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## **Policy Research Supporting Policy Making: The CIDE-CRE Agreement**

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### **Abstract**

This paper presents a case study of regulation of natural gas pricing in Mexico as a case of “successful” policy research. Studies done under an academic agreement between the Comisión Reguladora de Energía (CRE) and the Centro de Investigación y Docencia Económicas (CIDE) in Mexico City have analyzed the welfare efficiency implications of the netback rule based on the Houston gas price that is used to set the domestic gas price. This rule results from a well structured welfare maximization general model. However, in practice the netback rule has been debated during several North American price spikes. Policy makers relied on CIDE studies to keep the netback rule. This case study examines how and why policy makers did so. The debate within the Mexican government is analyzed, and the actors involved in the policy discussions are described, as well as the relationships between CIDE and CRE that were developed, and that helped in the communication with policymakers. The methods of dissemination of research are also discussed.

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## ***Introduction***

In 1996 the government of Mexico linked the price of natural gas to a natural gas price benchmark in Houston plus net transport costs. This pricing formula, called the netback rule, followed economic theory. It is an implementation of the Little-Mirrlees method, where the price in Houston is a measure of the opportunity cost to Mexico of consuming the gas rather than exporting it to the United States. But economic theory aside, in practice the netback rule has been attacked in Mexico during several North American price spikes. Many Mexican industrial consumers had not hedged during such events, and as a result there has been strong political pressure to drop the Houston benchmark in pricing gas.

In the midst of such controversies, Mexican policy makers have used research at the Centro de Investigación y Docencia Económicas (CIDE) to keep the netback rule and to design various hedging procedures.<sup>1</sup> This case study examines how and why.

## ***Policy problem***

Mexico has an energy market that is different from many other countries.<sup>2</sup> The national oil company, Pemex, is a very important political and symbolic institution. Foreign interests initially owned the oil industry, and its nationalization in 1938 was viewed by most Mexicans as a proud expression of sovereignty. Pemex's union has historically been very powerful. The privatization of Pemex (and of the other energy State utilities) is politically impossible.

In other ways, Mexico is not so different from other countries. Liberalization of the natural gas sector is complex because in every country the natural gas industry combines naturally monopolistic activities with potentially competitive ones. Pipeline transportation and distribution have natural monopoly characteristics and require regulation of price and nonprice behavior. Production is a contestable market, though in a few countries such as Mexico it is still maintained as a state monopoly. Marketing gas is also contestable, but the presence of a dominant upstream vertically integrated incumbent may pose significant barriers to entry. Market architecture decisions such as the degree of vertical integration, horizontal structure, and regional development are also crucial.

Could economic analysis help in these decisions? Formal analysis of the hydrocarbons sector in Mexico is tricky. Difficulties arise from three sources. First, Pemex is a monopoly and many of the markets involved are regulated. Prices in these markets are not a good guide for economic decisions as to production. Second, oil, gas and natural gas liquids are often produced jointly, and in such cases it is impossible to allocate costs of production to a specific product.<sup>3</sup> Hence, it is impossible to price associated gas by reference to the cost of production. Finally, the goods produced are substitutes in consumption. Gas and oil are substitutes in the generation of power; natural gas liquids, gas and oil are substitutes as feedstocks. This creates very difficult problems in regulating prices. Nonetheless, the CRE has the responsibility of regulating the price of natural gas.

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<sup>1</sup> The Comisión Reguladora de Energía (CRE) has typically required that natural gas local distribution companies get some type of hedging. However, the CRE only recommends industrial consumers to hedge. They sometimes chose not to buy hedging but to exert political pressure on the government so as to receive some kind of subsidy.

<sup>2</sup> See appendix 4 for background on the Mexican natural gas market.

<sup>3</sup> See Adelman (1963).

The CRE solved the problem by using an international benchmark. The natural gas price at Ciudad Pemex in Southeast Mexico (where 80% of total natural gas is produced as a byproduct of oil extraction) was linked to the price at the Houston Ship Channel hub through a netback formula. The price of gas in Ciudad Pemex is equal to the price at Houston plus transport costs from Houston to the arbitrage point (currently at Los Ramones, in northeast Mexico)<sup>4</sup> minus transport costs from the arbitrage point to Ciudad Pemex (see Figure 1).<sup>5</sup>

This pricing regulatory formula is an implementation of the Little-Mirrlees method, which proposes the use of world prices for pricing traded goods.<sup>6</sup> Thus the price of gas in Houston is a measure of the opportunity cost to Mexico of consuming the gas rather than exporting it to the United States.<sup>7</sup> The netback rule also implies that the Mexican gas price remains insensitive to variations in demand for gas in Mexico, and that consumers are facing a flat supply curve. The amount of gas imported or exported works as an equilibrating factor.

The netback rule was published by the CRE in 1996.<sup>8</sup> It has been debated during several North American price spikes such as the one in the 2000-2001 winter.<sup>9</sup> The price of gas in Houston rose from around \$2.00 per MMBTU in January 2000 to almost \$10.00 per MMBTU by January 2001.<sup>10</sup> Many Mexican firms had not hedged and as a result found themselves in serious trouble. Plants were being forced to close. There was strong pressure on the CRE to drop the Houston benchmark in pricing gas. Pemex rescued the firms in trouble by offering a \$4.00 per MMBTU three year take or pay (hedging) contracts. The netback rule based on the Houston price remained and—along with the design by the CRE of mechanisms that promoted hedging by gas users—our studies were used by policy makers to support such policy decision.

### ***CIDE-CRE Agreement***

The CIDE-CRE academic agreement was formally initiated in September 1997. It has consistently provided the Mexican energy regulatory authorities with a research foundation for policy decision making. CIDE and CRE initially signed an “umbrella” general contract agreement with an indefinite time horizon with the idea of arranging within this general agreement various “specific” subcontracts for time constrained specific issues. By 1997, the CRE was not expecting to urgently need the research studies, especially the one on the regulation of the price of natural gas. The CRE however wisely foresaw that such a study would be needed a few years later in case the North American gas market would have to face price instability.<sup>11</sup> This translated in generous time spans for academic research on natural gas pricing, which was of course very well received by an academic oriented think-tank such as CIDE. Therefore, timeliness was important but it did not really represent a binding constraint for CIDE’s research staff during the three major research contracts.<sup>12</sup> Likewise, the CIDE-CRE research contract agreements explicitly anticipated

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<sup>4</sup> The arbitrage point is the place where northern and southern gas flows meet, and where northern and southern gas prices coincide.

<sup>5</sup> See Comisión Reguladora de Energía (1996), section 4.

<sup>6</sup> See Little and Mirrlees (1968) p. 92.

<sup>7</sup> See Brito and Rosellón (2002).

<sup>8</sup> Pemex had previously been using a very similar rule based on another Texas marker (Tetco and Valero). See Rosellón and Halpern (2001).

<sup>9</sup> See Arteaga-García and Flores-Curiel (2003).

<sup>10</sup> See appendix 1 for Houston Ship Channel average prices in 2002-2007.

<sup>11</sup> See appendix 1 for US wellhead prices in 1980-2025.

<sup>12</sup> An exception was the fourth small scale research contract, which was signed in 2002 and developed in few months. It was designed to support a policy decision of the CRE in order to avoid increasing the price

that the studies would be carried out under academic freedom, a fact that would potentially imply that sometimes the conclusions of CIDE's academic studies would not precisely coincide with a final CRE's policy decision (as was the case with the regulatory scheme for gas marketing). Each major research agreement had a similar structure. Within each specific agreement, three research topics would be developed and an international conference would be organized.<sup>13</sup>

### ***Analytical approach***

The main participant from CIDE was Juan Rosellón, a professor at CIDE's Department of Economics. The other was Professor Dagobert L. Brito of Rice University. This research team included research assistants from the BA and MA economics programs at CIDE.

When we started our research in 1997, we had several meetings where staff from Pemex presented the models they used to compute gas prices across the country. For the case of LPG, Pemex used a very large programming model to plan production and to price LPG in Mexico. If the vectors of the quantities demanded and supplied are correct, the model will give a detailed allocation of LPG. The duals of the model are the values of the product and the costs of meeting the demands. However, the model was too detailed to be transparent as to the relationship between the variables. The extended model was a "black box" that had more than 1500 variables and 500 equations. Assumptions lurked everywhere, and they were difficult to make out.

For the purpose of determining the price of gas in Mexico, the key economic variable of interest is the dual associated with the stock of gas. Fortunately, the *Maximum Theorem* permitted us to reduce the Pemex's extended model to a much simpler model whose dimensionality was that of the input and constraint set. Additionally, this model could be solved analytically.

Most of our studies on regulation of pricing of natural gas used the Maximum Theorem to reduce the Pemex's extended model. In this way we derived the natural gas regulatory netback formula used in Mexico.<sup>14</sup> The netback rule follows from the condition that Pemex should be indifferent between the sale or purchase of gas in Houston, and the sale of gas at any point in Mexico. Therefore, the price of gas in Mexico turned out to be determined by the shadow price of the resource constraint of the associated gas produced in Mexico, and thus provided the price of natural gas that coincided with the regulators' objectives.

These results were derived by identifying the microeconomic foundations of the policy problem and by abstracting the most essential elements of a complex problem.

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of natural gas under Pemex's petition. Pemex wanted a displacement of the arbitrage point from Los Ramones (in the northern state of Nuevo León) to Cempoala (in the southern state of Veracruz), a change that would have implied an increase of the price of natural gas of around USD0.50 per Mmbtu.

<sup>13</sup> The topics of the first agreement (1997-1999) included pricing of natural gas and liquid petroleum gas (LPG) production as well as pricing of natural gas distribution. The second agreement (1999-2000) addressed the regulation of gas marketing activities, the timing of investment in LPG pipelines, and the effects of the reform on natural gas production and distribution. The third major research agreement (2002-2004) included the study of incentives for long-term investment in electricity transmission and generation, and the analysis of the strategic behavior of Pemex in the natural gas sector. It must be said that the issue of regulation of the price of natural gas was progressively addressed in all the research agreements. This consequently rendered numerous academic publications.

<sup>14</sup> Brito and Rosellón (2002).

For example, the pipeline system in Figure 1 (appendix 4) was reduced to a single pipeline connecting Burgos with Ciudad Pemex. The connections at Los Ramones and Cempoala might be ultimately modeled as mass points in the distribution of demand.

This model evolved over time as we addressed closely related issues. A first extension studied the effects of pipeline capacity on the netback rule.<sup>15</sup> We initially found that a pipeline capacity restriction that hinders gas exports is reflected in the domestic gas price through the shadow price of such a restriction. This is a corollary of the more general result that pipeline capacity restrictions generate rents to Pemex so that it does not have a strong incentive to invest in pipeline expansions. Moreover, PEMEX is vertically integrated among production, transportation, and marketing activities. This potentially permits PEMEX to carry out several strategies so as to preserve its vertical monopoly as well as to control pipeline capacity in order to circumvent the netback formula. When there is not enough capacity, the gas movement would not clear the markets, and Pemex could capture the rents associated with the capacity restriction. Reducing PEMEX's vertical integration might therefore contribute to a more competitive allocation of pipeline capacity, and hence to a better performance of the netback price regulation. Additionally, the CRE might enforce open access and monitor investment in pipeline capacity so that there is always enough capacity and the gas market can always clear. The savings from such a policy would more than cover its costs.

Another extension concerned the location of production. Surprisingly, we found that the optimal place to develop production sites is close to the arbitrage point and not close to consumption areas. And in yet another study, we examined the competitive conditions in the Texas natural gas market. Increases in gas prices --coupled with expected future increases of LNG imports to the North American market-- might justify the use of an alternative benchmark price.<sup>16</sup>

We later developed a more general model to study the netback rule,<sup>17</sup> since there were allegations that the netback rule could be partitioned in two so that the southern market could use a benchmark in South America as a reference price.<sup>18</sup> We developed a model where individuals located along a pipeline could spend their income on goods, an alternate fuel, or gas. The price of gas was given by a nonlinear price schedule that was a function of location and the quantity of gas purchased. We showed that under such conditions, the general optimal price of gas is still the netback rule. If the market were nonetheless segmented, the netback rule defines upper and lower bounds for the price in the segmented market. One possible segmentation is between Los Ramones and Cempoala. We showed that a one percent change in demand or supply would eliminate such a gap, so this is not an important issue.

Finally, we studied some short-term regulatory measures that CRE might use to provide PEMEX with incentives to increase supply in the domestic regulated market (and hence avoid a deliberated southwards displacement of the arbitrage point).<sup>19</sup> The first measure was to temporally fix the arbitrage point at Los Ramones so that Pemex had incentives to increase production (and investment) to a level corresponding to the price of gas implied by Los Ramones. The second strategy was to set a price based on the netback rule for internal gas transactions among PEMEX'S subsidiaries. We showed that, although these measures can be at odds with

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<sup>15</sup> Brito and Rosellón (2002), Brito and Rosellón (2003b), Brito and Rosellón (2005a).

<sup>16</sup> Brito and Rosellón (2005a).

<sup>17</sup> Brito and Rosellón (2005b).

<sup>18</sup> See Arteaga-García and Flores-Curiel (2003).

<sup>19</sup> See Brito and Rosellón (2005c), and Brito and Rosellón (2005d)

long-run Pareto efficiency, their effects are minimal in the short run and helped to deal with political pressures to keep domestic gas price low.

### *The Appreciation of Formal Analysis*

To some people within the government, formally analyzing the regulatory mechanism for pricing natural gas appeared unnecessary. They seemed to think that the use of complex mathematical models would not add anything essential to the discussion among policy makers, since some believed that economic theory was too abstract to provide results that could be relevant in practice.

However, once we set the formal model and derived the first order optimality conditions we were able to explicitly obtain a first very interesting (and somewhat surprising) result. The netback rule defines a peculiar structure of incentives. Small changes in the distribution of gas might result in big changes in its price. Pemex might divert production from the regulated market (or simply reduce its production or flare gas) to bring south the arbitrage point, and then cause an increase of the domestic natural gas price twice greater than the change in the marginal cost of transport. This does not change the efficiency properties of the netback rule, but it does change the allocation of economic rents. Regulators should take this into account when monitoring investment and production strategies of Pemex, and when implementing location changes of the arbitrage point. Generally speaking, a change in the location of the arbitrage point might be justified when a change in the pipeline flow pattern is not related to strategic anticompetitive behavior of Pemex.

This first result was essential in capturing the attention of policy makers, who promptly understood the importance that mathematical analysis had for policy discussions. From this point on, the framework provided by analytical policy research was generally accepted as a crucial input to all regulatory policy discussions on natural gas pricing.<sup>20</sup>

Our research was motivated by real policy problems faced by Mexican authorities. Our project helped in the development of relevant applied economic research in Mexico and, consequently, in basing policy decisions on theoretical concepts. To achieve this, we always had close relationships with the CRE staff during the elaboration of the studies. In each 18-month cycle of the CIDE-CRE agreement, feedback from CRE policy makers was obtained from each of three or four work-in-progress seminars, and from the project's international conferences as well. Through these mechanisms we were able to get valuable insights from CRE staff of all ranks and specialties. We also arranged personal meetings with experts on specific issues. We developed a close relationship with the CRE chairman, several commissioners, and with the CRE's chief economist.

We also had personal meetings with staff from Pemex and the Secretaría de Energía (the energy ministry of Mexico). The meetings with Pemex were most important at the beginning of the project so as to figure out the general structure of the models that CRE and Pemex had in mind to set the price of gas. We also met with industrial and consumers' organizations (such as *Concamin*). Contacts with other potential users or people interested in our research—such as staff from other government agencies, industrial consumers, congressmen, international scholars, and so forth— were mainly achieved in each international conference of the CIDE-CRE

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<sup>20</sup> Other results of our models on regulation of natural gas pricing are summarized in the next section.

agreement.<sup>21</sup>

These contacts were fundamental in the design of the research. We were able to appreciate first hand the opposed objectives of several actors, especially of CRE and Pemex. The complexity and speed of the public policy making have traditionally made it impossible for Mexican regulatory authorities to analyze topics that require rigorous academic research. Typically, government officials and consultants had to face short-term challenges. However, CRE authorities understood that although research on medium- and short-run topics could be temporarily postponed, their analysis was fundamental for the coherent and sustainable development of the energy sector. Price setting of domestic natural gas was one of such topics.

In the last seven years there have been hot discussions on the best way to determine the price of domestic gas in Mexico among the several actors of the gas industry. Besides the Little-Mirrlees netback rule, there have been at least two other proposals discussed as a way of pricing natural gas in Mexico (see appendix 2). One was to use the cost of production; the other was to use the cost of substitutes for natural gas. The first suggestion is not possible as most natural gas in Mexico is produced as a joint product with oil, so that there is no well-defined cost of production. There is not a free market in many of the substitutes for natural gas in Mexico, so it is not appropriate to use these prices. Compared with such alternatives, our studies showed the efficiency of the netback rule. And using the price of gas in Houston does take into consideration the cost of substitutes, since the Houston benchmark reflects the price of competitive sources of energy.<sup>22</sup>

The CRE adopted our recommendations both at the time of designing the actual regulations as well as at several times when the netback rules was attacked mainly by industrial consumers which sought to implement a “Mexico price” based on much lower benchmark prices. Energy policy makers used our studies to explain that the best welfare strategy for Mexico was to set the price of domestic gas in terms of its international opportunity cost, and to hedge from sudden price spikes. The fact that our papers had been published in various prestigious academic journals helped energy officials in Mexico to solidly support the netback rule.

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<sup>21</sup> For instance, the conference of the second cycle of the CIDE-CRE research agreement took place during October 30 and 31, 2000, and included the participation of international experts such as Eytan Sheshinski, (Harvard), Dagobert Brito (Rice), José Luis Guasch (World Bank and UCSD), Catherine Wolfram (UC Berkeley), and Daniel Fessler (private energy consultant) as well as top government officials of Mexico’s energy sector such as Luis Téllez (Secretary), Andrés Antonius (Deputy Secretary), Mauricio Touissant (Deputy Secretary), Carlos Hurtado (Office of the President of Mexico), and Héctor Olea (CRE’s chairman)). Industrial consumers participated with various top private sector members such as Angélica Fuentes (Mexican Natural Gas Association), Eduardo Andrade (Mexican Electricity Association), while the Mexican Congress also attended with people such as PAN’s Senator Rodríguez Pratts. Local academia was also represented by members of *El Colegio de México*, *Centro de Investigación de Energía* (UNAM), *Instituto de Investigaciones Eléctricas*, ITAM, and (of course) CIDE.

<sup>22</sup> Benchmark regulation has also been tried in several other countries. In some oecd countries, (Germany, the Netherlands, Switzerland, Spain, Sweden and Denmark) gas prices are set according to prices of substitutes. Countries like Belgium, France, United Kingdom and Italy use a mix of the this principle with cost-based pricing, while the price of imported gas has been determined in countries like Japan and the United States by adding the price at the border plus costs of transportation, distribution and storage.



### *What results and findings were generated?*

- Brito and Rosellón (2002) evaluated mechanisms for linking the Mexican market for natural gas with the North American market. The netback formula is shown to be an application of the Little-Mirrlees principle (Little and Mirrlees, 1968), and relies on the fact that the Houston hub has a liquid market of future contracts to hedge against externalities. The formula, however, can also lead to incentives to increase the price of domestic natural gas by diverting production from the regulated market. Pemex can sell gas to its own subsidiaries or simply reduce its production in order to bring the arbitrage point south and increase the price of domestic natural gas twice more than the value of marginal cost of transportation. Short-term regulatory measures that the CRE might use to provide PEMEX incentives to increase supply in the domestic regulated market include fixing the arbitrage point at a level that forces Pemex to increase production and investment, and setting a price based on the netback rule for internal gas transactions among PEMEX'S subsidiaries.
- A reduction in import tariffs does not imply an increase in natural gas imports from the US, and has a small effect on the domestic gas price (proportional to the tariff reduction). Additionally, it is socially optimal to develop new gas production sources closest to the arbitrage point rather than to load centers. These results are due to the existence of a monopoly in production, and the netback formula is still shown to be the second best option to liberalization in production (see Brito and Rosellón, 1998).
- The netback policy is critically conditional on the existence of adequate pipeline capacity. If there is insufficient capacity, the movement of gas will not clear markets and it will be impossible to implement the netback rule. Rents will accrue to Pemex (Bruto and Rosellón, 2003b). For example, Pemex can capture the rents associated with the constraint by selling output forward, and could then become a monopoly in the forward firm-service market. While Pemex should not be prohibited from entering into spot or futures contracts to sell gas, the price of gas should 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—or the regulated transport tariffs—even in a nondiscriminatory fashion because it can carry out several strategies (such as cross subsidies that Pemex might carry out due to its vertical integration) and evade regulation. This regulatory strategy is equivalent to vertically disintegrating Pemex in the gas market.
- In an open economy where agents can choose between gas and alternative fuels—and where the density function describing the distribution of agents along the pipeline can have intervals that are empty as well as mass points—the netback rule is Pareto optimal if the gas market is not segmented (Bruto and Rosellón, 2005b). The Mexican gas market has not been segmented as gas from Ciudad Pemex reaches Los Ramones. However, if the market should become segmented the netback rule defines an upper and lower bound to the price in the segmented market. The possible segmentation that could occur in the Mexican gas market is between Los Ramones and Cempoala. If such a gap should occur, its impact would not be important since a small change in demand or supply would eliminate it.
- The expected future increase of LNG imports to the North American market and the recent increasing trend in the gas price might however give good reason for the use of an alternative reference price (Bruto and Rosellón, 2005a). There is evidence that pipeline network capacity restrictions in Texas preclude the arbitrage between the LNG import price and the Houston natural gas price (see Hartley and Medlock, 2005). Therefore, the use of a net present lower

benchmark price (that considers the possibly lower future gas price resulting from the increased entrance of LNG to the Texas market) might be justified.<sup>23</sup>

### ***Dissemination***

The results of our research on regulation of natural gas pricing were disseminated among the energy authorities of Mexico, various other government agencies, consumers, the academic community as well as the Mexican general public. Our preferred way of dissemination (both national and international) was the publication of our papers in refereed journals.<sup>24</sup> This process was also a means to evaluate the academic soundness of our work. The publication process is however of long-run nature due the normal editorial refereeing timing of international journals. We therefore made available preliminary versions of our work through the CIDE's working paper series. Likewise, most of the original versions of the papers were uploaded to the CRE's webpage. This permitted a wide dissemination of our results to the industry and other government agencies. Likewise, the CRE used our studies in meetings with other government entities such as the Secretaría de Energía, Pemex, and the Secretary of Finance.

We communicated our results in more direct and simpler ways through the CIDE-CRE conferences. These conferences included the participation of international recognized academic scholars, top government officials of Mexico's energy sector, top private sector representatives as well as representatives of the Mexican Congress. They were divided into technical sessions and policy sessions and the topics discussed included the recent debates regarding the reform of the gas and electricity sectors in Mexico. They were covered by the national media including TV, radio, and press. Under the CIDE-CRE conferences we were not only able to impact public policy in the Mexican energy sector but also the national public opinion.

The more technical details of the results of our project reached authorities through progress seminars and personal meetings with officials of the Secretaría de Energía and the CRE. Typically, the mathematical technicalities of our papers were discussed with specialized (mid ranked) government staff, while the intuitive policy implications were discussed at large with (higher ranked) policy makers.

Additionally, dissemination of basic results reached the general public through non-technical articles and interviews in national journals as well as through interviews with the media including national TV and press.<sup>25</sup>

Our work also reached the international academia community by means of refereed academic international conferences such as those of the *Econometric Society*, the *Latin American and Caribbean Association (LACEA)*, the *International Association for Energy Economics (IAEE)*, and the *US Association for Energy Economics (USAEE)*, and presentations in US universities (such as the Harvard, Princeton, Cornell, UC Berkeley and Rice), as well as in several national conferences including those of the Mexican Association for Energy Economics (AMEE) (the Mexican chapter of the IAEE). Our joint work with researchers in the US also contributed to let the international community of energy economists know about the distinct policy problems (and

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<sup>23</sup> However, this is a very different reason to propose a change in the benchmark price to most of the reasons proposed by Mexican industrial consumers.

<sup>24</sup> The various publications on natural gas price regulation (as well as in other subjects) that were produced under the CIDE-CRE agreement are presented in appendix 3.

<sup>25</sup> For example, the results of our papers were presented in down-to-earth language in national newspapers (*El Financiero*, *Reforma*) and magazines (*Tecnogas*).

the formal solutions) in the Mexican energy sector.

### **Impacts**

Our work affected policy in many ways. Sometimes, we made specific recommendations that were adopted. For example, at the end of 2002 Pemex asked the CRE for an increase in the price of natural gas by moving south the arbitrage point from Los Ramones to Cempoala. We did a policy analysis that recommended that the arbitrage point should temporarily remain at Los Ramones, at least for two to three years. The CRE followed our recommendation and issued a formal legal *Resolución* on this matter.<sup>26</sup>

Sometimes our research helped to change the rhetoric or vocabulary about an issue. For example, using our research people discussed natural gas pricing in terms of the “netback rule”, the “Little-Mirrlees Rule”, or even the “Brito-Rosellón formula”.<sup>27</sup> The first term, reflecting a concept widely used among energy specialists, helped to make clear in the policy discussions that the formula was not considering production costs or referring to the prices of alternate fuels.<sup>28</sup> A third way that research can make a difference is to summarize and simplify what was before a model so complex as to be of little use. As explained earlier, Pemex used a huge programming model to price LPG in Mexico, a “black box” that had more than 1500 variables and 500 equations. We were able to simplify this to a model with few equations that could be solved analytically and that provided the same information of the Pemex model plus many more valuable insights. We think this was an important contribution to regulatory policy making in the gas industry. Pemex followed its role of a huge company trying to flood a small regulator with too much information. CRE (and almost all the non-Pemex parts of the government) were not able to understand Pemex model to price LPG until we did our simplifying job. The general model that we developed for LPG<sup>29</sup> was also later the basis to develop the rest of our analysis for natural gas pricing.

Even when its recommendations are not heeded, policy research can be useful by providing a factual foundation for constructive debate. For example, our study on the implications of the netback rule on gas marketing recommended that Pemex should be vertically disintegrated or, at least, it should not be permitted to discount the price of gas from the Houston netback price, or the regulated transport tariffs.<sup>30</sup> The CRE did not follow our advice. Unions and other forces in Mexico argued that this would be a prelude to privatization. The CRE instead issued in 2000 the Directive on Firsthand Sales of natural gas<sup>31</sup>, so as to regulate Pemex’s gas marketing activities. The underlying assumption of the Directive on Firsthand Sales was that Pemex would retain a de facto monopoly in gas marketing and therefore had to be regulated. Although regulatory developments in gas marketing have been somewhat unfortunate in terms of increasing competition,<sup>32</sup> our timely studies gave policy makers the elements to gauge the negative impacts

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<sup>26</sup> See Comisión Reguladora de Energía (2002).

<sup>27</sup> This last term was used in Comisión Federal de Competencia (2004).

<sup>28</sup> The second term was the one that really reflected the essentials of the formula. By saying that we were using the Little-Mirrlees formula to set the price of gas in Mexico, we were implicitly saying that it was much more important that the formula considered the international opportunity cost of Mexican natural gas rather than its cost of production, given that most natural gas in Mexico is a byproduct of oil extraction. This point was explained in an op-ed published in the national newspaper *Reforma* in 2001.

<sup>29</sup> See Brito, Littlejohn and Rosellón (2000).

<sup>30</sup> See Brito and Rosellón (2003b)

<sup>31</sup> See Comisión Reguladora de Energía (2000).

<sup>32</sup> The governmental interventions throughout the Fox’ administration during several price spikes in the

that their (politically driven) policy decisions would have on welfare.

Policy research can have another sort of impact: changing the analytical question. An example from our work concerned the proposal to have a “Mexico price” much lower than the opportunity cost of natural gas. We pointed out that this issue had to be analyzed as a problem of distribution of rents. The use of a price lower than the opportunity cost would have transferred money that could have been used by the government in social expenditures. This effect would have been vital in terms of Mexico’s social policy: it would have been very difficult to justify in the Mexican congress a transfer of public funds from (say) poverty fight to a group of firms that competed under NAFTA, with similar input and capital prices to those of their North American competitors (including natural gas), but with advantages in the price of natural gas. Our work helped redefine the question, making clear the very important rent-distribution implications of changing the pricing rule.

### ***Concluding Thoughts***

This research accomplished something that had rarely been attempted before in policy making in Mexico: namely, to study formally the microeconomic foundations of a policy problem.<sup>33</sup> This proved to be very well received in the policy discussions because it provided a framework to contextualize the different opinions on the best way to set the price of natural gas in Mexico. Our models produced some predictions that proved to be true in practice: for example, those related to the structure of Pemex’s production incentives due to the netback rule, to the effects of import tariff reductions, and to the consequences of not reducing Pemex’s vertical integration.

In retrospect, however, I think that we lacked more collaboration with the CRE in order to widely explain our results to different actors, especially the industrial consumers that always retake the same “Mexico price” political discussion every time there is volatility in the North American gas market.

This case study shows how theoretical concepts developed by an academic think tank (CIDE) were relevant for policy makers faced with the challenge of designing a coherent and detailed price regulatory framework. Here are a few lessons that might be derived from our experience.

#### Policy Analysis/ how to think about “successful” policy research

- Since theory is most often based on restrictive assumptions, it will be the unusual case in which reality and the assumptions of economic theory coincide nicely. Nonetheless, theory can provide a useful reference framework for policy making.
- Therefore, 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

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North American market (such as the “3-by-4” contracts) illustrates this argument. Instead of looking for hedging to protect from price volatility, firms simply put political pressure on the government to obtain such distortionary economical concessions. Such interventions were made without respecting the regulator’s attributions, and therefore institutionally weekend the CRE.

<sup>33</sup> The market for policy research is relatively a new one in Mexico. Policy makers have traditionally not been too fond of basing policy decisions on formal academic studies. However, for the last ten years public policy research programs have strengthened in Mexican research institutions, such as ITAM, UDLAP, ITESM; UIA, and CIDE. CIDE is very well positioned in this new market because --since its creation 30 years ago-- most of its research projects have addressed real-world policy problems.

are present before trying to apply any theoretical result.

- Regulation is best perceived 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 firms, ii) efficiently allocate rents between firms and consumers, and iii) minimize the costs of carrying out regulation (through incentive-compatible regulatory mechanisms).
- While applying this general conceptual framework, the regulatory authority must not forget that regulated firms have more information than the authority does. However, authorities must also be aware that the principle of revelation—a result from the mechanism design theory<sup>34</sup>—provides a conceptual framework to address the issue of policy making under asymmetry of information.<sup>35</sup>
- Benchmarking is a plausible option as long as the appropriate (competitive) benchmark is selected.

#### Dissemination of research

- Several means of disseminating research should be sought. While publication in international refereed professional journals is fundamental to validate the research, conferences, op-eds in major newspapers, and TV and radio interviews are important to explain in colloquial language the proposed policy and its implications.
- Likewise, close contact with client policy makers is essential to adjust research in progress and to communicate results among the government various actors, which might have opposed objective functions.

#### How to organize research

- Topics of research should be chosen in consensus with policy makers. Although they can be related to day-to-day problems addressed by policy makers and consultants, it is important that such topics are specific, of long-run and academic nature, and that they do not duplicate studies done by other consultants or CRE staff.
- Cycles of 18-24 months are adequate to develop quality academic research relevant to actual policy, to interact with policy makers and other actors, and to disseminate the basic results.
- Teams of two to four researchers (plus RA's) were sufficient to carry out research reported here. International teams proved useful. Online collaboration is the basis for development of the studies, but occasional personal meetings proved to be most useful.

#### Funding

- A general agreement of academic collaboration between the think tank and the government

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<sup>34</sup> See Laffont, J.J. (1988), ch. 5.

<sup>35</sup> Namely, 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.

agency proved to be administratively important in our case. This general agreement set the basic institutional infrastructure to develop specific research contracts.

- Funding from the CRE was essential to initialize the CIDE's program on energy economics and regulation. However, once the program became solid we were able to attract funds from other sources, both national and international.
- In the elaboration of the budget, we had to consider CIDE's overheads as well as administrative expenses. However, most of the budget was focused to research expenses, and the organization of the international conferences.
- Flexibility from CIDE in the amount and the form of payment by CRE proved to be very useful for the long-run stability of the CIDE-CRE agreement.

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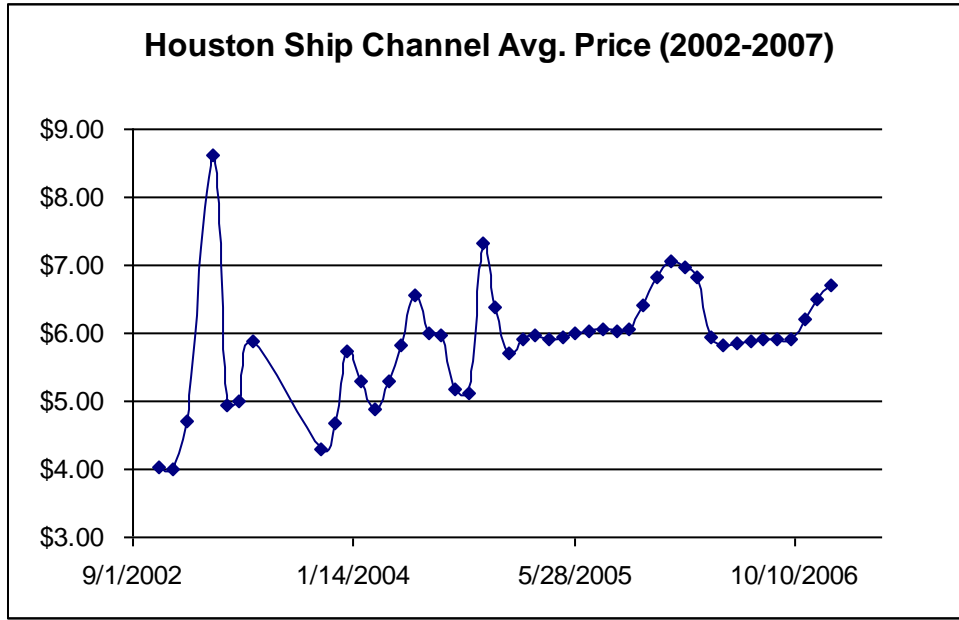
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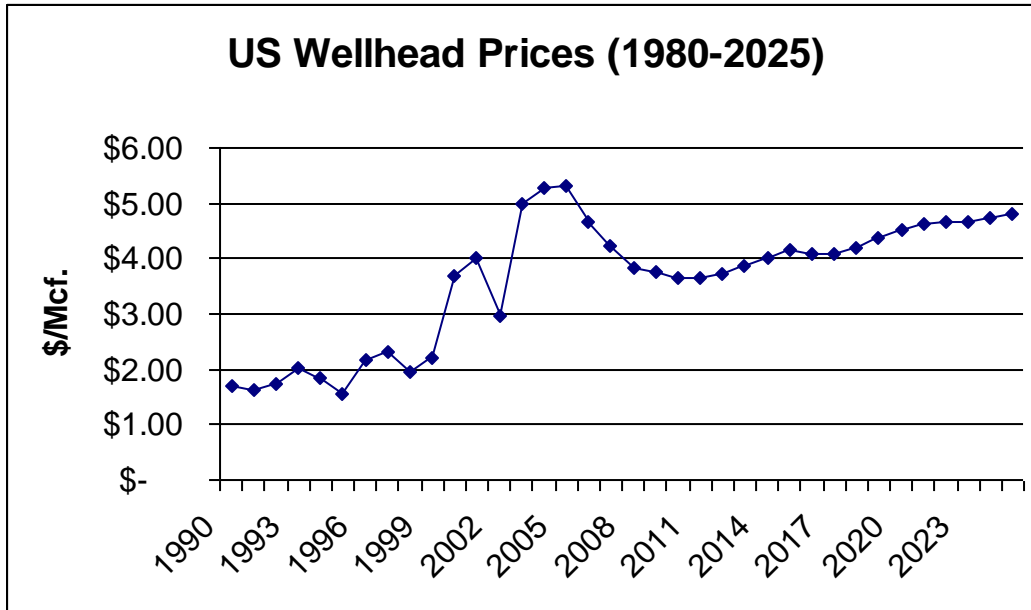
## Appendix 1

### *Houston Ship Channel Average Prices*



Source: X Group Gas Indices ([www.10xgroup.com](http://www.10xgroup.com))

### *Natural gas prices in the US*



Source: U.S. Energy Information Administration ([www.eia.doe.gov](http://www.eia.doe.gov))

## Appendix 2

### Pros and Cons of Pricing Options for Natural Gas

<i>Price based on</i>	<i>Pros</i>	<i>Cons</i>
Costs	<ul style="list-style-type: none"> <li>• Reflects costs.</li> <li>• Prices are related to costs at the wellhead in most countries with a competitive natural gas market.</li> </ul>	<ul style="list-style-type: none"> <li>• No marginal cost of extracting Mexican natural gas because it is a byproduct of oil.</li> <li>• Does not reflect the opportunity cost of selling Mexican natural gas in the North American market.</li> </ul>
Comparisons with other fuel prices	<ul style="list-style-type: none"> <li>• Reflects prices in international markets.</li> <li>• Prices of substitutes are economically related.</li> <li>• There are price series data.</li> </ul>	<ul style="list-style-type: none"> <li>• Potential prices of substitutes subsidized in non-explicit ways.</li> <li>• International markets of substitutes have different dynamics to the natural gas market.</li> <li>• Accounts for opportunity cost of other markets, not the natural gas market.</li> </ul>
A benchmark	<ul style="list-style-type: none"> <li>• Considers the opportunity cost of Mexican natural gas in the North American market.</li> <li>• The relevant benchmark, the Houston Ship Channel, is a liquid market, it has an associated hedging market, it is close to the physical connection to the Pemex pipeline system.</li> <li>• Methodology has some similarities with prior Pemex methodology.</li> <li>• Marginal costs of imported gas and domestic gas are the same at the arbitrage point.</li> </ul>	<ul style="list-style-type: none"> <li>• Brings disturbances from U.S. weather into the Mexican market.</li> </ul>

## Appendix 3

### Publications on Regulation of Natural Gas Pricing in Mexico

- (1) Brito, D.L. and J. Rosellón (2005), "Price Regulation in a Vertically Integrated Natural Gas Industry: The Case of Mexico", *The Review of Network Economics*, vol. 4, issue 1, March.
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- (3) Brito, D.L. and J. Rosellón (2005), "Implications of the Elasticity of Natural Gas in Mexico on Investment in Gas Pipelines and in Setting the Arbitrage Point," in Repsol YPF-Harvard Kennedy School Fellows 2003-2004 Research Papers, William Hogan, editor, Cambridge, MA, Kennedy School of Government, Harvard University, April.
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## Appendix 4

### Background

In 1992 the Mexican government initiated modest changes to permit entry of private participants in power generation, and a more ambitious reform in natural gas was begun in 1995. Before this, state companies had controlled energy activities: Pemex in the oil and gas sector, and Comisión Federal de Electricidad (CFE) and Luz y Fuerza del Centro (LFC) in the electricity industry. So far, no decisions have been made on private participation and structural reform in gas production, oil extraction and processing, and production of petrochemicals. Structural reform of the electricity sector has been postponed.

The natural gas sector in Mexico was reformed in 1995 through an amendment of the Regulatory law of Constitutional Article 27 (the Gas Law) to allow private investment in new transportation projects and distribution, storage, and commercialization of natural gas. The law established principles for developing the country's natural gas industry. Putting these principles in practice required creating a regulatory framework that specified the organization, operation, and regulations of the industry. Such a framework was designed in 1995 and presented in the *Reglamento de Gas Natural*. It explicitly took into account noncompetitive conditions in production since Petróleos Mexicanos (Pemex) would keep its statutory monopoly in gas exploration and production, and focus on increasing natural gas production and maintaining its existing large transportation network of more than 9,000 kilometers (see figure 1).<sup>36</sup>

Figure 1: Natural Gas Transportation Network of Mexico



<sup>36</sup> Pemex's transportation network covers most of the country with the exception of the northwest and north-pacific.

A new regulatory institution, CRE, was created in 1993 to provide limited regulatory oversight of private investment in power generation.<sup>37</sup> The CRE's mandate was expanded and clarified in 1995 in tandem with the natural gas reforms. After the publication of the *Reglamento*, the CRE needed to have a clear idea of the many implications of the reform process that took place during 1995-1997. In particular, the CRE wanted to understand in depth the long-term economic welfare implications of specific regulatory policy decisions on natural gas pricing, given that Pemex would keep its monopoly on production.

In 1997, an academic agreement was signed between CRE and CIDE in order to start an academic program on energy economics and regulation to provide the Mexican regulatory authorities with solid academic background for policy decision-making on natural gas price regulation as well as in other related areas. The CIDE-CRE agreement was also designed to provide researchers with incentives to write applied papers that could be published in top academic international energy journals, and that would consequently provide academic support to CRE's policy decisions.

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<sup>37</sup> CRE's original role in oversight the electricity industry is largely limited to issuing permits and approving wheeling and buyback charges for private sector generators. The Secretary of Finance (*Hacienda*) has a decisive role in setting retail tariffs and government guarantees, while the CFE predominates in the definition of bids for independent power projects, and contract contents