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Artículos Científicos

Regulación sin transparencia. Un estudio de costos de la distribución de gas natural para la Ciudad de México

Regulation without transparency. A cost study of natural gas distribution for Mexico City

Regulação sem transparência. Um estudo de custos de distribuição de gás natural para a Cidade do México

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Resumen

Existe un número de permisos de distribución de gas natural a diversas ciudades de México en los cuales los criterios de fijación de tarifas por parte del órgano regulador (CRE) no son replicables debido a la información incompleta. Esta falta de transparencia incumple los principios regulatorios y puede configurar una situación de captura del regulador. Esta situación incita la apertura de un campo de análisis académico sobre la práctica de la regulación del gas natural en México, la cual ha sido ajena a la investigación tradicional sobre la política energética.

Se estudia el caso de las tarifas de distribución de gas a la Ciudad de México del año 2015, bajo la pregunta de si la falta de información esconde subsidios cruzados y captura del regulador. La hipótesis es que mediante una metodología basada en contabilidad regulatoria es posible reconstruir la asignación de costos calculada por el regulador. Dicha hipótesis se

ISSN: 2007 - 9907

comprueba y arroja la existencia de subsidios cruzados en contra de los usuarios domésticos, quienes pagan el 70% de los costos pero reciben solo el 15% de la energía. Las consecuencias de este hallazgo son: 1) que es posible generar una metodología robusta de contabilidad regulatoria para ser aplicada al conjunto de casos existentes y 2) que la intervención de la academia puede ayudar a exponer y mejorar la práctica regulatoria para evitar la captura del regulador, lo cual sería significativo en el contexto de cambios de paradigma de la política energética en México.

Palabras clave: captura del regulador, contabilidad de costos, gasoductos, subsidios cruzados, tarifas.

Abstract

There are a number of natural gas distribution permits to various cities in Mexico in which the criteria for setting rates by the regulatory body (CRE) are not replicable due to incomplete information. This lack of transparency breaches regulatory principles and can set up a situation of regulator capture. This encourages the opening of a field of academic analysis on the practice of natural gas regulation in Mexico, which has been alien to traditional research on energy policy.

The case of the 2015 gas distribution tariffs to Mexico City is studied, under the question of whether the lack of information hides cross subsidies and capture of the regulator. The hypothesis is that through a methodology based on regulatory accounting it is possible to reconstruct the allocation of costs calculated by the regulator, despite the absence of information on the original calculation. This hypothesis is verified and reveals the existence of cross subsidies against domestic users who pay 70% of the costs but receive only 15% of the energy. The consequences of this finding are 1) it is possible to generate a robust regulatory accounting methodology to be applied to the set of existing cases and 2) the intervention of academia can help expose and improve regulatory practice to avoid regulator capture, which would be significant in the context of paradigm shifts in energy policy in Mexico.

Keywords: regulator capture, cost accounting, gas pipelines, cross subsidies, tariffs.

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ISSN: 2007 - 9907

Resumo

Existem várias licenças de distribuição de gás natural para várias cidades do México, nas quais os critérios de definição de tarifas pelo órgão regulador (CRE) não são replicáveis devido a informações incompletas. Essa falta de transparência viola os princípios regulatórios e pode configurar uma situação de captura do regulador. Essa situação favorece a abertura de um campo de análise acadêmica sobre a prática da regulação do gás natural no México, que tem sido alheio à pesquisa tradicional sobre política energética.

O caso das tarifas de distribuição de gás para a Cidade do México em 2015 é estudado, sob a questão de saber se a falta de informação esconde subsídios cruzados e captura do regulador. A hipótese é que através de uma metodologia baseada na contabilidade regulatória é possível reconstruir a alocação de custos calculada pelo regulador. Esta hipótese verifica-se e revela a existência de subsídios cruzados contra os utilizadores domésticos, que pagam 70% dos custos mas recebem apenas 15% da energia. As consequências dessa constatação são: 1) que é possível gerar uma metodologia robusta de contabilidade regulatória a ser aplicada ao conjunto de casos existentes e 2) que a intervenção da academia pode ajudar a expor e melhorar a prática regulatória para evitar a captura de regulador, o que seria significativo no contexto de mudanças de paradigma na política energética do México.

Palavras-chave: captura reguladora, contabilidade de custos, pipelines, subsídios cruzados, tarifas.

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Introduction

The adoption of the neoliberal economic model in Mexico meant for its energy sector a transformation of laws and institutions that allowed the entry of foreign investment in the operation of energy chains, starting with natural gas. In the period from 1994 to 1996, the modification of the Regulatory Law of Constitutional Article 27 in the Petroleum Branch took place, the creation of the Energy Regulatory Commission (CRE) and the adoption of the Natural Gas Regulation and the "Directive on the Determination of Prices and Tariffs for Regulated Activities in the field of Natural Gas" (Tariff Directive).

The CRE was created with the mission of applying antitrust principles in the energy industries, especially in the gas industry. The CRE's task was key in the new energy policy model, as it sought to encourage private investment in natural gas infrastructure, ensure fuel

prices based on reasonable profitability criteria, and thus achieve a new basis for economic development based on a expansion of energy supply.[1].

The rationale for regulation is to maintain a balance between the interests of companies and those of users (Posner, 1974, Boehm, 2015). Therefore, the keys to an efficient regulatory framework are to have clear policies, transparency, public disclosure, predictable rules and adequate institutional capacity, so that the regulator can oppose capture by industry or the State (Sunita and Nellis, 2004). The regulatory framework must establish rates that transparently reflect the costs incurred, avoid cross-subsidies, allow companies to obtain a reasonable return on their invested capital, and recover the total costs incurred to provide the service (CRE, 2007). If these assumptions are not met, the regulation incurs flaws that promote undue benefits to companies to the detriment of users (Stigler, 1971; Sunita and Nellis, 2004).

The principle of regulatory transparency requires that price and rate calculations be replicable, in order to generate certainty about the quality of the information and the accounting processes used. Without this possibility of replicability, the legal provisions that define the public function of regulation would not be observed by the regulatory body, resulting in a lack of transparency that hides the capture of the regulator (Boehm, 2015). In this sense, Martimort (1999) mentions that the source of the regulator's discretionary power emanates from the information obtained from its close relationship with the regulated company. Such information is socially useful, and when it is captured by the company, it can hide it to obtain bribes or future business opportunities.

Lack of transparency in the calculation of rates

In Mexico, academic studies on natural gas regulation are scarce. On the one hand, Ramírez and Rosellón (2000) and Ortiz, Ramírez and Rosellón (2021) have a modeling perspective to determine optimality in terms of competition. On the other, Micheli, et al. (2013) points to the description of the geographic market for natural gas and tangentially to its relationship

[1] The mission of the CRE is "Regulate in a transparent, impartial and efficient manner the gas, refined products, hydrocarbon derivatives and electricity industries, so generating certainty that encourages productive investment, fostering healthy competition, promoting adequate coverage and attending to the reliability, quality and security in the supply and provision of services, at competitive prices, for the benefit of users".
http://www.cre.gob.mx/articulo.aspx?id=11

with regulation. In general, relevant issues have been left aside in the international current of studies on regulation, from the very economic history of this policy (Serrani, 2020; Dammert and García, 2020), or the discussion of regulatory failures (Stigler, 1971; Laffont and Tirole, 1991; Martimort, 1999; Boehm, 2015; Rodríguez, 2008; Lesser, 2007).

The case analyzed in this text is that of the regulation applied to the company whose tariff was authorized in 2015 to distribute natural gas to various types of users in Mexico City, both domestic and of a commercial and industrial nature. This company belongs to a multinational corporation with a large number of companies in the electricity and gas business, and its name is omitted in this article. It is the main natural gas distribution operator in Mexico and has several distribution permits, thus providing service to the country's capital and several other cities.

The method of calculating the cost allocations by type of user, which derives in the rates authorized for this company, is not in the public domain, therefore it is not possible to emulate it and therefore the principle of transparency stipulated by the regulatory regulations in section VII of the Directive on the determination of tariffs and the transfer of prices for regulated activities in the field of natural gas, named the Tariff Directive (CRE, 2007). This anomaly is not particular in this case, but also in the following:

Table 1. Distribution systems without tariff transparency

Business group	Resolution	Geographical zone
A	RES/1745/2016	Valle Cuautitlán, Texcoco, Hidalgo
	RES/2948/2017	Querétaro
	RES/1744/2016	Río Pánuco
	RES/1746/2016	Puebla, Tlaxcala
	RES/187/2018	Guadalajara
	RES/109/2016	Norte de Tamaulipas

ISSN: 2007 - 9907

B	RES/089/2016	La Laguna
	RES/090/2016	Mexicali
	RES/088/2016	Chihuahua, Cuahutémoc Anáhuac y Delicias
C	RES/055/2016	Ciudad de México
	RES/051/2016	Nuevo Laredo
	RES/053/2016	Monterrey
	RES/054/2016	Saltillo
	RES/250/2016	Bajío
	RES/2753/2018	Toluca
D	RES/107/2016	Ciudad Juárez
E	RES/072/2016	Monterrey
F	RES/2633/2018	Hermosillo, Guaymas, Empalme
	RES/2861/2017	Piedras Negras

Source: Authors based on CRE Resolutions (the actual names of business groups are ignored)

ISSN: 2007 - 9907

Based on this evidence, the authors assume that there is a systemic failure in the regulation of natural gas that consists in the lack of transparency in the tariff calculation of the distribution sector, and that this lack of clarity in the calculation method results in tariffs that benefit improperly, from a regulatory point of view, to regulated companies. The accounting development presented in this article confirms this hypothesis in the case studied, which suggests a future methodology applicable to the set of cases that present similar conditions of lack of transparency in the information.

Economics and basic accounting of natural gas regulation

In the energy price structure, the rents that are captured at the different levels of the energy chain are a reflection of the power relations between the nodes that compose it. (Chevalier, Derdevet, Geoffron, 2012)[2]. In systems subject to regulation, rents originate from so-called regulatory failures, that is, the inability of the regulator to correctly emulate the economic behavior of the corresponding technical system. These failures are due to several factors: the asymmetry of information between the regulated and the regulator; lack of transparency; insufficient public outreach; regulatory uncertainty; discretionary power of the regulator; adoption of regulatory frameworks without taking into account the political, legal and institutional context; inadequate data collection and lack of quantitative models to determine the impact of regulatory decisions (Estache et al., 2003; Sunita and Nellis, 2004; Paulson, 2005; OECD, 2014). Taken together, they are some of the failures that allow the regulator to be captured by the regulated.

Regulation, as a particular body within economic theory, is based on basic economic principles (Veljanovsky, 2010). Indeed, the cost taxonomy has two aspects that are integrated into economic calculations: fixed and variable costs and direct and indirect costs. The first are costs that the company must recover and the second refer to the way in which the company allocates costs to its activities. Both aspects are integrated into the accounting

[2] The price at which energy consumed is paid is quite far from its production costs: "the cost of producing and refining gasoline is 4% of its price; the cost of producing gas is 4% of its price; that of electricity 40% of the price; although the cost of transportation must certainly be added, which is important in the case of natural gas" (Chevalier, Derdevet and Geoffron, 2012, pp.87-88).

ISSN: 2007 - 9907

necessary to obtain the result of regulated prices, which must correctly reflect the recovery and allocation of costs.

The firm's fixed and variable costs, divided by the quantity produced, determine unit costs. The greater the quantity produced, the part of fixed costs lowers unit costs -economy of scale- and the part of variable costs can be moderated or managed with organizational and salary efficiency. Unit costs are transformed into sales prices basically by adding a percentage that results from the expected return on invested capital. Investment in this industry is high and is considered a sunk cost because once materialized in physical infrastructure, it has a single economic function.

Phillips y Brown (1993) point out that the above characteristic is what justifies gas transportation and distribution companies to be regulated due to the existence of significant economies of scale. The companies that operate in this market, given that they lack competition because they are a natural monopoly in a specific regional market, do not transfer lower costs to the consumer, for which they acquire increasing rents. This trend is counteracted by regulation. Since there are other sectors in which there is a similar process and they are not regulated, the legal and social criterion is the determining factor: natural gas, like water or electricity, constitute public services whose price, quality and supply must be regulated, hence the broad definition of regulation: "Regulation is an economic, legislative and legal concept" (Phillips and Brown, 1993, p. 49).

In the taxonomy of costs, those that are characterized as direct and indirect are related by their role in production. In the case of multi-product companies, direct costs must reflect the specific activity of each type of good or service produced, and indirect costs are distributed among activities that are common within the company. In the case of companies that distribute gas to various types of users (domestic, industrial, etc.), each physical and operational infrastructure by type of user has its own direct costs, which must be reflected in the specific price (tariff). If this allocation is not met, there is a situation of cross-subsidies and it may be the case that domestic users pay a higher price in their tariff in relation to the costs of domestic service, benefiting industrial users who pay a higher price in their tariff. lower service in relation to the costs of the industrial service, thus generating a cross subsidy.

These basic economic principles are what give rise to regulatory accounting. Regulatory bodies calculate prices and tariffs of the companies with the accounting information of the different fixed and variable costs that they provide them (Lesser and Giacchino, 2007; Rodriguez, et al., 2008). To regulate the price there are two principles:

ISSN: 2007 - 9907

according to Boehm (2015), the regulation can be based on costs or incentives. The first consists of setting a price limit based on a cost and profit structure that the regulator considers reasonable in order to allow the sustainability of the company over time. Here, the company must demonstrate that it carries out efficient processes. The second consists of forcing the company to reduce unit costs (efficiency) and associating its unit price with that efficiency. It is easy to understand that it is easier for the regulator to generate the accounting methodologies for the first case.

Since market conditions are dynamic, the calculation processes must be updated periodically. The regulators then work with the data and results of the previous period and with the investment, efficiency management and market expansion plans of the companies, thus generating prices and tariffs for a following period.

The calculation of tariffs in the regulation of natural gas in Mexico

The above concepts are materialized in the methodological body of the regulation on transportation and distribution of natural gas in Mexico through regulatory instruments.

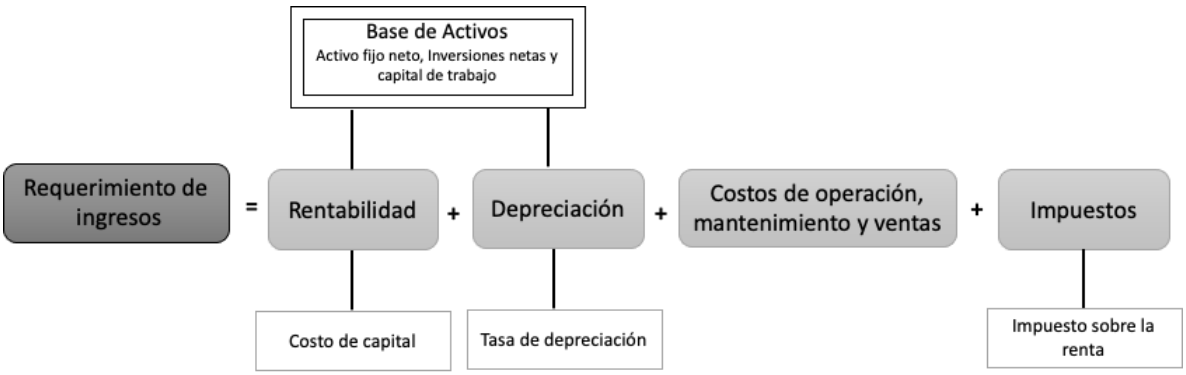
There are two regulatory instruments applicable to the determination of the tariffs for the natural gas distribution service through pipelines: the Accounting Directive for regulated natural gas activities (CRE, 1996), which in the text will be called the Directive of Accounting, and the Rates Directive (CRE, 2007).

The maximum initial rates for the pipeline distribution service are calculated and approved at the time of granting the corresponding permit and are reviewed every 5 years, although they are adjusted annually for the inflation rate and for certain costs that are considered transferable to the price. The company must submit to the regulatory body an "Income Requirement" (RI) within its business plan, which contains the projection of the investment and the proportion of the RI that corresponds to the cost of providing services to each rate group. . The allocation of costs that gives rise to a tariff must be based on a methodology that avoids undue discrimination and cross-subsidies among users of the distribution service, according to provision 7.1 of the Tariff Directive.

The following diagram illustrates the main variables involved in the calculation of the RI.

ISSN: 2007 - 9907

Figure 1. Income requirement ´s structure.



Fuente: Elaboración propia con base en CRE (2007)

Figure 1 shows the importance of the asset base, since it intervenes directly in the calculation of two components and indirectly in taxes, thus defining, to a large extent, the level of R. Said base is made up of for all the assets necessary for the provision of the service, plus the working capital, including the investments necessary to operate safely and efficiently.

Companies must submit the IR by rate group, identifying the items that are directly attributable to the provision of the service in each rate group (direct costs) and the common amounts assigned to all rate groups (indirect costs). , according to provision 12.5 of the Rates Directive. The criteria for assigning assets and operating, administration and sales costs (OMAV costs) must consider the factors that originate them, such as: "the gas units that are estimated to be carried by rate group, the number of users per rate group, the load factor, the distance between system routes and the cost of the specific service in relation to the total revenue requirement" (provision 12.6 of the Rate Directive).

The companies generally operate various distribution systems and offer various services, thus incurring common costs, and therefore, the regulator must ensure the correct distribution of such costs among the different tariffs, that is, the different types of users. The Accounting Directive suggests allocating common costs and expenses by calculating the ratio of common costs between the following variables by rate group: revenue, assets, number of employees, salaries, and gross profit. However, in the public information there is no evidence that the companies submit to the CRE the criteria for assigning costs and common expenses of systems and services operated by the company, which makes it difficult for the regulator to supervise that rates only include assets and costs related to the distribution of natural gas in the corresponding geographic area.

Based on the net fixed assets and the OMAV costs by rate group, the asset base is determined and with this the other two IR variables by rate group can be determined, which are: profitability and taxes. Next, rates are obtained by types of charges, which are three quotients: the RI divided by the number of users, by the reserved capacity and by the energy transported, as explained in Table 2.

Table 2. Structure of charges involved in maximum initial tariffs

Charge	Definition	Term used by CRE
Service	Recovers the costs related to the reading and maintenance of meters, billing and activities inherent to the provision of the service . Fixed monthly cost. Unit: $/month	Service
Capacity	Recovers the fixed costs that are part of the IR assigned to the respective tariff group. Unit: $/transported gas	Distribution & commercializati on Unit: $/GJ[3]
Uso	Recovers the variable costs that are part of the IR assigned to the respective tariff group. Unit: $/transported gas	

Source: authors based on CRE (2007)

Finally, "the maximum initial rates must reflect the capacity requirements of the different rate groups during the peak period of the distribution system." This must be accredited by the distributors before the CRE (provision 8.2 of the Tariff Directive). However, there is no public information about it.

[3] Gigajoule is not a gas volume or mass unit but of calorific one. The users measuring devices are calibrated in volume units.

Lack of transparency in the analyzed case

According to statistical information from the CRE (CRE, 2022), at the end of June 2022, 32 natural gas distribution systems are operating in Mexico through pipelines owned by private companies, of which 19 are in their fourth five-year review process of rates applicable for the fifth five-year period.

Among them is the distribution system of the geographical area of Mexico City whose owner is a company that did not present the IR to the regulatory body for the period 2016-2020 for each rate group. However, the CRE in its resolution number RES/055/2016 (CRE, 2016), by which it determines the list of maximum rates, presented the RI for the entire five-year period for each rate group, without providing information on the structure of costs and the criteria that were established for the allocation of assets and costs both by type of user and the common ones, a methodology that is a fundamental part of the determination of distribution rates.

This constitutes a pattern for the 19 distribution systems shown in Table 1 already mentioned, given which the interest of this article is to present a regulatory accounting exercise to reconstruct the calculation process that allowed the regulatory body itself to implicit allocations. of the costs of the maximum authorized rates, in resolutions number RES/730/2015 (CRE, 2015) and RES/055/2016 (CRE, 2016), by which the RI and the maximum rates, respectively, applicable were authorized to the fourth five-year period of operations (2016-2020), of the natural gas distribution service in Mexico City, which are still in force to date (January 2023), with their respective inflation adjustments.

Analysis methodology and results

The research carried out for this text is of an applied and quantitative nature. It is a study of a case of lack of public information on the comprehensive process for calculating rates that were authorized for a natural gas distribution company. The hypothesis is that the calculation method applied by the authors makes it possible to reveal all the missing information, part of which is the cost allocation criteria. The calculation method is accounting applied to regulation and, as it is a reconstructive process, it has a deductive basis without losing accounting or regulatory rigor.

The reconstruction process must be able to determine the cost structure shown in Figure 1, for each rate group, that is, in this case for the 5 different types of users stipulated in Resolution RES/730/2015. Table 3 shows the data available for the start of the calculation

process, where those published are those in columns (1) to (3), while those requested for the calculation are those in columns (4) and (5).

Table 3. Public data about the gas distribution tariff approved by CRE to the company , by users groups

Tariff Group	Income Requiremet	Service Charge ($/month)	Distribution & Commercialization Charge (Pesos/GJ)	% of Users	% Energy
	(1)	(2)	(3)	(4)	(5)
Residential	4,366,872,330	42	94.3575	98.7%	21.7%
Commerce	285,516,910	100	42.6721	1.2%	3.9%
Big commerce - small industry [1]	513,835,032	1,000	N/A	0.1%	9.6%
Big Industry [1]	1,079,795,206	5,000	N/A	0.0%	64.9%
GU1	39,926,943	10,000	0.7029		
	6,285,946,421			100%	100%

Source : Authors based on : (1) CRE (2015), (2) y (3) CRE (2016); (4) y (5) authors calculation based on firm´s business plan projection (CRE, 2015).

1 Tariffs are grouped in 5 consuming blocks.

As noted in Table 3, the public information available only provides the IR data for each rate group and the two corresponding charges that make up the rate, but it is not possible to know how each requirement of the rate group is composed in its structure (base of assets and OMAV costs). This contravenes the principle of transparency and makes it impossible to know whether or not there are cross-subsidies.

Methodology

The following Table 4 shows the sequence, in a vertical sense, of the basic calculations that must be followed in order to determine the tariff charges to the different users, based on the initial information of the total RI and its cost structure. Table 4 indicates which information is public and which has not been made public. Therefore, the calculations that are made are a bottom-up reconstruction, in order to estimate non-public information.

Tabla 4. General sequence of tariffs calculation according to the Tariffs Directive, public information gaps and reconstruction steps .

Sequence according to Tariffs Directive	Variables	Information´s nature	Reconstruction Sequence
1. Regulator receives this initial information	Total RI	Public	
	Total (asset basis + OMAV costs)	Public	
2. Regulator assigns Total RI components to each RI 1..n	Process which it must be accounted for under the principles of cost functionalization and classification, in order to carry out an efficient allocation of costs to each type of company user	Non Public	2 nd step
3. Obtaining a RI 1..n	(asset basis + OMAV costs) 1…n = RI 1…n	Public	
4. Energy and users are assigned to each user group.	Total energy and users	Non public	1 st step
	Energy and users 1…n		
5. An RI assigned to energy and another assigned to users are obtained.	RI by energy 1…n RI by users 1…n	Non public	
6. The user charges guarantee the income of the company for each concept.	Charge by energy 1…n Charge by user 1…n	Public	

Source : authors

In the reconstruction methodology, the bottom-up calculations are carried out in two stages. In the first stage, the value of the variables indicated in steps 4 and 5 is calculated. In the second stage, the value of the step indicated as 2 is calculated.

ISSN: 2007 - 9907

First Stage: consists of calculating: i) the value of the IR associated with the service charge (IR per service), ii) the IR associated with the charge for distribution with commercialization (RI per distribution), iii) the energy and iv) projection of the Number of users. Table 5 shows the sequence of these calculations.

Table 5. Sequence for calculating the service revenue requirement and the distribution revenue requirement

Variable	Formula	Definitions
1. Service RI	$RICS_i = USU_i * CS_i * 60$ 1.1 Number of users $USU_i = \%USU_i * USU_{promedio}$	$RICS_i =$ Service charge income requirement by tariff group i. $USU_i =$ Number of users by tariff group i $CS_i =$Service charge by tariff group i 60 = Months of the five-year period $\%USU_i =$ Users percentage by tariff group i estimated on the basis of the five -year period users average as required by the company , shown in column 4 of table 3. $USU_{promedio} =$ Users number average, approved by CRE (622,575). $RICDC_i =$ Income requirement by the commercialization and distribution charge of tariff group i . $RI_i =$ Income requirement of tariff group i. $Ene_i =$Energy of tariff group i. $CDC_i =$ Commercialization and distribution charge of tariff group i.
2. Distribution RI	$RICDC_i = RI_i - RICS_i$ 2.1 Implicit Five-Year Energy $Ene_i = \frac{RICDC_i}{CDC_i}$	

Source : authors

Second stage: This second set of calculations requires reaching the reconstruction of the IR structure in its four major components. This makes it possible to verify whether the rates authorized by the CRE are based on an analysis of costs by user group.

Initially it is required to determine the asset base and OMAV costs, and then calculate profitability, depreciation and the amount of taxes. However, there are two big unknowns: the percentage of investments and the percentage of OMAV costs authorized by the CRE to the company with respect to its proposal. For this, the solver tool contained in Excel is used, in order to estimate the percentage of OMAV costs "authorized" by the CRE, given an "authorized" percentage of the amount of investments proposed by the company, in order to obtain the RI authorized by the CRE.

To facilitate the understanding of the accounting sequence that is applied, the formulas used in tables 6 and 7 below are grouped together.

ISSN: 2007 - 9907

Table 6. Sequence for the asset basis calculation

Variables	Formulas	Definitions
1. Active Basis	$BA_t = AFN_t + AFN_{futurot} + CT_t$	BA_t = Asset Basis in the year t. AFN_t = Net fixed assets existing in the year t. $AFN_{futurot}$ = Future Net fixed assets in the year t. CT_t = Working capital in the year t. $t = 1, \dots, 5$ AFB_t = Gross fixed assets in year t, equal to the gross fixed assets at the beginning of the fourth five-year period (2,682.63 millones de pesos de 2013). Gross fixed assets remain constant throughout the five-year period because investments are analyzed separately. DA_t = Accumulated Depreciation of Actives at Year t $DA_{inicial4Q}$ = Accumulated Depreciation at the beginning of the fourth five-year period (766.27 millones de pesos de diciembre de 2013). δ = Fixed annual depreciation rate using the straight-line method . The rate is equal to 1/ probable useful life number of years $AFB_{futurot}$= Gross Fixed Asset corresponding to Capital Investment in Year t. Proposed investments by the Company in the amount of $3,967 million Pesos de 2013 (Table 12 from the Anexo de la RES/730/2015). $DA_{futurat}$ =Accumulated Depreciation of Capital Investments in the year t. $CAPEX_t$ =Capital Investments in year t.
1.1 Net Active Assets	$AFN_t = AFB_t - DA_t$ 1.1.1 Acumulated Depreciation $DA_t = DA_{inicial4Q} + \sum_{t=1}^{5} AFB_t * \delta$	
1.2 Future AFN (Net Investments in Capital)	$AFN_{futurot} = AFB_{futurot} - DA_{futurat}$ 1.2.1 Future Goss Fixed Asset $AFB_{futurot} = \sum_{t=1}^{5} CAPEX_t$ 1.2.2 Future Accumulatad Depreciation $DA_{futurat} = \sum_{t=1}^{5} AFB_{futurot-1} * \delta$	
1.3 Working Capital	$CT_t = \frac{1}{8} CostosOMAV_t$	

ISSN: 2007 - 9907

		$AFB_{futurot-1}$= Gross Fixed Assets corresponding to Capital Investments in year t-1. $CostosOMAV_t =$ Operation, Maintenance and Sales Costs in the year t.

Source: Authors

Within the calculations of the asset base, two assumptions are involved. The first consisted of establishing an average useful life of 17 years for all the assets of the distribution system, due to the fact that it has been in continuous expansion and given that the useful life of the pipelines on average is 30 years. The second assumption is that the CRE authorized the company 100% of its proposed investment program, which is reasonable because the CRE increased the company's number of users and energy proposals by 7.6% and 37.7%, respectively.

Once the active base is obtained, it is possible to determine the RI based on the sequence shown in Table 7 below.

ISSN: 2007 - 9907

Table 7. Sequence for the Income Requirement calculation

Variables	Formulas	Definitions
1. Profitability	$R_t = BA_t * i_t$	R_t =Distribution System Profitability in year t . BA_t = Assets Basis in year t. i_t = Capital cost in year t, calculated under CRE methodology considering 100% own capital. $t = 1, \ldots, 5$ D_t = Distribution System ´s Annual Depreciation at year t. $D_{existentest}$ = Annual Depreciation of Assets at year t. $D_{futurat}$= Capital Investments Anual Depreciation at year t. AFB_t =Gross Fixed Asset at year t. δ = Fixed Anual Depreciation Rate equal to 1/17. $AFB_{futurot}$= Gross Fixed Asset corresponding to Capital Investment at year t. Table 12 of Annex RES/730/2015. $OMAV_t$ = Operation, Maintenance and Sales Costs in the year t $OMAV_{Empresat}$ = Operation, Maintenance and Sales Costs proposed by the Company in the year t. Table 15 of Annex RES/730/2015. $\%AutorizadoCRE$ = OMAV Costs Percentage authorized by CRE to respect to what it was requested by the Company. A Solver method was used. $Impuestos_t$ =Amount of income taxes paid at year t. ISR = Income Tax Rate . Current value of 30 % was considered.
2. Depreciation	$D_t = D_{existentet} + D_{futurat}$ 2.1 Current Assets Depreciation $D_{existentest} = AFB_t * \delta$ 2.2 Investment Depreciation $D_{futurat} = AFB_{futurot-1} * \delta$	
3. OMAV Costs	$OMAV_t = OMAV_{Empresat} * \%AutorizadoCRE$	
4. Taxes	$taxes_t = \frac{R_t * ISR}{1 - ISR}$	

Source: Authors

ISSN: 2007 - 9907

In summary, the second stage consists of the reconstruction of the IR at the level of the four components, through a model formulated based on tables 6 and 7 above. For this, the IR authorized by the CRE is based on an amount of $5,301,406,981.30 in 2013 pesos and a capital cost of 10.81%, determined with the current methodology approved by the CRE through resolution number RES/233/2013 (CRE, 2013) and in accordance with the parameters established in Annex II of resolution number RES/099/2009 (CRE, 2009), considering 100% own capital, that is, the company did not contract debt during the five-year period. Also, it is assumed that the CRE authorized 100% of the investments proposed by the company and that the assets have an average useful life of 17 years.

When formulating the model, using tables 6 and 7, the percentage of OMAV costs is calculated using the *solver*[4], thus determining the RI that equals the calculated RI (cell G8 of Figure 2) to the RI authorized by the CRE (cell G10 of Figure 2).

Figure 2. Income Requirement Estimation Using Solver

	A	B	C	D	E	F	G
1	**Estimación del requerimiento de ingresos**						
2							
3	**Componente**	**2016**	**2017**	**2018**	**2019**	**2020**	**Quinquenio**
4	Rentabilidad	256.75	308.40	368.90	445.74	511.87	1,891.66
5	Depreciación anual	157.80	192.45	231.55	277.82	335.72	1,195.35
6	Costos OMAV	203.61	246.55	282.62	316.17	354.72	1,403.68
7	Impuestos	110.04	132.17	158.10	191.03	219.37	810.71
8	**Requerimiento de ingresos**	**728.20**	**879.57**	**1,041.17**	**1,230.78**	**1,421.69**	**5,301.41**
9							
10						**RI autorizado**	**5,301.41**
11							
12				**Celda objetivo: RI calculado - RI autorizado**			**0.00**
13							
14						**% Costos OMAV**	**55.1%**

Source . Own calculations based on Tables 5 and 6, and CRE (2015, 2016)

Specifically, when executing the solver, it returns the result of 55.1% of OMAV costs (cell G14 of Figure 2) which allows having a value of 0 in the objective cell (cell G12 of Figure 2) and therefore calculating a RI of $5,301.41 (cell G8 of Figure 2).

[4] Solver is a tool that performs spreadsheet functions for optimization and that comes packaged in Microsoft Excel, being used in various professional fields where modeling tools are required. (Fylstra, Lasdon, Watson and Waren, 1998; Londoño and Boada, 2017).

Reconstruction Results

The tables with the results of the two stages are presented below, in tables 8, 9 and 10. The findings are commented at the end of each table.

Table 8. Income requirement by tariff group, according to fixed and variable costs

Tariff group	RI by service (pesos 2015)	% RICS	RI by distribution (pesos 2015)	% RIC DC	Users	% Users	Energy (GJ)	% Energy
Residential	1,548,033,480	94.0%	2,818,838,850	60.8%	614,299	98.7%	29,874,031	14.6%
Commercial	46,182,000	2.8%	239,334,910	5.2%	7,697	1.2%	5,608,698	2.7%
Big commerce-small industry	30,360,000	1.8%	483,475,032	10.4%	506	0.1%	36,627,397	17.8%
Big Industrial	21,600,000	1.3%	1,058,195,206	22.8%	72	0.0%	77,191,303	37.6%
GU1	600,000	0.04%	39,326,943	0.8%	1	0.0%	55,949,557	27.3%
Total	1,646,775,480	100%	4,639,170,941	100%	622,575	100.0%	205,250,985	100%

Source : Own calculations based on Table 4 and CRE (2015, 2016)

The results presented in Table 8 show the cost structure implicit in the IR for each rate group and highlights the disproportionate burden on residential users, especially if we observe the difference between the IR per distribution assigned to residential users (60.8%) and the one assigned to user GU1 (0.8%). The former consume only 14.6% of the energy and in contrast, GU1 consumes 27.3%. In the same way, the proportion of the IR per service assigned to the residential group can be observed: it constitutes 94.0% of the total of said charge. Here it should be noted that approximately 26% of the total costs of the company's system (RI per service as a percentage of RI per service + RI per distribution) correspond to

ISSN: 2007 - 9907

the RI per service, that is, fixed costs that must be recovered in their near future. residential users, which, let us repeat, only consume 14.6% of the energy.

Table 9. Components of the income requirement per year according to direct and indirect costs

Component	2016	2017	2018	2019	2020	5-Years Period	% RI
Profitability	256,751,706	308,396,049	368,899,878	445,744,215	511,867,848	1,891,659,695	35.7%
Anual Depreciation	157,801,765	192,454,118	231,553,529	277,822,941	335,721,765	1,195,354,118	22.5%
OMAV Costs	203,611,117	246,550,966	282,621,541	316,174,667	354,723,580	1,403,681,871	26.5%
Taxes	110,036,445	132,169,735	158,099,948	191,033,235	219,371,935	810,711,298	15.3%
Income Requirement	728,201,033	879,570,867	1,041,174,896	1,230,775,059	1,421,685,126	5,301,406,981	100 %

Source: authors calculations , based on Tables 6, 7 and CRE (2015, 2016)

From the results of the second stage, it can be seen that the component of the total IR with the greatest weight is the amount assigned to profitability (35.7%), which is due to the investment of almost 4,000 million pesos. This means that it is known that there is an investment component that must be recovered by the different users, but it is unknown in what proportion this recovery will be made through the rates. The new investment appears simultaneously with a new user that is a power generating company. In resolutions RES/730/2015 and RES/055/2016, the CRE does not present an analysis of the assets (gas pipelines) that will be used for consumption by the electricity generation company. Thus, the regulatory body does not break down the investment costs, and as seen in Table 8, the decision is that domestic users are the ones who pay -through the tariff- said new investment. Finally, the exercise was carried out to obtain the IR associated with the two charges by rate group and at the level of the four components, applying the IR allocation percentages by component from Table 9 above, to the revenue requirements of the two charges obtained in the first moment (Table 8), as shown in Table 10 below.

Table 10. Income requirement by tariff group, according to fixed and variable costs, by component

Tariff group	Income Requirement	% of Total RI	Profitability	Depreciation	OMAV Costs	Taxes
Residential	1,548,033,480	24.6%	552,372,710	349,048,508	409,881,101	236,731,161
Commerce	46,182,000	0.7%	16,478,763	10,413,055	12,227,855	7,062,327
Big commerce-small industry	30,360,000	0.5%	10,833,122	6,845,532	8,038,580	4,642,767
Big industrial	21,600,000	0.3%	7,707,359	4,870,339	5,719,147	3,303,154
GU1	600,000	0.0%	214,093	135,287	158,865	91,754
Total RI by service	1,646,775,480	26.2%	587,606,047	371,312,721	436,025,549	251,831,163
Residencial	2,818,838,850	44.8%	1,005,824,276	635,587,994	746,359,034	431,067,547
Commerce	239,334,910	3.8%	85,400,009	53,964,914	63,369,984	36,600,004
Big commerce-small industry	483,475,032	7.7%	172,514,624	109,013,300	128,012,269	73,934,839
Big industry	1,058,195,206	16.8%	377,587,540	238,600,432	280,184,002	161,823,231
GU1	39,326,943	0.6%	14,032,726	8,867,386	10,412,805	6,014,026
Total RI by distribution	4,639,170,941	73.8%	1,655,359,175	1,046,034,026	1,228,338,094	709,439,646
Total RI	6,285,946,421[1]	100%	2,242,965,222	1,417,346,747	1,664,363,642	961,270,810

Source: authors calculations , based on Tables 8 and 9

Note: The difference between the income requirement of Table 9 ($5,301.4 million pesos) and that of Table 10 ($6,285.9 million pesos) is due to updating to 2015 pesos, using an

implicit inflation factor of 18.6%. This is done because the authorized service charge and distribution charge with marketing were derived from the 2015 peso revenue requirement.

This table is the one that concludes and orders the findings. It shows the IR associated with the two charges, broken down by rate group and the 4 components (direct and indirect costs). The charges are for service (fixed) and for distribution (variable) and their composition is observed for each of the five groups of the rate. Each rate group, in turn, is broken down by the 4 direct and indirect cost factors. This is the allocation made by the regulatory body and with the method used, the data that was hidden due to lack of transparency was reached.

Discussion

The setting of tariffs under a regulatory regime supposes the existence of a practice of transparency of the calculations made by the authority, under the methodological norms that are known in the Directives. This principle is what guarantees the rights of final consumers in the case of services of a social nature, such as the supply of natural gas. This article shows the breach of transparency and through an accounting exercise that the authors call reconstructive, also shows the existence of cross-subsidies, which is an important probability of causation to hide the comprehensive calculation process used by the regulator.

The academy has not significantly explored cost accounting in regulatory matters, in the natural gas sector, in Mexico. The authors consider that there is the possibility of establishing a pioneering line since what has been deprived is the elaboration of rate optimality analysis under assumptions of orthodox economics, in the cited authors, but to date there has been no interest in analyzing the accounting nature of the rates and their determination process through costs and their principles. Without it, it is not possible to recognize the existence or not of cross-subsidies and regulator capture, which are central themes of the economic theory of regulation.

As mentioned in the text, the current rates of the analyzed permit had an expiration date of 2020, and since then the normal five-year rate review process has been interrupted. It should be added that this interruption is due to a decision of the regulatory body in an act that, in the opinion of the authors, is an implicit recognition of previous regulatory failures in the natural gas pipeline distribution market, as shown in the case. analyzed. The context during these years of a new energy policy has been one of tension between companies in the industry and the regulatory authority, and this only confirms the political and social nature of the regulation and, therefore, its changing nature. Phillips and Brown (1993) point out that

ISSN: 2007 - 9907

"regulation is an economic, legislative and legal concept" (p. 49) and they abound: "regulation can be expanded on the same principles that gave rise to it, but also for reasons unrelated to initials New reasons may be enough to justify extending regulation, but smart policy making should be judged on its own merits 'Logical' extensions of regulation are not always logical: Similarly, conditions that originally produced the regulation may have changed to the point that the regulation is reduced or otherwise drastically modified" (Ibid. p. 51) .

This reality leads to the central point of the discussion proposed here: an academic reassessment of the practice of economic regulation in energy matters is necessary to provide methodologies and research from the perspective of regulatory accounting, which is the center of interpretations and application of energy policies. Exercises of emulation or regulatory accounting reconstruction should be a more frequent practice in the academy and organizations of the society, to combat the bad applications of the principles of regulation. This leads us to think that it is necessary that, despite its autonomy, the CRE can be audited by specialized entities to help in the same sense of improving regulatory practice for the benefit of consumers.

Finally, regarding the assumptions and scope of the methodology, it should be said that the reverse accounting of costs contains a couple of assumptions that are worth recovering: one is the average useful life period for all assets, which is assumed 17 years because the distribution system has been in continuous expansion and since the useful life of the pipelines is 30 years on average. The other assumption is that of the percentage authorized by the regulator to the company of the proposed investment amount, assumed to be 100%, which is reasonable because the CRE increased the proposals for the number of users and energy of the company, by 7.6% and 37.7 % respectively.

Both assumptions are based on technical considerations of the operation of this type of infrastructure and, in the opinion of the authors, are plausible.

ISSN: 2007 - 9907

Conclusions

In the case study addressed, as mentioned, the regulatory authority fails to comply with information transparency to know the accounting exercise and the allocation of costs that leads to the setting of the 5 rates per type of user in the permit granted to the company. that distributes natural gas to Mexico City. This is a case that also presents the peculiarity that it is a distribution system that combines various types of end users, from residential through commercial and industrial, to an electricity generation company, which was recently added to the system. through a significant capital investment. Therefore, it is a case that can be considered paradigmatic for verifying in practice the application of the principle of not incurring in cross-subsidies, a situation that would denote capture by the regulator.

The hypothesis proposed was that, with the final public data, it was possible to make a calculation based on regulatory accounting, of an inverse or reconstructive type, that would allow showing the calculations and allocation of costs carried out by the regulator to originate the rates. approved. The hypothesis was verified and the methodology is replicable because it follows the principles of regulatory accounting and can be used in situations similar to the case analyzed.

The final result sought was to know the cost structures associated with each of the tariffs approved by the regulatory body and compare them, since from this contrast it is possible to recognize if the principle of efficient allocation of the different costs between the different types of services is fulfilled. user. However, the result points to the existence of cross subsidies, since the data shown in tables 8, 9 and 10 indicate that there is a manifest lack of proportionality in the allocation of costs when comparing the tariff group of domestic consumers with the rate of a single consumer that is the electricity generation company. As the numbers obtained by this method show, through the rates that were approved, the company basically recovers the costs of its distribution system from residential consumers and this allows it to avoid charging the rate applied to the electricity generator for the investment you had to do to incorporate it into the system. This is a case of cross-subsidies to the detriment of residential consumers and to the benefit of the electric company.

The quantitative evaluation of the results indicates that the income requirement charged through the distribution charge with marketing represents 74% of the five-year income requirement approved by the CRE. Of this, 60.8% is recovered through residential users, who only have 14.6% of the energy assigned. For its part, the GU1 user is only assigned 0.8% of the recovery of the revenue requirement associated with the charge for distribution

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with marketing, but consumes 27.3%. For its part, the large industrial rate group recovers 22.8% of the IR for distribution and consumes 37.6% of the natural gas in the distribution system. It is not efficient that two tariff groups consume 65% of the energy and pay only 24%, and it is shown that the implicit cost allocation authorized by the CRE responds to a company strategy to recover the revenue requirement through the group of captive users and the largest number of residential users.

The lack of transparency and the existence of cross-subsidies that have been demonstrated lead to the conclusion that the case study is that of a situation of capture by the regulator motivated by the regulatory body's own practice of failing to comply with the principles of transparency of tariff calculations.

The article shows that asymmetric regulation that benefits private companies, as is the case shown, can be transparent and quantified even though there is no public information on the tariff process, thereby establishing the bases for an improvement in regulatory activity, a key role of economic regulation in the natural gas sector.

Future lines of research

The result that is reached allows a next step, which is to apply the method followed in this case to calculate the real costs in the set of tariffs with the same opacity of different natural gas distribution services in large cities of Mexico, contributing Thus, from the academy, conceptual and methodological tools for an improvement in regulatory practice, with social benefits, in the context of a paradigm shift in energy policy by the Mexican State, a situation in which regulatory management with better analytical instruments is essential.

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