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CIDE

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**PRICE AND RATE REGULATIONS FOR THE MEXICAN
NATURAL GAS INDUSTRY: COMMENTS
ON POLICY DECISIONS**

Introduction

This paper describes the economic rationale of the new price and rate regulations for the Mexican natural gas industry. These regulations are policy instruments of the regulatory reforms recently applied to this industry. The reforms maintain the state's monopoly over production but allow private investment in transportation, storage and distribution of natural gas¹.

The basic goal of the regulations is, of course, limiting market power and fairly allocating monopolistic rents between monopolistic firms and consumers. After regulatory reform of the natural gas sector in Mexico, three main areas with market power remained: production (the state owned company *Petróleos Mexicanos* (PEMEX) legally maintained its monopoly), transportation and distribution (activities with naturally monopolistic characteristics), and distributor's gas sales to captive customers.

The ways in which the price and rate regulations limit market power are varied. While benchmarking is used to control PEMEX gas prices, a sophisticated revenue cap methodology was designed to regulate transportation and distribution rates. However, all of the mechanisms share the common feature of being incentive regulations.

This paper presents the theoretical concepts and international lessons that, from my point of view, were considered in Mexico during a policy making process immersed in rapidly changing events. Among other things, the intention here is to assist policy makers who confront similar challenges. The paper may also be of interest to economists or other professionals not familiar with theoretical or applied aspects of the economics of regulation.

The paper is divided into four sections. In each section, the specific challenges faced by regulatory policy are defined, the related theoretical and empirical backgrounds are reviewed, and the policy decisions taken are described and justified.

The first section explains how the national gas price is set by considering fluctuations in the conditions of an international benchmark market as well as changes in transportation costs. This methodology seeks to i) moderate the effects of the transition towards new regulation, ii) reproduce the conditions of an international competitive market, and iii) transparently reflect the impact of transportation rates on the price of gas.

The second section describes the regulation for transportation and distribution rates. This methodology aims to promote productive efficiency through providing incentives for cost minimization. The specific incentive scheme chosen by the Mexican regulatory authority was "average revenue" regulation which provides

¹ For a detailed description of such reform consult Rosellón (1995) and International Energy Agency (1996).

greater rate setting flexibility than the “tariff basket” methodology. This flexibility is necessary for the development of the new natural gas projects in Mexico.

The mechanisms used to assure that rates adequately reflect the cost of providing service to different customer types are also described in section II. A central goal of those mechanisms is to deter companies from cross subsidizing among consumers.

Section III presents the implicit economic justifications for the price methodologies designed to protect captive customers from distribution companies. The paper concludes with some observations on the experiences confronted in trying to apply theoretical and empirical considerations in the design of a broad regulatory framework.

1. National-Gas Price Regulation

Specific Challenge

The basic problem faced by regulatory policy in the production of domestic natural gas was the determination of a maximum price for the product. This problem was present because production remains a monopoly of PEMEX by constitutional mandate.

Theoretical and Empirical Background

Monopolies' Disadvantages

Theory and practice confirm that non-regulated monopolies may not have incentives for cost reduction nor for product innovation. This can result in productive inefficiency which does not promote quality improvement of goods. Likewise, a monopolist may set a markup between prices and marginal cost with no relation to consumer welfare and thereby creating inefficient resource allocation.

Some other undesirable characteristics of a market dominated by an unregulated monopoly are:

- Maintenance of non-equilibrium situations where markets do not clear;
- Rigidity in contracts;
- Preservation of inflexible practices which slow down timely reactions to unexpected market changes;
- Abuse of market power so as to avoid entrance of new market players;
- Hindrance of technological change by limiting competitiveness;
- Generation of uncertainty in other industry sectors due to the inelastic and anticompetitive structure of supply;
- Discouragement of new investments;

- Inefficient resource allocation among different geographic zones generating unequal regional opportunities, and
- Lack of compatibility with measures seeking environmental improvements.

The evils of an unregulated monopolistic firm are more evident in markets where consumers have a low elasticity of demand. Such firm may establish prices much greater than marginal cost and generate inefficiencies in resource allocation. This would further produce a decrease in social welfare.

Additionally, inefficiencies of an unregulated monopoly have greater consequences in the energy sector. This is true because a healthy and competitive economy is based on an efficient energy sector. Lack of efficiency in the production and exploitation of energy affects a whole economy in several ways: i) it may have immediate effects on those sectors directly linked to the energy sector, ii) it may increase the cost of the energy inputs demanded by any firm, and iii) it undercuts the benefits of deregulation in other sectors. For example, a monopolist may ration its supply of certain fuel, causing a nationwide fuel use pattern different from that which would be consistent with productive, technical and allocative efficiency.

With respect to ownership of monopolies, theory states that incentives of private and state monopolies may not be the same. A state monopoly may manipulate its supply not only to increase its profits, but also to expand its scope of control. However, irrespective of ownership, both theory and practice suggest that regulatory policy must focus on recognizing different market structures, regulating market power and eliminating barriers to entry in potentially competitive markets. Regimes of competition and regulation in which an industry operates seem to be crucial in determining the consequences of ownership.

Objectives of Regulation

The economics of regulation is the public economics face of the new theory of industrial organization as synthesized in writings such as Tirole (1988). This new theory analyzes interactions among economic agents in conditions of imperfect competition. According to the theory of economics of regulation, the structure of the relationship between a regulatory agency and a regulated firm is isomorphic to the “principal-agent” paradigm.² In this model, a government agency (*the principal*) seeks to regulate a firm (*the agent*) which has market power and private information, both endogenous and exogenous, not available to the agency. In other words, both “moral hazard” and “adverse selection” phenomena are present in the principal-agent relationship.³ The agent manipulates such information so as to maximize his benefits and evade actions of the principal.

² Laffont and Tirole (1993).

³ For a nice detailed description of the principal agent relationship see Sappington (1991).

In this context, the “benevolent regulator assumption” states that the regulator’s mission is to make the agent behave competitively while simultaneously redistributing monopolistic rents and reducing uncertainty and risk in the economy. More precisely, regulation seeks to:

- Promote certainty among market players by setting a regulatory framework which allows firms to obtain adequate profits;
- Protect consumers from market power abuse by guaranteeing fair prices, and enough quantity of and quality in services and products;
- Support the process of technological change, and
- Contribute measures which preserve the environment.

It is clear that the *raison d’être* of regulation is controlling market power. In absence of such power, there is no economic-efficiency reason for regulating prices or market entry. Two alternative ways in which regulatory policy can address market power are the i) introduction of regulation to prevent a monopolist from arbitrarily manipulating prices, and ii) promotion of competition by, for example, eliminating entry barriers or creating public information which promotes competition.

It must be emphasized that promotion of competition only makes sense in contestable markets. Therefore, regulatory policy seeks to combine regulation of natural monopolies and promotion of competition in potentially competitive activities.

Gas Pricing: International Experience

Pricing of natural gas is determined by the market in several countries. This is due to the fact that production of natural gas is recognized as a contestable activity. For example, in the United States and in several European countries, wellhead prices reflect competition in the market for gas production. An intense marketing activity occurs in these countries, ensuring best price conditions for consumers.

In the case of the UK, gas prices result from competition among producers for contracts.⁴ Such contracts were usually arranged with a single purchaser, British Gas, which was able to obtain low prices and longer terms due to its monopsonistic power. Later, with the arrival of competition, contracts were sought and arranged through several purchasers.⁵

Negotiations between buyers and sellers determine gas prices in most of continental Europe (for instance France and Germany). Contracts are usually with national gas companies in the cases of Statoil (Norway), Sonatrach (Algeria) and

⁴ BP, Shell, Statoil, Norsk Hydro and Exxon are examples of companies which compete with British Gas in the production of natural gas. However, British Gas has remained as a main producer. For example, in March 1992 the three largest producers in the United Kingdom Continental Shelf were British Gas with a share of 18.7%, BP with 14.9% and Shell-Exxon with 21.6% (Ofgas (1993)).

⁵ Nowadays, the legal monopoly of British Gas is restricted to consumers of less than 2,500 therms per year. In 1998, full competition for domestic gas will be allowed.

Gazprom (Russia). In OECD countries, there are two main principles for natural gas pricing: in some countries (Germany, the Netherlands, Switzerland, Spain, Sweden and Denmark) gas prices are set according to prices of substitutes, while in others gas prices are set according to cost.⁶ Countries like Belgium, France, United Kingdom and Italy use a mix of the two principles, while the price of imported gas is set in countries like Japan and the United States by adding the price at the border plus costs of transportation, distribution and storage.

Policy Decision

Mexico is unusual in that its natural gas production sector is the legal monopoly of PEMEX. Theory and practice suggest that the market structure of such a sector is potentially competitive or contestable.⁷ Therefore, regulation in Mexico had to do its best within applicable legal constraints to design measures which replicate market conditions. One such measure was a formula which set a cap on the price of gas and promoted both productive and allocative efficiency.

The principal regulatory methods considered during development of the price-cap formula for natural gas were:

- Pricing based on costs at the wellhead. This would be a passthrough mechanism, allowing PEMEX to transfer to consumers the costs of gas acquisitions;
- Comparisons with other fuels on a netback basis in order to give a margin of advantage for gas, and
- Pricing based on a benchmark such as the price of imported gas at the border. Alternatively, a reference hub could be used as benchmark. This hub should reflect conditions of a competitive market, possess characteristics of liquidity (which makes it less vulnerable to price manipulation), and have an associated hedging market.

The first possible method was not followed since most of the gas produced in Mexico is a byproduct of oil extraction, and, consequently, the cost of producing this associated gas could be very low (if not zero). Further, basing the maximum price of Mexican natural gas on cost would have not reflected the market value of the product, and, therefore, market distortions would have been created since the natural market give and take among North American markets would have been impeded:

- PEMEX would have not been able to obtain the margin between its price of gas and that of the North American gas market, and
- Natural gas from the United States and Canada would rarely have flowed to Mexico.

⁶ International Energy Agency (1991).

⁷ Armstrong, et al (1994), p. 246.

The second methodology was also not a very attractive option given Mexico's circumstances. The reasons for this are that the possible natural gas substitutes are either:

- Somewhat cost reflective but, in some cases, subsidized in ways that are not explicit,⁸ or
- Reflective of prices in international markets with dynamics different from the Mexican natural gas market, which is closely linked to the behavior of the larger North American market.

Therefore, linking the price of natural gas to the price of substitutes would have meant transmitting distortions of noncompetitive markets to the natural gas market or ignoring the economic linkage of this market to the North American natural gas market.

The third methodology of regulation compares the performance of regulated companies with that of similar firms in comparable settings. This proved to be the best option for Mexico for several reasons. First, Mexico is close to the country with the most competitive natural gas market in the world. Therefore, finding a benchmark with conditions relevant to the Mexican gas market was feasible. The designed regulatory formula takes as a benchmark the dynamic behavior of a hub located in the South of Texas. This hub, the "Houston Ship Channel," satisfies three fundamental characteristics:

- It is a liquid market, which assures that the benchmark price is neither subject to manipulation, nor influenced by Mexico's gas trade balance;
- It has an associated hedging market, which enables gas marketers to reduce price volatility to their customers, and
- It is very close to the South Texas area which has a physical connection to the PEMEX pipeline system.⁹ Therefore, Houston Ship Channel is a better selection for a hub relevant to the economics of the Mexican gas market than, say, a hub or a set of hubs in regions of North America not physically linked to the Mexican market.¹⁰

Second, the benchmarking methodology was not so different from the netback methodology that PEMEX had previously used.¹¹ In fact, the new regulatory formula uses the price charged by PEMEX in March 1996 as its initial starting point.

⁸ Such as high-sulfur fuel oil or liquid propane gas.

⁹ Texas Eastern Transmission (Tetco) and Valero Transmission (Valero) are the South Texas pipes which have a physical connection to the PEMEX network. A historical price differential between Tetco and Valero and Houston Ship Channel of .07 USD was calculated by the Comisión Reguladora de Energía for the prices and rates regulations.

¹⁰ Following this argument, the suggestion of Swydan (1996) of using a weighted average of prices from different trading U.S. gas centers would not have been adequate.

¹¹ PEMEX' methodology takes the price of natural gas in the south of Texas (more precisely, an average of the Tetco and Valero prices) and adds the cost of transportation to Ciudad PEMEX in the south of Mexico.

This is a very desirable feature since the transition to the use of the new formula will not create a large jump in prices for consumers.

The application of the benchmarking methodology to determine the price cap for domestic gas resulted in the formula:¹²

$$VPM_i = B_0 + [HSC_{i-1} - HSC_0] + [TP_i - TP_0]$$

where:

VPM_i = Price of domestic gas (or "first hand sales" price) at time i ;

B_0 = PEMEX price for natural gas as of March 1, 1996 (initial price condition);

$HSC_{i-1} - HSC_0$ = Houston Ship Channel price adjustment between date $i-1$ and date 0, and

$TP_i - TP_0$ = Adjustment for changes in regulated transportation rates in Mexico between

date $i-1$ and date 0.

II. Transportation and Distribution Rate Regulation

Specific Challenge

Transportation and distribution services have natural monopoly characteristics. This market failure justifies regulatory intervention to limit market power.¹³ The challenge for Mexican regulation was to design adequate transportation and distribution rate methodologies which also provided incentives for productive and allocative efficiency and incorporated recent international ratesetting trends and developments.

Theoretical and Empirical Background

Cost of Service vs. Price Cap Regulation

Cost of service regulation implies setting prices equal to average cost so that price setting is the result of equating total revenues and total costs. This kind of regulation usually goes together with a restriction on the rate of return on capital to restrain monopoly power. Under this regime, prices remain fixed until some agent (regulators, consumers or firms) asks for a modification of prices in a public hearing.

Cost of service regulation has been subject to several criticisms. First, since the regulated firm usually produces other non-regulated products, cross subsidization is always a potential risk. Second, rate-of-return measurements are not one-hundred

¹² More details regarding natural gas pricing in Mexico can be found in Comisión Reguladora de Energía (1996), pp. 5, 6, 8-11. It must be pointed out, that gas price methodology does not eliminate the agents' possibilities of contracting gas prices under more favorable conditions.

¹³ International Energy Agency (1994), pp. 69-70.

percent objective due to differences in accounting treatments of capital and depreciation. Third, under cost of service, incentives for cost minimization and quality are almost nonexistent since the complete restitution of costs does not promote monetary expenditures for the improvement of efficiency or quality. Fourth, from a theoretical perspective, cost of service lacks of any normative framework.

However, cost of service also has a basic advantage in that it provides certainty and a long run commitment of the governing authority. These two elements are very important for the typical long run investments needed in utilities.

As an alternative to cost of service regulation, different schemes have been designed and applied in several countries for varied industries. Such schemes seek to promote efficiency by providing incentives for cost minimization. Examples of incentive schemes are benchmarking, yardstick competition and price caps.

Price cap regulation in its purest form does not make explicit use of accounting data. Under this regime, the regulatory authority sets ceiling prices for either all goods or a basket of goods. In its purest form, price cap regulation is unlikely to be optimal since the lack of cost reflectiveness makes it very improbable that, in the case of no government transfers, the regulator will target the optimal difference between price and marginal cost. Too low a cap could violate the "individual rationality" constraint of the firm¹⁴ and elicit a disincentive for firms to produce since they cannot get a minimum level of profits. Too high a cap could permit a monopolist to continue to enjoy excessive profits at the consumers' expense.

Therefore, the kind of price cap regulation used in practice is combined with cost of service exercises performed at the end of fixed periods (usually of four or five years) and incorporates adjustments for inflation and efficiency during such periods. In fact, there are theoretical models which determine the optimal level of cost passthrough for a price rule which combines elements of price cap and cost of service regulation.¹⁵ The results of such models show that i) a pure price cap would be optimal when the firm is risk neutral or when there is no uncertainty about costs and ii) cost-of-service rules are adequate when the firm is risk averse and when there is more cost uncertainty.

Therefore, when applying incentive schemes, regulators consider issues also faced in cost of service regimes such as: level of capital stock, depreciation, "fair" and "reasonable" rates of return, expected rates of growth of productivity and demand, and level of investments. However, the main differences between such applied incentive schemes and the cost of service method are the incentive schemes i) have a more forward-looking philosophy and ii) are characterized by periods in between regulatory reviews which are meant to be exogenous.

¹⁴ Which requires a non-negative firm's utility level.

¹⁵ See, for example, Milgrom and Roberts (1992, ch. 7).

Natural Monopoly Regulation and Ramsey Pricing

Regarding regulation of a firm operating in an industry with natural monopoly conditions or, in other words, with a subadditive cost technology,¹⁶ basic economic theory states that marginal cost pricing is not advisable. This is true because marginal cost pricing would not allow a firm to recover its fixed costs unless the loss in profits is covered by the government through a direct subsidy. Then, a pricing rule yielding revenues which permit a firm to recover its costs must set a price greater than marginal cost. But, the question here is: how much greater?

A rule for the optimal difference between prices and marginal cost is provided by the Ramsey equation. This equation is obtained from solving, under conditions of asymmetric information, the program which maximizes the expected social welfare¹⁷ subject to incentive and individual rationality constraints of the firm. Under certain conditions,¹⁸ the solution to this program provides the familiar inverse-elasticity rule for markups between price and marginal cost:

$$\frac{P_i^* - C_i}{P_i^*} = \frac{\lambda}{\eta_i}$$

where P_i is the price of product i , C_i is the marginal cost of producing product i and η_i is the elasticity of demand of product y ¹⁹.

Tariff Basket vs. Average Revenue

There are different forms of price cap regulation. The two most well known variations are: "regulation with fixed weights" (or *tariff-basket* regulation) and

¹⁶ An industry cost function is said to be subadditive if:

$$c\left(\sum_{j=1}^m q_j\right) \leq \sum_{j=1}^m c(q_j)$$

for any set of outputs Q_1, \dots, Q_m . In words, this condition means that an industry is a natural monopoly if a single firm can produce a set of outputs at a lower cost than several firms, each having the same cost function.

¹⁷ Most of the literature of regulatory economics defines social welfare as the sum of consumer surplus plus a fraction (between 0 and 1) of the firm's surplus. The "benevolent regulator assumption" supposes that regulators have a tendency to give more weight to consumer surplus than to firm surplus (see Laffont and Tirole (1993), pp. 38-39).

¹⁸ Independent consumer demands and rents from asymmetric information unaffected by the change in outputs.

¹⁹ Laffont (1994), pp. 513-520, presents the generalized version of the program whose solution derives in Ramsey-Boiteux pricing. The interpretation of such version is that optimal regulation can be achieved by offering a transfer function and by letting the regulated firm select itself by choosing a cost level. Through this mechanism, the firm will reveal its true level of efficiency (which is represented by an adverse-selection parameter β known only to the firm). The "revelation principle" states that any method of regulating a firm is equivalent to such mechanism.

"average revenue regulation." Under tariff-basket regulation, a cap is set over the weighted sum of prices of the different products. More precisely, the firm faces a restriction in which an index $E(P) \leq \sum_{i=1}^n \bar{w}_i P_i$ of its prices cannot be greater than the cap, but is otherwise permitted to chose relative prices (where \bar{w}_i are fixed weights so that $\sum_{i=1}^n \bar{w}_i = 1$). The set of prices actually charged will depend on the characteristics of the index and the firm's cost function. That is, the firm will find a set of prices which maximize

$$\Pi(P)$$

subject to

$$E(P) \leq \bar{P}$$

where $\Pi(P)$ is the profit of the firm.

Under the tariff-basket regime, weights assigned to each price typically depend on known demands for each product. That is, if $Q_i(\tilde{P})$ are known demands for some vector of prices \tilde{P} , weights are defined as $\bar{w}_i = Q_i(\tilde{P})$. Therefore, under this tariff-basket regime the firm is allowed to select any vector of prices P which satisfy:

$$\left\{ \mathbf{P} \mid \sum_{i=1}^n P_i Q_i(\tilde{P}) \leq \sum_{i=1}^n \tilde{P}_i Q_i(\tilde{P}) \right\}$$

The dynamic version of the tariff-basket mechanism establishes the fixed weights of each period based on previous period's outputs. More specifically, the firm is allowed to choose a set of prices P^t in period t so that:

$$\left\{ \mathbf{P} \mid \sum_{i=1}^n P_i^t Q_i^{t-1} \leq \sum_{i=1}^n P_i^{t-1} Q_i^{t-1} \right\} \quad (1)$$

Therefore, weights are endogenous over time since one period's prices set next period's weights.

The tariff-basket mechanism has several theoretically positive features which include:

- A firm which maximizes the net present value of its profits subject to (1) will choose a price vector which satisfy Ramsey pricing conditions.²⁰
- It has an unambiguously positive effect on welfare (in particular, on consumer surplus) compared to a regime which fixes prices at a certain level.
- It will promote productive efficiency, optimal efforts and minimal wasteful expenditures.

²⁰Vogelsang (1989).

However, the fixed-weight form of regulation has a basic drawback which has to do with flexibility. Since weights are fixed, changes in prices which are not congruent with the fixed weights chosen will not be allowed. This puts an enormous burden on regulators, especially in cases of bids for new projects where winners are selected based on proposed minimum prices. In such cases, regulators must be sufficiently capable to choose weights arbitrarily -- sometimes without reliable information -- which will remain fixed irrespective of the unexpected events which may occur during development of the project.

In practice, a modified version of the tariff-basket mechanism is used mainly in telecommunications. The modification incorporates factors for inflation and efficiency adjustments. In such a case, (1) becomes:

$$\sum_{i=1}^n P_i' Q_i'^{-1} \leq (RPI - X) \sum_{i=1}^n P_i'^{-1} Q_i'^{-1}$$

where RPI is the factor for inflation adjustments and X is the factor which measures productivity improvements.

Another kind of price cap regulation is average revenue regulation which sets a cap \bar{P} on a firm's revenues per unit; that is, the firm is permitted to choose any price vector from:

$$\left\{ \mathbf{P} \mid \sum_{i=1}^n Q_i(P) P_i \leq \bar{P} \sum_{i=1}^n Q_i(P) \right\}$$

Under this scheme demand for information is not too harsh since the price index weights are endogenous to the firm because they depend on chosen prices. According to Armstrong et al. (1994), average revenue regulation is most adequate for firms whose costs depend on total output and whose products are commensurable.

Another feature of this kind of regulation is that relative prices of different products may vary as long as the average revenue obtained is below the average revenue cap. Even more, total revenues and rates of return can be as high as possible as long they comply with the cap. Under average revenue regulation, a firm will find optimal values for total output Q and revenue R which maximize

$$R - C(Q)$$

subject to

$$R \leq \bar{P} Q$$

$$R \leq R(Q)$$

where $R(Q)$ is the maximum revenue the firm can obtain by selling output Q .²¹ To solve this problem, the firm will first choose a level Q^* of total output satisfying $R(Q^*) = \bar{P} Q^*$ and then select relative prices for the different products in Q^* consistent with the maximum possible revenue. Usually, there can be many sets of relative prices that are optimal. A firm will choose that set which is most adequate to the technological and market characteristics of its project given a certain level of risk and uncertainty. In case of eventualities, the firm would be able to choose another set of relative prices as long as the average revenue obtained is less than the cap. Since weights are not fixed, flexibility for changing relative prices is much greater in average revenue than in tariff-basket regulation.

Nevertheless, theory states that average revenue regulation has one essential problem. Typically, a firm establishes a set of prices such that total revenue is maximized subject to a constraint on total output. When cross elasticities of demand are zero, it can be shown that the optimal price for product i satisfies:

$$P_i^* = \hat{c} \left(\frac{\varepsilon_i}{1 - \varepsilon_i} \right)$$

where \hat{c} is constant and ε_i is the elasticity of demand of product i . In case $\varepsilon_i < 1$, then $\hat{c} > 0$, which implies prices directly proportional to elasticity of demand. This contradicts the Ramsey rule.

As in the case of fixed-weight regulation, a "lagged" average revenue scheme is used in the dynamic context.²² The constraint is that price vectors in period t lie in the set:

$$\left\{ \mathbf{P} \mid \sum_{i=1}^n P_i Q_i^{t-1} \leq (RPI - X) \sum_{i=1}^n \bar{P} Q_i^{t-1} \right\}$$

where \bar{P} is the average-revenue cap for each period t .

In case of "greenfield" projects, where data from previous periods is unknown, total output in period t , Q_t must be used. However, such output is not usually known until the end of the period, while prices must be set at the start of the period. Therefore, the regulated firm must forecast Q_t at the beginning of the year, and a correction factor must be applied at the end of the year to correct for wrong estimation of output.

As it might be expected, another characteristic of the average revenue R/Q is that it is very sensitive to changes in the different kinds of outputs. However, the

²¹Mathematically: $R(Q) = \max \sum_{i=1}^n P_i Q_i(P)$ subject to $\sum_{i=1}^n Q_i(P) = Q$.

²²A variant of this scheme has been used in the U.S. telecommunications' industry.

effect of a change in the amount produced of a certain output Q_i on R/Q will depend on relative prices. For instance, when there are only three types of consumers -- residential, commercial and industrial -- the average revenue per unit R/Q can be defined as:

$$\frac{R}{Q} = \frac{P_r Q_r + P_c Q_c + P_i Q_i}{Q_r + Q_c + Q_i}$$

where:

P_j : rates for different types of consumers (j = residential, commercial and industrial);

Q_j : throughput for different types of consumers; and

$Q = Q_r + Q_c + Q_i$: total throughput.

Then, the change in average revenue when output Q_i increases is given by:

$$\frac{\partial IM/Q}{\partial Q_i} = \frac{Q_r(P_i - P_r) + Q_c(P_i - P_c)}{(Q_r + Q_c + Q_i)^2}$$

This expression is negative if $P_r > P_i$ and $P_c > P_i$. Similarly, it can be shown that $\frac{\partial IM/Q}{\partial Q_r} > 0$ whenever $P_r > P_i$ and $P_r > P_c$. Therefore R/Q decreases as industrial volume Q_i grows, and increases as residential volume Q_r rises, as long as $P_r > P_c > P_i$.

Additionally, it is clear that R/Q increases as consumer prices increase. When prices are set through an initial cost of service, they reflect costs plus an appropriate rate of return. Thus, R/Q will grow as investment costs and the rate of return rises.

International Experience on Incentive Regulation

Price cap mechanisms have been adopted for regulation in natural gas industries in some countries, such as, Argentina, the United Kingdom and the United States. In Argentina, an RPI-X price cap methodology is used to regulate rates for transportation and distribution of natural gas. However, instead of using a retail price index for inflation adjustments, Argentinians use the United States producer price index. Also, an X efficiency factor is used. This factor has a value of zero for the first five years of a project.

In the United Kingdom, adjustable price caps are used to regulate British Gas (BG) as to customers that consume less than 25 thousand therms per year. The adjustment formula includes the retail price index (RPI), the gas price index (GPI), X factors for both gas and non-gas costs, and an energy efficiency factor (E).

In California, some companies are now implementing performance-based rate making (PBR) programs and benchmark programs so as to share benefits equally between shareholders and customers. The PBR programs are similar to RPI-X

schemes where rates are linked to inflation and productivity indexes and also to a correction factor for unexpected costs. These programs have also been implemented by companies in other states in the U.S.

Other industries have also adopted mechanisms to promote efficiency. For example, the Canadian National Energy Board has recently approved proposals for the implementation of "revenue cap" regulation in the oil industry. Under this scheme, an initial "reasonable" revenue is established according to a cost of service exercise. If the firm achieves certain cost reductions, additional profits are "socially reallocated," and the allowed revenue cap for the next year is reduced. This mechanism provides benefits for both consumers and the firm when the latter increases efficiency.

Likewise, in the United States electric and telecommunications industries there are many programs with incentive mechanisms. For example, the Illinois Power Company implemented a rate setting method based on a benchmark index of 23 other utilities. Similar measures have been implemented for electric companies in California. Tariff-basket methods have been applied by several U.S. telecommunications companies.

Also, incentive programs have been designed along with privatization programs. In Great Britain's telecommunications industry privatization occurred together with implementation of a revenue-cap methodology.

Policy Decision

Cost of Service or Incentive Regulation?

In the rate design process for transportation and distribution services, the Mexican regulatory authority had to take two basic decisions. First, it had to decide whether to use cost of service or incentive regulation. If incentive regulation were chosen, a second decision had to do with the kind of incentive regulation that would be appropriate for the Mexican natural gas industry. Here the options considered were price cap regulation via fixed weights and average revenue regulation.

With respect to the first decision, cost of service initially seemed to be an appealing option for two reasons:

- Many of the natural gas projects would be greenfield enterprises, characterized by long term investments with a relatively high degree of risk and uncertainty. Therefore, the cost-plus nature of cost of service regulation would reduce uncertainty for these investments, and
- Since cost of service regulation is widely used in the United States and Canada, its application in Mexico could in some ways promote integration of North American markets.

However, pure cost of service regulation was not chosen principally because it has disincentives for utilities to be more efficient, cut costs, be innovative, and

take appropriate risks. Moreover, this kind of regulation entails a very large regulatory burden on regulatory commissions. Additionally, there is an international tendency to substitute cost of service regulation for incentive mechanisms to regulate utilities. This is the case even in countries, like the United States and Canada, which have a long tradition of cost of service regulation.

Unlike cost of service, incentive schemes promote productive and allocative efficiency, cost reduction, and innovation. Further, they provide a mechanism to distribute monopolistic rents between the firm and consumers and permit light-handed regulatory intervention. Nevertheless, even though incentive regulation was selected, the specific final choice was a combination of price cap and cost of service regulation. At the beginning of every five-year period, a price cap will be determined through a cost of service. This initial value will remain fixed and will only be adjusted during the period by inflation, efficiency and correction factors. This methodology builds upon the central and important virtues of both cost of service and price cap regulation, namely:

- It limits risks and permits efficient business to earn an appropriate return;
- It provides incentives for efficient development and operation;
- It protects customers from abuses of market power while simultaneously promoting the firm's rationality constraint to obtain adequate profits;
- Since it combines cost of service with incentive regulation, it does not represent a great departure from practices followed in other North American countries;²³
- It entails relatively light regulatory intervention which reduces regulatory costs; and
- It provides incentives to increase throughput.

Tariff-Basket or Average-Revenue Regulation?

Once the type of incentive methodology to be used was chosen, the specific form of price cap had to be selected. Would it be a cap on the price of each single service or on a basket of services? Would it regulate prices directly or indirectly? This decision had to consider state-of-the-art elements of economic theory, experiences of other countries and industries, and the particular characteristics of the Mexican natural gas industry.

Transportation and distribution services in Mexico's gas industry are characterized by a nascent distribution infrastructure and a rather well developed transmission network, with a need for new projects. Therefore, price regulation had to be designed to account for the fact that it would be applied both to the existing PEMEX facilities and to the new greenfield projects.

²³ And, as mentioned before, it follows the tendency all over North America of moving towards incentive methodologies.

The Mexican regulatory authority decided to use average revenue instead of a tariff-basket regulation. This was in recognition of the revenue risks present when companies start a new businesses. Accordingly, rate regulation in Mexico considered it important to grant companies enough flexibility to rebalance the relative rates for different types of services. This flexibility was thought necessary for the development of the gas industry.

Furthermore, average revenue rate regulation was chosen since most of the distribution permits would be granted through a bidding process that would use rates as assigning criterion. If a fixed-weight method had been used, then either regulators or bidders would have been under enormous pressure to accurately calculate weights for different types of users which would have remained fixed for at least five years. Since most distribution projects are new ones, calculation of these relative weights would have relied on forecasts rather than actual market information regarding demands and costs. In case of abrupt changes in the project, which make the estimated composition of consumers obsolete, the tariff-basket method would have not permitted a change in weights.

However, the concrete final form of price cap methodology was a combination of tariff-basket and average revenue regulation. Weights for different types of users may be used in the calculation of the average revenue cap once a first period of five years has elapsed.²⁴ This decision was taken recognizing the theoretical and practical advantages of a fixed-weight methodology while, at the same time, considering that a large amount of rate setting flexibility may be needed at least during the first five years of development of a project.

The Average Revenue Formula

The application of the above described methodology to the determination of distribution and transportation rates for the natural gas industry in Mexico resulted in the following formula:

$$IM_t = [1 + (\Pi_t - X_t)/100] P_{t-1} + Y_t + K_t \quad (2)$$

where

IM_t = Maximum average revenue per unit in year t ;

P_{t-1} = Initial maximum average revenue (P_0) adjusted by changes of $\Pi_t - X_t$;

Π_t = Inflation index in year t ;

X_t = Efficiency factor;

Y_t = Passthrough factor, and

K_t = Correction factor

²⁴ See CRE (1996), article 6.12, p. 15.

As mentioned above, this formula reflects a mix of cost of service, tariff-basket and average revenue regulation. Before the start of any five-year period,²⁵ an initial maximum average revenue P_0 is determined through a cost of service methodology.²⁶ P_0 is then adjusted during the period by inflation, efficiency, passthrough and correction factors. As mentioned above, this particular regulation does not constrain returns. An efficient business can keep all achieved revenues as long as they are not higher than the revenue yield cap.

The first five-year period has special characteristics in recognition of the risks of starting new projects. During such period, the correction factor is applied both when realized revenues are greater than or smaller than the average revenue. For distributors, correction adjustments are only used in years four and six.²⁷

The Inflation Factor

The inflation factor was designed to account for the peculiarities of Mexico's economy. For every operator, P_0 will be allowed to escalate in line with an inflation index on an annual basis. This index is a weighted average of Consumer Price Indices (CPI's) of Mexico and the United States, as applicable, and incorporates a factor which corrects for fluctuations in the exchange rate. The index is based on historic, rather than forecast movements in the Mexican and U.S. CPI's and the peso/US dollar exchange rate.

When P_0 is set, the starting proportion for cost denominated in pesos and in dollars will be defined so that the appropriate indices are applied. Each permittee will have to gain approval from the regulatory authority for the starting proportion which will remain fixed for a period of five years.

The basic idea behind having a hybrid inflation factor is to reduce exchange risk as opposed to using an index denominated in a single currency. Formerly, regulatory authorities considered options such as:

- Indexation in dollars using CPI or a production price index (PPI);
- Indexation in pesos using Mexican CPI or PPI, and
- An indexation which uses a number of indices for different costs.

²⁵ Periods between cost-of-service reviews represent a regulatory lag in which prices and costs may diverge. The shorter the regulatory lag the more regulation tends to cost-of-service regulation, the longer the lag the more incentives for efficiency. On one hand, too long lags may not be desirable in volatile economies and may have negative effects on allocative efficiency (since divergence between prices and costs could increase over time). On the other hand, too short lags may be a constraint for productive efficiency. A regulatory lag of five years was chosen in Mexico in accordance to the experience of other countries applying price-cap schemes, such as Argentina and United Kingdom.

²⁶ For distributors that obtain their permit through a bidding process, P_0 will be determined in the bid proposal. New transporters' P_0 will be set after evaluating costs, investment and throughput projections for the first five years of operation. See CRE (1996), articles 6.19, 6.20. p. 15.

²⁷ See section CRE (1996), section 6.F, pp. 19-20.

This last option was discarded due to its complexity and the lack of sufficiently detailed Mexican indices to track peso costs. A combination of the first two options seemed to be more appropriate:

- Since many of the existing Mexican operators have a large proportion of their costs denominated in pesos, it would have been inappropriate to move entirely from peso to dollar indexation since this would have increased their risk. Likewise, customer risk would have increased since customer incomes are denominated in pesos. Thus it appeared correct to index some of the costs by a peso denominated factor;
- Also, some new investors will likely want to obtain returns on their investment in dollars and to reduce exchange risk by having most capital costs indexed to dollars. Therefore, it seemed right to have some of the costs denominated in dollars.

In developing the indexation, a decision had to be taken as to what kind of indices should be used. Since simplicity in application was important, the decision was to use published indices instead of constructing new ones. A second decision had to do as to whether CPI or PPI should be used for the index.²⁸ For the peso cost, CPI was chosen because this index was more likely to reflect the ability of consumers to pay for service and was a reliable price indicator in Mexico. The US CPI was chosen because it was most compatible with the Mexican CPI.

The Efficiency Factor

The efficiency X factor is an essential instrument in the incentive scheme for natural gas regulation in Mexico. Through this factor, monopolistic rents are distributed between consumers by means of lowering the cap and, thus, encouraging allocative and productive efficiencies. The X factor is designed to capture the difference between the productivity improvement of a particular firm and the productivity increase in a certain benchmark that, in some cases, is the average productivity growth of all the firms in the industry.

The efficiency factor will be zero for the first five years of operation so as to provide companies which start a new project with incentives to improve profitability and expand networks and throughput. Following international experience, the efficiency factor will be set after the first five-year period based on expected efficiency gains considering historic trends of permit-holders' efficiency, international efficiency standards and benchmarking with other permittees in Mexico.²⁹

²⁸ In Argentina, rates are denominated in dollars and converted into Argentinean Pesos. Rates are adjusted every six months using the U.S. PPI

²⁹ British Gas has set $X=2\%$ (1987-1992), $X=5\%$ (1992-1994), and $X=4\%$ (1994-1997). Additionally, $X=0\%$ on fixed charge for consumers of less than 5,000 therms.

The Correction Factor

The correction factor K is required in the revenue cap formula to enforce compliance with the cap. It is subtracted from the average revenue cap in year t and will correct for mismatches between the cap and achieved revenues in year $t-1$. It will generally only apply when the achieved revenue exceeds the cap. However, during the first five years of service, the correction factor will also be added to the cap when the permittee's achieved revenue is less than the cap. This is to provide permittees greater flexibility to rebalance rates during the initial development period of their projects.

The K factor is necessary since it is unlikely that in a given year a firm will be able to achieve an average revenue which exactly matches the cap. This is true because the average revenue cap will depend on forecasts of the mix of services, passthrough costs and throughput. As these variables are partly outside the control of operators, it will be very difficult to set rates so that achieved revenue precisely matches the cap.

In order to calculate the correction factor for each year it will be necessary to calculate the actual average revenue dividing total revenues from contract and regulated sales by total throughput. Revenues earned from contract sales will be adjusted so that they reflect the revenue which would have been earned if the services had been sold at a regulated rate. Since most of contract sales will normally be made at a per unit rate below the equivalent regulated rate, this adjustment is done so as to prevent cross subsidies between different customer classes. Without the adjustment, permittees could increase regulated rates whenever there was an increase in the units sold by contract.

Once a decision regarding the specific form of regulation had been taken, another decision had to do with how regulation would apply to the way companies set rates for their various services. As noted, rate regulation in Mexico grants firms with substantial flexibility to rebalance their relative rates. Therefore, additional regulation on rate setting methodologies was required to ensure cost reflectiveness of relative rates for different services, avoid cross subsidies and impede reductions in consumer surplus.

The specific challenges regarding rate setting were:

- A. Definition of an optimal allocation of fixed and variable costs to transportation and distribution charges, and
- B. Design of specific methods to calculate capacity charges.

A. ALLOCATION OF COSTS TO CHARGES

With respect to the allocation of costs to transportation and distribution charges, international practice generally tends to allocate costs to a two-part tariff based upon

a combination of charges for the maximum capacity used during the year (capacity charge) and the volume supplied during the course of the year (commodity charge).

Two-part tariffs are nonlinear tariffs which vary as quantity changes. They are usually formed by a fixed charge, which does not depend on quantity, and a variable charge per unit of quantity consumed. Under "ideal conditions,"³⁰ it can be shown that optimal two-part pricing involves setting the fixed charge equal to fixed cost and the variable charge equal to marginal cost. In comparison to an average-cost pricing methodology, the addition of a fixed charge for the right to consume allows marginal price to come closer to marginal cost and helps the firm to recover its fixed costs.

Under more realistic assumptions, with consumers having heterogeneous preferences, it is optimal to offer a menu of two-part tariffs: tariffs with a low (high) fixed charge and a high (low) variable charge would be offered to consumers with low (high) consumption.³¹ This is due to the fact that offering identical two-part tariffs for all consumers, disregarding their particular tastes, may cause some consumers to stay out of the market.

The split between capacity and commodity charges depends on how the capacity charge is calculated. If it is assumed that the majority of capital costs of a gas utility are determined by the capacity needed to meet demand at its peak, virtually all fixed costs (which for gas utilities constitute the majority of costs) can be attributed to capacity, and only those (few) costs which vary with throughput could be counted as "commodity".

In practice, cost allocation between capacity and commodity charges has varied at several places and times.³² The main differences have been related to the amount of fixed costs allocated to the capacity and the commodity charges so as to attain one or more policy objectives. For example, the more fixed costs are allocated to the commodity variable charge, the more a firm depends on throughput to recover its long run investment. Therefore, a policy which assigns more fixed costs to the commodity charge generally has the effect of promoting gas consumption.

Regulatory authorities in Mexico decided to allocate costs to charges through a two-part tariff consisting of a capacity charge and a commodity charge. This was done to enable charges to reflect the fact that system costs depend upon when system use occurs, as well as on how much gas is moved through the pipes.

Regarding the structure of two part tariffs, there were two separate decisions, one for distribution and another for transportation. For transportation, the choice was

³⁰ One-product world, free flow of information (so that regulators are as well informed as firms), and consumers homogeneous in their preferences.

³¹ See Armstrong et al. (1994), p. 20-24, 53-54.

³² For instance, in the United States cost allocation to charges has varied from an "Atlantic Seaboard" method which assigned 50% (later 100%) of fixed costs to the commodity charge, to the "Straight Fixed Variable" method which allocates all fixed costs to the capacity charge.

a straight fixed variable methodology, that is, transporters will be required to set capacity and commodity charges to recover their fixed costs from capacity charges and their variable costs from commodity charges. This methodology is consistent with the cost structure of transportation businesses and with current practices and interests of existing transporters and potential transportation investors.³³ However, transporters are allowed to set a different split between capacity and commodity charges if they can demonstrate that it is consistent with the particular characteristics of their projects.

On the other hand, distributors are required to set capacity and throughput charges so that revenues from each recover 50 percent of total costs. This methodology was designed differently from that of transporters since regulators considered that peak capacity is a less important cost driver in distribution than in transportation. In other words, for distribution projects the number of consumers is a more important cost driver than actual throughput. Also, since Mexican distribution networks are scarcely developed, the 50-50 split was thought to provide an incentive for development and for increasing throughput.

As in the case of transportation, distributors will be allowed to recover more than 50 percent of their costs through capacity charges if they are able to justify this in relation to their specific cost drivers.

B . OTHER SPECIFIC METHODS

Recognizing the potential ability of a company to dilute the stringency of the average revenue cap, several other measures had to be established to ensure that charges, especially capacity charges, accurately reflected costs.

Some of these measures included decisions regarding methods that must be used by permittees to calculate capacity use. These methods had to encourage efficient system use while avoiding uncertainty as to capacity payments which system users will have to make.

Policy decisions regarding capacity use and charging included:

- Capacity payments must be based on capacity booked or reserved in advance. This provides certainty to i) consumers with respect to the capacity charges they will have to face, and ii) transporters and distributors regarding their revenues from capacity;
- Booking has to be made for the capacity required at the system peak. This is preferable to consumers booking the maximum capacity they require (regardless of whether or not there is a system peak) because the timing of capacity requirements is a major cost driver of the network system;

³³ In February 1996, hearings with players of the gas industry took place so that the Mexican regulatory authority could consider practical issues regarding price and rate methodologies.

- Transportation users and unbundled distribution users (including marketers) will be required to reserve peak system capacity. Distributors providing bundled service will be required to reserve sufficient peak transportation capacity and set sufficient peak distribution capacity;
- There will be a system of penalties for under booking at the system peak which should give users an incentive to reserve the correct amount of capacity. Capacity reservations, penalty arrangements and competition among permittees and marketers will encourage the emergence of a secondary market for capacity which will promote the efficient use of the system;
- The system peak will be defined in advance by transporters and distributors based on historic timing and duration of the peak load, or on deemed customer class load profiles (when historic data are not available or relevant for the system);
- Transportation capacity charges for different regions must be based on marginal cost differences so that pricing signals facilitate the efficient development of the system. Thus, transportation charges will encourage the use of the system at points where there is excess capacity and discourage use where the system is near full capacity.
- Distributors will be allowed to charge different rates for distinct pressure tiers of the system, as there are genuine cost differences associated with providing service at different pressures (due to, for example, different pipe diameters). Likewise, distributors may charge different rates to different customer groups according to their distinct load profiles;
- Companies will be allowed to offer interruptible contracts.³⁴ Through these contracts, companies will be better able to stay within their booked capacity and to overcome capacity constraints. Interruptible rates must, of course, be below the corresponding firm rate.³⁵

Flexibility of Regulation and Contract Sales

As mentioned above, rate regulation in Mexico is a combination of several methodologies which provide a mix of certainty for investments, incentives for efficiency and flexibility in rate setting:

³⁴ In some cases, the regulatory authority may require interruptible contracts to be offered; for example, in cases when interruptible contracts may help to postpone investments intended to overcome capacity bottlenecks.

³⁵ Economics of interruptible and firm rates can be analyzed under the Ramsey framework. Let P_f and P_i be the prices, $Q_f(P_f, P_i)$ and $Q_i(P_f, P_i)$ be the demands, and C_f and C_i be the marginal costs for firm and interruptible services respectively. Optimal price/marginal cost markups are given by the Ramsey rule for each kind of service. C_f is expected to be substantially greater than C_i because supply of an extra unit of the firm service will require capacity expansion.

- The cost of service performed at the beginning of every five-year period provides enough certainty to firms' projects since it permits passthrough of fixed and variable costs plus an adequate rate of return;
- The incentive methodology used sets a cap on prices which provides incentives for cost reduction and, therefore, for productive and allocative efficiency;
- The addition of weights to the calculation of the cap when projects have achieved maturity assures long-run efficiency, and
- The average revenue nature of the regulation permits flexibility in the establishment of relative rates for different kinds of services and consumers,

This flexible regulation was designed to reduce risks in new uncertain projects. However, the regulation also had to consider that variable market conditions might demand different rate arrangements than the regulated ones. Therefore, rate regulation in Mexico has another important virtue. As long as regulated rates exist as a fallback, parties may freely contract for regulated services if they follow some general requirements such as:

- Revenues from contract rates will be taken into account when comparing permittees achieved average revenues with the cap, since contract arrangements could be used by the market-powered firm to evade regulation;
- Contract sales will be deemed to have been made at the corresponding regulated rate so as to prevent cross subsidies between contract and regulated sales; and,
- Contract rates must be equal to or greater than the minimum rate.³⁶

There is another mechanism of the rate regulation which provides flexibility in case of unexpected economic circumstances. This mechanism adjusts the formula for calculating achieved revenues. In case of a 10% volume drop in a certain year t due to causes beyond the control of the firm, this adjustment will limit the extent to which lower throughputs inflate year t achieved revenue. Therefore, the K factor will not adversely affect unduly the average revenue cap of year $t+1$.

The adjustment to the achieved revenue will be made by using i) 90 percent of the previous year's throughput volume as denominator, and ii) actual contract revenues in the numerator. The first of these adjustments limits the impact of throughput drops in the calculation of actual revenues. The second is required because contracts may have been designed such that revenues are not tied to volume throughput. In such a case, estimating contract revenues with regulated rates when volume drops would overstate the operator's true revenues.

III. Acquisition Pricing

³⁶ The minimum rate for a transportation or distribution service will be equal to the corresponding commodity charge. When a transporter follows the regulated method of cost allocation to charges (that is the "straight fixed variable" method) his minimum rate will be close to the variable charge of providing the service (see Comisión Reguladora de Energía (1996), ch. 11).

Specific Challenge

Mexican regulatory authorities decided to promote the development of distribution systems by allowing regional monopolies in distinct geographic zones. These zones will be bid, and the winner will generally enjoy an exclusive franchise period in which he will be the only party allowed to provide gas transmission service inside his zone. The exclusivity is a principal reason why this service is regulated by the methodology described in section II of this document.

However, marketing of the gas commodity inside a distribution geographic zone constitutes a contestable market where distributor's gas sales compete with those from marketing companies. Therefore, when there are enough players in such a market, a primary role of regulation is just to assure that there are no artificial barriers to entry which hinder competition. By the same token, when there are no marketers and thus no competition in the gas sales market, the distribution company which holds the franchise might be the only supplier for a group of captive customers. Therefore, the regulation in Mexico had to devise a mechanism to protect captive customers in geographic zones where the distributor is the only seller of gas.

Theoretical and Empirical Background

Cost passthrough, incentives and risk

A distribution franchisee must seek to have a balance between risk and incentive in its gas marketing activities. On one hand, the distributor would like to recover all of its gas procurement costs consisting of gas purchasing, storage and transportation expenses. On the other hand, if there are no incentives to acquire gas efficiently, distributors will not seek to purchase gas cheaply unless they face competition from marketers or from other fuels.

The above scenario has been studied in some theoretical models. For example Milgrom and Roberts (1992) present a simple model where the optimal level of cost passthrough is calculated. The point of the model is to find an optimal price rule of the form:

$$P(c) = \bar{P} + (1 - \rho)c$$

where $0 \leq \rho \leq 1$ is the parameter which determines the level of cost passthrough. The model shows that when the regulator minimizes the expected payment to the firm subject to the firm obtaining at least some reservation utility level π_0 , the optimal level of cost passthrough is given by

$$\rho^* = \frac{1}{1 + \gamma\sigma^2}$$

where γ is a parameter that measures the degree of risk aversion, and σ^2 reflects the amount of cost uncertainty. Therefore the more risk averse the firm is and the more cost uncertainty there is in a project, the more the price rule should permit passthrough of costs. At the extreme, when γ or σ^2 are zero -- meaning that the firm is risk neutral or that there is no cost uncertainty -- $\rho = 1$ and a pure price cap rule would be optimal. As γ or σ^2 tend to infinity, the optimal pricing policy would be cost of service. *Ceteris paribus*, the more risk averse consumers are, the lower will be the optimal value of ρ .

In case the firm produces more than one product, the above model shows that the optimal value of the cost passthrough parameter is given by

$$\rho^* = \frac{1}{1 + \gamma\sigma^2(1+r)}$$

where $0 \leq r \leq 1$ is a parameter which measures the degree of correlation between the cost parameters of two firms. Therefore, the more positive correlation there is between cost uncertainties of each firm, the more aggregate uncertainty there is and the higher the cost passthrough that must be allowed to each firm.

International Experience

In Argentina, tariffs for natural gas charged to end users in a distribution zone consist of the sum of three elements:

- a) The price of gas at the point of entry into the transportation system,
- b) The transportation rate, and
- c) The distribution rate.

Transportation and distribution rates are determined through a price cap methodology. The selling price of gas is regulated through benchmarking. The regulatory authority can limit passthrough gas costs if it finds that that gas prices to end users exceed those negotiated by other distributors under similar situations.

In the United Kingdom, the price cap formula which regulates British Gas' sales to customers who consume less than 25,000 therms a year includes a term intended to regulate the passthrough of gas costs. Prior to the date when the formula came into operation³⁷ average gas costs could be passed through in full. The term in the new formula only permits the passthrough of an index GPI of gas costs which is based on the escalation clauses in BG's contracts. The costs that are allowed to be passed through under the cap are given by an initial average cost of gas, adjusted by the gas price index less a 1% efficiency factor. If BG is able to perform marketing activities which permit the actual gas price to be below the cap, it can retain the extra gains.

³⁷ The price cap formula started to operate in 1992.

Policy Decision

Gas regulatory authorities in Mexico decided to implement a mechanism that could protect captive customers from the market power of a distributor who sells gas in its geographic zone without confronting competition from any other economic agent. This mechanism aims to strike a balance between the risks and incentives given to such a distributor.

The three methods of regulation initially considered were:

- A simple mechanism allowing the distributor to passthrough its procurement costs of gas;
- A yardstick basis for passing through the cost of gas based on the average cost of gas for all distributors; and
- A variation or combination of these two methods.

A simple passthrough mechanism was discarded -- despite its reduction of the distributor's real risk -- because it provided little incentive for the distributor to purchase gas efficiently.

The use of a yardstick to passthrough the costs of procuring gas was not chosen either. This method would have been adequate only if a competitive and transparent activity of gas commercialization or marketing had already been present in the various distribution systems of Mexico. However, this was not the case.

The methodology chosen to regulate the acquisition price of gas was a variation of the first two possible options considered. A distributor is allowed to transfer its cost of acquiring gas as long as they are less than or equal to a predetermined benchmark. This benchmark is given by the regulated price of gas plus the regulated rates for transporting and storing gas.

The mechanism establishes a cap on the gas purchased costs that a distribution company can transfer to its customers. The formula is:

$$PA_t = \frac{G_t + T_t + A_t}{V_t}$$

where

PA_t = Acquisition price cap;

G_t = Maximum cost than can be passed through;

T_t = Total transportation cost;

A_t = Total storage cost, and

V_t = Total volume.

Thus, to construct this cap, the methodology uses the domestic gas price and the rate regulations described in sections I and II. That is, in distribution zones where most of the gas is brought from Mexican fields the price of gas will normally be

capped by the national domestic firsthand gas price,³⁸ while transportation costs must be in accordance to regulated transport rates.

Nonetheless, this methodology does not preclude parties from agreeing by contract to a price different from (even greater than) the regulated acquisition price. However, in order to be eligible for this contracting option a distributor must have a marketing subsidiary which contracts with final consumers.

IV. Concluding Remarks

This paper had a twofold purpose. On one hand, it aimed to survey the theory and international experiences relevant for policy makers faced with the challenge of designing a coherent and detailed price regulatory framework. On the other hand, it sought to describe the rationales that supported a policy decision process which listened to economic theory, international experiences and market players.

The document presents an example of how complex economic concepts were taken into account in reaching concrete decisions. Therefore, it shows an example of how a bridge between abstract theory and practice can be built. This should be of interest both to theorists seeking to make innovations driven by real-world phenomena, as well as to policy makers who try to find some theoretical guidance while in the churn of day-to-day operations.

Some lessons can be taken from the exercise that, from my point of view, should prove useful to both researchers and policy makers. A brief list of such lessons is:

- A perhaps trivial and sometimes forgotten lesson is that the results of economic theory should always be taken with reference to the assumptions of the model. A decision maker should try to compare such assumptions with the prevailing real-world conditions that are present before trying to apply any theoretical result;
- Since theory is most often based on very restrictive assumptions, it will be the unusual case in which reality and the assumptions of economic theory coincide nicely. Nonetheless, theory can always provide a useful reference framework for policy making;
- Regulation is best perceived and applied only as a substitute for competition. Regulatory measures should only be taken when and where natural or artificial market power or barriers to entry into contestable markets exist;
- The general objective of regulatory authorities is to maximize welfare subject to incentive and individual rationality constraints of the firm. The solution to this problem should reconcile several conflicting goals: i) provide enough rents to

³⁸ When a distributor is not connected to a national production field, the regulatory authority may authorize a reference price different from the gas regulated price.

firms, ii) efficiently allocate rents between firms and consumers, and iii) minimize the costs of carrying out regulation;

- While applying this general conceptual framework, regulatory authority must not forget that regulated firms have more information than the authority does. However, authorities must also be aware that the asymmetry-of-information problem can be solved by applying methods of regulation which induce firms to reveal their true level of efficiency and to behave accordingly;
- Rate flexibility is important for firms that start new projects since it helps them to appropriately handle risk and uncertainty. However, too much flexibility may also be detrimental for consumers. Therefore, flexibility in rates must go together with cost reflective methodologies;
- Extremes in the application of methodologies are dangerous. It is preferable to have a mix which extracts the best of each methodology and which considers the specifics of the economic environment. For example, price caps should be combined with cost of service regulation and average revenue regulation should be similarly accompanied by cost reflective methods;
- Regulatory strategies toward incipient and mature industries may diverge. In general, a new industry requires of a transition phase where regulation is flexible enough to encourage initial development. Also, this transition phase should seek to moderate large swings in certain variables (such as prices) that accompany regulatory reform and that may undermine a regulatory contract due to reductions in consumer surplus that are too deep;
- Regulation itself must be sufficiently flexible to change its structure once maturity is achieved in the industry. When such a level of maturity is reached, regulation can begin to trade off the flexibility initially granted to firms for more long-run welfare issues;
- Parties should have the option of freely contracting in any regulatory scheme as long as viable regulated prices, rates and terms and conditions of service exist as a fallback. However, regulatory authorities should oversee contract activities to insure that they are not used improperly to achieve that which regulation is fundamentally designed to prevent.
- Benchmarking is a plausible option as long as the appropriate benchmark is selected.

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