Price Regulation of the Electricity Sector in Argentina

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1. Abstract

By employing microeconomic theory, the paper explores different alternatives to price regulation in public utilities concerning the goals established by a specific legal system or regulatory framework. This work aims to demonstrate the various policy trade-offs that must be faced when designing retail price schemes (at the distribution stage) in a natural monopoly industry. It also addresses the need to balance the various policy objectives (efficiency, equity -access and affordability-, a zero-budget constraint, and demand management or resource conservation) by analyzing the case of a large emerging market economy, Argentina, and its electricity sector. The paper especially considers the use of increasing block tariffs (IBTs) as a tool capable of balancing the policy goals mentioned. The conclusions apply to other public utility sectors, such as water or natural gas, and other emerging market economies with similar macroeconomic conditions (high growth, inequality, and inflation).

2. Introduction

Every legal system establishes a series of goals to be achieved through the implementation of public policies by the government. Economic theory, on the other hand, provides valuable concepts and tools of analysis to achieve those goals efficiently. Modern politics, in turn, is not based anymore mainly on norms of command and control but instead on setting the appropriate incentives to guide individual behavior towards achieving those social goals.

Overall, there is, or there should be, a system of norms and policies designed as the optimum means for the realization of the established social goals. This thesis aims to find the optimal policy or pricing regulation to achieve Argentina's goals concerning its electricity provision. The fundamental question is: which price regulation mechanism could best accomplish the goals set by Argentina concerning its electricity sector?

That question raises many other related ones. First, why is the case of Argentina relevant for regulating the electricity markets in general? Then, logically, what are Argentina's goals concerning its electricity provision? Where can they be found? Also, what is the current legal framework or pricing regulation existent in the country? Does that regulation optimally achieve the goals prescribed, or is it insufficient as a tool to pursue those goals? If that is the case, what are then the alternatives at hand? Of those, which one can prove to be the best means to achieve Argentina's goals and those countries that pursue similar objectives? These questions, one by one, will be explored throughout the analysis conducted in this paper and will try to be answered by the end of it.

2.1. Argentina: a big emerging market economy

The United Nations identifies Argentina as one of the countries with high human development (38th on the list) [OBJ]. Its GDP (gross domestic product) per capita, as of 2005, measured in PPP (power purchasing parity) terms, was 14.280. That same year, its GDP was 553,3 US$ billion, making it the 23rd economy.[12]

More importantly, in the distinction between the advanced and the emerging and developing economies, elaborated by the International Monetary Fund[3], Argentina belongs to the second category. It is one of the Big Emerging Market (BEM) economies, with countries like Brazil, China, India, Russia, Turkey, Mexico, South Africa, and Indonesia. [OBJ] They are "rapidly growing economies;" they all tend to have a higher rate of growth than the most advanced, industrialized, and developed economies. However, these economies often share more than just high growth; they also have remarkable similarities in their economic contexts. The emerging markets still have substantial portions of their populations below the poverty line.

e. The distribution of wealth and income in those countries tends to be unequal among different population sectors. Additionally, these countries have been suffering recently from solid inflation rates, mainly because of the high increase in commodities prices and undervalued national currencies (as in Argentina, China, and India). These are considered "rapidly growing economies"; they all tend to have a higher rate of growth than the most advanced, industrialized, and developed economies. However, these economies often share more than just high growth; they also have remarkable similarities in their

1 The standing is consistent with data from the International Monetary Fund and the World Bank.

3 World Economic Outlook, April 2008, International Monetary Fund, <http://www.imf.org/external/pubs/ft/weo/2008/01/pdf/text.pdf>

economic contexts. The emerging markets still have substantial portions of their populations below the poverty line. The distribution of wealth and income in those countries tends to be unequal among different population sectors. Additionally, these countries have been suffering recently from solid rates of inflation, mainly because of the high increase in commodities prices -which tend to represent a larger share of consumption in these countries- and in some cases, the existence of an undervalued national currency (as in Argentina, China, or India) as a tool of monetary and trade policy.

This macroeconomic indeed conditions the public policies that can and need to be implemented for each sector, particularly for the energy and electricity sector, considering that its product serves as input for any other economic process. The case of Argentina illustrates it. During the last five years, the country has grown at an average rate of 8.5%. It has triggered a significant expansion in electricity demand, at an annual rate of 7%. The rate is slightly less because of the increase in energy efficiency and productivity, which allows the production of each unit of GDP with lower employment of resources).[4] (Slightly less because of the increase in energy efficiency and productivity, which allows for each unit of GDP to be produced with lower employment of resources).

2.2. The organization of the electricity market in Argentina

Before understanding the price regulation of the electricity market in Argentina, analyzing its current situation, and detecting viable options, it is necessary to describe the organization of the energy sector in broad terms. In effect, the electricity sector depends on two national laws: the Electricity Regulatory Framework Law 24.065 and Law 15.336 for the federal authority over hydroelectric power. These two laws depend, in turn, on the

4 FUNDELEC, January 2005 and FUNDELEC, 2008.

constitutional provisions regulating the organization of public utilities and the use of natural resources, given that the Constitution has legal supremacy over any other norm or authority over hydroelectric power[5]. These two laws depend, in turn, on the constitutional provisions regulating the organization of public utilities and the use of natural resources, given that the Constitution has legal supremacy over any other norm in the system.

The Constitution of Argentina establishes, in article 42, the provisions for organizing public utilities. It entrusts Congress to sanction the regulatory frameworks for public utilities of national authority (those laws mentioned in the precedent paragraph) and determines three fundamental competition law and regulation principles in its second paragraph. First, the law must defend competition against every form of distortion of the markets. Second, there must be control of the natural and legal monopolies. Third, the provision of public services must be with quality and efficiency.

These principles are broad but also quite clear, meaning that this has been allowed to operate freely in the sectors or stages where competition is possible. Regulation, instead, has been present only in the sectors or locations where market failures exist, particularly in natural monopoly industries. There, there are decreasing average costs. It is more efficient to allow a monopolist to produce and have him regulated than to allow the presence of different competitors with higher prices.[6] That has been the rule followed by

5 In fact, the regulation of electrical power is a reserved power of the individual provinces, not an authority delegated to the federal government. However, the power stations that are part of the interconnected national system, which represent almost all of the electricity systems, are subject to national jurisdiction because of Congress's power to regulate interprovincial commerce. Therefore, the entire electricity system is subject to federal regulations.

6 It has also been contented that regulation is not the best option for a natural monopoly because the gains from the monopoly position could be offset by granting the legal monopoly through a public auction. However, the discussion of alternatives to the regulation of natural monopolies is outside the scope of this work, given that it presupposes that the will of the Argentinian legislator, as expressed in its Constitution, is the regulation of industries with such characteristics. Good reviews, however, of natural monopoly theory and its critics in the context of regulation of public utilities can be found in GEDDES R., *Public Utilities*, and DEPOORTER B., *Regulation of Natural Monopoly*, Encyclopedia of Law and Economics, 1999.

Congress in sanctioning the regulatory framework by identifying that the stage of generation of electricity is a market susceptible to competition.

In contrast, it has been declared that the transmission and distribution of electricity are natural monopolies7 because of the high fixed costs of the infrastructure and the meager variable costs present, which would make the duplication of infrastructure economically inefficient. In practice, electricity generation prices are unregulated, while the prices of transmission and distribution of electricity are regulated[7]. It is more efficient to allow a monopolist to produce and have him controlled than to allow the presence of different competitors with higher costs.[8] That has been the rule followed by Congress in sanctioning the regulatory framework, by identifying that the stage of generation of electricity is a market susceptible to competition, while it has declared that the transmission and distribution of electricity are natural monopolies[9], because of the high fixed costs of the infrastructure and the meager variable costs present, which would make the duplication of infrastructure economically inefficient. This means, in practice, that the prices of electricity generation are unregulated, while the prices of transmission and distribution of electricity are regulated.

The regulatory framework, thus, creates a market segmented in three stages: generation, transmission, and distribution. In the generation stage, multiple private and public companies are active in the market, operating power stations (as a general concept, it could be said that the nuclear and largest power stations are operated by public companies, while the rest of the hydroelectric and thermoelectric power stations -from fossil fuels as gas, oil, or coal- are used by private companies). In the transmission stage, there is a series

7 Strictly speaking, because of the subadditivity of the cost functions, one firm can supply the entire market at a lower cost per unit than what two or more firms could produce. BAUMOL W., 1977.

of regulated monopolies that operate regionally (usually covering a group of provinces) and a company that administers the wholesale market transactions. In the distribution stage, one company in each area usually operates under a license granted by the provincial government through a procurement process (except in some provinces where a public company directly operates the electricity distribution). Three companies work with licenses granted by the national government, present in the metropolitan area of the capital (Buenos Aires). These last are of most relevance because of the significant differences in the price regulation schemes between them and the former ones, which allows comparisons and draws important conclusions about the electricity price regulation in the country.

Juan Legisa, former President of the National Electricity Regulatory Commission (ENRE), explains how the rates' regulation is designed in the concession contracts signed by the government and the distribution companies. "Maximum rates are established for each rate period"; thus, there is a regulation by price controls or price caps. "The biggest advantage of price control regulation is promoting efficiency. When a rate is set for a given period (rate period), any productivity improvement the company achieves initially results in higher profits."[10] Therefore, companies have incentives to save costs and be more efficient, as opposed to the systems where there is a rate of return over the capital. The rate periods last ten years first, then five years in the subsequent[11]. Therefore, companies have incentives to save costs and be more efficient, as opposed to the systems where there is a rate of return over the capital. The rate periods last ten years first, then five years in subsequent concession renewals.

The rates consist of two terms: "one term is the purchase cost of power and

10 LEGISA, J., 2000, pages 21-27.

capacity in the wholesale market, which is directly passed on to users (pass-through condition. The other terms represent the compensation to the company for the electric power distribution and sale activity (distribution added value -VAD-), which contemplates the cost of investment required for grid expansion and replacement, operation, and maintenance of equipment and facilities."[12]

To avoid price abuses between the actors in the wholesale market and those in the retail one, the regulation prohibits the vertical integration of companies operating in generation or distribution with those in the transmission stage of the electricity market[13]. There is an entire issue surrounding the regulation of access pricing because of the operation of the network of transmission lines, which is covered extensively in the economic literature and that of the law and economics of regulation. However, the issue of price regulation in the wholesale market is outside the scope of this thesis, as it is, of course, the law of the market structure and other non-price-related issues. The focus of this work is on the rule of prices at the distribution stage of electricity, that is, the prices faced directly by consumers and households (the only exception made in the legislation is for the so-called "great users," that are big industries that can bypass the distribution companies and obtain their electricity supply directly at the wholesale market[14]).

2.3. The regulatory framework's goals

The legal system establishes several goals that the energy policy must pursue. A price system is fundamental for providing adequate incentives to achieve those goals. Thus,

12 LEGISA, J., 2000, page 27.
13 Electricity Regulatory Framework Law, articles 30 and 31.
14 Electricity Regulatory Framework Law, articles 6 and 10.

as has been previously said, the design of particular price regulations in the field of electricity must be instrumental to the objectives set by democratic rule in a specific country. In the case of Argentina, there are many goals that the legal regulations, some of the constitutional order, and others passed by Congress indicate the policymakers to pursue when setting a policy in the field of electricity, and that affects the way price schemes ought to be designed.

2.3.1. Demand management

Article 41 of the Constitution, which is the foundation for the regulations on environmental law, prescribes the rational use of natural resources. It commands that productive activities must satisfy the present needs without compromising those of future generations, which is the definition of sustainable development. This very profound principle fully impacts the regulation of energy and electricity. It means, in practice, that the use of primary energy sources (such as fossil fuels and other natural resources that serve to produce electricity) and, thus, the consumption of electricity itself, must be made at a pace that allows for a smooth transition in the energy system (from non-renewable to renewable resources), instead of a shock that would mean abundance of resources for the present and severe scarcity for the future, due to the depletion of those resources. Demand management programs also rely on increasing energy efficiency (through price incentives) is less costly than building new infrastructure to cover demand.

This is a relevant issue in Argentina at present (and it could be argued that it is too for other emerging markets that, because of their fast growth, are consuming their reserves of natural resources). Although Argentina has extensive freshwater reserves that permit the production of almost 40% of all the electricity from hydroelectric power stations and is also a net exporter of oil and gas, its margin for autarchy is getting thinner as electricity demand grows more muscular. The ratio of reserves/years of production is increasing, with

the latest predictions indicating that fossil fuel reserves will not last more than a decade. Considering that more than half the electricity is produced from thermoelectric power stations that use those fossil fuels as inputs[15], the proximity of the date of internal resource depletion is of great concern for energy policy, as a sudden severe restriction of supply or primary energy inputs could result in a collapse of the electricity system.

Guaranteeing an adequate level of internal supply to cover the electricity demand in Argentina is, therefore, a very pressing matter.[16] One of the goals of the legal system for the electricity sector is energy conservation or managing demand up to a point as to make the consumption of primary energy sources sustainable in the long term. When analyzing the policy alternatives, the issue is whether rationing demand just by the price is sufficient to fulfill this goal.

The reference to rationing just by price is not in opposition to non-price rationing mechanisms but to the modification of prices by regulation. The level of electricity consumption would be lower if the price of electricity fully internalized the costs that its production represents to society. Sustainability could be redefined as an externalities problem, and the costs of burdening future generations -the unavailability or depletion of natural resources- could be discounted to see their present value. This policy, however, could have very unpredictable effects on the quantity of electricity demanded, as it is first challenging to estimate the marginal negative impact of a kilowatt on society and then the sensibility of consumers to that marginal increase in price. In practice, when avoiding surpassing a determined level of demand is necessary to allow the system to continue

15 Secretaría de Energía de la Nación, Serie Histórica 1930-2006. The remaining share of electricity production, not accounted for by either hydroelectric or thermoelectric power stations, belongs to nuclear power, representing less than 10% of the total.

16 The promotion of investments to secure a long-term supply is a specific goal of the Electricity Regulatory Framework Law, listed in its article 2.b, which mentions the "competitiveness of the markets of production and demand of electricity".

functioning normally, with stability, adjusting prices -by regulation- until achieving the precise target might be the best solution.

Additionally, it is essential to understand the interaction of demand rationing with the other goals of the legal system will be enumerated. Achieving one and only one legal goal can be very straightforward if a measure is taken that directly targets that objective; however, the interesting point that is the substance of this work, as pointed out, is to balance multiple legal goals and to see what tradeoffs exist in the pursuit of those goals. The solution is to find an optimal price regulation or tariff scheme best suited or tailored to the purpose of the different objectives.

2.3.2. Efficiency

One of the Constitution's fundamental principles concerning public utilities (those of article 42) is that public services must be provided with quality and efficiency. Here the concept of efficiency is not the instrumental one used at the beginning (that is, to achieve whatever goals in the least costly manner) but is a substantive one related to the optimal allocation of resources, which is at the core of the law and economics analysis.

The allocation of resources is optimal when market supply and demand reach equilibrium; that is, the market is cleared. If distortions prevent the market from reaching balance and result in a shortage or surplus, then efficiency is not achieved. The idea is that everyone faces the actual costs of each kilowatt they consume. Suppose the cost of producing a kilowatt is higher than the consumer's valuation, but consumption still occurs because of a subsidy that makes it possible. In that case, that is already a market distortion that results in inefficiency. On the other hand, the price of a kilowatt is higher than the cost to produce it 18, which could result from different policy alternatives (particularly those

focused on energy conservation), which is also inefficient. In [17] words, efficiency requires prices to be equal to marginal cost (P=MC); any departure from it is, in principle, inefficient.

In the last years, Argentina has suffered from an energy crisis. As previously mentioned, the high growth in energy demand and tariffs that have remained frozen despite the general increase in prices has had the electricity system operating at its total capacity and falling short of covering needs at certain times. The existence of an energy shortage or excess demand shows, by necessity, a market that is operating inefficiently. If this were only temporary, seasonal, or sporadic by nature, then a scheme of peak-load pricing could solve the problem[18]. However, when the crisis remains for more than three years, as is the case in Argentina, and supply never manages to catch demand, so the shortage is persistent[19], then that is a vital sign that there is something wrong with the price system or price regulation.

The Electricity Regulatory Framework Law states that it is a goal of the energy policy "to incentive the efficient production, transmission, distribution and use of electricity by setting appropriate tariff methodologies"[20] and to "stimulate private investment in production, transmission, and distribution, reassuring the competitiveness of the markets where possible"[21]. What all this means is that the regulated prices of electricity must be aligned to obtain an adequate level of investment in the system, that is, that market actors have sufficient incentive to provide the quantities of electricity demanded and that there should be no need for the government to act directly in the generation, transmission, or distribution of electricity due to lack of private interest.

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18 The instrument of peak-load pricing consists in raising prices when demand is highest and reducing it when demand is lowest.

19 In fact, the installed capacity has always remained above the level of demand. However, for technical reasons, usually around 20% of the installed capacity is non-operational, which in practice puts the system in shortage.

20 Electricity Regulatory Framework Law, article 2.e.

21 Electricity Regulatory Framework Law, article 2. f.

What has happened in the country is that, especially in those areas where the federal government grants the distribution concession, prices have remained unchanged despite inflation and, thus, there has not been an adequate level of private investment in energy infrastructure. As electricity generation costs are free, producers have charged at the wholesale market prices according to the market conditions. Still, distribution companies have later been unable to pass these costs to final consumers -because of the regulation of prices at this stage. The distortion has been such that, since 2002, the great users (those big industries that could buy their electricity directly at the wholesale market) have started buying electricity from the distribution companies, in the retail market, because of how depressed prices are.[22]

2.3.3. Financial Sustainability

The situation previously described has resulted in disequilibrium in the electricity wholesale market. The distribution companies have accumulated significant debts with the company that administers the wholesale market (CAMMESA), and the generation companies have extensive credits, in contrast. Somebody eventually must pay that deficit of the system: if it is not the consumers, because of the depressed tariffs, then it is the government through subsidies, as has occurred in the last years (and at an increasing rate[23]) When primary energy inputs are imported and paid for from public funds.

This situation is financially unsustainable. Not only because the subsidies by the government distort the market (which is the case, logically, because consumers face each time

22 FUNDELEC, 2003. The strongest factor in that configuration of prices was the devaluation conducted by Argentina in 2002, during its massive financial crisis. The tariffs that were originally set in an Argentinian peso -currency with parity of 1 to 1 with the US dollar-, later meant just a fraction -a third or a quarter- of a dollar. Given that many inputs and capital goods for electricity were imported, this represented for public utilities a great increase in costs with no corresponding increase in prices.

23 In the budget for 2008, the subsidies for the energy sector have reached 2% of the GDP.

a smaller portion of the actual costs of producing electricity, which contributes to the explosion in demand and the persistent shortages), but also because it goes against the principle that the electricity sector altogether should raise enough revenues to finance the system itself. That is, it should operate under a zero-budget constraint.

The Electricity Regulatory Framework Law, when establishing the principles related to tariffs, states that "they shall give the carriers and distributors that operate economically and prudently the opportunity to earn sufficient revenues to cover the reasonable operating costs applicable to the service, taxes, depreciation, and a rate of return determined." [OBJ]. This means that financial sustainability is an objective that should be balanced with the other objectives. This must be considered when assessing the different policy alternatives at hand.[24]. This means that financial sustainability is an objective and should be balanced with the other objectives enumerated. This must be considered when assessing the different policy alternatives at hand.

2.3.4. Affordability

The last objective to enumerate is equity. The Universal Declaration on Human Rights, in its article 25.1, states that "Everyone has the right to a standard of living adequate for the health and well-being of himself and his family, including food, clothing, housing, and medical care and necessary social services...." The International Covenant on Economic, Social and Cultural Rights, sanctioned by the General Assembly of the United Nations in 1966, also declares in its article 11.1: "The States Parties to the present Covenant recognize the right of everyone to an adequate standard of living for himself and his family, including adequate food, clothing, and housing, and to the continuous improvement of living conditions.".

24 Electricity Regulatory Framework Law, article 40.a.

These international conventions on human rights have in Argentina's constitutional hierarchy[25], so their prescriptions are equal in value to those of the Constitution. The laws passed by Congress must follow them. Consequently, the Electricity Regulatory Framework Law indicates that one of its objectives when regulating the transmission and distribution of electricity is "to achieve fair and reasonable tariffs"[26].

There are indeed two sides to equity in public utilities. First, there is the issue of access. Suppose everybody has a human right to an adequate standard of living and necessary social services. In that case, everybody must access essential public services, such as water or electricity. That explains the provisions for universal service obligations. Second, there is the issue of affordability. It is not enough to access a public service connected to the grid if one cannot pay. Reasonable tariffs are tariffs that the general population can afford. Admission alone does not guarantee the right to an adequate standard of living; it must be complemented with affordability.

In the case of Argentina, access is not an issue. 95% of the population is connected to the grid and has electricity, so the universal service is covered. Affordability, however, is an important matter. The high inflation of prices is deteriorating the acquisitive power of families, especially of low-income households. The latest statistics indicate that, despite an unemployment rate of 7%, more than 30% of the population cannot cover a minimum standard of living and have the capacity to buy only 43% of what is considered essential goods and services. Therefore, a large segment of the population, as it occurs in other emerging markets, cannot afford the electricity bills they receive every month, so that must be solved through subsidies or a pricing regulation that diminishes their burden. Logically, an adequate standard of living does not represent the unlimited provision of

25 By disposition of the Constitution itself in its article 75.22.
26 Electricity Regulatory Framework Law, article 2.d.

electricity, but instead consumption of a certain number of kilowatts (usually, the line is drawn internationally at 240 kilowatts each month for a regular size -four people- household) that are needed to operate everyday appliances or devices. That constitutes a concept of preferential or merit good, the economic translation for economic and human rights, as considered in legal terms. Equity points to cover that merit consumption. Beyond that, there is no reason to alter the market and efficiency in the name of fairness.

In this chapter, three critical issues have been described and analyzed: first, the Argentinian economic context and that of the big emerging market economies, and how certain macroeconomic variables condition the implementation of public policies in specific economic sectors; second, the legal and financial organization of the electricity market in the country; third, the regulatory framework's policy goals, together with a description of the electricity sector's present situation and an explanation of the economical relevance of those particular goals.

Now it is time to analyze the pricing regulation alternatives usually implemented in public utilities and electricity providers and assess whether any of them can achieve the four regulatory goals presented. That is the task for the next chapter.

3. Analysis of Tariff Alternatives

Four policy goals have been presented: efficiency, financial sustainability, affordability, and demand management. The optimal price regulation can achieve all four goals simultaneously or, at least, balance them, given that every policy presents trade-offs that impede reaching each destination to its full extent. No first-best solution can be fully efficient and financially sustainable or achieve demand management or affordability without compromising other goals. However, second-best solutions might present local optimality; they are the best under the conditions set with these parameters (the four policy goals).

It is helpful to remind the natural monopoly characteristic of the distribution stage of electricity, which is the reason for price regulation at this stage, as stated in the previous chapter. By presenting a typical natural monopoly graph, it is possible to observe some of the alternatives and the trade-offs they imply.

3.1. P=MC and P=ATC

3.1.1. Efficiency of P=MC

The first and simplest (theoretically) alternative is setting the price equal to marginal cost. This is indicated in the graph by the legend "efficient price." In effect, when the price is equal to marginal cost, the consumer pays what it costs to produce that kilowatt of electricity. If the rice were higher than the marginal cost, then consumers would be willing to pay more than what it costs to have the kilowatt but still would not buy it because the price is higher, which is inefficient. This excludes some consumers from the market, as will

tice Hall, 2006.

be seen happening when the price is equal to the average total cost. On the other hand, the price is lower than the marginal cost (for example, because the price is subsidized with government funds), it is also inefficient because even consumers who value the kilowatt less than what it costs to produce it would obtain it. Any departure from P=MC is, in principle, inefficient.

3.1.2. P=MC: Is it always efficient? Willingness vs. ability to pay

As it was said previously, P=MC is the very definition of efficiency in economic terms, at least in principle, because it works under the strong assumption that he can express the willingness to pay every consumer or her in monetary terms, that is, the consumer can pay a sum equal to the level they value the good. This, however, is not always true, and it is particularly false in the case of emerging market economies where a substantial portion of the population is under the poverty line. When some consumers have insufficient income to afford goods and services that other consumers can afford, their ability to pay is restricted (by income itself or wealth, which also creates an effect). It does not accurately represent the value consumers assign to those goods.

Consequently, they could be more willing to pay for the goods than other consumers. Still, because of the income effect on their ability to pay, the effective monetary disposition to yield is higher in the consumer that values the thing less. If this happens, the goods do not go to the consumer that values them most but to another one, an event that distorts the efficient allocation of resources in the market. This is a crucial point to consider, especially in unequal economies, given that the effect of this phenomenon in those contexts could be massive, and overlooking it could lead to very undesirable outcomes. It could very well be the case that, without explicit subsidies that empower low-income consumers to express their willingness to pay, the efficiency of the market is only illusory.

3.1.3. Efficiency vs. financial sustainability: P=MC and P=ATC

Setting aside the previous issue for the moment, the goal of efficiency is achieved through the alternative P=MC.

What happens, however, to the goal of financial sustainability? The distribution of electricity is an activity requiring significant infrastructure investments that, once made, need less expensive maintenance and operation. Thus, the distribution of electricity has remarkably high fixed costs with low variable costs, which makes the average total cost curve decrease as the fixed costs of infrastructure get spread through more kilowatts distributed (this is the scale that justifies the monopoly -for which is called "natural"- and that discards as inefficient the presence of competitors that duplicate infrastructure). Suppose the price is set, however, equal to the marginal cost of the last unit. In that case, the revenues are insufficient to cover the fixed costs of operation, which leaves the distribution company at a loss, and makes the system financially unsustainable. This situation would force the government to provide a subsidy to cover the fixed costs, which would go against the zero-budget constraint, that is, the ability of the system to sustain itself financially.

For the system to be financially sustainable, the revenues from tariffs must also cover the fixed costs of the distribution company. For that to happen, the price must be set equal to the average total cost, indicated in the graph with the legend "regulated price." Then the goal of financial sustainability would be achieved, but at the expense of efficiency, given that P=ATC would create an exclusion from the market, as stated, of those consumers that value each kilowatt more than what it costs to produce it, but less than the price set. [OBJ][27]

27 This effect, logically, is even stronger if price is set equal to marginal revenue, indicated in the graph with the legend "monopoly price". This is the price the distribution monopolist would fix if the electricity tariff was unregulated. The system would be financially sustainable, and the company would have more than normal profits, but the cost to economic efficiency would be very high, due to the large dead-weight loss resulting from the exclusion of consumers from the market.

As can be seen, there is a conflict between the efficiency and financial sustainability of the electric sector. If price is equal to marginal cost, then it is the efficient price but financially unsustainable. If the price is similar to the average total cost, then the system is economically sustainable but at the expense of efficiency reductions. This is the first trade-off that neither of these two tariff schemes can solve.

3.2. Ramsey-Boiteux pricing: a solution to the efficiency -financial sustainability trade-off

Another technical instrument has been proposed that solves the trade-off between efficiency and financial sustainability in the operation of a public utility where, as has been seen in the case of the distribution of electricity; there are economies of scale or increasing returns to scale that make pricing at marginal cost always insufficient to sustain the company financially (because marginal cost remains lower than average total cost). This form of linear pricing is known as Ramsey-Boiteux, about the economist who thought of that pricing mechanism as an instrument of optimal taxation (Ramsey, in 1927) and who later applied it to the field of regulated public utilities (Boiteux, in 1956)[28].

Ramsey-Boiteux pricing consists in attributing the fixed costs of operation (unallocated in marginal cost pricing) in a way inversely proportional to the elasticity of demand. That is, where the need for electricity is very inelastic (the quantity demanded has a low sensibility to changes in price), there is a high mark-up for fixed costs to the price. Given that this demand is rigid (the price change will not affect the disposition of consumers to buy), the exclusionary effect from the market that occurred under P=ATC is minimized, and the loss in efficiency much reduced. Where electricity demand is elastic (the quantity

28 NETZ J., 1999, page 411.

demanded has the sensibility to changes in price) and, thus, flexible, the mark-up charged to the fee to cover fixed costs is low and so affects demand extraordinarily little.

While in practice, it has been little used, especially in distribution, because of exceedingly high informational requirements for implementation and other practical difficulties,[29]Ramsey-Boiteux pricing is theoretically a solution to the efficiency-financial sustainability trade-off. It has been created to satisfy the zero-budget constraint, and its use of the concept of elasticity makes efficiency suffer only a minimum loss.

What happens, however, to the goal of equity?

3.2.1. Efficiency vs. affordability: an unsolved problem made worse

Affordability is an issue sometimes overlooked when analyzing the price regulation of public utilities, despite its remarkable relevance, especially in the context of emerging market economies. It is not that the pricing alternatives of P=MC or P=ATC are unfair. Still, in societies where substantial portions of the population are under the poverty line and can only afford a part of the essential goods and services, they represent tariffs that, for most poor people, are not affordable.

Logically, P=ATC, being ATC higher than MC in a natural monopoly industry, is less affordable than P=MC, but this is not affordable for low-income households without explicit subsidies in their consumption, either through income supplements, earmarked grants, or other forms of pricing (such as increasing block tariffs or IBT's, which are the core of analysis of this work). The fact is that affordability can be achieved only if low-income households face prices below cost. That gap must then be filled from other funds whose origin will determine whether the financial sustainability is still met (when the funds come

29 NETZ J., 1999, 414-415.

from revenues of other services or consumers of the public utility) or not (when the funds come from the government or outside the electricity sector itself).

And what is the effect of Ramsey-Boiteux pricing on the affordability of electricity? The answer is that not only does it not solve the efficiency-affordability trade, but it makes it even worse. By raising the prices to the inelastic segments of demand (to cover fixed costs of operation), Ramsey-Boiteux pricing hits the poor harder, considering that low-income households consume less electricity than large-income ones[30]. Therefore, if the goal of equity guarantees a minimum and necessary level of electricity consumption (100, 200, 300 kilowatts or whatever quantity) considered as merit or preferential good, Ramsey-Boiteux pricing is very inadequate tool to achieve that goal. It is superior to P=MC and P=ATC in balancing the efficiency-financial sustainability trade-off, but it is inferior to them concerning the efficiency-affordability trade-off.

3.3. And what about demand management?

The relations of three of the four policy goals in the context of linear pricing alternatives (P=MC, P=ATC, Ramsey-Boiteux pricing) have already been explored, but what about the effect of those alternatives on the goal of natural resource management? As it has already been said (when stating that sustainability -of development- could be restated as an externalities problem), achieving the goal of energy conservation requires some form of pricing above cost (with a mark-up linked to the marginal impact of each kilowatt and primary energy source used on the environment, or with another criterion), given that is

30 This assumption, however, must be taken with great care because, although it is generally true that a higher income represents a higher level of consumption, it is also the case that the differences in consumption among poor and middle-class households may not be as significant as expected, especially in the case of water provision.

soaring prices the ones that discourage consumption and that make a substantial reduction in the quantity demanded possible.

With that idea in mind, it is possible to see how this policy goal of demand management conflicts with the other purposes enumerated. With financial sustainability, there is not much problem, given that soaring electricity prices will usually bring enough revenues to cover fixed and variable operation costs, given the condition of electricity as an essential, necessary good. Pricing above cost, however, implies a departure from marginal cost pricing that distorts the allocation of resources and reduces efficiency[OBJ].

Additionally, the most vital contradiction may appear with the goal of equity or affordability. If it was said that for affordability to be achieved, some form of pricing below cost was needed, then this goal goes in the opposite direction. Prices above cost will make electricity even less affordable, and subsidized prices will do nothing to discourage demand but only increase it. Taking this into account, the trade-off between affordability and demand management may be the most substantial challenge of any policy instrument.

This critical issue will be dealt with later. Intuitively, however, it is evident that some form of pricing must work in providing electricity to the poor with prices below cost while compensating for that loss by pricing above cost in the rest of the market. No linear pricing method can do this: P=MC shifts part of the operational costs to outside funds, and Ramsey-Boiteux pricing performs even poorer than P=ATC because, by shifting the most significant portion of fixed costs to the less elastic segments of the market, its prices slightly above cost only those who will consume anyway. In contrast, its prices are below the cost of those with the most elastic demand, encouraging and not reducing need. The instrument of increasing block tariffs (IBTs) is the one that proposes to achieve that tariff scheme, and whether they can do that or not is analyzed later.

With these elements, however, it is now possible to complete the assessment of the linear pricing instruments currently possible to complete the linear pricing instruments assessment concerning the four policy goals established. In summary, it is as follows

	Demand Management	*Efficiency*	*Financial Sustainability*	*Affordability*
P=MC	NO	YES	NO	NO
P=ATC	NO	NO	YES	NO
Ramsey-Boiteux	NO	Minimum Loss	YES	NO

4. Two-part tariffs

4.1. Coase

An alternative to linear pricing is the establishment of a two-part tariff, that is, "one where each customer pays a monthly fixed price for access equal to the total fixed costs divided by the total number of customers, and then the customer pays an additional fee equal to the marginal cost for each unit consumed. The fixed fee covers the fixed cost of operation, and the per unit fee covers variable costs."[31] This idea of non-linear pricing goes as early as Coase, in 1946, and is introduced with the idea of improving social welfare in a natural monopoly price setting. As marginal cost pricing, which is the economic paradigm of efficiency, is not compatible with the zero-budget constraint, the two-part tariff achieves the goal of financial sustainability (with the second tariff part that covers the fixed costs) while at the same time maintaining a component of marginal cost pricing for the variable costs. Zero-budget constraint, the two-part tariff achieves the goal of financial sustainability (with the second tariff part that covers the fixed costs) while simultaneously maintaining a component of marginal cost pricing for the variable costs.

Is the two-part tariff a definitive solution to the efficiency-financial sustainability trade-off? Not necessarily, because the efficiency of the two-part tariff alleged by Coase occurs under the assumption that every consumer stays in the market after setting the fixed fee. By placing a fixed price just for connection to the grid, however, the two-part tariff segments the demand for electricity distribution into two submarkets: the market for access or connection (that pays for the infrastructure and sunk costs) and the market for

31 NETZ J., 1999.

consumption (which pays for the cost of producing each kilowatt). In the consumption market, if the kilowatt price is equal to the marginal cost of production, then that is efficient.

In the access market, on the contrary, as the total of the fixed costs is divided by the number of consumers and a fixed fee is established, it could very well happen that there is a consumer who values being connected to the network more than what the cost of adding him to the network is (the marginal cost of inclusion of an additional user to an already existing network, which is zero), but less than the fixed fee he must pay. If that is the case, then the existence of the two-part tariff has a potential for exclusion from the market for access, which is not efficient there. That is avoidable "only if consumer surplus, which is the value the consumer places on consuming the product less the cost the consumer must pay, for the consumer with the smallest demand is greater or equal to the fixed price. Otherwise, some consumers will exit the market, which means the scheme does not achieve the social optimum."[32]

4.2. Ramsey

What could be done then to minimize this loss of efficiency in the market for access? Again, using the concept of elasticity by Ramsey-Boiteux pricing can aid in the design of the two-part tariff.[33] If the number of users (the access market) has a lower price elasticity than the quantities of kilowatts (the demand for consumption), then fixed fees are set high and variable charges are set down. If the situation is the opposite, then fixed or connection fees are set low, and consumption charges are set high (above marginal cost).

32 NETZ J., 1999.
33 This idea was first elaborated by NG and WEISER, 1974.

Therefore, as observed, Ramsey-Boiteux pricing can also be implemented in the non-linear pricing alternatives to reduce the loss of efficiency to the minimum. However, what is the result of equity or affordability? To begin with, two-part tariffs with uniform fixed charges for every user are very unfair. Given that a low-income family consuming 100 kilowatts a month pays the same fixed fee as a wealthy family consuming 400 kilowatts a month (the variable charges, logically, differ), the final per-kilowatt average price paid is higher for the low-income family than for the rich one, what is regressive for distribution. Two-part tariffs, consequently, have an inherent conflict with a goal of equity[34].

To make things worse, using Ramsey-Boiteux pricing in the context of non-linear pricing intensifies that iniquitous effect. As is typically the case in electricity, consumers will not get disconnected because of a high fixed fee. Still, they will consume less if they must pay more for each kilowatt, resulting in the price elasticity for connection (the access market) being lower than for consumption (the first case described). Fixed fees are set high, variable charges down, and the poor pay a much higher per-kilowatt average price. As was the case also for linear pricing, the implementation of Ramsey-Boiteux pricing hits the poor hardest. Therefore, when equity or affordability is a public policy goal for the retail price regulation in a public utility, Ramsey-Boiteux pricing is not recommendable.

Two-Part Tariffs	*Demand Management*	*Efficiency (Access)*	*Efficiency (Consumption)*	*Financial Sustainability*	*Affordability*
Coase	NO	NO	YES	YES	NO
Ramsey	NO	Min. Loss	Minimum Loss	YES	NO

34 Unless, of course, fixed fees are set differently for each consumer group, as is the case in many actual regulatory schemes, among them the tariff scheme of Argentina, as will be seen.

4.3. The tariff scheme in Argentina

As previously stated, the tariff scheme in Argentina is not uniform, given that some distribution companies are subject to the federal government's authority (the ones for the capital and its metropolitan area[35]) And the rest to the provincial governments.

The three companies subject to federal authority represent more than 40% of the total electricity demand in the country, thus the importance of the federal regulations on electricity tariffs. These companies use two-part tariffs and distinguish the residential users into two categories: R1, for those who consume up to 300 kilowatts bimonthly, and R2, for those who consume more than 300 kilowatts every two months. The first pay a lower fixed fee but a higher variable charge than the others. This results, as in other two-part tariff schemes, in a higher per-kilowatt average price for those who consume less energy, the very element which was criticized for going against the goal of equity. There is an idea of equity behind the lower fixed fees, but it is not so, given the compensation in a lower variable charge for R2, which in practice constitutes a decreasing block; besides, higher consumption of electricity requires a higher use of the infrastructure, which should naturally correspond with a higher fixed charge.

FUNDELEC, an organization of the civil society that studies the development of the electricity sector in Argentina, showed in a report the comparison of tariffs for residential users with various consumption levels[36]. The following table is done based on the data report

Consumption	Category	Bill (without taxes)	Price per kilowatt
280 kw/h	R1	26,57 AR$	0,094 AR$

35 The companies are EDENOR (for the northern area of Buenos Aires), EDESUR (for the southern region of Buenos Aires), and EDELAP (for La Plata, the capital city of the province of Buenos Aires and its metropolitan area).

36 FUNDELEC, 2008.

320 kw/h	R2	29,59 AR$	0,092 AR$
1.700 kw/h	R2	87,65 AR$	0,051 AR$

As it can be observed, the very intensive residential user with every household appliance (computers, TVs, washing machine, dishwasher, microwave oven, air conditioning devices, and others) pays half for each kilowatt consumed that the user who has just the essential appliances (a fridge, one TV and a few lightbulbs). This is the extreme of unfairness and directly clashes with the goal of equity and affordability.

This tariff scheme even goes against the use of the concept of elasticity recommended by Ramsey-Boiteux pricing, making the alternative less efficient (the high variable charges for R1 may discourage users who would be willing to pay the kilowatt at its marginal cost). It is a scheme that favors the consumption of energy surpluses, of which are none; the reality, on the contrary, is scarcity and demand that grows three times as fast as supply. In the five years between 2002 and 2007, demand grew almost 5.000 megawatts, against 1.500 megawatts of increase in supply37. This, of course, is because of the frozen tariffs that encourage consumption but discourage investment. It resulted in a severe restriction of electricity during the winter of 2007 (that could be repeated during any peak in demand, both for low or hot temperatures) when the government had to cut off supply and administer the order of industries and significant users to avoid the lack of provision for households.

It could be said that this two-part tariff scheme is the predominant alternative in the pricing regulation of the electricity sector in Argentina. That structure is repeated in many provinces (Formosa, Salta, San Luis, Santiago del Estero, San Juan, the interior of the province of Buenos Aires), with the only difference that some establish the distinction

37 FUNDELEC, 2008.

between categories at diverse levels (Jujuy, 270 kilowatts; La Rioja, 430 kilowatts; Neuquén, 250 kilowatts)[38].

In other provinces, the increasing block tariffs (IBTs) system is in effect39. Santa Fe has a uniform monthly fixed charge for every residential user. Then the variable amount depends on the block of consumption (one price for the first 120 kilowatts, a higher cost for the second block of 120 kilowatts, and yet a higher price for further consumption)40. "Córdoba, Entre Ríos, Corrientes, Misiones and La Pampa have similar schemes."41

4.3.1. The tax distortion

In addition to the tariff alternative implemented in one province or another, it is necessary to consider that taxes are also added to the electricity price augments the bill users receive every month or two months. Given the universality of the electricity service and the low rate of nonpayment (for fear, logically, of disconnection from the grid), the government at its various levels (federal, provincial, or local) takes advantage of the situation to collect revenues through the electricity bill. The federal government imposes a value-added tax (IVA) of 21% over the price of electricity for residential users42. Then there are provincial taxes and municipal taxes and contributions, which vary according to each district (with all taxes together, the fiscal pressure ranges from 26% to 64% of the total price of electricity, with an average of 35% for the country, which is remarkably high in comparison

38 FUNDELEC, February 2005, pages 4-5.

39 There is a legal issue linked to the establishment of increasing block tariffs (IBT's) and it is that the Electricity Regulatory Framework Law allows explicit subsidies as a budget item -despite the goal of financial sustainability- but prohibits distribution companies to use cross-subsidies from one user or category of users to another (article 42.e) and price discrimination (article 44), that the increasing block tariffs could be considered. However, each province is free to set the tariff regulation it sees adequate; the only risk is to forfeit funds from the federal government for electricity development, by not following the federal guidelines, but that could be avoided by an intelligent regulation. In any case, of course, the federal regulation could be reformed to implement specifically the increasing block tariffs.

40 FUNDELEC, February 2005, pages 4-5.

41 FUNDELEC, February 2005, page 5.

42 It is 27% for commerce, industry and services.

with other countries in the region43).

In some provinces or cities, the taxes imposed on the electricity bill are so high that they represent the main component of the total price, ahead of the distribution or generation value. This mixed taxes and subsidies in the electricity bill create a significant distortion in the electricity sector. For efficiency to work, the price of electricity must be transparent and explicit.

The Argentinian government is currently in a deadlock concerning electricity price regulation. The massive energy subsidies not only undermine the goal of financial sustainability and self-reliance of the electricity sector (in addition to contributing to an explosion of uncovered demand because of the submarginal prices) but also threaten to deplete the budget surplus entirely. On the other hand, ending the frozen distribution tariffs and allowing for extensive readjustments of the electricity price would reinforce the inflationary pressures and further hurt the affordability of electricity. The question then becomes: is there a way out of this deadlock? The increasing block tariffs (IBTs), with their promise to raise prices only for those who consume more while leaving the fees of low-quantity consumers subsidized, seem to ensure financial sustainability and rationing demand without hurting the affordability of those who have less. Is this so? Can the system of increasing block tariffs be the solution to the policy dilemma? What are the experiences of other countries or governments that have reformed their public utility price regulations and implemented IBTs?

A rapid review of this and the previous chapters denotes the insufficiency of

43 FUNDELEC, 2006. Brazil has 24%, Uruguay 23%, Chile 11%, Venezuela 1%.

the different tariff alternatives explored (marginal cost pricing, average cost pricing, Ramsey-Boiteux pricing, Coasian two-part tariffs, two-part tariffs with a Ramsey-Boiteux correction, and the current counter-elasticity Argentinian two-part tariffs) to achieve the four policy goals enumerated (efficiency, affordability, financial sustainability, and demand management). Now is the time to finally assess in detail whether the scheme of increasing block tariffs (IBTs) can be designed to achieve those goals simultaneously or not. That is the task for the next chapter.

5. Increasing Block Tariffs (IBTs)

Block tariffs are generally a form of non-linear pricing "where consumers pay one price for the first block of the product they use (say, the first 500 kilowatt hours of electricity used), then a different price for the second and subsequent blocks. Standard or declining block pricing refers to declining prices for subsequent blocks; inverted block pricing refers to increasing prices for subsequent blocks. (Block pricing of either kind is a common feature of gas, electricity, and water price structures.)." [OBJ]

While decreasing block pricing is implemented to increase efficiency in the context of electricity surpluses, inverted block pricing or increasing block tariffs are used for income redistribution[44] or demand management. These, the IBTs, is the subject of interest now. The tariff scheme implemented under this idea consists of the first block of consumption defined by the amount of electricity (kilowatts per month or every two months) that a household needs to function essential domestic appliances. The first block of consumption is fundamental for covering basic needs and, thus, is considered merit or preferential good that must be available to all. That availability, therefore, is secured through full or partial subsidization of that first block of consumption, to the extent of making the necessary amount of electricity affordable to everybody.

Once consumption exceeds that first block, and it goes over the merit-good provision, the price of electricity rises significantly, in fact, beyond marginal cost (that is the second block). This is done precisely with the idea of discouraging "excessive," "irrational,"

44 From a theoretical law and economics perspective, the use of public policy to redistribute income is usually criticized, considering that that goal should always be left to the tax system. However, in the reality of politics, and especially with the fiscal weaknesses of emerging economies, it is unrealistic to believe that the tax system can be thoroughly reformed to achieve an equitable income distribution. Consequently, some redistribution through public policies becomes the only feasible political alternative; besides, distribution, in this case, is not the goal per se but the affordability of an essential service.

or "frivolous" consumption, that is, the one that is not necessary for a context of resource scarcity, where demand must be rationed. Resources are carefully allocated to secure the minimum provision for residential users and the functioning of commerce, industry, and services. This higher price for the second block is also supposed to raise enough revenue to compensate for the loss generated by pricing below marginal cost in the first block and, thus, achieve financial sustainability in the system altogether. Although that is usually not the primary goal of these schemes (demand management is), a careful design of this tariff scheme must be done if the policy goals are not only demand management and affordability, but there is also a zero-budget constraint.

Subsequent blocks can be defined to discourage very intensive consumption further, for example, but at least two blocks are required (a first, merit good amount, and a second, normal one) to name the system as such and to respect its substance. It must also be considered that the increasing block tariffs in their pure nature (that is, without discrimination of consumers according to income or another characteristic) are a quantity subsidy; that is, low consumption is subsidized while high consumption is punished. This element must always be present in the policymaker's mind to avoid possible unintended consequences of the tariff scheme, such as the exclusion of those the policy targets (the poor that intend to help) and the inclusion of others who do not need subsidization. For every case that can be presented and each failure that the scheme might have, there is usually also a solution or tweak that can be implemented to correct the problem by making the policy more precise. However, it must be remembered that those exact specifications that make subsidies or tariff schemes more accurate also raise the information, administration, and transaction costs of implementing the policy.

It has been observed that the alternative tariff schemes analyzed cannot balance

the four policy goals enumerated (efficiency, affordability, financial sustainability, and demand management). To see whether IBTs can achieve those goals, a review of the issues raised regarding their implementation must be performed before a clear assessment of their effectiveness can be done.

5.1. Revisiting efficiency: reallocation of power from large to small users

The impact of increasing block tariffs on different policy goals is widely discussed in the academic circle and by technicians of international institutions (such as the World Bank) implementing tariff systems in different countries. The literature is generally divided, with strong proponents and critics of the increasing block tariffs and other assessments of their effects.

One of those debated points, the most divisive issue, is the impact on efficiency and social welfare. The critic is almost intuitive. Considering that marginal cost pricing is paramount to efficiency, any deviation from it (even to create cost-recovery tariffs) is considered inefficient. One such opinion is that "Economic efficiency is promoted when prices reflect the marginal costs of the services provided. IBTs result in customers paying different prices for the same water delivery service. At most, one of these prices can be equal to marginal cost. Whichever block price that is, many customers will face different prices, either higher or lower. Marginal cost pricing requires a single price for all users with similar cost accountability (e.g., residential users). However, that price may vary (for all users)

according to time of use or location."[45]

Although some authors have tried to show the consistency of IBTs with marginal cost pricing by saying that marginal cost curves of some utility services are rising, and then marginal cost pricing is reached by setting the price of the most expensive block equal to its marginal cost[46], the truth is that marginal cost pricing and IBT's are two tariff structures that operate under entirely different logic. While marginal cost pricing has a linear system (where the total price is proportional to the level of consumption), IBTs make it a point to differentiate prices according to each consumption group in a multi-part tariff structure. Some users deliberately pay tariffs below any cost measure (to ensure affordability). In contrast, others pay fees deliberately above any estimate of charge (to discourage wasteful consumption and provide resource conservation).

Nevertheless, the departure of IBTs from marginal cost pricing is not the last word in assessing their impact on efficiency. If IBTs are implemented under a scenario of evident resource scarcity (the designed system), a particular situation arises. If the energy supply is strongly insufficient to cover the needs of all users (residential, commercial, industrial users) and a linear price structure is in place. The result is that most power is allocated to large users, not necessarily because they value the resource the most, but because they are the only ones able to afford it. That is, reviewing the previous discussion of the impact on the efficiency of a limited ability to pay, what may quickly occur in the context of resource scarcity is that small users, even though they assign a high value to a kilowatt of electricity, are unable to afford the high structural price that results out of a severe energy shortage.

This results in a distorted expression of the willingness to pay in the market that

45 BOLAND J. and WHITTINGTON D., 1997, page 6.
46 HALL D. and HANEMANN W., 1996.

favors the acquisition of energy by large users to the detriment of smaller ones and of a correct allocation of resources that maximizes social welfare. Implementing IBTs, in this case, correct this distortion by shifting demand from large to small users, all using differentiated price structures. In consequence, the use of IBTs becomes, in this case, efficiency-enhancing despite its departure from marginal cost pricing.

The conclusion, however, is very restricted. It has to be taken into account that it only applies to situations where the following conditions are present: a) a severe resource scarcity because of lack of reserves or resource depletion; b) a structural incapacity of supply to meet demand because of the resource scarcity and impossibility to obtain energy through other sources or imports at reasonable prices; c) a substantial portion of consumers for which cost-recovery prices would represent a significant fraction of their incomes and therefore an income effect on their willingness to pay. As it can be observed, the conditions for IBTs to be efficiency-increasing are not few, but they can be found in the description made of many emerging market economies and in the case of Argentina.

Therefore, it must be concluded that under the economic conditions described, using IBTs, accurately designed maximizes social welfare.

5.2. Discouragement of consumption: financial sustainability vs. demand management

At this point, it is already established that how the IBTs achieve both affordability and demand management is through a price differentiation among user categories, setting at least two different blocks of consumption: one block, considered a merit good, which is strongly subsidized, and one or more subsequent blocks with prices above marginal cost to discourage excessive consumption. For this cross-subsidization mechanism to work, logically, the surplus revenues collected from the second and subsequent

tariff blocks must be sufficient to recover the losses generated in the first subsidized block. If this condition is not met, total costs are not recovered, and the system is not financially sustainable.

Although, at first sight, implementation of this system may seem simple, it is not, as it requires a careful definition of the consumption blocks and their prices, as this can affect each one of the policy goals pursued. If the subsidized block is enormous (for instance, 400 kilowatts every month), then a significant fraction of households may be subsidized without a need to; some may even increase consumption -up to the block limit- because of the low prices. This does not mean that each family will control its consumption kilowatt by kilowatt up to the block limit. Still, it may very well happen that a family that consumes only 200 kilowatts a month -and covers with them all their basic needs- expands their consumption to other non-basic appliances due to the low prices. This, in the end, would lose the virtue of helping the poor and those that cannot afford essential services, and it would even go against the goal of demand management, as it would encourage consumption. Additionally, a significant first block would require substantial price increases in the subsequent blocks to collect enough revenues for cross-subsidization. As it can be observed, consequently, the definition of the first block of consumption in an IBT's scheme is crucial.

Another critical issue is that low prices for the second and subsequent blocks do not achieve financial sustainability or demand management (a slight mark-up over marginal cost does not compensate for strong subsidization in the first block and may also not be a sufficiently strong disincentive to consume, as users usually perceive abrupt changes in prices rather than marginal ones). However, remarkably soaring prices for the second and subsequent blocks achieve the goal of resource conservation but may still lack financial

sustainability. This is since non-essential electricity demand tends to be very elastic, and a high increase in price may discourage the market to such an extent that, even though demand is rationed, the system again becomes financially unsustainable. This is what happened in the state of California, in the United States, when IBTs were introduced for water tariffs in the 1980s (to administer water demand in the context of droughts): the scheme was so successful in discouraging consumption that the revenues collected were insufficient to pay for the subsidies of the first, more inelastic, essential block.

It can be seen, therefore, that there is a trade-off present in the implementation of IBTs between the goals of financial sustainability and demand management. A remarkably high price achieves demand management but not economic sustainability, and a meager price reaches neither. Consequently, the price must be set at a level that permits discouragement of consumption while at the same time securing enough revenues to fulfill the zero-budget constraint. With this, the practical importance of defining the extent and price of each consumption block is demonstrated.

5.3. Are income and electricity consumption correlated?

Increasing bock tariffs, as quantity subsidies and punishments, vary in effectiveness on the assumption that income and electricity consumption are correlated. Poor people consume low electricity, while rich people consume considerable amounts. That assumption of high income-high consumption and low income-low consumption is fundamental for assessing the impact of IBTs on the goal of affordability (not in demand management, given that the reduction in energy consumption due to soaring prices in any

case[47] occurs in any case[48]).

Although the general agreement seems to be that this assumption has more accuracy for the case of electricity than for water (where consumption between low-income and high-income households tends not to differ), a series of issues may appear and deny that correlation. The matter is that whatever degree of inaccuracy in the assumption affects the performance of IBTs, as quantity subsidies, concerning the goal of affordability. Put it another way: if it is only poor households with low levels of consumption and only wealthy families with elevated levels of consumption. Then the IBT is perfect as a quantity subsidy targeted to improve affordability, given that it subsidizes everybody who needs it, but only them. There are no errors of exclusion (poor people who are not supported) or errors of inclusion (rich people who are subsidized). Then the IBT is perfect as a quantity subsidy targeted to improve affordability, given that it supports everybody who needs it, but only them. There are no errors of exclusion (poor people who are not sponsored) or errors of inclusion (rich people who are supported).

The one presented is, logically, the perfect scenario. However, things could not be exactly like that. If there are poor households, for instance, that consume much electricity (beyond the merit good level or whatever measure the IBT defines). The subsidy they get for the first block, they may lose by overpaying in the second one or might even end up behind if their consumption level is in a subsequent block, given that the "punishment" premium (the one put into discouraging excessive consumption) will exceed the initial subsidy. If that is the case, then IBTs will be effective for demand management but not for affordability, at least for some poor households.

47 In fact, the effect might be more substantial in the case of high-consuming-low-income households, given the large fraction of their budgets that energy prices would represent.

And why could low-income families consume as much electricity as affluent families? The truth is, for a variety of reasons. First, poor households may have more family members than wealthy households (fertility rates tend to be higher in low-income families than in rich ones). Hence, as a household, they consume more electricity than a wealthy household, as a matter of total quantity. This was noted when implementing IBTs in electricity reform in South Africa. One solution, of course, is to establish a per capita level of consumption or first block instead of a household level of consumption. That would certainly do the trick, but it is also much more challenging to implement because of the prominent status of information it requires about each household, which may raise the administration costs of the system.

Another issue is that the implementation of quantity subsidies requires a connection to the grid for every household (it was already said that, in the case of Argentina, the rate of electricity access is 95%) and that every house has its meter. This last part may be a problem for many developing or emerging market economies. It is common in many of these countries to share connections among neighbors. There may be two, three, or even more families connected to the grid, but only one with a legal relationship arranged with the distribution company, and the rest just "hanged" from that one. If that is the case, the meter will measure the consumption of all those families, considering them as just one, which will for sure exceed the minimum level of consumption contained in the first subsidized block (even if each family on its own is within the merit good level, in reality). This will increase prices per kilowatt, discouraging shared connections and hurting affordability.

Yet another thing to consider is the interrelation of electricity with other public utilities, particularly with the provision of natural gas. In the case of Argentina, for example, most families use natural gas for heating and cooking (and tariffs for it are also being

subsidized similarly to the electric ones, with frozen prices and funds from the government's budget for the acquisition of inputs). Middle-class and high-income families have it provided through a network of gas pipelines for transportation and distribution in a market segmentation like the electricity sector. However, the difference between the two sectors lies in the fact that the rate of connection to the natural gas network is much lower than that of electricity, so many low-income families are excluded from it, which constitutes a significant issue of affordability and equity, which can be better targeted in that case with a connection rather than with consumption subsidies. The fact is that these low-income families end up acquiring more expensive natural gas tubes or directly using electricity for heating, which the wealthier families do not need. This adds up to the electricity bill of those low-income families and increases the quantity of electricity consumed. This, in turn, would go to the detriment of the subsidies, and the IBTs could punish these families if they are not identified. Specifications, however, again raise the administration costs of the system, so they always present a policy trade-off. In the world of theory, all information is available to make decisions; in practice, however, informational requirements of public policy are costly.

Another element to consider is the regional disparities within a country, particularly within one with the size and extension of Argentina. In effect, there are parts of the country where there are much fewer hours of daylight in winter than in the other parts of the country or are colder than the others. This, logically, affects the amount of electricity and primary energy sources in general that are consumed. Families of all levels of income, thus, have there a price mark-up concerning families in the rest of the country[49]. If that situation is not considered, implementing an IBT tariff structure across the board may have unintended consequences.

49 Here, the example of Argentina is more illustrative than anything else, given that similar situations can be found in many other countries that could be subject to this same analysis.

Therefore, the IBTs are optimal under an assumption of a perfect correlation between income and electricity consumption. However, many circumstances may be imagined that affect the quantities of electricity consumed and reduce the effectiveness of quantity-based subsidies as a tool of income redistribution.

5.4. Direct subsidies as an alternative

Some studies claim the superiority of direct subsidization concerning IBTs, showing that how quantity subsidies tend to be implemented has a regressive impact on income redistribution[50]. As has been stated, the full progressiveness of IBTs occurs only when the correlation between income and electricity consumption is perfect. However, when circumstances affect that correlation, there appears to have a certain degree of regressive impact on IBTs. As has been stated, the full progressiveness of IBTs occurs only when the correlation between income and electricity consumption is perfect. However, when circumstances affect that correlation, there appears to have a certain degree of regressive impact on IBTs.

Direct subsidies, on the contrary, can be means-tested (to see exactly who does not have enough income and needs help to afford the electricity bill) and, in that way, only be provided to the ones that a policy of affordability targets (hence avoiding or minimizing errors of inclusion and exclusion). At the same time, direct instead of cross-subsidies would allow the rest of the electricity users to pay cost-recovery (and not above-cost) tariffs, aligning the system with the principles of marginal cost pricing, given that the only consumers who would face distorted prices would be the subsidized ones, but in the name of affordability.

50 KOMIVES K., FOSTER V., HALPERN J., WODON Q., and ABDULLAH R., 2005.

Consequently, direct subsidization has a better performance than IBTs concerning the goal of affordability and with less cost to efficiency. It balances the efficiency-affordability trade-off more straightforwardly. That is true. However, what these statements overlook, besides the fact that means-testing and identification of proven unsatisfied basic needs bring exceedingly high administrative costs, is that direct subsidization does a poor job concerning the other two policy goals enumerated: demand management and financial sustainability.

Direct subsidization does a poor job of demand management because it eliminates the premia or mark-up that IBTs impose on excessive consumption, thereby relaxing the price pressures over consumers of high quantities of electricity and allowing demand to expand. That adds up to the underpriced tariffs that those subsidized face, and it becomes a trigger for consumption. That is not necessarily a problem for an economy with energy surpluses (which are not abundant), but it is a nightmare for an economy in the context of energy shortage.

The suppression of premia over the consumption of high-income households (which allowed for cross-subsidization among categories of users) makes the revenues of the electricity system altogether decrease, which calls for the government to provide the funds to subsidize the electricity consumption of those who cannot afford it (that is the very idea of direct subsidization). This measure jeopardizes the goal of financial sustainability, given that the system cannot finance itself anymore. Still, it must depend on government subsidies and the taxes imposed to support them. That is direct subsidization, by definition, violates the zero-budget constraint.

In conclusion, if the only concern of a policy concerning the electricity sector

is to achieve efficiency and equity, then a well-designed system[51] of direct subsidization is better than IBT's. However, if the policy intends to balance all four goals (efficiency, affordability, financial sustainability, and demand management) together, then IBTs are the only alternative.

	Demand Management	*Efficiency*	*Financial Sustainability*	*Affordability*
Direct subsidization	NO	YES	NO	YES
IBT's	YES	YES	YES	YES

51 Saying that it must be a "well-designed" system is not an obvious or redundant statement, given that subsidies provided by many governments are far from achieving their goals, and instead produce many unintended consequences. A well-designed system must ensure that the funds are given to those who need them, and not the middle or upper-middle class who can afford to pay for the services themselves. Also, that the subsidies transferred help consumers, and do not serve just to enrich corporate treasuries.

6. Conclusion

At the beginning of this work, several questions were raised, and the intention was to explore them one by one throughout the paper to give a definitive answer at the end. First, as stated then and reaffirmed, there is no absolute best tariff system for the electricity sector or any public utility. Every tariff scheme is contingent on the needs of each society and country. There are specific solutions that economic theory provides to certain problems, but all of them are instruments to objectives defined elsewhere. That is why, since the very beginning, the topic of this thesis has been constrained to the goals set by one legal framework, that of the Argentinian nation.

The question was: which price regulation mechanism could best achieve the goals pursued by Argentina concerning its electricity sector? That fundamental question of the thesis triggered other related questions. What are the purposes of the Argentinian legal system? That was determined by the four goals enumerated and described: efficiency, equity (affordability), financial sustainability, and demand management. Then, what is the price regulation currently in place? That was not an easy answer: it was observed that there are not one but twenty-six electrical jurisdictions over prices, given that some distribution companies operate under the control of the federal government and others under the power of the provincial government. That, however, permitted us to present different experiences in the same country, mainly variants of two-part tariffs and increasing block tariffs.

It was also seen that despite those different tariff schemes, the predominant one in Argentina, for its impact on most residential users, is a two-part tariff variant with decreasing block prices. Does the regulation in place optimally achieve the goals prescribed by the legal system, or is it insufficient as a tool to pursue those goals? That was the other initial question, and the answer was clear. The two-part tariff scheme set in Argentina is

insufficient to follow the four purposes enumerated. Its structure with decreasing block tariffs is designed for a situation of energy surplus, not scarcity, and thus goes directly against the goal of demand management. Additionally, with its lower per-unit price for large users than small users, that two-part tariff scheme leaves the poor with a higher share of the electricity bill, clashing intensely with the goal of equity.

The following question then was: what are the alternatives at hand? One by one, the traditional pricing schemes were analyzed, and their impact on each goal was assessed. The conclusions were summarized in tables, and they were the following: marginal cost pricing satisfies efficiency but none of the other purposes; average cost pricing is financially sustainable but neither efficient nor equitable (or conservationist, for that matter). Ramsey-Boiteux pricing solves the policy dilemma between efficiency and financial sustainability at a minimum loss to efficiency but a high cost to affordability. The same conclusion applies to the typical two-part tariff schemes (whether in the version of Coase or that of Ramsey), given that they are built to make a system both efficient and financially sustainable, but with disregard to the other goals presented. The truth is, none of these traditional tariff schemes were set to care for affordability or for a transition period between energetic models, where the resources currently used to produce electricity start to run out severely. Those traditional price systems were conceived to achieve only the goal of efficiency and tweaked exclusively for the concern of implementing cost-recovery tariffs and the government's imposition of a zero-budget constraint.

That is, the typical linear or nonlinear tariff alternatives could be recommended if the goals were efficiency, financial sustainability, or both in some cases. However, if the objectives pursued by the legal system are also others, as in this case (and, in fact, in most countries), those tariff schemes become insufficient policy options. Direct subsidization is a

clear alternative to achieve affordability without much distortion of the price system, but it requires government funds and thus violates the zero-budget constraint. Also, as analyzed, its segment of submarginal prices increases demand, which does not help with energy conservation.

At last, the time came to test another idea: increasing block tariffs. As seen, this system was construed precisely to target the goal of demand management, and its effectiveness in that area is proven. However, that is not all it achieves; with its combination of high tariffs for the rich and low for the poor, it makes electricity prices affordable without putting at risk the affordability of the system. Also, in severe scarcity, it reallocates resources to those most need them, even if they cannot express that monetarily.

Logically, as in any public policy implemented, this can also have unintended consequences. This has also been covered, and the conclusion is that the significant problems of increasing block prices arise when the correlation between income and resource consumption is not strong.

That last point leads to another warning: although IBTs are a system that can be used for pricing in any public utility, their effects can be much different depending on what industry it is implemented in. In the case of water or natural gas provision, a careful analysis of the consumption pattern of households with various levels of income must be conducted to determine the correlation between income and water or natural gas. If that correlation is weak, a system of increasing block tariffs may become regressive instead of aiding the affordability goal. Therefore, IBTs must be implemented only when the necessary conditions for their effectiveness are given.

The last issue to reaffirm is that the conclusions exposed are particular to the economic context analyzed and should not be universalized. Although what applies to public

utilities in Argentina may apply to other countries as well, this is restricted to other emerging economies where, as described, the macroeconomic context and economic conditions are remarkably similar.

In summary, a price regulation including professionally designed increasing block tariffs is the best alternative that Argentina has at hand to achieve its own regulatory goals for the electricity sector. That is all that can be said for sure. Extensions of that assertion to other public utility sectors or countries are a matter of further research.

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