REGULATION OF GAS MARKETING ACTIVITIES IN MEXICO*

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Resumen: Estudiamos las implicaciones de vincular el precio del gas natural en México al del sur de Texas sobre la comercialización eficiente del gas en el primero. Argumentamos que a Pemex se le debería permitir firmar contratos *spot* o de futuros en la venta de gas. Sin embargo, el precio del gas debería ser siempre igual al precio *netback* basado en el *Houston Ship Channel* al momento de entrega. A Pemex no debería permitírsele descontar el precio del gas del precio *netback* de Houston, incluso si lo hace de una manera no discriminatoria. Esta metodología es transparente, fácil de llevar a la práctica y no elimina ninguna opción legítima de mercado para ninguna de las partes involucradas. Pemex o los consumidores de gas pueden usar el mercado de Houston para cubrirse de transacciones especulativas.

Abstract: We study the implications of linking the Mexican natural gas price to the Houston price on the efficient marketing of gas in Mexico. We argue that Pemex should be permitted to enter into spot contracts or future contracts to sell gas. However, the price of gas should always be the net back price based on the Houston Ship Channel at the time of delivery. Pemex should not be permitted to discount the price of gas from the Houston netback price even in a nondiscriminatory fashion. This arrangement is transparent, it is easy to enforce and does not eliminate any legitimate market options for any of the parties involved. Pemex or consumers of gas can use the Houston market for hedging speculative transactions.

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1. Introduction

The question we are addressing is what restrictions should be placed on Pemex's marketing activities in the natural gas market. To address this question, it is useful to review what are probably well-accepted public-interest goals for regulation.[1] These include the efficient allocation of resources, achieving some redistributive goals, simplicity, and transparency. With these goals in mind, it is clear that the decision to link the price of natural gas in Mexico to the price at the Houston ship channel by a netback rule solves some very difficult technical and institutional problems in a very simple fashion.[2] The netback rule links the price of gas at any point in Mexico to the price of gas in Houston adjusted by the cost of transportation. The natural gas market in Mexico then has all the properties of the gas market at Houston. In particular, all agents are price takers with respect to the market and the Houston market can be used by agents in Mexico for hedging and other forward contracts. The key to the implementation of this policy is that there be sufficient pipeline capacity so that the gas markets can clear and rents do not accrue to the pipelines. If there is not sufficient pipeline capacity so that the natural gas markets in Mexico can clear at the Houston netback prices, it is impossible to implement the netback rule. At the net back price, demand will be greater than supply.

A proposal that is being discussed is to change the system so that Pemex sells gas only at the point of injection.[3] The prices in the local markets would be set by local supply and demand conditions. These changes would create uncertainty in the gas market and also create the possibility of strategic manipulation of the price of gas that would be very difficult to regulate. Further, the current regulations permit the net back price to be an upper bound and Pemex can sell gas below that price if it does so in a nondiscriminatory fashion.

The reason that has been given for allowing Pemex to sell at a price below the Houston netback price, as long as the sales were non-discriminatory, is that there is no reason to restrict voluntary transaction between parties. However, there is a substantial agency

[1] Political economy goals of regulation are more general since interest group pressure could influence the design of regulatory institutions, regulatory frameworks, and industry structures (see Laffont (2000)).

[2] See Brito and Rosellón (2002).

[3] Future challenges of the Mexican natural gas reform are discussed in Comisión Reguladora de Energía (2001).

problem in these transactions. It is hard to understand why Pemex (acting as a agent for the Mexican people) would want to sell gas in Mexico for less than it could net by selling the gas in Houston. There may be policy reasons to subsidize gas in certain circumstances; however, this does not seem like a decision that should be delegated to Pemex gas marketing.

Pemex should be permitted to enter into spot contracts or future contracts to sell gas. However, the price of gas should always be the net back price based on the Houston Ship Channel *at the time of delivery.* Pemex should not be permitted to discount the price of gas from the Houston netback price even in a nondiscriminatory fashion. This arrangement is transparent, it is easy to enforce and does not eliminate any legitimate market options for any of the parties involved. Pemex or consumers of gas can use the Houston market for hedging of speculative transactions.

The Houston market can also serve as a buffer for fluctuations in Pemex's production or in demand. Pemex can vary its sales in the Houston market to smooth fluctuations in Mexico.[4] This buffer allows Pemex to only sell "plain vanilla" gas without having to engage in complex market operations in Mexico. Thus, it is very difficult to see what useful role can be played by Pemex acting as a gas marketer in Mexico. If Pemex wants to engage in speculative market behavior, it can do so in the Houston market. Houston has the advantage of being a well-developed market. Pemex's transactions in that market would not create any regulatory issues for the Comisión Reguladora de Energía, CRE, as long as Pemex sells gas in Mexico at the Houston spot netback price. As long as there is sufficient pipeline capacity so that there are no bottlenecks in transporting gas, this simple rule will result in an efficient and transparent natural gas market in Mexico.

Allowing Pemex discretion in pricing gas becomes an even more complicated problem if Pemex is allowed to sell gas for future delivery at a price other than the Houston netback price at the time of delivery. For example, Pemex can sell gas for delivery 30 days in the future at a given price and the next day sell gas for delivery 29 days in the future a different price. Technically, these transactions would not be discriminatory. Transactions that involve selling forward gas at a predetermined price would be very difficult to monitor and give Pemex gas marketers a very large amount of power and discretion.

There are important and legitimate reasons why private oil companies use forward markets to reduce risk; let us grant that such

4 This assumes that Pemex is exporting gas.

reasons may also apply a national oil company such as Pemex. Restricting Pemex to sell gas in Mexico at the Houston spot market netback price does not eliminate any options for Pemex. Linking the price of gas in Mexico to the Houston market permits Pemex to operate in these sophisticated markets with out involving their customers for gas delivered in Mexico. Further, buyers of natural gas in Mexico can enter into transactions in Houston without involving Pemex. Thus, there is no economic reason why Pemex has to operate as a gas marketer in Mexico.

It may seem more efficient to permit Pemex to enter into such transactions directly in Mexico without going through the Houston market. However, due to the vertical integration of Pemex in the gas industry, restricting Pemex to make such transactions only in the well developed Houston market reduces the possibility that Pemex could to set entry barriers to other participants in the gas commercialization business, reduces the regulatory burden in Mexico, and permits the development of proper market institutions in Mexico for futures and forward contracts.

2. Problems with Flexibility in the Netback Rule

The present regulations permit Pemex to sell gas at below the Houston netback price as long as it does so in a nondiscriminatory fashion. This policy is supported by the received wisdom in regulatory theory that holds that prohibiting a voluntary transaction on the part of two competent parties does not improve welfare.[5] However, this result does not apply in this case. The linkage to Houston means that all parties in the Mexican market are price takers. Since Mexican gas can always be sold in Houston, the value of the marginal cubic foot of gas at the well in Mexico is the Houston price less cost of transport. We will demonstrate that a policy to sell at the Houston netback price is Kaldor-Hicks superior to a policy that discounts the price of gas in a nondiscriminatory fashion.[6]

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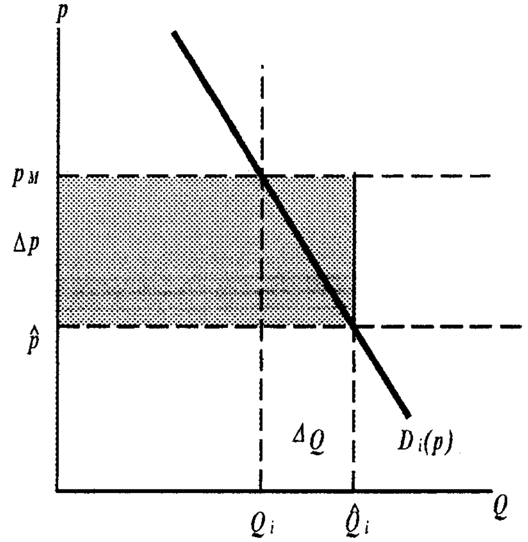
[5] Suppose the regulator forces the firm to charge prices P^0. Total welfare would be $V(P^0) + \alpha\pi(P^0)$, where V is consumer surplus, π is profits and α in [0,1]. If the firm is allowed to offer P such that $V(P) \geq V(P^0)$, this alternative policy would not make consumers worse off and the firm would make a greater profit. (See Armstrong, Cowan, and Vickers (1994), p.67).

[6] Under the Kaldor-Hicks test, state A is preferred to state B if those who gain from the move to A can hypothetically compensate those who lose and yet

Figure 1



It is Kaldor-Hicks superior to have the price of gas in Mexico equal to the Houston price adjusted for transportation costs. Assume that gas is produced at Burgos and shipped to Houston and Monterrey.[7] Let p_H be the spot price at Houston and p_M be the spot price at Monterrey. Let c_h be the cost of moving gas from Burgos to Houston, c_m be the cost of moving gas from Burgos to Monterrey. The netback rule would lead to the condition that the price of gas less transport cost is the same at Houston and Monterrey,

$$p_m - c_m = p_h - c_h \tag{1}$$

Suppose a customer in Monterrey had a demand curve $Q_i = D_i(p)$ for the gas. Pemex can sell the gas to the customer in Monterrey

be better off. The Kaldor-Hicks criterion suggests that A is preferable even if compensation does not actually occurs.

[7] The gas fields of Burgos are located in the northeast of Mexico, close to the Texas border. In recent years over 44 trillion cubic feet of non-associated gas have been discovered in Burgos (over 35 years of reserves). Burgos' reserves represent 57.1 percent of total natural gas reserves in Mexico but contribute only 17.3 percent of total uatural gas production.

or sell the gas in Houston. Suppose Pemex sold the consumer $\hat{Q}_i$ amount of gas at $\hat{p} < p_m$. It is feasible for Pemex to sell the gas in Houston and transfer an amount $\Delta p Q_i + \frac{\Delta p \Delta Q}{2}$ to the Monterrey consumer. (See figure 1).[8] This would lead to greater revenue, $\frac{\Delta p \Delta Q}{2}$, to Pemex and make the Monterrey consumer no worse off. Thus it is Kaldor-Hicks superior to have the price of gas in Mexico equal to the Houston netback price and sell the balance of the gas on the Houston market rather than to sell gas in Mexico at a price below the Houston netback price.

3. Regulation of Pipeline Rates

Pipelines have a high fixed cost, and for a substantial portion of their operating region low marginal costs. The capacity of the pipeline is ultimately limited by the pressure limits of pipe. Figure 2 illustrates the cost curves for a 48-inch pipeline 100 miles long.[9] The dashed lines represent what the cost curves would be if the pressure limits were not binding. At a pressure limit of 1,500 pounds per square inch, the pipeline reaches its limit at approximately 3,800 million cubic feet per day. At this point it becomes impossible to increase throughput by increasing power and it becomes necessary to add compressor stations which increases throughput without exceeding the line limit by increasing the pressure gradient.

We have shown that the netback-pricing rule is the solution of a static welfare optimization problem if the fee for transporting gas is the marginal cost of transporting gas.[10] However, marginal-cost pricing results in a loss of rents. (See figure 2). One solution to this problem is to set a fee that yields a regulated rate of return over the life of the project sufficient to cover all costs. An alternative, more sophisticated alternative is a two-part tariff with a price cap. CRE currently regulates Pemex transportation (and distribution) tariffs through a (average-revenue) price cap over two-part tariffs.[11] The

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8 Recall that under the netback rule, the revenue after transportation costs of selling gas in Houston or Monterrey would be the same.

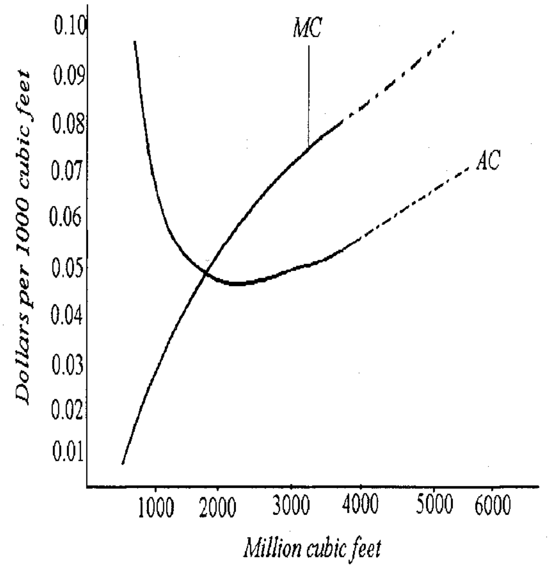
9 The parameters used in constructing this example are based on numbers reported in the Oil & Gas Journal, November 27, 1995.

10 See Brito and Rosellón (2002), and Brito, Littlejohn and Rosellón (2000).

11 Pemex estimates its fixed, variable and financial transportation costs (including an 11.5 percent rate of return) and sets its two-part tariff according to its revenue requirements.

cap prevails during each five-year period. The initial value of the cap is set in each period through cost of service and adjusted by inflation, efficiency, pass through and correction factors. Average revenue is calculated as the ratio of total revenue to output in the current period. Ramirez and Rosellón (2002) show that this regime creates a stochastic effect that implies higher levels of consumer surplus for higher levels of risk aversion and uncertainty.[12]

Figure 2



More generally, the economics literature on gas (and electricity) transportation shows how usage congestion charges can be used to

[12] We must point out that when only one product is supplied, as in the transportation service, average-revenue regulation coincides with tariff-basket regulation. For the case of gas distribution, Ramirez and Rosellón (2002) also show that the CRE's average-revenue regime creates incentives for setting two-part tariffs strategically. The usage charge is typically dropped to its lowest feasible level while the fixed charge can be raised to compensate for the loss of operating profit.

give proper incentives for capacity investments.[13] However, there are two caveats to the use of a flexible pricing mechanism to regulate Pemex transportation tariffs that seem to make preferable a fixed-price regulation that does not allow Pemex to carry out price discounts.[14] The first problem is Pemex's vertical integration in gas production, transportation, and marketing, which allows Pemex to carry out cross subsidies among these three economic activities. A second problem is the limited institutional capacity of a small regulator to obtain true cost information on all segments of the more than 9,000-kilometer-long Pemex transportation network. Under these conditions, Pemex could strategically manipulate pipeline rates to maximize its revenues but reduce consumer surplus.

As an example of the latter assertion, suppose Pemex is producing gas in Burgos and Ciudad Pemex, and selling gas in Houston and Mexico City (see figure 3. The arrows indicate which way gas is moving). Los Ramones is the arbitrage point. Assume that t_1 is the "real" (cost-reflective) price per mile for transporting gas through the pipeline segment Burgos-Los Ramones and through the Ciudad Pemex-Mexico City segment. Let t_2 be the corresponding price for the Houston-Burgos segment and the Los Ramones-Ciudad Pemex segment ($t_1 < t_2$).[15] The dashed line in figure 4 illustrates the regulated price pattern that would result under perfect information.

Suppose however that the regulator does not have information on the real cost in each pipeline segment, and that Pemex can set a price for transporting gas through the pipeline network in the range between t_1 and t_2 per mile. Pemex can then exploit its flexibility to set the pipeline tariffs to increase revenues. Pemex can charge the

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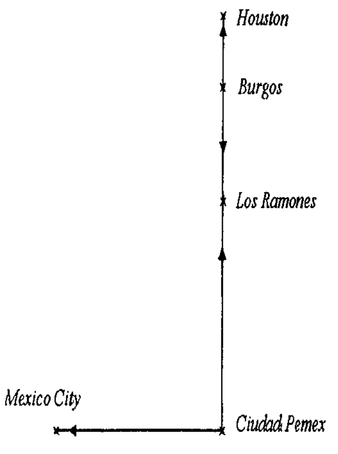
13 Vogelsang (2001) proves how a two-part tariff can be used to solve short-run congestion problems as well as the long-run capacity expansion problems of an electricity transmission network. Under capacity congestion, the variable charge becomes a pure congestion charge and, whenever congestion charges are greater than the marginal costs of increasing capacity, the transmission company will have incentives to expand capacity.

14 This is not equivalent to the use of cost-of-service regulation. Rather, we propose to keep calculating the initial value of the (average revenue) cap in each regulatory period through cost of service and adjust it along the period by inflation and efficiency factors, but without allowing price discounts.

15 Then, according to the netback pricing rule, the price of gas at Mexico City will be equal to the benchmark price in Houston less the transport costs from Houston to Burgos, plus the transport costs from Burgos to Los Ramones, less the transport costs from Los Ramones to Ciudad Pemex, plus the transport costs from Ciudad Pemex to Mexico City

Figure 3



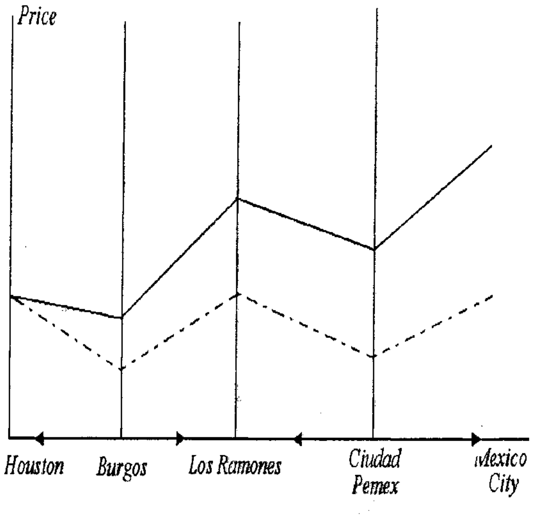
low transport charge t_1 between Houston - Burgos, the high transport charge t_2 between Burgos - Los Ramones, the low transport charge t_1 between Los Ramones - Ciudad Pemex and the high transport charge t_2 between Ciudad Pemex - Mexico City. This is illustrated by the solid line in figure 4. This pricing policy maximizes the revenues for Pemex by cross-subsidizing its pipeline segments. The result is a higher price of gas in Mexico as compared to the one that would prevail if Pemex charged the real transport charges per segment.

The CRE then needs Pemex to provide accurate information on its transport costs by segment. Under the vertically integrated structure of Pemex, which allows cross-subsidization among gas production, transportation and marketing, the regulator should implement a fix-price regulation by transportation region so that Pemex cannot make discounts in transportation charges. Of course, the (first) best solution would be to vertically separate Pemex –allowing unbundling and competition in marketing– and to regulate transportation charges with the incentive scheme already in place.

4. Pemex Selling Gas Only at the Point of Injection

One advantage of using the netback rule with a fixed fee for transporting gas is that all parties act as price takers at all points along

Figure 4



the pipeline. Restricting Pemex to sell gas only at the point of injection and allowing local market conditions to set the price creates the possibility that marketers could acquire some degree of market power. Parties could buy the gas at the point of injection and ship either to the Houston market (where they face an essentially flat demand curve) or to the Mexican markets where they face an inelastic demand curve. Collusive behavior on the part of marketers would allow them to equate marginal revenue in both markets and exploit the fact that demand curves in the local markets are very inelastic and earn monopoly rents. It then becomes necessary to regulate the activities of the marketers. The regulatory problem is much simpler if Pemex sells at all points on the pipeline system using the netback rule to determine the price. This would not eliminate other marketers' activities.

5. Forward Markets and Pipeline Capacity

If Pemex is required to sell gas on the spot market at the Houston Ship Channel price adjusted by the netback rule, can Pemex use its monopoly power over the pipeline to get monopoly rents in this forward market? To address this question let us consider a simple model. Assume a two period model. Gas is produced at Burgos and shipped to Houston and Monterrey. Let p_{0h} be the spot price at Houston at time 0, p_{0m} the spot price at Monterrey at time 0, p_{1h} the spot price at Houston at time 1, p_{1m} the spot price at Monterrey at time 1, $\hat{p}_h$ the forward price at Houston at time 0, and $\hat{p}_m$ the forward price at Monterrey at time 0. Let c_h be the cost of moving gas from Burgos to Houston, c_m be the cost of moving gas from Burgos to Monterrey, and $\Delta c = c_m - c_h$. Let $\bar{Q}_m$ be the capacity constraint on the pipeline from Burgos to Monterrey. If the capacity constraint does not bind, the netback price at Monterrey is $p_{\tau m} = p_{\tau h} + \Delta c$, (see figure 6 left). If the capacity constraint binds, the price at Monterrey is $p_{\tau m} = p_{\tau h} + \Delta c + R$, where R are the rents associated with the capacity constraint, (see figure 6 right).

Figure 5

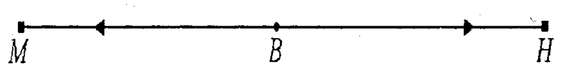
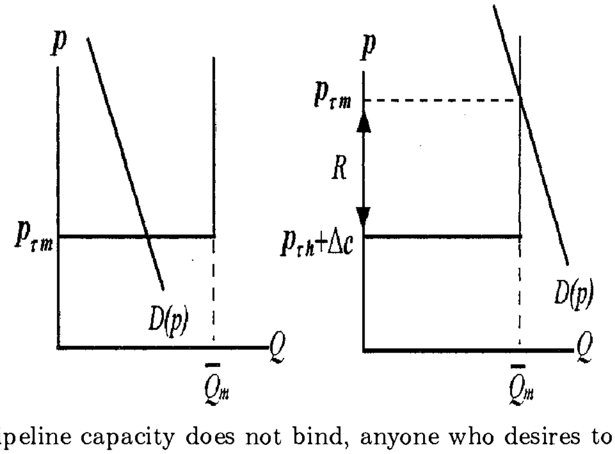


Figure 6



If the pipeline capacity does not bind, anyone who desires to engage in forward transactions can do so in the Houston market and Pemex does not have an effective monopoly of the forward market and will capture no rents. However, if the pipeline capacity does bind, Pemex can capture the rents associated with the pipeline constraint by selling output forward. Pemex can become a monopoly in the forward firm-service market. Note that if the pipeline capacity does bind, rents will exist and the only question is who will appropriate them. Given that the capacity constraint on the pipeline is binding, there are no real effects.

The key regulatory issue in this context appears to be insuring that Pemex invests sufficiently in pipeline capacity so that capacity constraints are not a serious issue.

6. Optimal Pipeline Capacity

A necessary element in implementing a policy where the Houston gas market is the reference point for pricing gas in Mexico is that there be sufficient capacity so that the market for gas can always clear at the netback price. The obvious question is whether the cost of maintaining such capacity is warranted. This is a very difficult question in that there are economic, political and institutional constraints involved in the basic question of pricing gas along the Mexican pipelines.

A benchmark for discussion is the pattern of investment that would be followed by a planner who is attempting to maximize a measure of welfare. Such a policy may involve periods where the capacity constraint binds. The length of this period is a measure of the cost of the deviation from "optimal" that results from the policy of using the Houston gas market as a benchmark for pricing gas. We will show that a policy that insures sufficient pipeline capacity so that the gas market can clear at the Houston netback price deviates from an "optimal" policy by only a matter of weeks.

Let us consider a case where pipeline capacity is given by $\bar{Q}$. Demand is growing at a rate λ. Let $\bar{p}_M$ be the price in Monterrey based on Houston netback. Assume that demand reaches pipeline capacity at $t = 0$ so that $p_M = \bar{p}_M$ for $Q < \bar{Q}$ and $\bar{p}_M = \theta(\bar{Q})$. If the pipeline capacity binds, $p_M = \theta(\bar{Q}e^{\lambda t}$ and the excess burden associated with this bottleneck is given by:

$$X_1(t) = \frac{\Delta p \Delta Q}{2} = \frac{\bar{Q}(e^{\lambda t} - 1)[\theta(\bar{Q}e^{\lambda t} - \bar{p}_M]}{2} \qquad (2)$$

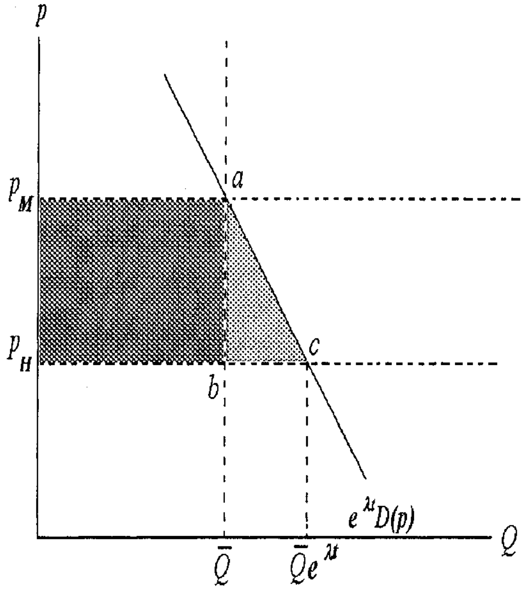
This is the triangle *a-b-c* in figure 7. The bottleneck results in rents being generated and these rents result in the loss given by

$$X_2(t) = \gamma_1 \bar{Q} \Delta p = \gamma_1 \bar{Q} [\theta(\bar{Q} e^{\lambda t}) - \bar{p}_M] \tag{3}$$

where γ_1 is a parameter that can range from 0 to 1, and is the weight of the rents generated by the bottleneck in the welfare function. The loss in equation (3) represents the fraction of rents that are consumed in transfer and reflects such factors as rent seeking and X-inefficiency. This is the rectangle $p_M - \bar{p}_M - a - b$ in figure 7. Define the total loss in welfare as:

$$X(t) = X_1(t) + X_2(t). \tag{4}$$

Figure 7



Opening a second pipeline reduces the marginal costs of transporting gas moving the operating range of both pipelines to $\frac{Q}{2}$. With capacity constraints binding, the marginal cost of transportation depends on the construction of the new pipeline. The marginal cost of moving gas will then be reduced by ΔMC. This will reduce the cost of moving gas by $\varphi = \Delta MC\bar{Q}$. Let γ_2 be the weight of the cost savings of opening a second pipeline in the welfare function. A welfare maximizing planner would want to pick the time of opening the second pipeline to minimize the welfare loss less the savings in operating costs which is given by:

$$\Psi = \int_0^T e^{-rt}\left\{\frac{\bar{Q}(e^{\lambda t}-1)[\theta(\bar{Q}e^{\lambda t})-\bar{p}_M]}{2} + \gamma_1\bar{Q}[\theta(\bar{Q}e^{\lambda t})-\bar{p}_M] - \gamma_2\varphi\right\}dt + e^{-rT}C_0 \tag{5}$$

The first order condition for this maximization is

$$\left\{\frac{\bar{Q}(e^{\lambda T}-1)[\theta(\bar{Q}e^{\lambda T})-\bar{p}_M]}{2} + \gamma_1 Q[\theta(\bar{Q}e^{\lambda T})-p_M] - \gamma_2\varphi\right\} - rC_0 = 0 \tag{6}$$

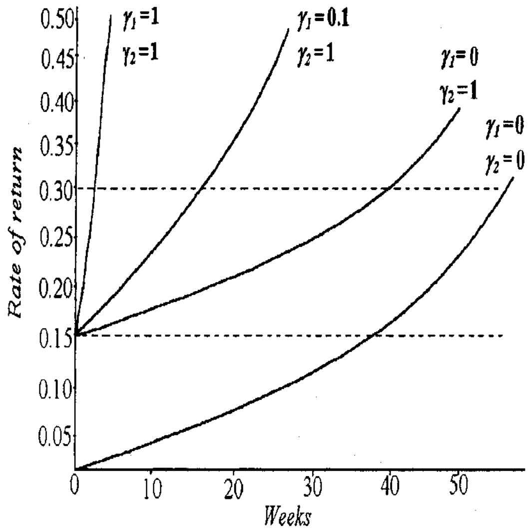
which can be written as

$$\frac{\frac{\bar{Q}(e^{\lambda T}-1)[\theta(\bar{Q}e^{\lambda T})-\bar{p}_M]}{2} + \gamma_1\bar{Q}[\theta(\bar{Q}e^{\lambda T})-\bar{p}_M] - \gamma_2\varphi}{C_0} = r \tag{7}$$

We construct a numerical example to calculate the value of T for those values of the parameters and get a rough approximation of the length of the period where it is efficient for the capacity constraint to bind. Assume, as before, that a 48-inch pipeline reaches its limit capacity at 3,800 million cubic feet per day when it is 100 miles long.

Figure 8 illustrates the solution of the minimization problem for a 48-inch pipeline, 300 miles long. The curve labeled $\gamma_1 = 1$, $\gamma_2 = 1$ depicts the loss to the consumers. If we examine the curve we see that even for a very high rate of return on the order of 30 per cent, the "optimal" investment time is about two weeks after the capacity constraint begins to bind. For a rate of return of 15 percent, the consumers will never want the capacity constraint to bind. Consumers of natural gas are willing to pay for the facilities to transport the gas they demand at the Houston netback price. Thus it is feasible to construct a rate structure that will compensate the operator of the pipeline for maintaining sufficient capacity to transport the gas demanded at the Houston netback price. Note that such a policy is Pareto superior.

Figure 8



The curve labeled $\gamma_1 = 0.1$, $\gamma_2 = 1$ depicts the welfare loss if we assume that 10 percent of the rents transferred to Pemex are lost to X-inefficiencies. For a rate of return of 30 percent, the "optimal" period for the capacity constraint to bind is 15 weeks. For a rate of return of 15 percent, it is not optimal for the capacity constraint to bind. The savings in operating costs are sufficient to warrant the investment.

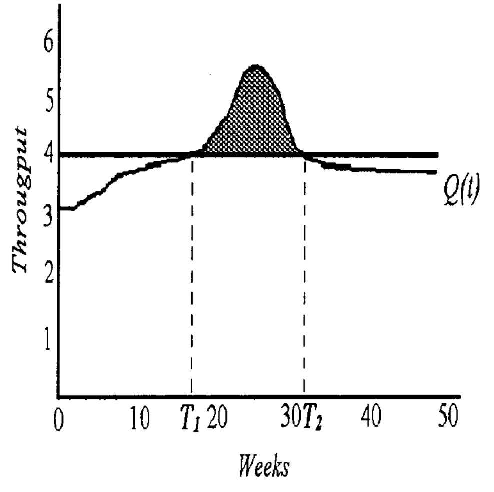
The curve labeled $\gamma_1 = 0$, $\gamma_2 = 1$ ignores the transfers from consumers and includes the savings in operating costs and the deadweight loss. The curve labeled $\gamma_1 = 0$, $\gamma_2 = 0$ ignores everything but the deadweight loss. Even using this measure of welfare loss the optimal period for the constraint to bind is less than one year for a rate of return of 15 percent.

The weather in Mexico does not fluctuate as much as in the United States, however, peaks that could result in seasonal bottlenecks do occur. Assume the bottleneck starts at $t = T_1$ and ends at $t = T_2$, (see figure 9). The welfare loss associated with such a bottleneck is then $\int_{T_1}^{T_2} X(t)dt$. It pays to invest in additional pipeline capacity to eliminate the bottleneck if:

$$\frac{\int_{T_1}^{T_2} X(t)dt - \gamma_2\varphi}{C_0} = \frac{\bar{X}(T_2 - T_1) - \gamma_2\varphi}{C_0} \geq r, \qquad (8)$$

where $\bar{X}$ is the average of welfare loss, (see figure 10).

Figure 9



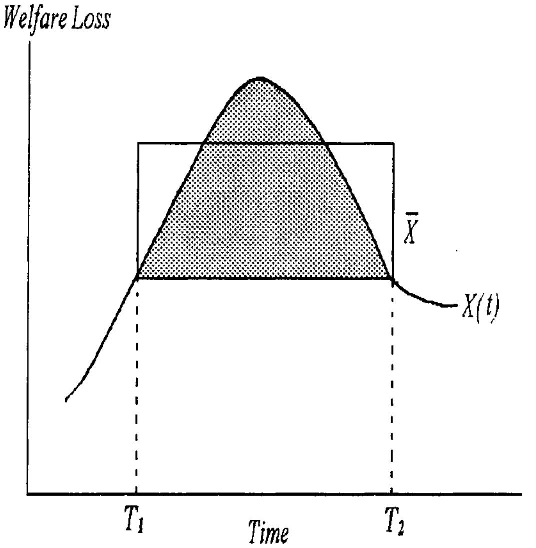
Let $\Delta T = T_2 - T_1$, figure 11 depicts the relationship between ΔT and $\bar{X}$ for r=0.15.

Consumers of gas are willing to pay to eliminate a five-day peak whose average is 10 percent over capacity. A planner that assigns a 10 percent cost to transfers will invest to eliminate a 35-day peak whose average is 10 percent over capacity.

The need for concern about the possibility of capacity constraints in gas pipelines follows from projections about demand. Demand for natural gas in the Pemex transportation system will grow at an annual rate of 11.0%. These estimates are based on increases in the demand for natural gas of electricity generation, industrial consumers, and

LDC's (see table 1). The northeastern and northwestern regions will register a growth of 12% and 18%, respectively, during the 1999 - 2003 period due to the CFE's projects. (CFE is the national electricity monopoly.) These two regions will represent 36% of total market demand.

Figure 10



In 1999, demand and supply for natural gas in Mexico will be 4,824 and 4,838 million cubic feet per day (mcfd), respectively, in 2000-2001 5,096 mcfd and 5,111 mcfd, respectively, and in 2002-2003 5,259 mcfd and 5,275 mcfd, respectively. According to the permit granted by CRE to Pemex to transport natural gas,[16] Pemex will face this increase in demand by expanding its transportation capacity, (see table 2).[17]

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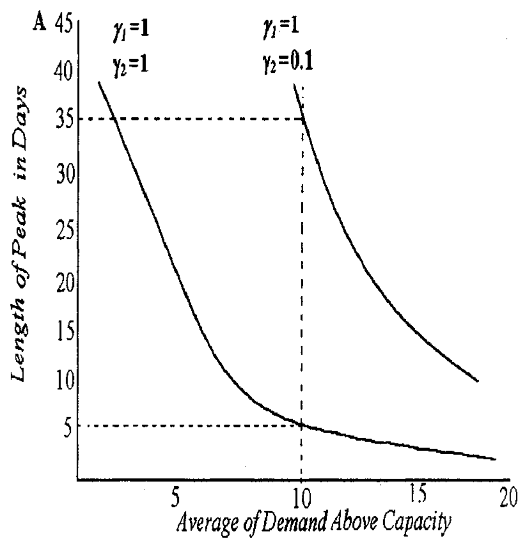
[16] *Comisión Reguladora de Energía* (1999). This permit states all the technical details and investment plans that Pemex will have to fulfill during the next five years in its transportation activities.

[17] These calculations are based on estimates of injection and extraction requirements at each node (*Comisión Reguladora de Energía* (1999), appendix 3.1), flow

Figure 11



As shown, the increase in pipeline capacity will barely cope with the increase in demand, and there could be bottlenecks during peak periods. Especially important is the 1597 kilometer-long pipeline system in the Reynosa and Monterrey operating sectors where a huge increase in demand is expected and where two of the three compression stations are old.[18]

A very strong case can be made from these calculations that a policy that makes sure that there is always sufficient pipeline capacity so that the gas market can always clear should be followed. Such a policy would generate sufficient savings to the consumers of gas so that they will be willing to pay for such an investment.

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and capacity technical information for each transportation sector (annex 3, appendix 3.1 and 3.2), repowering needs at each compression station (appendix 3.1), and investment needs for expansion of the pipeline network (annex 6.2.1).

[18] There are three compression stations located in these sectors. In the Monterrey sector here are two old "reciprocate" compression stations *Ojo Caliente*, and *Santa Catarina*, with more than 30 years of operation, and with huge drops in pressure and low volumes. In the Reynosa sector there is a "turbo compression" station" that was constructed in 1997.

The only argument that can be made against investing in this pipeline capacity is that the government loses the revenue created by rents to the pipeline. However, the Mexican government can at present capture the rents that would be generated by pipeline congestion by taxing gas. If we take as given that additional taxation of natural gas is not desired, then a pipeline investment policy that prevents pipeline congestion can be Pareto superior. Consumers would be willing to pay for this capacity and the only cost to the government is not collecting rents it can now collect and has chosen not to do so.

Table 1
Natural Gas Demand: Annual Growth Rates by Consumer Type

	1994 - 1997	*1997 - 2003*
CFE	7	17
Industrial	5	5
Cogeneration	—	76
Pemex	1	5
Vehicles	—	51
Distribution	1	13

Source: *Escenarios de oferta y demanda en el sistema nacional de gasoductos de Pemex-Gas, Comisión Reguladora de Energía* (1999).

Table 2
Maximum Average Transport Capacity of Pemex's National Pipeline System

Units	*Year 1*	*Year 2*	*Year 3*	*Year 4*	*Year 5*
MMGcal/Year	421.5	445.3	445.3	459.5	459.5
MMPCD	4,824	5,096	5,096	5,259	5,259

Source: *Comisión Reguladora de Energía* (1999).

Conclusions

Pemex should be permitted to enter into spot contracts or future contracts to sell gas. However, the price of gas should always be the net back price based on the Houston Ship Channel at the time of delivery. Pemex should not be permitted to discount the price of gas from the Houston netback price even in a nondiscriminatory fashion. This arrangement is transparent, it is easy to enforce and does not eliminate any legitimate market options for any of the parties involved. Pemex or consumers of gas can use the Houston market for hedging speculative transactions.

The Houston market thus serves as a buffer for fluctuations in Pemex's production or in demand. Pemex can vary its sales in the Houston market to smooth fluctuation in Mexico. This buffer allows Pemex to only sell "plain vanilla" gas without having to engage in complex market operations in Mexico. Thus, it is very difficult to see what useful role can be played by Pemex acting as a gas marketer in Mexico. If Pemex wants to engage in speculative market behavior, it can do so in the Houston market. Houston has the advantage of being a well-developed market. Pemex's transactions in that market would not create any regulatory issues for the CRE as long as Pemex sells gas in Mexico at the Houston spot netback price.

The key to this policy is that there be sufficient investment in pipeline capacity so that bottlenecks do not develop. A very strong case can be made from our calculations that a policy that makes sure that there is always sufficient pipeline capacity should be followed. Such a policy would generate sufficient savings to the consumers of gas so that they will be willing to pay for such capacity investment in the rate structure. The only argument that can be made against investing in this pipeline capacity is the loss of revenue created by rents to the pipeline. However, the Mexican government can at present capture these rents and does not do so. If this is the correct policy, then a pipeline investment policy that prevents pipeline congestion can be Pareto superior.

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