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## Pricing natural gas in Mexico: An application of the Little Mirrlees rule. The case of quasi-rents

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# **Pricing Natural Gas in Mexico: An Application of the Little Mirrlees Rule - The Case of Quasi-Rents\***

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## **Abstract**

In 1997, the Comisión Reguladora de Energía of Mexico implemented a netback rule for linking the Mexican natural gas price to the Texas price. At the time, the Texas price reflected a reasonably competitive market. Since that time, there have been dramatic increases in the demand for natural gas and there are various bottlenecks in the supply of natural gas. As a result, the price of natural gas in Texas now reflects the quasi-rents created by these bottlenecks. We address the optimality of the netback rule when the price of gas at the Texas market reflects the quasi-rents created by bottlenecks in the supply of natural gas to the United States pipeline system. In this paper, it is shown that it is optimal for the Mexican government to use the netback rule based on the Texas price of gas to set the price of natural gas in Mexico even though the Texas market cannot be considered a competitive market, and the Texas price for natural gas reflects quasi-rents created by various bottlenecks.

**Keywords:** Natural gas, welfare, pricing, Mexico, regulation

**JEL classification:** Q40, L51

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## 1. Introduction

The Comisión Reguladora de Energía (CRE) has implemented the netback rule that uses the price of gas in Texas to set the price of gas in Mexico adjusting for transportation costs since 1996.<sup>1</sup> At that time, the price of gas in Texas was viewed to be the result of a competitive market. The netback rule meant that the Mexican gas market would also have the characteristics of the Texas market as long as gas was able to move to equilibrate supply and demand.<sup>2</sup> The pricing rule was an implementation of the Little-Mirrlees proposal for pricing traded goods. (See Brito and Rosellón, 2002, and Brito and Rosellón, 2005.)<sup>3</sup>

Since then, conditions have changed. The price of gas in the United States now reflects the quasi rents to these bottlenecks.<sup>4</sup> The current pricing policy in Mexico is now imputing these economic rents to the Mexican gas. The problem is complicated by two factors. First, the revenue from the sales of the gas goes to the government and is a substitute for taxes that could be distortionary; and second, the cost of adding to gas reserves differs from the price of gas in Texas so there is an intertemporal distortion. Since there are wedges in the marginal conditions, this is a question in the Theory of the Second Best.<sup>5</sup>

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<sup>1</sup> See Comisión Reguladora de Energía (1996).

<sup>2</sup> This assumption is discussed in Brito and Rosellón (2002). Since the prices of gas in Mexico are linked to the Texas price, the viability of the netback rule required that gas be free to flow to equilibrate markets.

<sup>3</sup> Little and Mirrlees (1968) proposed the use of the world prices for traded goods, not necessarily because these prices are more rational, but rather because these prices reflect the terms under which a country can trade. Thus, the price of gas in Texas is a measure of the opportunity cost to Mexico of consuming the gas rather than exporting it to the United States.

<sup>4</sup> See Hartley and Medlock (2006)

<sup>5</sup> Lipsey and Lancaster (1956)

This note is a reexamination of the optimality of the netback rule when the base price of gas reflects quasi rents. It is shown that the netback rule is optimal. An important assumption is that the flow of gas between Mexico and the Texas is not constrained.

## 2. Model

The model must include certain essential elements. First, since the net revenue from sale of hydrocarbons by the state-owned monopoly, Pemex, goes to the government and the government captures the quasi-rents from natural gas, it is necessary for the model to have a private good and a public good to justify a role for government revenues. Since in Mexico gas is mostly a joint product of the production of oil, it is necessary to have oil in the model. It will be assumed that utility depends on consumption of the private good,  $X$ , natural gas,  $G_1$ , oil,  $Y_1$  and a public good  $Z$ .

Assume then that the utility function of the representative agent is given by

$$(2.1) \quad u(G_1, X, Y_1, Z)$$

The representative agent maximizes (2.1) subject to the budget constraint

$$(2.2) \quad F(T) = p_1 G_1 + p_2 X + p_3 Y_1 + Z$$

where  $p_1$  is the domestic price of gas,  $p_2$  is the price of the consumption good,  $p_3$  is the domestic price of oil, and  $T$  is the tax. It will be assumed that the tax can create distortions in the economy. Thus, the marginal conditions for efficiency do not hold and this is a problem of the second best. Recall that in the theory of the second best, the

existence of distortions in some markets implies that it may not be optimal to set the prices in the other markets so that the standard marginal conditions hold.<sup>6</sup>

It will be assumed that the government has two sources of revenue: taxation of individuals,  $T$ , and the revenue from the sale of oil and gas.<sup>7</sup> The purpose of government is to provide a public good. Government provides the public good,  $Z$ , and the price of  $Z$  will be normalized to 1. The planner is assumed to control the domestic price of gas. It is assumed that the price of the private consumption good and the domestic price of oil are set on the world market. The market allocates the domestic consumption of oil.

We will define

$$(2.3) \quad v[p_1, T, Z] = \max u(G_1, X, Y_1, Z)$$

as the indirect utility function. Note, that we are not including the price of the consumer good,  $p_2$ , or  $p_3$ , the domestic price of oil, as arguments of the indirect utility function as they are parameters whose value is determined by the world market. We will assume that the goal of the planner is to maximize the utility of the representative agent.

Pemex produces  $Y$  amount of oil; of this oil  $Y_1$  is consumed in Mexico and,  $Y_2$  is exported. Thus

$$(2.4) \quad Y = Y_1 + Y_2.$$

There is a flow constraint on the production of oil so that

$$(2.5) \quad Y \leq \bar{Y}$$

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<sup>6</sup> Lipsey and Lancaster (1956)

<sup>7</sup> We have looked at the problem of the redistributive impact of the netback in the context of a two-sector model. The result that the netback rule is optimal does not depend on the structure of the welfare function. Results depend on the assumption made about the curvature of the underlying utility functions. We decided to use the more general and simpler model to illustrate the result.



Associated gas,  $G_2$ , is produced jointly with oil. The production of Mexican associated gas is given by

$$(2.6) \quad G_2 = \alpha Y$$

where  $\alpha$  is a technological parameter that links the production of oil to the production of associated gas. Mexico also produces non-associated gas,  $G_3$  and there is a flow constraint,  $\bar{G}_3$ , on the production of non-associated gas:

$$(2.7) \quad G_3 \leq \bar{G}_3$$

Gas is also exported to or imported from the United States. Denote imported gas by  $G_4$  and exported gas by  $G_5$ . It will be assumed that there is a cost,  $q$ , of discovering non-associated gas.<sup>8</sup> Since non-associated gas discovered is added to the stock and since non-associated gas sold in the market is withdrawn from the stock, there are two margins for Mexico to consider. The first is the tradeoff between consumption of gas now and consumption of gas in the future. The second is the tradeoff between consuming gas and importing or exporting gas.

In summary, the sources of gas in Mexico are associated gas,  $G_2$ , non-associated gas,  $G_3$  and imported gas,  $G_4$ . Gas is used for consumption,  $G_1$  and exports,  $G_5$

$$(2.8) \quad G_2 + G_3 + G_4 = G_1 + G_5$$

Define  $p_4$  as the price of both imported and exported gas. Again, it is assumed that all prices, except the price of natural gas in Mexico, are given and fixed.

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<sup>8</sup> The problem can be formulated as a dynamic programming problem, and the variable  $q$  would correspond to the costate variable associated with the stock of non-associated gas. The value of this variable would be determined by the appropriate transversality condition. This complication is not necessary to our purposes. The condition we want to study is the case where the cost of adding reserves differs from the export price, and it is easier to assume this condition explicitly rather than assume the transversality conditions that imply this assumption.

The government sets the price of natural gas, and the tax rates. The government also chooses the production oil, and the level of exports of oil and imports of gas.

The budget constraint of government is

$$(2.9) \quad T + p_3 Y + p_1 G_1 + p_4 G_5 = p_4 G_4 + Z .$$

Government revenue is tax revenue plus the revenue from the sale of domestic gas, plus oil and gas exported. Government expenditures are the cost of imported gas plus the cost of the public good.

### 3. Optimality Conditions

If the government is maximizing welfare, the Lagrangian is given by

$$(3.1) \quad L = V(p_1, T, Z) + \lambda_1 (G_2 + G_3 + G_4 - G_1 - G_5) + \lambda_2 (\alpha Y - G_2) \\ + \delta_1 (\bar{G}_3 - G_3) + \delta_2 (\bar{Y} - Y) + \gamma (T + p_3 Y_1 + p_1 G_1 + p_4 G_5 - p_4 G_4 - Z) - q G_3$$

The first order conditions are:

A. Choice of prices, taxes and public good:  $p_1, T$  and  $Z$

$$(3.2) \quad \frac{\partial V(p_1, T, Z)}{\partial p_1} + \gamma G_1 = 0$$

$$(3.3) \quad \frac{\partial V(p_1, T, Z)}{\partial T} + \gamma = 0$$

$$(3.4) \quad \frac{\partial V(p_1, T, Z)}{\partial Z} - \gamma = 0$$

B. Extraction and Exports of Gas and Oil:  $G_3$  and  $Y$ .

$$(3.5) \quad \lambda_1 - \delta_1 - q \leq 0; \quad G_3 [\lambda_1 - \delta_1 - q] = 0$$

$$(3.6) \quad \lambda_2 - \delta_2 + \lambda_2 \alpha \leq 0; \quad Y [\lambda_2 - \delta_2 + \lambda_2 \alpha] = 0$$

C. Allocation of gas:  $G_1, G_4$  and  $G_5$

$$(3.7) \quad -\lambda_1 + \gamma p_1 \leq 0; \quad G_1[-\lambda_1 + \gamma p_1] = 0$$

$$(3.8) \quad \lambda_1 - \gamma p_4 \leq 0; \quad G_4[\lambda_1 - \gamma p_4] = 0$$

$$(3.9) \quad -\lambda_1 + \gamma p_{41} \leq 0; \quad G_5[-\lambda_1 + \gamma p_{41}] = 0$$

**Proposition**

If the Texas market price for natural gas reflects quasi-rents to a scarce factor, it is still optimal to use the Texas price to set the price of gas in Mexico and the Little-Mirrlees Rule is optimal.

Proof

The Kuhn-Tucker conditions for gas imports,  $G_4$ , and exports,  $G_5$ , given by (3.8) and (3.9) can be written as

$$(3.10) \quad \lambda_1 - \gamma p_{41} \leq 0$$

$$(3.11) \quad \lambda_1 - \gamma p_4 \geq 0$$

These two conditions can only be satisfied if both hold as equalities and

$$(3.12) \quad \lambda_1 = \gamma p_4.$$

If gas is consumed in Mexico,  $G_1 > 0$ , then the Kuhn-Tucker condition given by (3.7) must also hold as an equality

$$(3.13) \quad -\lambda_1 + \gamma p_1 = 0$$

and using (3.12)

$$(3.24) \quad p_1 = \frac{\lambda_1}{\gamma} = p_4.$$

It then follows immediately from the Kuhn-Tucker conditions that if gas is consumed in Mexico the Little-Mirrlees Rule is optimal.

**Remark**

The relevant margin for pricing gas is the tradeoff between importing-exporting gas and consumption. It is useful to understand why the intertemporal tradeoff between consumption and the shadow price of gas reserves is not the correct margin. If we examine the first order condition given by (3.5), we see that the Lagrange multiplier associated with the flow constraint on non-associated gas,  $\delta_1$ , is a wedge between the Lagrange multiplier for gas,  $\lambda_1$  and the shadow price of gas reserves,  $q$ . The implication of this condition is that if the flow constraint for the production on non-associated gas was not binding, Mexico could produce enough non-associated gas to bring the Texas price to the shadow price of non-associated gas reserves.

**4. Conclusions**

When the CRE introduced the netback rule to price of gas in Mexico, the policy could be justified as linking the Mexican market to what was a competitive market for gas in Texas. Linking the Mexican market to the Texas market made Pemex a price taker and as long as gas was free to move the Mexican gas market had most of the attributes of a competitive market.

The increase in the demand for gas has resulted in various bottlenecks in the supply of natural gas. The price of gas in the United States now reflects the quasi rents associated with these bottlenecks. The question is whether the use of the Texas price is still a good way to price gas in Mexico. This paper shows that if Mexico is importing gas, the Texas price is the opportunity cost of consuming gas; and if Mexico is exporting gas,

the Texas price is still the opportunity cost of consuming gas. It is what Mexico has to give up to consume that marginal amount of gas.

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