to minimize any impact on derivatives prices.

The central bank again hedged oil revenues to protect the state budget during the first quarter of 1993, this time purchasing NYMEX put options with a strike price of $19/barrel for WTI, equivalent to about $13.50/barrel for Mexico's export slate. About 150 million barrels for delivery in 1993 were hedged, covering about 30 percent of Mexican exports for the year.

Both of these hedges turned out to be profitable for Mexico, because crude oil prices fell sharply in the first half of 1991 and the second half of 1993. The profitability of the transactions and the fact that they

[19]Information about Petrobonos is from Priovolos (1991).

turned out be prescient ex post is less important, however, than the fact that they served to guarantee a portion of the government's revenue.

2. Commercial Hedging[20]

It is not known whether the Banco de Mexico has hedged at other times, but the sales and trading arm of the national oil company, Petróleos Méxicanos (PEMEX), actively hedges its profits using both exchange-traded and over-the-counter contracts. Petróleos Méxicanos International (PMI) markets PEMEX's crude oil exports, as well as exports and imports of petroleum products.

PMI acts as a broker on the crude side, negotiating PEMEX's sales contracts, but faces no price exposure, and thus does not utilize crude oil derivatives contracts. Although PEMEX is one of the world's largest crude-oil-producing (2.7 mmbd) and crude-oil -exporting (1.3 mmbd) companies, it does not hedge its oil-price exposure. (As noted above, the central bank has hedged the portion of PEMEX's profits that are paid as taxes). In contrast, currency and interest rate risks are managed.

PMI does face price risk on the petroleum-product side (products trade is currently 250 mbd), however, since it purchases products from PEMEX, and then resells them both domestically and internationally, as well as purchasing products internationally for import into Mexico (Mexico is a net exporter of some products an importer of others). Sometimes PEMEX' s products are resold immediately on the same terms ("back-to-back deals"), so that no exposure is generated (these product sales are analogous to crude sales), but often they are not. Instead products may be stored, or sold under contracts based on price indices, thus generating price exposure.

PMI hedges its product purchases and sales on exchanges when futures contracts are available, using swaps when they are not (e.g., jet fuel), with maturities out to 3 months as of mid-1995. The main sources of risk are indexation (due to differences in formulas between PMI sales contracts and purchases from PEMEX) and timing (due to price movements between PMI's purchase date and sales date), both relatively short-term issues. After studying derivatives markets for two years, PMI started paper trading in 1992, and is still moving down the learning curve of risk management; paper-contract maturities are likely to be extended to a year in the near future.

Although PMI's trading strategy is described as "hedging," it is in practice far more sophisticated than protection of price margins on PEMEX's refined products, which PMI is charged with marketing. The goal is "flexibility" in marketing, which means tailoring contracts for purchasers needs, and charging differentially for the services PMI provides. PMI also trades on behalf of its clients; such "third-party trading" is important in middle distillates, fuel oil, and residual oil.

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[20]Information in this section is based on Petroleum Intelligence Weekly (1991), Petroleum Argus (1993), Claessens and Varangis (1995), and discussions with PMI officials.

Mexico is one of the few oil-producing countries that exports significant volumes to the Americas, Europe, and Asia, and PMI has gained expertise in trading internationally. The company's trading is not based solely on cargoes imported into or exported out of Mexico. Rather, PMI looks for arbitrage profits between cash markets, and between cash markets and paper markets, in petroleum products worldwide. Paper trading is limited by rules regarding the company's maximum open positions and capital exposure (positions are marked-to-market daily), not the source or destination of the physical commodity underlying the contracts traded.

Thus, despite the fact that PEMEX is in many ways typical of national oil companies in oil-exporting countries -- large in terms of labor and role in the national economy and budget, protected from competition domestically, and subject to often-intense political scrutiny -- the company has succeeded in instituting physicals and derivatives trading on a commercial basis similar to that of large private oil companies, by creating a separate trading arm to handle risk management and arbitrage opportunities.

C. Other Examples

Examples of use of risk management techniques by state organizations in the petroleum sector are chiefly on the importer side. While many oil exporting countries have studied risk management techniques, few have used them. When the Alberta Petroleum Marketing Commission marketed the province's crude-oil exports, it engaged in commercial hedging of inventories, etc. Ecuador's central bank has hedged the country's oil revenues (Verleger 1993). Petróleos de Venezuela recently announced its intention to adopt some of these techniques (Donnelly 1995).

In 1989 Sonatrach, the Algerian state oil company, borrowed $100 million at a floating rate over seven years from a syndicate of international banks led by Chase Manhattan.[21] Sonatrach was able to obtain a lower interest rate by embedding call options in the loan. When oil prices rise, the banks can call for higher payments on the loan. Sonatrach's risk is reduced because it makes the higher payments only when it is receiving more revenue. The protection is only partial, however, because when oil prices fall, Sonatrach does not pay a rate lower than the base rate in the loan (LIBOR + 1%). More recently, Brady Bonds (the restructured debt of many developing countries) issued by Mexico, Venezuela, and Nigeria, have payments linked to oil prices.

IV. CONCLUSION

This paper has examined the forecasting performance of Venezuela, a major petroleum-exporting country. Our major findings are two. First, the ability to forecast their petroleum fiscal revenue on an

[21] Information in this paragraph is from Claessens and Varangis (1995).

annual budget cycle is poor. Given the volatility of petroleum prices, this result is not surprising. What is surprising is the lack of risk management to protect the government budget. We examined a case of such risk management in a country where it is less important – Mexico.

The second finding, that windfalls (unexpected increases in fiscal revenue) in revenue are not saved, and thus that shortfalls (unexpected decreases in fiscal revenue) result in unplanned cuts in government spending, indicates that these countries stand to benefit greatly from smoothing their petroleum income through hedging activity.

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