Pemex: oil price and financial management in the context of elevated fiscal burden

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Abstract

Purpose – The article analyzes how oil price fluctuations are reflected in the management of Petróleos Mexicanos (Pemex) based on its balance sheet (BS) and particularly how oil price fluctuations affect Pemex's corporate income.

Design/methodology/approach – The author uses a vector auto-regressive (VAR) model with seven variables for the period 1977–2019. The first variable is the oil price and the others belong to Pemex's BS: total income, sales revenue, operating costs, investment, payment of taxes, duties and contributions (TDC) and the payment of interest on debt.

Findings – The results show that in an environment of elevated fiscal burden that is of an excessive payment of tax by Pemex to the state, the price increases positively affected the income obtained from sales, but that surplus is used primarily to finance the fiscal expenses coming from the TDC, which is associated with the production and commercialization of hydrocarbons; physical and financial investment is disconnected from the evolution of price. Under a fiscal scheme that extracts, on average, 98.46% of Pemex's income, investment is not a priority.

Practical implications – The findings of the research have important implications for Mexico's energy policy because of affecting the long-term financial and productive sustainability of Pemex.

Originality/value – First, the study contributes to the literature on oil prices in Mexico by analyzing Pemex's fiscal burden from a corporate finance perspective, an area in which there are few rigorous studies. Second, the study contributes by providing quantitative support for the relationship between oil prices and BS variables through the VAR model.

Keywords Oil price, Pemex, Oil tax, VAR model, Balance sheet

Paper type Research paper

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Introduction

The influence of oil price in oil endowed economies, also called "petro-states", has been analyzed from different perspectives (Priest, 2012; Alekperov, 2015; Bouoiyour *et al.*, 2017; Sánchez, 2016). The effects of price volatility depend on the social, economic and geopolitical conditions of the country or region. In the case of Mexico, the economy is marked by the "paradox of abundance" or the "resource curse" (Sánchez, 2016); oil revenues contribute between 25 and 30% of public revenues (CEFP, 2019), making it, highly dependent on them (Anderson and Park, 2016; Huizar, 2015; Sierra and Méndez, 2017). Mexico is among the top 20 crude oil-and-condensate-producing and -exporting countries (EIA, 2020). Compared to other oil companies, Pemex is cost-competitive and profitable (Pemex, 2020a). However, the link between oil and public finances is an opportunity cost at a corporate level. The bonanzas from price increases go mostly to finance the federal budget through TDC, which, during 1977–2019, represented, on average, 98.5% of Pemex's profits (Pemex, 2019a, b; SIE, 2019).

At a corporate level, the best way to look at the price effect is through the BS (Cornejo *et al.*, 2012; Morales *et al.*, 2013). On a financial level, the situation of Pemex is defined by two variables, which play a determining role in the cash flow achieved annually: the oil price and the payment of TDC. The payment of TDC is an expense recorded in the BS and an accounting overview of inflows and outflows that reflects the balance of losses or profits of the firm at the end of the year (Pemex, 2019a). Conversely, the price is an external element to Pemex which is regulated by the international market, and in Mexico, that is taken as a reference to prepare the federal budget due to its influence on the public income and the investment decisions (Rodríguez and López, 2019; Reed *et al.*, 2019).

In BS, the annual balance is determined by making a sequential subtraction of Pemex's total income, which, in turn, is determined by the oil price. The objective of this study is to understand how oil price expansions are reflected in Pemex BS and how they affect its corporate income and investment. For this purpose, six variables are used as follows: (1) total income; (2) sales revenue; (3) operating cost; (4) investment; (5) payment of TDC (6) payment of interest on debt. Total income includes sales of goods and services (internal and external); operating cost, salaries, rents and purchase of supplies; investment, i.e. the use of capital in various activities that yield benefits; TDC, i.e. the payment of tax obligations to the state and interest, i.e. the cost of indebtedness (Pemex, 2019a). This information is incorporated into a VAR model, which has been used in different research on oil prices (Cologni and Manera, 2008; Muhammad *et al.*, 2018; Mirmirani and Cheng Li, 2004; Ismail *et al.*, 2021; Kamaljit and Vashishtha, 2020).

Oil in Mexico is managed by a company that has its own accounting records where it reflects revenues and expenses that are equally affected by price. However, Pemex embodies two contradictory objectives within the national economy. On the one hand, it serves as a financial ark for the public treasury, which obtains a third of its financing from oil revenues; on the other hand, it needs resources to strengthen itself corporately (Pemex, 2019b). Over time, Pemex management adjusts to the two scenarios which cannot be linearly related, as it would be proposed by a deterministic regression model that omits mutual adjustment dynamics of variables. Consequently, this research uses a VAR model because it assumes endogenous dependence of variables, i.e. the price and BS variables are mutually determined and are not the result of rational processes (Sims, 1982; Rodríguez, 2011). It should be noted that the results support this endogenous dependence between variables; however, there is a strong bias in favor of using Pemex financial management as an instrument of tax collection over the productive strengthening of the company. The contribution of the paper, in this sense, is an analysis of a corporate and accounting vision of Pemex. The results give solid support to the recommendation of reducing the tax burden and an impulse to new research with a micro-economic or financial focus, focusing on an in-depth proposal of a real plan for recovery and strengthening of Pemex, as opposed to the alternative of leaving it in the role of a supplier of public funds, exclusively (Sánchez, 2016; Hernández and Bonilla, 2020). Our first hypothesis is that Pemex responds to the state tax collection objectives and, at the same time, has investment needs; these two elements compete at a financial level, affecting the use of available resources. The second is that the oil price has a positive impact on Pemex's total income, but all the potential effect on investment is absorbed by TDC.

The rest of this paper is structured as follows. Section 2 reviews the most relevant literature on oil prices and literature focused on Mexico. Section 3 presents descriptive statistics on oil price, oil revenues and oil production, as well as a financial description of the variables and BS balance. Section 4 describes the method. In Section 5, the paper exhibits the results while Section 6 discusses them, including practical implications of the research. Finally, Section 7 presents the conclusion.

Literature review

Regarding oil price, the same variation is perceived differently by households, politicians, financial markets and economists (Baumeister and Kilian, 2016), depending on the conditions of each country, its position (oil exporter or importer), macro-economic policy and its level of development (Derbali *et al.*, 2019). This has been corroborated by Muhammad *et al.* (2018), for BRICS economies with a time-varying structural vector auto-regressive (TV-SVAR) model, which simulates the transmission dynamics of the effects stemming from random shocks and by Cologni and Manera (2008) for G-7 countries with a structural-cointegrated VAR model. In general, global energy demand reshapes oil trade (Priest, 2012), influencing the productive dynamics of countries (Shen *et al.*, 2018; Abboud and Betz, 2021) and the best incentive for oil investment, in the face of price uncertainty, is non-distortionary taxes (Blake and Roberts, 2006).

Unlike companies that demand oil-derived inputs and experience a rise in costs, price expansions benefit those that produce oil, since they generate a higher-cash flow than expected. In this sense, the studies of Iqbal and Shetty (2018) are important, which address the impact of oil prices on capital expenditure of a group of oil companies, applying a VAR model, impulse-response function (IRF) and augmented-Dickey–Fuller test; they find that price effect depends on the sector in which they are located (exploration and extraction and refining) and size. ElFayoumi (2018) performs a similar analysis for USA companies in the manufacturing, commercial and mining sector, using a financial approach and a VAR model. His results show that price variations do affect company profits And that of Wahhed *et al.* (2018), who estimate the effect of price on the stocks of companies in different sectors in Pakistan, finding that an increase gives positive signals to stock markets, boosting their performance. VAR models were born as a solution to classical econometric modeling based on the work of Sims (1982). Sims strongly criticized the classical macro-econometric models, since they do not consider many restrictions of economic theory that would cast doubt on the veracity of the results obtained (Rodríguez, 2011, pp. 86–87).

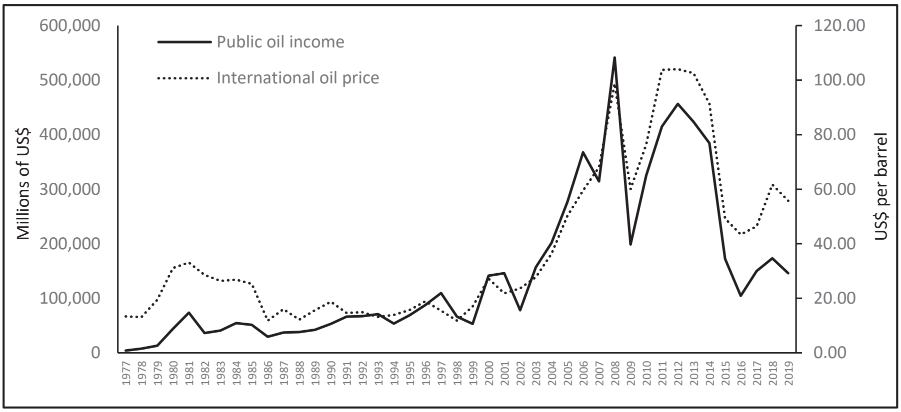
In the case of Mexico, oil is usually examined from a sectoral perspective and particularly from its contribution to public revenues (Bazán and González, 2011; Beshears, 2013; Fuentes and Cárdenas, 2010; Martínez, 2004; Sánchez, 2016; Silva *et al.*, 2021; Huizar, 2015). Pemex is crucial for the Mexican state. Well-documented economic and market-based reasons (Álvarez, 2014; López and Nava, 2018; Salazar and Venegas, 2018), among other reasons, highlight the strategic value of oil and the possibility that Mexico can play its oil card to enhance its development. Pemex is a firm that, despite the policy of fiscal asphyxiation which has characterized it, has survived and generates profit. If the fiscal burden, the cost of its debt and other liabilities had been administered in the past within a framework balancing the national and business priorities, they could have been covered adequately or with minimal damage to the corporate finances, taking advantage of the periods of high prices that also led to higher income (Rodríguez and López, 2019; Sánchez, 2016). Any strategy to revitalize and stimulate oil activity requires considerable resources and high prices as incentives for investment (Bazán and González, 2011). The current government has undertaken a rescue plan for Pemex, which is a task of maximum complexity due to financial fragility caused by tax burden, excessive indebtedness (which exceeds US$100bn) (Fitch Ratings, 2020) and a drop in production (Hernández and Bonilla, 2020). Most notably, Pemex is once again playing an important role in national politics and is expected to progressively improve its presentation card in the global environment (Pemex, 2019b; Álvarez, 2014; Durán-Encalada and Paucar-Cáceres, 2012; Cabrera and Díaz, 2021).

The originality of the research consists of examining the impact of oil prices at the company level using Pemex BS variables, which is something that in the case of Mexico has not been proposed in the literature. The benefit from price increases is diluted by subtracting TDC payment, which is the highest compared to the rest of the BS expenditures. The VAR model captures this situation, giving quantitative support to the analysis and demonstrating empirically that Pemex management, in the face of oil price variations, privileges payment of TDC over investment.

Pemex financial statement, 1977–2019

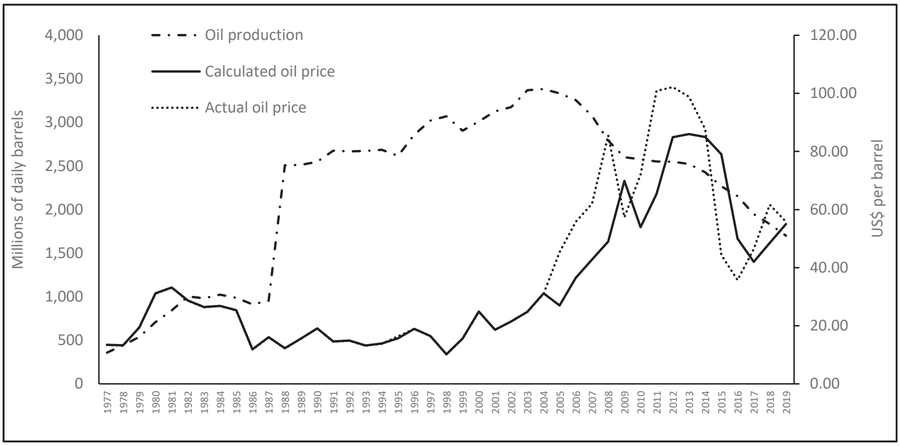
This section presents descriptive information on the trajectory of oil prices, public oil revenues and oil production during 1977–2019. Likewise, BS variables are used in the VAR model; their description and position in each of the formulas and the financial margin when subtracting each outlay. In general, the analyzed series shows a strong trend component. As shown in Figure 1, the oil price determines the magnitude of Mexico's oil revenues, which is a country that is trapped in the "paradox of abundance" (Huizar, 2015; Sánchez, 2016; Sierra and Méndez, 2017). Oil contributes one-third of public revenues and is a volatile variable (SIE, 2019).

Although production had the possibility of being strengthened by price increases, it fell progressively for 15 years (2004–2019) (Figure 2). Funds were not allocated for the development of new oil fields or for the improvement of crude oil processing in refineries (Pemex, 2019b; Silva *et al.*, 2021). Pemex's investment was not favored by price dynamics and private capital inflow after the 2013 reform, which promised to be the solution to the needs of capital, was not as expected (Menchar, 2015). The outcome was that production went from 3,371 million barrels a day (mbd) in 2003 – the highest amount – to 1,701 mbd in 2019.



Source(s): Own elaboration based on SIE (2019) and CEFP (2019)

Figure 1.
Public oil income and oil price, 1977–2019



Source(s): Own elaboration based on SIE (2019) and CEFP (2019)

Figure 2.
Oil production and oil price, 1977–2019

In terms of income, production capacity and brand equity, Pemex is the most important company of Mexico and one of the largest in Latin America, a region where it ranks number one in phosphate production. It is one of five companies with the largest logistics infrastructure in the world (Pemex, 2020a, b). Considering profit and loss statements, Pemex's earnings before interest, taxes, depreciation and amortization (EBITDA) leaves it at a margin of 33% over net earnings, exceeding the ones generated by similar companies in other industries and by larger oil production companies. On the other hand, if it is appraised using the corporate indicators of the financial balance, as shown in Table 1, the average profit margin from 1977 to 2019 before payment of TDC (BBTDC) is 58.7% (formula 2) and drops to 4.5% after deducting the amount of the payment of TDC (formula 3). After deducting interests, it drops further to −2.9% (formula 4).

The profit margin, before and after TDC, shows that the tax burden represents a structural problem as it restricts the generation of enough cash flow not only to meet investment requirements, but also to obtain acceptable profits after taxes. If the oil price is taken into consideration along with the indicators above, the payment of TDC, for the time being, and only descriptively, has the closest relation to the oil price, which, in financial terms, poses a high-opportunity cost to the other indicators (Figure 3). Pemex creates value and has of the oil industry highest EBITDA margins and BBTDC when analyzed using the method herein (Figure 4). Tax burden remains the main problem for the company, regardless of whether it continues focusing on extraction or seeks to reactivate the whole production chain (Pemex, 2019a, 2020a).

Method

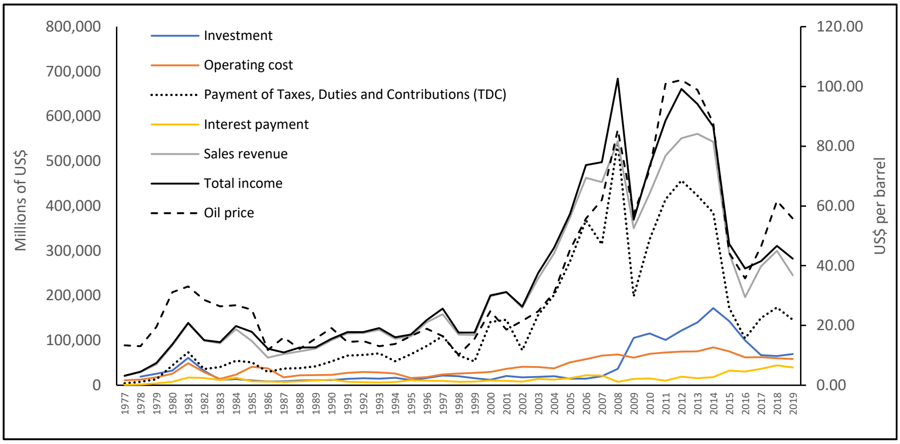
Sample and variables

Data obtained monthly from variables for the period between 1977 and 2019 amount to 516 observations. They correspond to the oil price and the BS indicators, which are described in Table 1. Data were obtained from the Subdirección de Programación y Presupuestación de la Dirección Corporativa de Finanzas de Pemex (Subdivision of Planning and Budgeting of Pemex's Corporate Direction of Finance) and the Sistema de Información Económica del Banco de México (SIE) (Bank of Mexico's Economic Information System, SIE for its Spanish

Table 1.
Indicators from Pemex's financial balance and average profit margin, 1977–2019

BS indicators	Description	Formulas	Profit margin (%)
Total income	Including income from sale of goods and services (internal and external), as well as other sources	1. Operational balance (OB) = Total Income -Operating cost	1. OB = 78.0%
Sales revenue	Internal and external sales of goods and services		
Operating cost	Personal services, acquisitions and others		
Investment	Physical and financial investment, as well as transfers to Pemex's subsidiaries	2. Balance before TDC (BBTDC) = Operational balance–Investment	2. BBTDC = 58.7%
Payment of Taxes, Duties and Contributions (TDC)*	Payment of taxes, duties and contributions (TDC)	3. Balance after TDC (BATDC) = balance before TDC -TDC	3. BATDC = 4.5%
Interest payment	Expenses resulting from the payment of interest on domestic and foreign debt	4. Financial balance (FB) = balance after TDC – Interest payment	4. FB = –2.9%

Note(s): *Indicator linked to the company's tax burden
Source(s): Own calculations based on data from Pemex's Financial Balance for 1977–2019 (Pemex, 2019a)



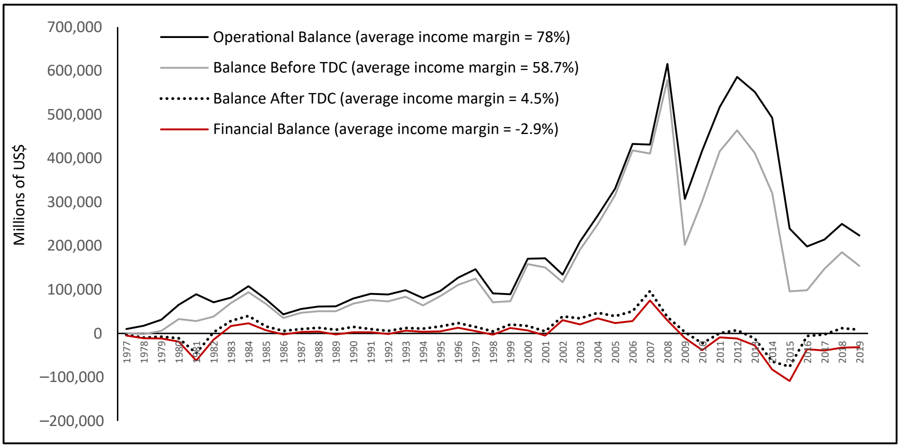
Source(s): Own elaboration based on Pemex (2019a) and SIE (2019)

Figure 3.
Oil price and Pemex's financial indicators, 1977–2019

acronym). In this period, information availability and the possibility of having a homogeneous database was key, which was built for a total of 42 years – a period long enough to reaffirm what some studies conclude about Pemex profitability before TDC (Cornejo *et al.*, 2012; Morales *et al.*, 2013). For simplicity, Table 2 presents BS variables on an annual basis (in dollars and their averages), following the corresponding financial sequence.

Procedure

The VAR model has been useful in several studies on oil price (Mirmirani and Cheng Li, 2004; García *et al.*, 2018; Ali *et al.*, 2018; Cologni and Manera, 2008; Muhammad *et al.*, 2018).



Source(s): Own calculations based on Pemex (2019a) and SIE (2019)

Figure 4.
Pemex's financial balance, 1977–2019

The analysis in Section 3 allowed identifying some important relationships between oil price and BS variables, which can be verified with a VAR model, whose assumptions are that the series used are non-stationary and that there are lagged effects with each other and with the variables. Furthermore, there is endogeneity among variables; at one end, the selected variables depend on each other. The dynamic relationships of variables are analyzed with the Granger causality test, which determines causality unidirectionality or bidirectionality, and the IRF, which estimates the magnitude and persistence of the responses of variables to unexpected shocks (Ismail *et al.*, 2021; Kamaljit and Vashishtha, 2020). The VAR model accommodates the fact that Pemex management responds to conflicting interests that a linear model could not represent (Sims, 1982; Rodríguez, 2011). As mentioned, the findings of Iqbal and Shetty (2018) and ElFayoumi (2018), who applied the VAR model to analyze the impact of oil price variations at the company level, were the most useful. About the procedure, the augmented-Dickey–Fuller unit root test corroborates series stationarity. The lagged test, Akaike information criterion (AIC), determines the lagged effects of variables. The χ^2 test obtains the significance level. The Granger causality test defines the unidirectional or multi-directional character of lagged values of variables; the significant relationships obtained are measured with the IRF (Ehrmann and Valla, 2003).

Results and analysis

Figure 5 shows the original series. Pemex's financial indicators and the oil price show high volatility (short-term cycles, as well as stationary and random effects) and non-stationarity (a mean and variance that change through time, thus displaying a trend), which is confirmed by performing the augmented-Dickey–Fuller test for unit root (Table 3).

By applying a logarithmic transformation to obtain stationary data, a system of seven equations, with a 12-month difference is obtained as follows:

$$Growth\ in\ investment = \ln(investment_t) - \ln(investment_{t-12}) \tag{1}$$

$$Growth\ in\ operating\ cost = \ln(operating\ cost_t) - \ln(operating\ cost_{t-12}) \tag{2}$$

$$Growth\ in\ TDC = \ln(TDC_t) - \ln(TDC_{t-12}) \tag{3}$$

Table 2.
Pemex's financial balance, 1977–2019 (US$)

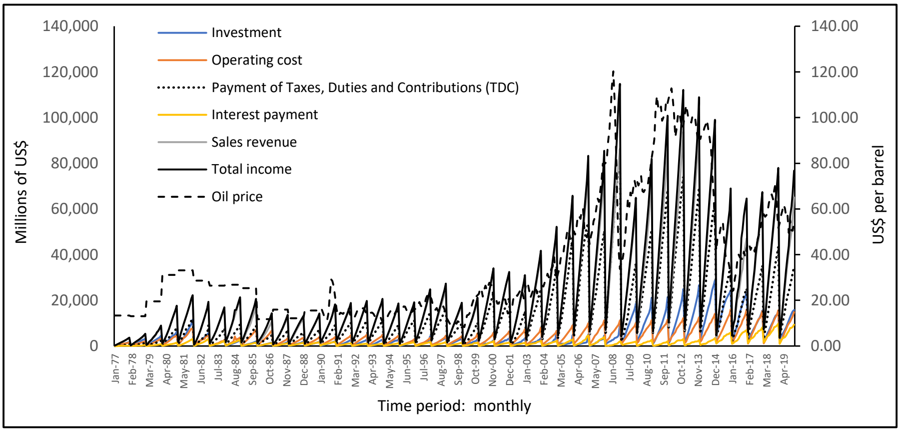
Year	Total income	Operating Cost	Operational balance (OB)	Investment	Balance before TDC (BBTDC)	Payment of taxes, duties and contributions (TDC)	Balance after TDC (BATDC)	Interests	Financial balance (FB)
1977	21,260	11,165	10,095	9,482	613	4,215	−3,603	1,080	−4,683
1978	29,965	12,578	17,387	18,993	−1,606	7,664	−9,270	1,842	−11,112
1979	49,402	17,864	31,538	25,654	5,884	13,143	−7,259	4,046	−11,305
1980	90,995	25,591	65,405	32,478	32,927	44,048	−11,122	7,760	−18,882
1981	139,023	49,296	89,727	61,252	28,475	73,748	−45,273	16,953	−62,226
1982	100,403	29,341	71,062	32,341	38,721	36,196	2,525	16,383	−13,857
1983	95,994	14,313	81,682	12,209	69,473	40,885	28,588	11,749	16,839
1984	131,919	23,819	108,100	13,762	94,338	54,452	39,887	16,606	23,281
1985	119,223	41,110	78,113	10,782	67,331	51,152	16,179	8,797	7,383
1986	81,561	37,756	43,805	8,539	35,266	29,439	5,827	7,958	−2,131
1987	73,353	17,548	55,805	8,639	47,166	37,052	10,114	6,942	3,172
1988	83,905	22,335	61,569	10,613	50,956	38,133	12,823	8,615	4,208
1989	84,359	22,647	61,711	11,144	50,567	42,051	8,516	10,818	−2,303
1990	103,383	23,352	80,031	11,703	68,328	53,112	15,216	12,657	2,559
1991	118,327	27,779	90,548	14,163	76,385	66,311	10,073	7,550	2,523
1992	118,780	29,804	88,976	15,853	73,122	67,464	5,658	6,880	−1,222
1993	127,362	28,723	98,639	14,873	83,766	71,096	12,670	6,358	6,313
1994	106,978	26,136	80,842	16,614	64,228	53,468	10,760	7,228	3,533
1995	113,103	16,127	96,977	11,656	85,320	69,139	16,181	11,291	4,890
1996	145,488	18,279	127,209	16,182	111,027	87,548	23,478	10,423	13,056
1997	171,069	24,182	146,887	21,893	124,994	109,762	15,232	9,738	5,493
1998	117,431	25,942	91,490	20,275	71,214	66,588	4,627	7,639	−3,013
1999	117,456	27,783	89,673	15,889	73,783	53,234	20,549	8,014	12,535
2000	200,529	29,870	170,659	12,195	158,464	141,247	17,218	10,563	6,655
2001	207,974	36,531	171,443	20,709	150,734	146,013	4,721	9,677	−4,956
2002	175,458	40,897	134,561	17,441	117,120	78,286	38,834	8,315	30,519
2003	250,613	40,581	210,033	18,692	191,341	156,866	34,475	13,974	20,500
2004	306,900	37,780	269,120	20,095	249,025	201,660	47,365	12,852	34,513
2005	382,269	51,268	331,001	14,829	316,172	276,469	39,703	15,875	23,828
2006	491,063	57,911	433,151	14,862	418,289	367,687	50,602	22,075	28,527
2007	497,696	66,148	431,548	20,384	411,164	314,453	96,711	21,449	75,261

(*continued*)

Table 2.

Year	Total income	Operating Cost	Operational balance (OB)	Investment	Balance before TDC (BBTDC)	Payment of taxes, duties and contributions (TDC)	Balance after TDC (BATDC)	Interests	Financial balance (FB)
2008	684,003	68,415	615,588	36,618	578,970	541,414	37,556	7,744	29,812
2009	369,138	61,509	307,629	105,509	202,120	198,664	3,456	14,119	−10,663
2010	488,455	70,101	418,354	115,408	302,946	325,532	−22,586	15,406	−37,992
2011	590,447	73,302	517,144	101,203	415,942	414,985	956	10,109	−9,152
2012	660,794	75,025	585,770	121,908	463,862	456,491	7,371	18,949	−11,578
2013	627,507	75,478	552,028	140,250	411,779	423,467	−11,688	15,701	−27,389
2014	577,252	84,513	492,739	171,988	320,751	384,658	−63,906	18,371	−82,277
2015	315,298	75,840	239,458	143,132	96,326	172,293	−75,967	32,727	−108,694
2016	260,597	62,039	198,558	99,952	98,606	104,385	−5,779	30,469	−36,248
2017	277,072	62,452	214,620	66,949	147,672	150,189	−2,517	36,463	−38,980
2018	310,687	60,363	250,323	64,997	185,326	173,357	11,970	44,388	−32,418
2019	282,159	58,390	223,769	69,696	154,073	145,884	8,188	39,865	−31,677
Average	239,457	40,974	198,483	41,670	156,813	147,533	9,280	14,103	−4,822

Source(s): Own calculations based on Pemex (2019a) and SIE (2019)



Source(s): Own elaboration based on Pemex (2019a) and SIE (2019)

Figure 5.
Oil price and Pemex's financial indicators, 1977–2019

Table 3.
Results of the augmented-Dickey–Fuller for unit root

Variable name	Abbreviation	Statistic $Z(t)$	MacKinnon approximate p-value for $Z(t)$
Investment	Investment	−1.425	0.5704
Operating cost	Operating cost	−1.012	0.7487
Payment of Taxes, Duties and Contributions (TDC)	TDC	−2.779	0.0613
Interest payment	Interest	−0.727	0.8396
Sales revenue	Sales	−1.893	0.3352
Total income	Income	−1.826	0.3676
Oil price	Price	−1.687	0.438

Source(s): Own calculations

$$Growth\ in\ interest = \ln(interest_t) - \ln(interest_{t-12}) \tag{4}$$

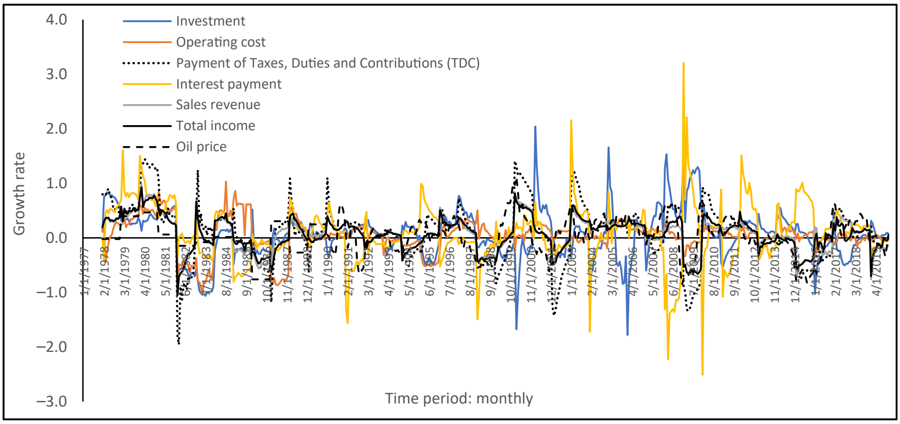
$$Growth\ in\ sales = \ln(sales_t) - \ln(sales_{t-12}) \tag{5}$$

$$Growth\ in\ income = \ln(income_t) - \ln(income_{t-12}) \tag{6}$$

$$Growth\ in\ price = \ln(price_t) - \ln(price_{t-12}) \tag{7}$$

New series are interpreted as annual growth rates (Figure 6). The unit root hypothesis is rejected using the augmented-Dickey–Fuller test, thus confirming stationarity (Table 4).

A multivariate time series regression analysis is performed. Assuming the variables' endogeneity, each variable growth is considered to be consecutively consistent with the growth of other variables or, if taken to an extreme, dependent on each other's growth. The VAR model rests on the premise that each variable helps to forecast the other ones, thus providing an equation system that is solved simultaneously and that allows characterizing its dynamics at different lag levels (Sims, 1982; Stock and Watson, 2001). The result of AIC lag test, which is used for knowing the lagged effects of a variable's performance on another variable, points to the inclusion of three lags in the model (Table 5).



Source(s): Own calculations based on data from Figure 5

Figure 6. Oil price and Pemex's financial indicators, 1977–2019

Table 4. Results of augmented-Dickey–Fuller test for unit root

Variable name	Abbreviation	Statistical analysis $Z(t)$	MacKinnon approximate p-value for $Z(t)$
Investment	Investment	−4.331	0.0004
Operating cost	Operating cost	−4.552	0.0002
Payment of Taxes, Duties and Contributions (TDC)	TDC	−4.995	0
Interest payment	Interest	−4.359	0.0004
Sales revenue	Sales	−4.587	0.0001
Total income	Income	−4.693	0.0001
Oil price	Price	−4.158	0.0008

Source(s): Own calculations

In the VAR model with three lags, there is a high degree of collinearity between the variables, total income and sales revenue (correlation of 0.99). This is because the second variable derives from the first one. The sales revenue variable was chosen due to its better fit to the model, thus leaving six out of seven initial equations. Table 6 shows the results on the goodness of fit.

The χ^2 test indicates that all the equations are statistically significant. From R-squared values, which show the variations explained by the equations, the lowest one corresponds to Interest (0.56), while the highest corresponds to price (0.88). The remaining variables show an R-squared exceeding 0.72.

The Granger causality Wald test (Table 7) served to determine whether a variable's lagged values help to forecast another variable and whether they are unidirectional or multi-directional is validated (Stock and Watson, 2001; Ismail *et al.*, 2021; Kamaljit and Vashishtha, 2020). In total, thirty relationships were assessed for the six equations, but only five relationships were statistically significant:

(1) The growth rate of operating costs and interests is consistent with the growth rate of investment;

(2) The growth rate of oil prices and sales revenue is consistent with the growth rate of TDC;

(3) The growth rate of oil prices is consistent with the growth rate of interests;

(4) The growth rate of oil prices is consistent with the growth rate of sales revenue and

(5) The growth rate of TDC is consistent with the growth rate of oil prices.

It is worth noting that the operating cost equation (2) is unable to identify any causal relationship with other variables. There is not enough statistical evidence to assume that other variables are consistent with operating costs. Therefore, for this model, these expenses constitute a variable that depends solely on its trajectory through time. Table 8 summarizes the results.

The significant relations obtained with the Granger causality test are measured using IRF over eight months as shown.

Operating cost, interest and investment

Increases in operating cost and interests have two effects on investment. The first one is positive. A 1% increase in operating cost causes an increase of 0.24% in investment, having a one-month lag which tends to disappear eventually. The second effect is negative. A 1% increase in interest reduces investment by −0.10%, whose effect also weakens over time. Based on the results from the VAR model, it is possible to state regarding the first relationship that although the operating cost had a positive impact on investment, there is no evidence suggesting that the first relationship is bidirectional. On the other hand, the negative effect of interest points to the persistent demand for resources caused by the cost of debt (see Figure 7).

Price, TDC, sales and interest

The price influences three variables: TDC, sales and interests. Regarding TDC, the most significant relationship regarding price, a 1% increase in price causes an increase of 0.36% in

Table 5.
Results of the Akaike information criterion (AIC) test

Number lags/gaps	AIC
0	8.36799
1	2.04465
2	1.84356
3	1.82507*
4	1.86261

Note(s): *statistically significant at 0.01
Source(s): Own calculations

Table 6.
VAR model goodness of fit

Dependent variable	R-squared	χ^2 Test	$P > \chi^2$
Investment	0.7322	1369.833	0
Operating costs	0.7595	1582.351	0
TDC	0.854	2929.85	0
Interest	0.5693	662.2975	0
Sales	0.832	2481.501	0
Price	0.8828	3773.589	0

Source(s): Own calculations

Table 7.
Granger causality test

Equation	Independent variable	Hypothesis test	Dependent variable	χ^2	Prob > χ^2	Result of the hypothesis	Interpretation
1	Operating cost	Does not cause	Investment	14.161	0.003	Reject	Operating cost affects investment
	TDC		Investment	3.8393	0.279	Do not reject	There is no relation
	Interest		Investment	12.45	0.006	Reject	Interest affects investment
	Sales		Investment	4.1693	0.244	Do not reject	There is no relation
	Price		Investment	4.3055	0.23	Do not reject	There is no relation
2	Investment	Does not cause	Operating cost	2.825	0.419	Do not reject	There is no relation
	TDC		Operating cost	2.3373	0.505	Do not reject	There is no relation
	Interest		Operating cost	0.8513	0.837	Do not reject	There is no relation
	Sales		Operating cost	1.3599	0.715	Do not reject	There is no relation
	Price		Operating cost	3.7763	0.287	Do not reject	There is no relation
3	Investment	Does not cause	TDC	1.2902	0.731	Do not reject	There is no relation
	Operating cost		TDC	4.8947	0.18	Do not reject	There is no relation
	Interest		TDC	5.9645	0.113	Do not reject	There is no relation
	Sales		TDC	16.449	0.001	Reject	Sales affects TDC
	Price		TDC	92.146	0	Reject	Price affects TDC
4	Investment	Does not cause	Interest	6.0351	0.11	Do not reject	There is no relation
	Operating cost		Interest	1.3069	0.727	Do not reject	There is no relation
	TDC		Interest	3.7995	0.284	Do not reject	There is no relation
	Sales		Interest	5.5828	0.134	Do not reject	There is no relation
	Price		Interest	21.152	0	Reject	Price affects interest
5	Investment	Does not cause	Sales	2.4004	0.494	Do not reject	There is no relation
	Operating cost		Sales	3.1533	0.369	Do not reject	There is no relation
	TDC		Sales	2.2716	0.518	Do not reject	There is no relation
	Interest		Sales	3.7395	0.291	Do not reject	There is no relation
	Price		Sales	88.519	0	Reject	Price affects Sales
6	Investment	Does not cause	Price	2.5166	0.472	Do not reject	There is no relation
	Operating cost		Price	0.45067	0.93	Do not reject	There is no relation
	TDC		Price	11.166	0.011	Reject	TDC affects Price
	Interest		Price	3.9405	0.268	Do not reject	There is no relation
	Sales		Price	4.0738	0.254	Do not reject	There is no relation

Note(s): The model meets the assumptions of not having auto-correlation and normality of the errors
Source(s): Own calculations

Equation	Dependent variable	Independent variables*				
1	Investment	Operating cost (a 1% increase increases the investment by 0.24%)	TDC	Interest (a 1% increase contracts the investment by −0.10%)	Sales	Price
2	Operating cost	Investment	TDC	Interest	Sales	Price
3	TDC	Investment	Operating cost	Interest	Sales (a 1% increase increases the payment of TDC by 0.38%)	Price (a 1% increase increases the payment of TDC by 0.36%)
4	Interest	Investment	Operating cost	TDC	Sales	Price (a 1% increase increases the payment of interest by 0.09%)
5	Sales	Investment	Operating cost	TDC	Interest	Price (a 1% increase increases income from sales by 0.15%)
6	Price	Investment	Operating cost	TDC (a 1% increase contracts the price by −0.005%.)	Interest	Sales

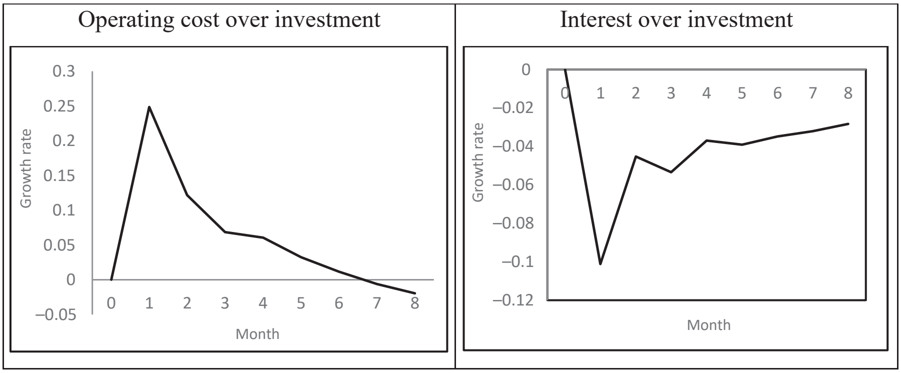
Note(s): *The variables effect corresponds to the first month of the given time period
Source(s): Own elaboration based on data from Table 7

Table 8.
VAR model results

TDC in the first month; in addition, it is the only variable exceeding 1% in the following months. For sales, of 1% increase in price causes an increase of 0.15% in sales in the first month, exceeding 0.50% in the following months; following the logical financial sequence, the effect of price must be first applied to income. Lastly, an increase of 1% in price causes an increase of 0.09% in interests in the first month. No robust evidence was found to suggest that increases in oil price or sales have an impact on investment; in other words, the variable is unrelated to price cycles and/or income. On the contrary, the most notable effect is the one that price has over TDC, which confirms the assumption about Pemex's poor-financial management, which is reflected by two facts: it provides a considerable portion of its profits for public financing and inadequate investment for the development of the energy sector (see Figure 8).

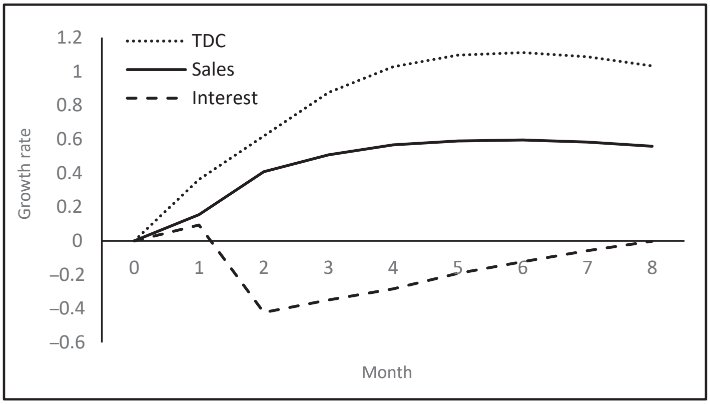
Sales and TDC

The impact of the Sales variable on TDC is another very important interaction and the result of the previous assumption. A 1% increase in Sales causes an increase of 0.38% in TDC in the first month and it remains positive in the following months (Figure 9). As shown in Figure 8, the price has an effect on TDC, but this effect is first reflected in the company's income, from which expenses are deducted to obtain the ending financial balance. Therefore, the behavior



Source(s): Own calculations

Figure 7.
IRF operating cost and interest over investment



Source(s): Own calculations

Figure 8.
IRF price over TDC, sales and interest

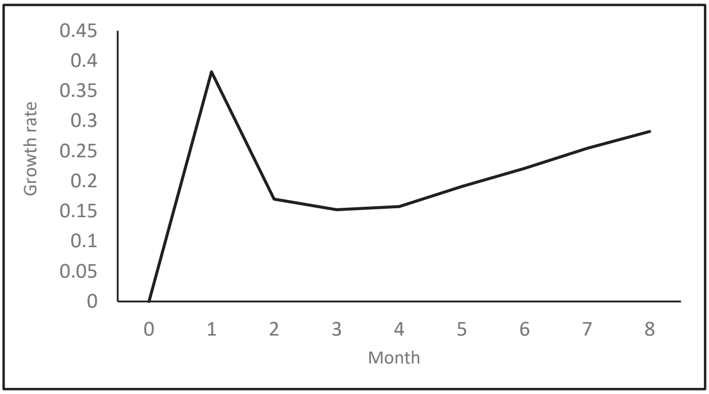
of the payment of TDC, which is related to an increase in sales, confirms the reduction of Pemex's financial margin to negative levels.

TDC and price

The payment of TDC negatively affects price. A 1% increase causes a decrease of −0.005% in the first month, which tends to worsen in the following months (see Figure 10). The interpretation here has to do with the nature of the price as a variable dictated by the international market (Cologni and Manera, 2008; Muhammad *et al.*, 2018; Derbali *et al.*, 2019). Pemex's stability and financial viability is assessed according to price volatility and the impact it has on its finances. If Pemex reacts by increasing TDC during high-price seasons, it would be sending a wrong message to the market; it would be considered insolvent to meet its current liabilities. Pemex is the only case in the world where price expansion does not increase investment but rather the tax cost of producing oil.

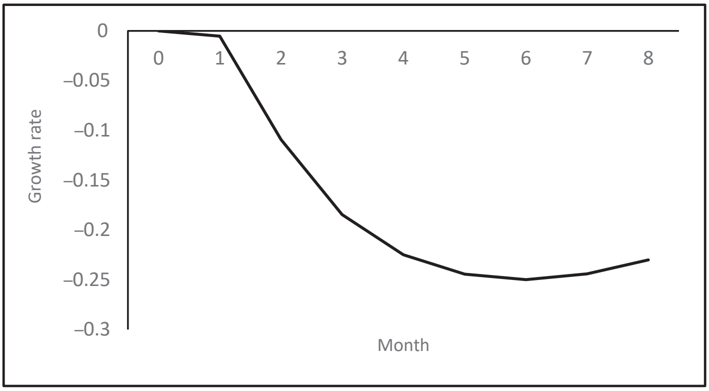
Analysis of results

From the obtained results, the most important ones are those showing a relationship between investment (1) and TDC (3) equations. The first equation shows that Pemex's physical and



Source(s): Own calculations

Figure 9.
IRF sales over TDC



Source(s): Own calculations

Figure 10.
IRF TDC over price

financial investments are unrelated to price cycles and sales; in other words, these do not have any impact on investment. It is worth noting that from 1977 to 2019 prices experienced increased seasons, staying at and even exceeding US$100 per barrel. The surplus generated from oil market dynamics, which in Mexico reported on an average annual extraordinary income of almost US$500,000m during a whole decade (2005–2014), was absorbed by the tax burden (SIE, 2019). The second equation shows that an increase in price and sales of 1% caused tax increases of 0.36 and 0.38%, respectively. In other words, the surplus resulting from price increases was extracted by increases in Pemex's tax burden and, on top of that, investment was not encouraged, all of which accounts for production cutbacks at every level of the oil production company (Fuentes and Cárdenas, 2010; Silva *et al.*, 2021; Hernández and Bonilla, 2020).

On the other hand, investment would have a positive increase of 0.24% as a result of a 1% increase in operating cost; but considering equation (2) apart, it is also unrelated to price. In fact, it only depends on itself in the model. Therefore, labor, materials, maintenance costs and general services do not increase as price increases. On the contrary, Investment decreases when the payment of interest increases, a variable on which price did have a positive effect.

Pemex is the most indebted company in the world, and since the company gets more resources during certain periods of price increases, incentives have been created to cover the cost of debt over other priorities; under normal conditions or during low-price periods, debt acquisition tends to increase in order to pay TDC (Fitch Ratings, 2020).

In general, the most notable result of the model is that price increases – reflected by financial sequence in business income growth – are absorbed by three variables, which in order of importance are as follows: TDC, sales and interests; on the other hand, it does not have any impact on the other two variables: investment and operating cost. From a corporate finance approach, Pemex lacks management oriented to value creation (Huizar, 2015; López and Nava, 2018). Strategic investment has not been considered in making long-term operational and financial decisions and it will not be if paying excessive taxes remains a structural problem. The results validate the working hypothesis: in Pemex financial management, the interest of using it for fiscal objectives prevails, and the oil price and corporate income derived from it do not have a positive impact on financial balance, since the entire effect is absorbed by TDC.

Discussion

Pemex manages a strategic resource for the Mexican economy and its contribution to public revenues is significant. The research corroborated with an empirical method (VAR model), which several studies have already analyzed about Pemex's fiscal burden (Fuentes and Cárdenas, 2010; Bazán and González, 2011; Cornejo *et al.*, 2012; Morales *et al.*, 2013; Anderson and Park, 2016). The information from the BS was essential. The influence of the oil price is easily corroborated in a "petro-state" like Mexico, but the most relevant thing was to know how it affected Pemex's corporate income and its distribution among the different financial expenditures of the company.

In that sense, the results of this research have important implications for Pemex's financial sustainability. In the realm of economic policy, they invite those responsible for the energy sector to evaluate the role it has played in the national economy. It is necessary to assess whether its finances are being managed in a balanced way and whether price expansions have really benefited from it. The results show that they have not. First, the relationship found between oil price and TDC is strong evidence of Pemex's fiscal role in the national economy and of its main function as a provider of public funds (Sánchez, 2016; Salazar and Venegas, 2018). Second, when weighing the price–investment relationship, it is also evidence of the negative impact that it generates on productivity, since it restricts investment in aspects such as infrastructure, technological development and human capital. The fiscal role of Pemex prevails, and according to the financial balance, the financial and productive cost of this is high, since oil revenues do not favor savings and investment (Huizar, 2015; Rodríguez and López, 2019). The main recommendation is that fiscal and energy policy should reconcile objectives, implementing a progressive tax reduction plan.

In the academic and research fields, a new perspective is provided by focusing on Pemex through its BS, which is a key instrument that until now the literature has overlooked. Knowing, in terms of accounting and quantitatively, the reaction of financial variables to price movements, in particular of TDC, is a significant contribution to studies that have worked on the issue of the tax burden but with a qualitative or quantitative perspective that fails to capture the real impact of the tax burden at a corporate scale (García *et al.*, 2018; Sierra and Méndez, 2017; Durán-Encalada and Paucar-Cáceres, 2012). At the same time, it opens an opportunity to further explore the micro-economic part of Pemex in its different facets, since investment, in the results of the model, is not affected by price and is a fundamental variable at the corporate level due to its relationship with asset formation, productivity and competitiveness.

Conclusion

The research examined the impact of oil price on Pemex BS in the period 1977–2019. In the VAR model, the most significant relationship found with the Granger causality test and IRF was that of price – TDC. In the face of price increases, TDC also increased (immediately and over time). In contrast, there was no evidence that price affected Investment; it is a variable disconnected from price cycles. The benefit in total income from oil price expansions was diluted by subtracting TDC payment, which is the highest BS outlay. The revenue margin and profit after TDC were mostly negative; therefore, Pemex is a company managed for fiscal purposes.

The results managed to give quantitative support to the study of the Pemex tax burden. It is suggested that future research should approach Pemex from micro-economic, financial and accounting theory. For example, going deeper into the data of its BS or income statement, whose impacts are sectorial and macro-economic. It would be interesting to study how the investment affects the formation of public capital in the sector – derived from the null impact that the price of oil has on it, associating this concept with the investment destined for productive infrastructure, research, and development of technology – which is registered in its BS, or analyze the trajectory of Pemex's corporate debt, which is the highest in the world and takes away about 10% of its total annual income through interest payments. Both perspectives could have important political implications at the national, sectoral and corporate levels. Let us remember that oil revenues account for one-third of the country's income, which determines Pemex's fiscal burden, its disposable income and its capacity to finance investment.

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