Centro de Estudios Económicos
El Colegio de México, A.C.
www.colmex.mx

Serie documentos de trabajo

ON THE POTENTIAL DISTRIBUTIVE IMPACT OF ELECTRICITY REFORM IN MEXICO

Luis F. López-Calva and Juan Rosellón

DOCUMENTO DE TRABAJO

Núm. I – 2002

On the Potential Distributive Impact of Electricity Reform in Mexico*

Luis F. López-Calva
El Colegio de México and Universidad de las Américas-Puebla

and

Juan Rosellón
Centro de Investigación y Docencia Económicas

Abstract

Even though the evidence on the benefits of privatization around the world has been established in the literature in a robust manner, public opinion surveys show a widely negative perception of the reform process in Latin America. Among other factors, this may be due to the fact that the reform mainly affected urban middle classes through the elimination of generalized subsidies. In Mexico, the electricity sector has not been included in the still ongoing reform process, which started in the eighties. Among the main reasons for the latter is the allegedly potentially negative impact such reform would bring about from a distributional perspective. The analysis of such potential impact is the main theme of this paper. Both regional measures of progressivity and the estimation of distributional characteristics, following previous work by Newbery (1995), show that the current tariff structure is clearly regressive. A framework is proposed to construct non-linear tariffs with a clear distributional rationale, which could also be implemented in a competitive electricity market.

Keywords: Privatization, Electricity, Reform, Inequality

* This paper was funded by the Tinker Foundation and The Program on Regulation at CIDE. The authors thank Alethia Rivero, Cristina Rodríguez, Yamilia Orozco and Lorena Cendejas for able research assistance at different stages.

1. Introduction

The benefits derived from the privatization of public enterprises in terms of increases in productivity, profitability, and overall efficiency have been documented in the literature.[1] Yet, *Latin Barometer*, a survey carried out periodically in Latin America, shows that people's perception of the privatization process is widely negative. People included in the survey tend to perceive that privatization might be associated with massive layoffs and price increases. The literature on the benefits of privatization mentioned above also shows robust evidence that the higher the degree of monopolization of the sector and the weaker the regulatory capacity of the government, the lower the efficiency gains derived from privatization (see also Levy and Spiller, 1997).[2]

This paper analyzes the potential distributional impact of the reform in the electricity sector in Mexico. In doing the latter, it also provides evidence to explain public opinion's reaction to privatization. Surveys like the one mentioned above have an urban bias and, as it shall be hereby shown, privatization tends to affect urban middle classes who use to benefit from generalized subsidies that state-owned enterprises (SOEs) typically provide (see López-Calva, 2001). Consumption of certain commodities like electricity is highly unequal and generalized subsidies are in turn regressive. In the case of Mexico, the latter situation will be aggravated by the fact that the logic behind electricity subsidies does not have any distributional basis. Quite on the contrary, subsidies are based on average temperature in the location, while relatively poorer people tend to be less protected against harsh weather than people who are relatively better-off. Even though this paper only discusses in detail the case of subsidies for domestic consumption, subsidized rates for agricultural use, for example, also have a seriously regressive logic by supplying electricity for irrigation systems at considerably lower prices –around 15% of its cost—than those for other use, while it is clear than the poorer regions in agriculture only possess rain-fed lands.

These distributional pathologies may have a different rationale, which could be a valid one from a specific perspective, but the objective of this research is to focus on the distributional implications.

---

[1] For the case of México, See Laporta and López-de-Silanes (1999). A cross-country review can be found in Sheshinski and López-Calva (1999) and Megginson (1999).
[2] In the specific case of power, a review of the distributional impact can be found in Foster and Tre (2000).

The paper contains seven additional sections. After discussing the theoretical links between privatization and distributional outcomes, the current tariff structure in electricity in Mexico is discussed. After that, the distributional implications of the current structure is analyzed, as well as the potential incidence of current subsidies. Newbery´s methodology is then applied to calculate the distributional characteristic of power consumption in Mexico, as compared to other public services. Finally, we propose a non-linear scheme to provide well-targeted subsidies in electricity. Our conclusions close the paper.

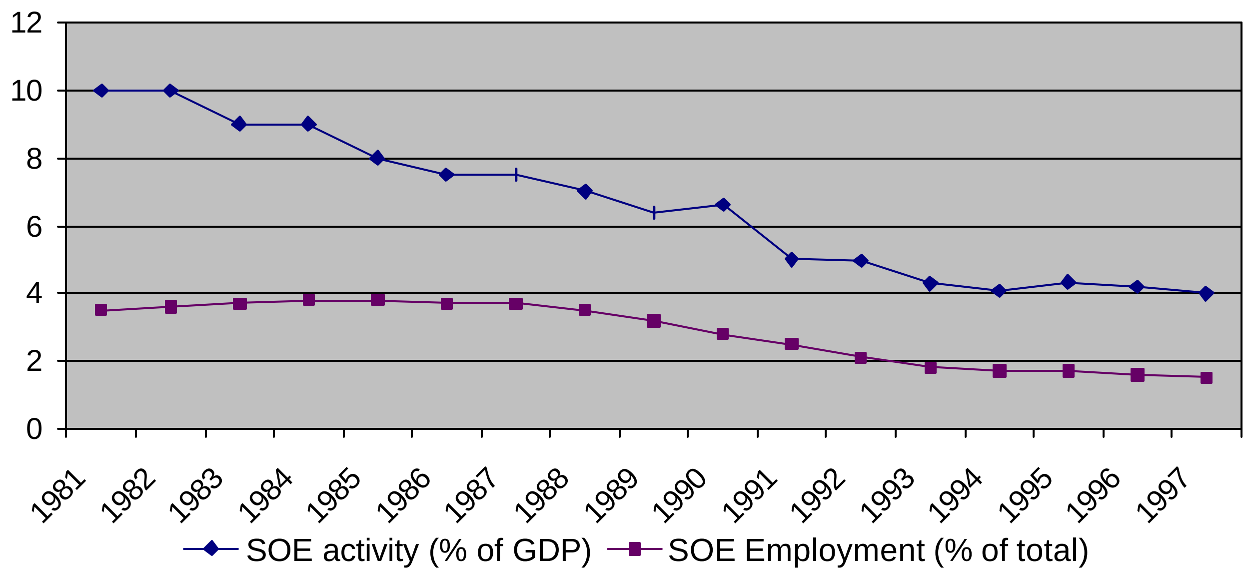
2. Privatization and Distribution: The Links

One way to think of the different links between privatization and income distribution is to separate the effects into fiscal effects (F), employment and wage effects (E), price and access effects (P), changes in ownership (O), and spillover, general equilibrium effects (S). Whether privatization has a concentration or re-distribution impact is an empirical question, as the theoretical discussion shows impacts that go in opposite directions. As an example, in the case of the fiscal effects, once subsidies are eliminated, prices increase. However, when the fiscal situation improves, interest rates go down and debt-service is decreased, which eliminates an implicit transfer from net borrowers (typically poorer groups) to net lenders (typically better-off groups). Also, a better fiscal health may induce higher social expenditure on the side of the government. At the same time, the E-effect tends to be negative, at least in the short run, due to the fact that increases in productivity usually come to an important extent from the elimination of labor redundancy. The net effect is clearly difficult to estimate *a priori*.

In the case of Mexico, the privatization process that took place during the late eighties and the nineties seems to have shown a positive fiscal effect. Graph 1 shows that employment ion SOEs and SOE activity as a percentage of GDP declined during the period. At the same time, both public debt as percentage of GNP and the interest rates showed a reduction, as predicted (graphs 2 and 3). The financial health of the public sector, as measured by the public deficit as percentage of GDP also shows a clear decline (graph 4). At the same time, social expenditure grew both as proportion of GDP and even in per capita terms, which is important given the strong demographic pressure on social expenditure in Mexico.[3] These are all correlated events, though many other things happened during that period. We are not hereby arguing a *post hoc ergo propter hoc* argument, while indeed stating that such changes would not have been possible without an aggressive public sector reform.

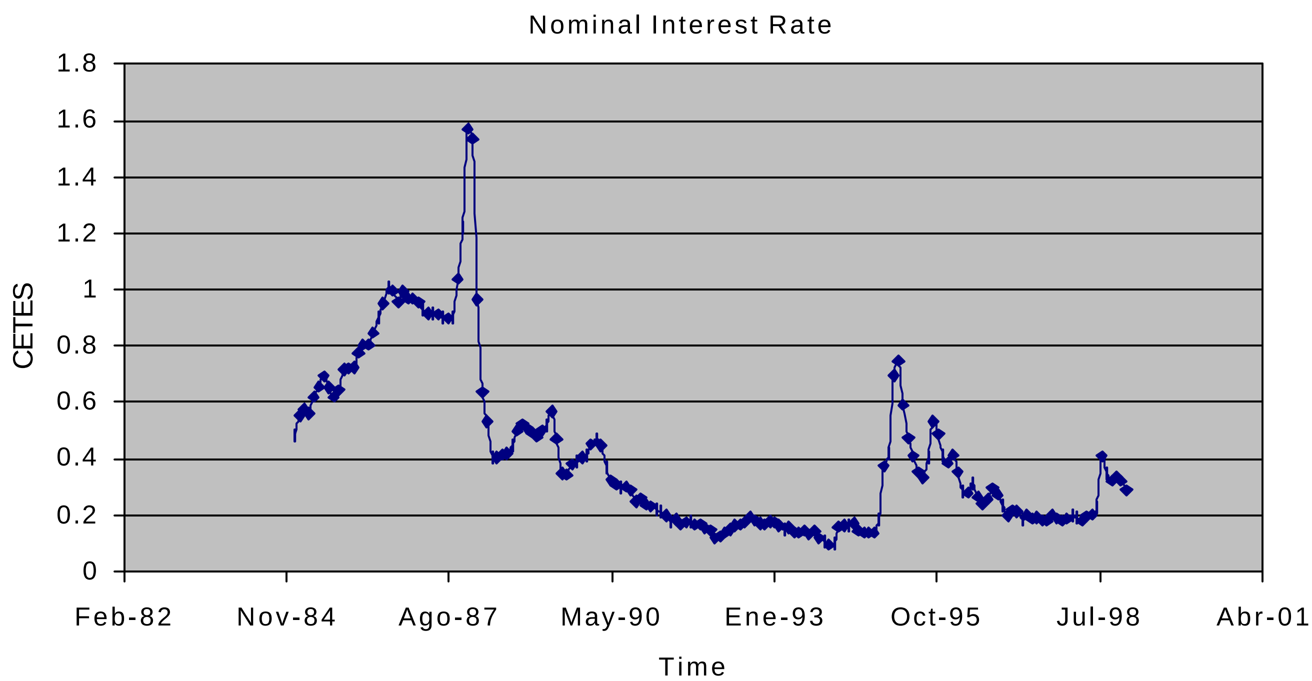
Few sectors were not included in the reform program. Among those, perhaps the most important ones in terms of their potential impact on overall efficiency are electricity and oil production.

Graph 1
Privatization in Mexico 1981-1998

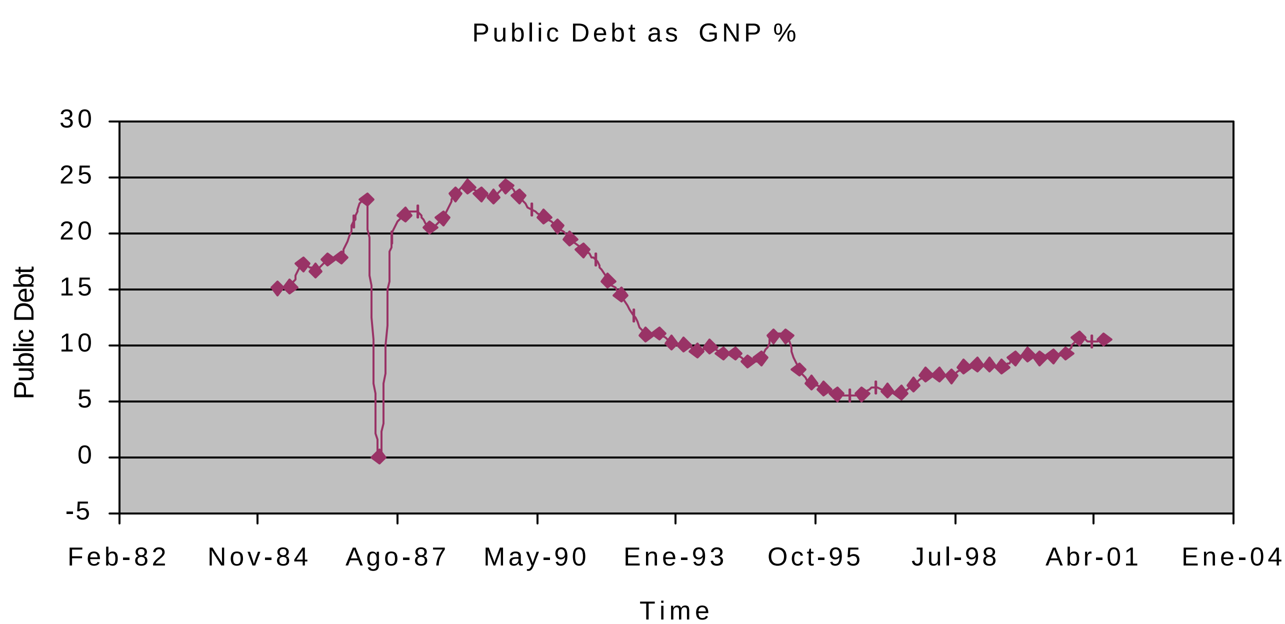


[3] After decades of population growth rates above 2% per year, it has finally gone down to 1.9-1.8% annual rate.

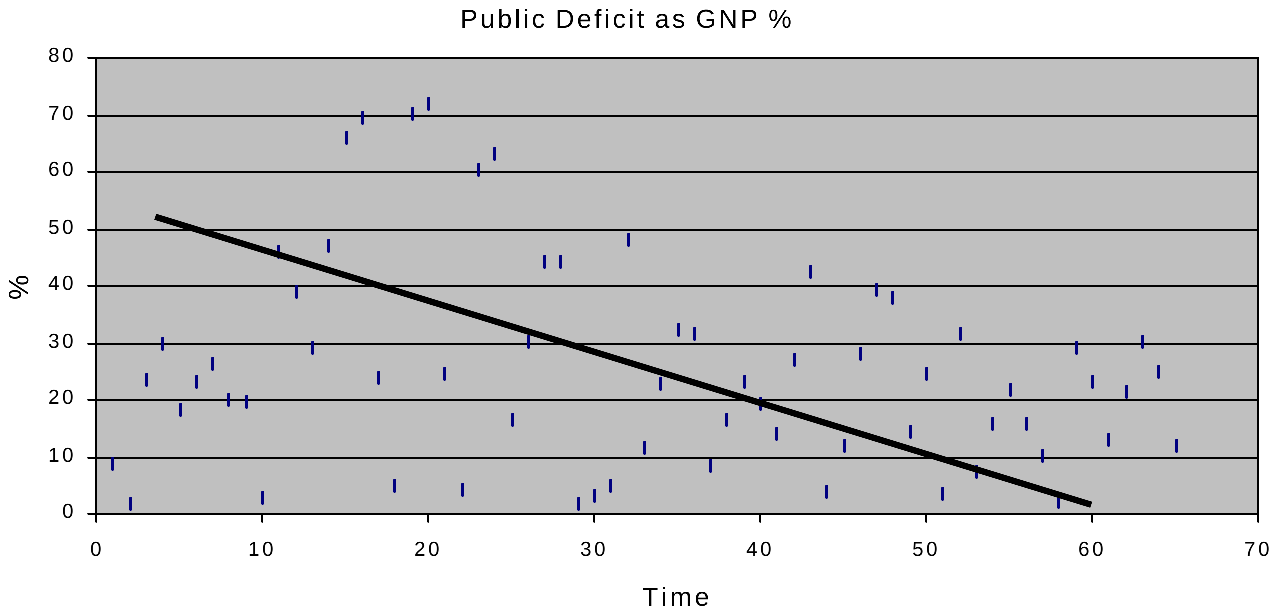
Graph 2



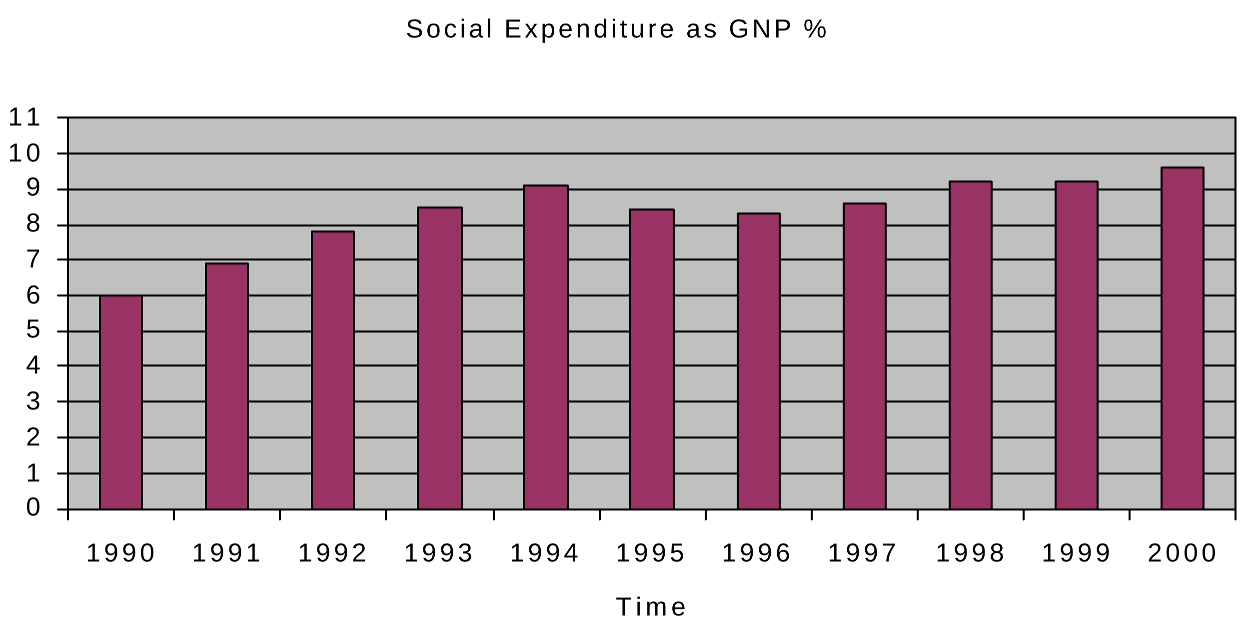
Graph 3



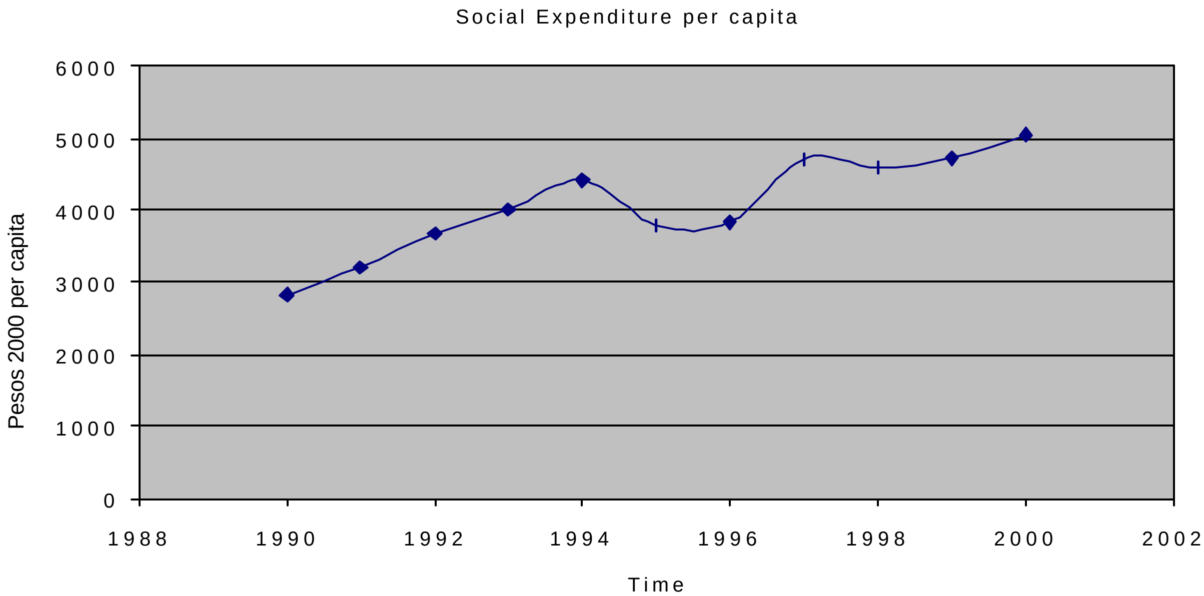
Graph 4



Graph 5



Graph 6

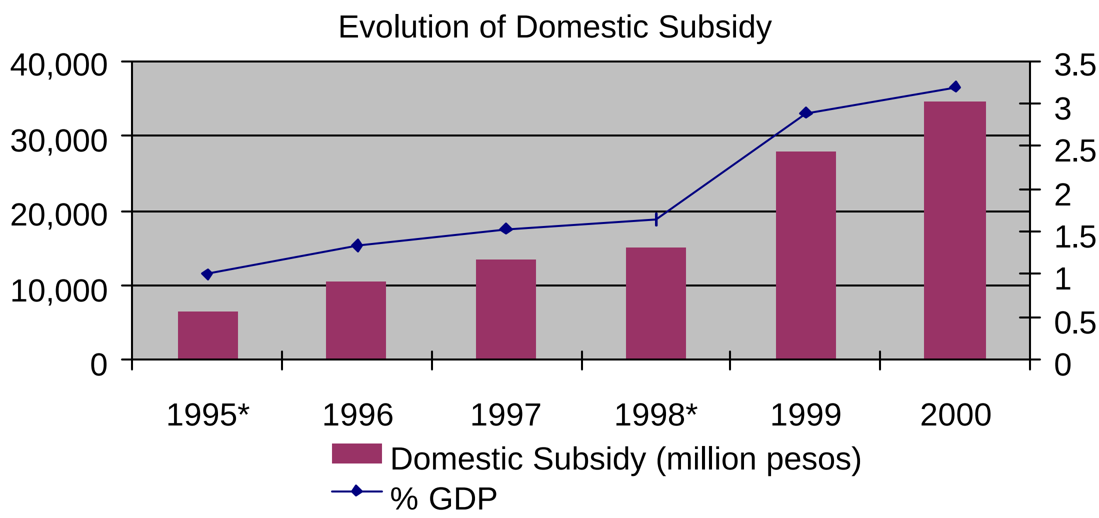


Political economy constraints prevented the government from reforming the later sectors. In the specific case of electricity, opposition from the union, potential opposition from urban middle classes and large agricultural producers, and the technical difficulties involved in the reform process itself are the main reasons for the delay. Is there a reason to believe that the reform would have a negative distributional impact in terms of domestic electricity consumption? That is the question to be investigated further below. The focus will be exclusively on the P-effect, putting aside the other effects, which are the subject matter of a different study.

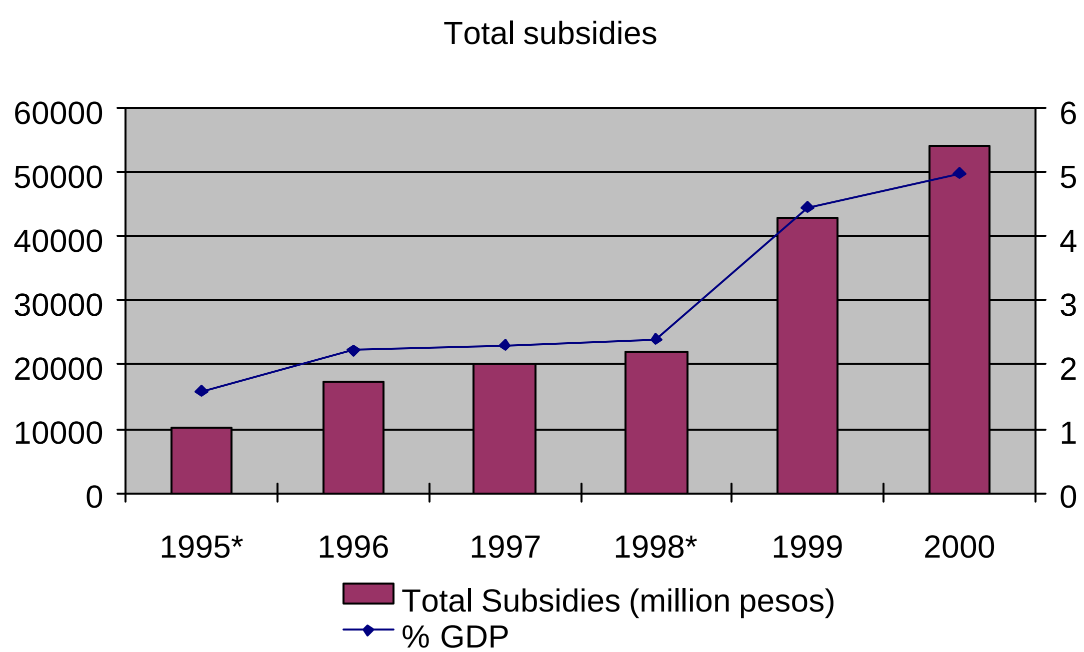
3. Electricity Subsidies: How Important?

The importance of the question on whether the domestic subsidy is progressive or regressive depends on how important the subsidy is in the first place. After dealing with the difficulties in dealing with the scarce information available for the sector, a reasonable estimate of the amount of subsidies shows that it could be as high as 3% of GDP (graph 7). The latter estimate makes the distributional impact of such expenditure a matter of fundamental importance.[4] Following the same methodology, the estimate of total subsidies in electricity, including rural, commercial, and industrial sectors, reaches up to 5% of GDP (graph 8).

Graph 7



Graph 8



[4] In order to put this in perspective, consider the fact that total tax collection in México, without the oil sector, is below 10% of GDP.

Subsidies are clearly not trivial. In the next section, we start by analyzing the current structure and providing some first insights on its distributional implications.

4. Description of the Current Tariff Structure

In December 2000, the tariff structure consisted of 31 different categories for the commercialization of electricity in Mexico (see appendix 1). Tariff levels are classified into five groups, according to the modality of use, i.e., residential, commercial, services, industrial, and agriculture. (Table 1).

Table 1

Type of user	**Number of tariff levels**
Domestic	6
Commercial	2
Public Service	4
Agriculture	2
Industrial	17
Total	**31**

The residential sector includes tariffs for domestic service only. The tariffs that correspond to public service in low-voltage include mainly public lighting, pumping of waste and drinking water, as well as temporary services. The agriculture sector includes tariffs for water pumping. The industrial sector operates with tariffs for medium and large firms. The tariffs for large firms generally include high-voltage. Users in the latter category are basically big industrial units and important drinking-water pumping systems.

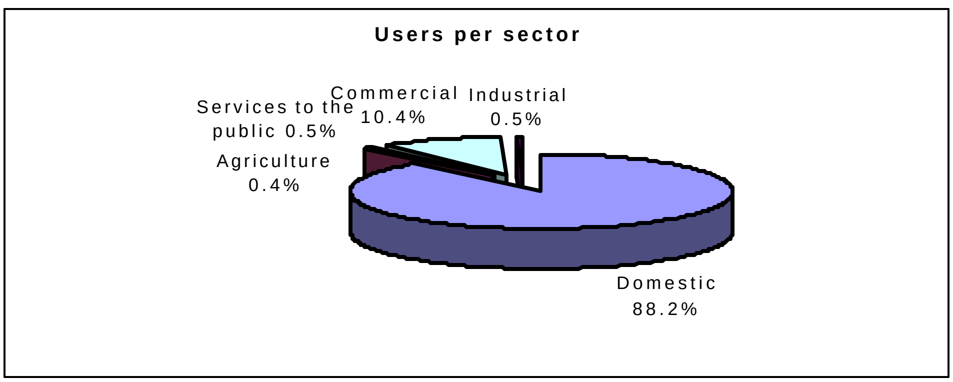
In 2000, from the total number of users in the total service of power provision, the industrial sector only represents the 0.5% of the total, when measured by number of users (see Table 2 and Graph 9). Yet, it purchases 53.8% of total sales. The number of residential users is equivalent to 88.2% of the total number of users, though their consumption represents a little less than the one fourth of the national electricity demand (21.5%). Altogether, these two sectors represent almost four fifths of the total power sold in the country.

Table 2
Total Sales (2000)

Sector	Billing (million pesos)	Billing (%)
Domestic	20.259	21.5
Commercial	14.815	15.7
Service to the	6.121	6.5
Agriculture	2.326	2.5
Industrial	50.737	53.8
Total	**94.258**	**100.0**

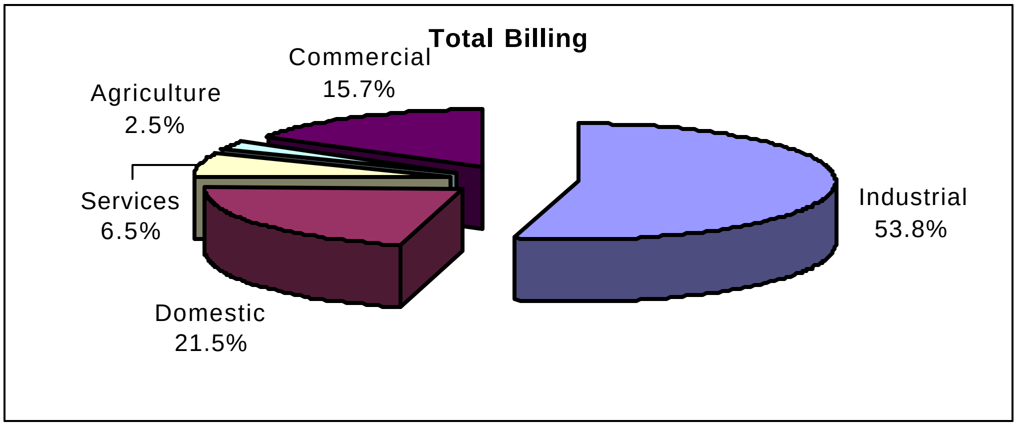
Data until December 2000.

Graph 9



Summarizing, total billing of electric power in the country during 2000, shows that 53.8% was directly used by the industrial sector, 21.5% by the residential sector, 15.7% by the commercial sector, 6.5% by the services sector, and 2.5% by agriculture for irrigation (graph 10).

Graph 10



As explained above, the paper will focus on the distributional impact of domestic tariffs (residential use), even though there is evidence of distributional pathologies in other tariffs, such as agriculture, which will be mentioned here only briefly (López-Calva, 2001).

Domestic Tariffs

Domestic tariffs are below the costs of production and they imply a subsidy to more than 98% of users. Among the six current tariff levels for domestic consumption, most of the power is sold within tariff 1, since tariffs 1A and 1B where created for the Summer in regions with the highest temperatures during that season. All tariffs have an increasing structure in several steps, determined by range of consumption. After the first range, the tariff increases for the marginal amount of power used. What varies mainly among tariff levels is the range of consumption that determines each step in the structure. Table 3 shows the range of consumption for different tariff levels, in terms of kilowatt/hour per month. As can be seen in table 4, most of the subsidy is concentrated in the basic and, especially, intermediate consumption.

Table 3

Ranges of Consumption (kWh/month)						
Range of Consumption	Domestic Tariff					
	1	1A	1B	1C	1D	1E
Basic	1-	1-100	1-125	1-150	1-175	1-300
Intermediate	76-	101-250	126-300	151-750	176-1000	301-2500
High(grearter than)	200	250	300	750	1000	2500

GWh: Gigawatt hour
kWh: kilowatt hour
Source: CFE.

Table 4

Subsidy according to Range of Consumption - Domestic Tariff				
Range of Consumption	Users (millions)	Consumption (GWH)	Billing (million pesos)	Annual Subsidy (million pesos)
Basic	10.0	5,067	2,228	8,670
Intermediate	9.0	19,546	8,306	21,153
High	1.9	11,582	9,716	4,855
Total	**20.9**	**36,195**	**20,250**	**34,678**

Data up to December 2000.
Source: CFE.

Evolution of the Subsidies

Partly as a result of the economic crisis of 1995, in the last presidential period the largest part of electric tariffs lagged with respect to the corresponding increase in costs for the company, after a period in which tariffs almost reached their cost levels during the Salinas' administration. During 1999 the government gave $42,782 million pesos in subsidies to users of electricity (more than $4.2 billion dollars), out of which 65% was directed to the domestic sector and 17% to the industrial sector. During 2000, due to the increase in the fuel prices for power generation, subsidies increased to $54,069 million pesos (more than $5 billion dollars) (table 5). The residential sector benefited with 64.1% of the subsidies, the industrial sector with 17.9%, agriculture 11%, and commercial users with 5.3%. The service sector received only 1.7% (Table 6 y Graph 11).

Table 5

Evolution of the Subsidies (nominal million pesos)						
Sector	1995*	1996	1997	1998*	1999	2000
Domestic	6,491	10,454	13,374	14,973	27,793	34,678
Commercial	0	0	0	0	2,001	2,849
Services	225	512	590	248	634	896
Agriculture	1,779	3,224	3,850	4,109	5,024	5,946
Industrial	1,767	3,111	2,252	2,530	7,330	9,700
Total	**10,262**	**17,301**	**20,066**	**21,860**	**42,782**	**54,069**

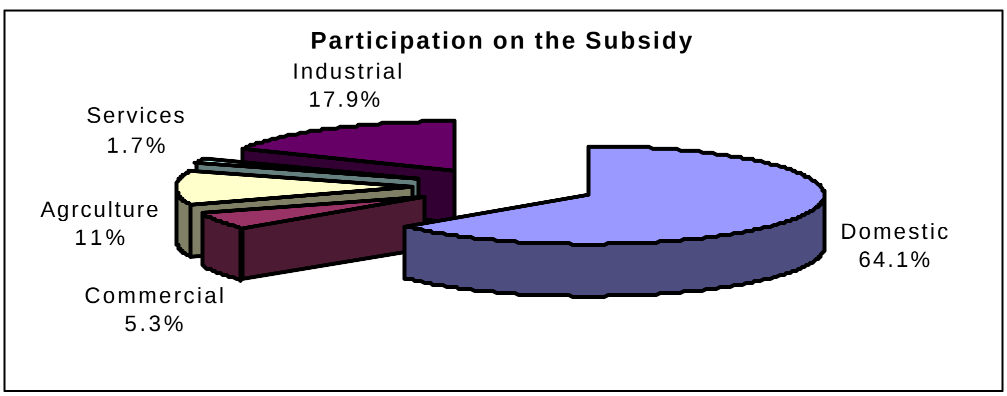
* Does not consider LyFC.

Table 6

Billing v.s. Subsidies		
Tariff	Billing (mp)	Subsidies (mp)
Domestic	20,250	34,678
Commercial	14,794	2,849
Services	5,865	896
Agriculture	2,326	5,946
Medium Business	32,920	7,177
Large Industry	17,670	2,523
Exportations	80	0
Total	**93,905**	**54,069**

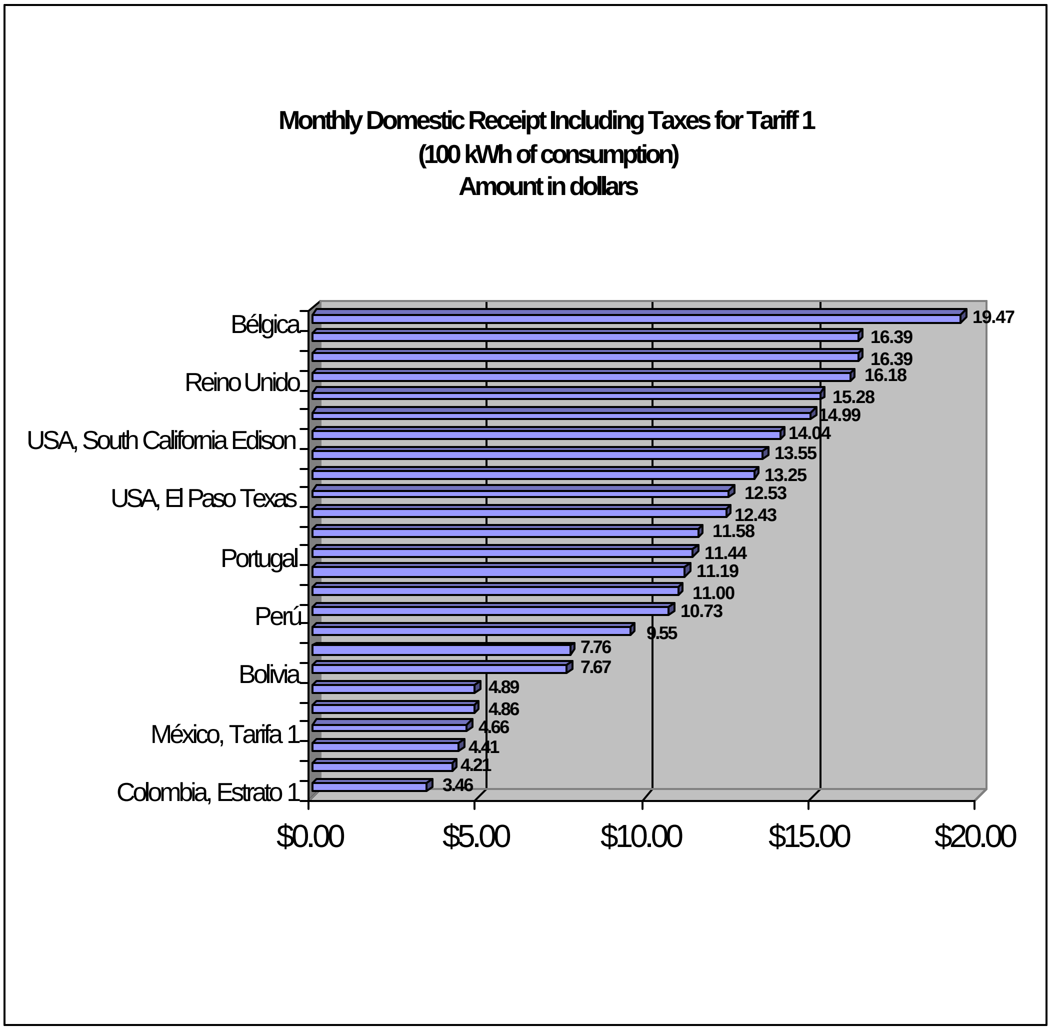
Data until to December 2000.

Graph 11



Given the subsidies to residential consumers, these pay in Mexico about half of what they would pay in the United States (New Mexico) (Graph 12). This regressivity is mainly caused by the fact that the criterion to determine the level of the subsidy is average temperature in the area. In general, poorer people consume less power and, even in places with high temperature, they usually do not have air conditioning. As discussed below, there are at least three dimensions in which the regressivity of the current tariff structure can be verified: the regional dimension, sector-specific dimension, and by income levels.

Graph 12



Source: NERA.

In the commercial and industrial sector prices are more likely to reflect real costs. In general, however, the inefficiency of generation, transmission and distribution of power in Mexico *vis-a-vis* the cost structure in the United States implies that costs are 48% in the former above the average cost in the U.S. (table 7). This means that consumers pay less in Mexico than in the United States even though the costs of generation and distribution are higher in the former country (table 8).

Table 7

Average cost of provision per kilowatt-hour Commercial and industrial use (Cents, US dollar)		
Year	USA	Mexico
1990	6.040	6.876
1992	6.245	9.596
1994	6.250	9.609
1996	6.120	6.944
1998	5.945	7.863
1999	5.790	8.583
Var. % 90/99	-4.14	24.82

Source: NERA.

Table 8

Residential and Industrial Tariffs Mexico vs. other countries		
	Price (Cts. USD / kWh)	
Country	Residential	Industrial
Germany	15.9	6.7
Spain	15.4	5.9
Portugal	15.4	9.4
France	12.9	4.7
Great Britain	12.1	6.5
Greece	9.9	5.0
United States	8.3	4.0
Mexico	6.0	4.2

Source: NERA.

Inefficiencies in Mexico are thus hidden to the final consumers by subsidies. The cost of such inefficiencies is borne by the taxpayers.

Evolution of Tariffs

Table 9 shows how the price-to-cost ratio fell for all tariff categories between 1994 and 2000. In the latter year, consumers were paying around 40% of the actual cost of power and the highest subsidy went to the agricultural use, where consumers were paying as low as 28% of the cost. The regressive nature of the agricultural tariff is thus obvious, as the poorest users in agriculture are unable to have irrigated lands, while large producers do indeed use such systems. The latter is not however, the subject matter of this study.

Table 9

Evolution of the Relation Price/Cost *							
Sector	1994	1995	1996	1997	1998	1999	2000
Domestic	0.53	0.47	0.42	0.40	0.43	0.41	0.41
Commercial	1.38	1.31	1.16	1.13	1.21	1.19	1.11
Services	0.99	0.88	0.79	0.81	0.94	0.92	0.90
Agriculture	0.44	0.33	0.28	0.28	0.30	0.29	0.28
Medium Firms	1.06	0.88	0.84	0.91	0.92	0.91	0.88
Large Industry	0.92	0.81	0.83	0.91	0.90	0.90	0.89

* Estimated (does not consider Luz y Fuerza del Centro (LyFC)).

Analyzing the information on Table 9, the following can be highlighted. For the domestic sector, the price/ cost ratio fell from 0.53 in 1994 to 0.41 on 2000. This was mainly due to the fact that tariff increases did not compensate the corresponding increase in costs. It is important to emphasize that a fundamental premise for the development of a successful electricity market is that tariffs are established according to economic criteria with independence and transparency of the subsidies policy.

5. Distributive Impact of the Current Tariff Structure

There are several dimensions in which the progressivity or regressivity of the subsidy can be analyzed. First, looking at different sectors. It has been already mentioned that the highest subsidy goes to agricultural producers, and given the fact that the poorest producers do not have irrigation systems, this is regressive in itself. Second, we can also take a quick look at the regional dimension. In principle, one should expect that poorer regions or states would receive, on average, higher subsidies, paying lower prices for power.[5] Thus, we construct average prices paid by each state in Mexico and estimate a correlation coefficient of such prices with the level of state GDP per capita (table 10). As can be seen, this coefficient is not high and, in some cases, it is even negative, showing a non-progressive, and sometimes regressive, pattern.

Table 10

State	Average price[3]						
	weighted[2] $/KWh	Tariff 1 $/KWh	Tariff 1-A $/KWh	Tariff 1-B $/KWh	Tariff 1-C $/KWh	Tariff 1-D $/KWh	Tariff 1-E $/KWh
Aguascalientes	0.48	0.48					
Baja California	0.55	0.62					0.50
Baja California Sur	0.57	0.56	0.54	0.70	0.51	0.46	
Campeche	0.49				0.49		
Coahuila	0.49	0.53	0.41	0.49	0.46	0.53	
Colima	0.47	0.47	0.44	0.49			
Chiapas	0.43	0.45	0.40	0.44	0.44		
Chihuahua	0.51	0.50	0.49	0.53		0.45	
Distrito Federal	0.51	0.51					
Durango	0.46	0.46		0.46			
Guanajuato	0.49	0.49					
Guerrero	0.47	0.49	0.30	0.49	0.36		
Hidalgo	0.45	0.46	0.58	0.41			
Jalisco	0.49	0.49	0.42	0.54			
México	0.48	0.48	0.49		0.72		
Michoacán	0.45	0.45	0.41	0.47	0.46		
Morelos	0.47	0.56	0.44				
Nayarit	0.45	0.48	0.43	0.47			
Nuevo León	0.60	0.47	0.69	0.61	0.45	0.41	0.33
Oaxaca	0.44	0.46	0.43	0.43	0.41		
Puebla	0.46	0.46	0.36				
Queretaro	0.49	0.49	0.42				
Quintana Roo	0.59		0.37	0.59			
San Luis Potosí	0.47	0.48	0.45	0.43	0.44		
Sinaloa	0.43			0.35		0.46	0.39
Sonora	0.46		0.61	0.51	0.43	0.56	0.44
Tabasco	0.49			0.47	0.50		
Tamaulipas	0.52	0.46	0.44	0.55	0.54	0.48	
Tlaxcala	0.43	0.43					
Veracruz	0.47	0.46	0.43	0.49	0.38		
Yucatán	0.46		0.43	0.44	0.47		
Zacatecas	0.46	0.46					
Total Nacional							
Correlation with GDP-PC	**0.67**	**0.46**	**0.44**	**0.71**	**0.16**	**-0.28**	**-0.16**

4/ Correlation coefficient between GDP per capita and average price

Again, the stated rationale for the subsidies is average temperature and not distribution. It must be said that it would be difficult to find an economic logic behind establishing the subsidies on the basis of temperature.

[5] Even though it would be difficult to justify a subsidy that would distort location decisions in that way.

Lorenz Curves for Electricity Expenditure

A typical way to look at distributional issues starts by looking at the Lorenz curves for electricity consumption. After showing those curves graphically for 1992 and 2000 using data from the National Income-Expenditure Survey, we follow Kakwani and Podder (1989) to estimate the parameters of the Lorenz curve and the Gini coefficient for those years, splitting the sample into rural, urban, and total consumption.

According to this methodology, observations must grouped into several categories (for example, income deciles). Assume there are N families grouped into T classes, where n_t is the number of families that belong to class t, then:

$$f_t = \frac{n_t}{N}$$

is the relative frequency, and

$$p_t = \sum f_t$$
$$q_t = \left(\frac{1}{Q}\right)\sum x^* f_t$$

where x^* is the average expenditure in electricity, so that total consumption is

$$Q = \sum x^* f_t$$

Finally, a change in coordinates is needed ,

$$r_t = \frac{p_t + q_t}{2^{\frac{1}{2}}}$$
$$y_t = \frac{p_t + q_t}{2^{\frac{1}{2}}}$$

Then the equation of the Lorenz curve in terms of the observations on *r* is:

$$log(\, y_t \,) = \boldsymbol{a}\, log(\, r_t \,) + \boldsymbol{b}\, log(\, 2^{\frac{1}{2}} - r_t \,) + \boldsymbol{w}_t$$

The regression is run based on this function, where the parameters are *á* and *â*; *a* is the constant and $\grave{u}_t$ is the error term. After having found the parameters, they are substituted into the equation and the estimated *y´*s are obtained. This allows us to estimate the *q´*s and then plot the Lorenz curve. The curves and the estimated parameters are shown below for total consumption in 1992 and 2000. In appendix 2, the estimates are shown for the different groups, rural and urban, in both years.

Graph 13

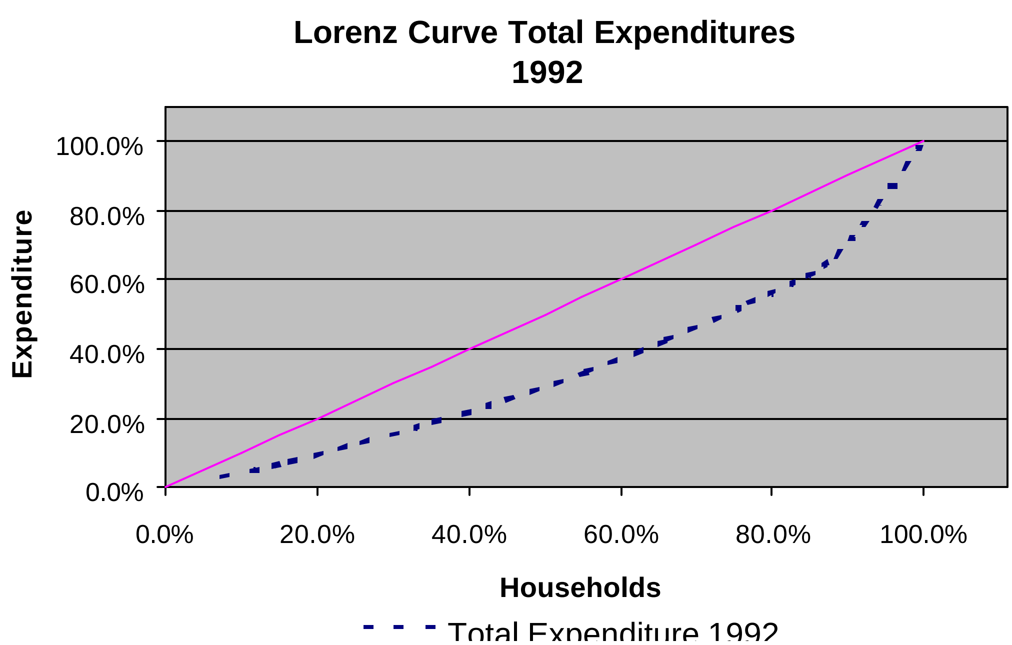


Table 11
Fitted Lorenz Curve
Total Expenditure, 1992

Source	SS	Df	MS	Number of obs = 9		
Model	.475499212	2	.237749606	$F(2, 6)$ = 2535.82		
Residua l	.00056254	6	.000093757	*Prob > F* = 0.0000		
Total	.476061752	8	.059507719	*R-squared* = 0.9988 *AdjR-squared* = 0.9984		
				Root MSE = .00968		
Ly	**Coef**	**Std. Err.**	**t**	**P>|t|**	**[95% Conf. Interval]**	
Ir |	.8996415	.0177745	50.61	0.000	.8561489	.9431341
Iraiz	.5856284	.032575	17.98	0.000	.5059203	.6653365
_cons	-.5633974	.0101705	-55.40	0.000	-.5882839	-.538511

Graph 14

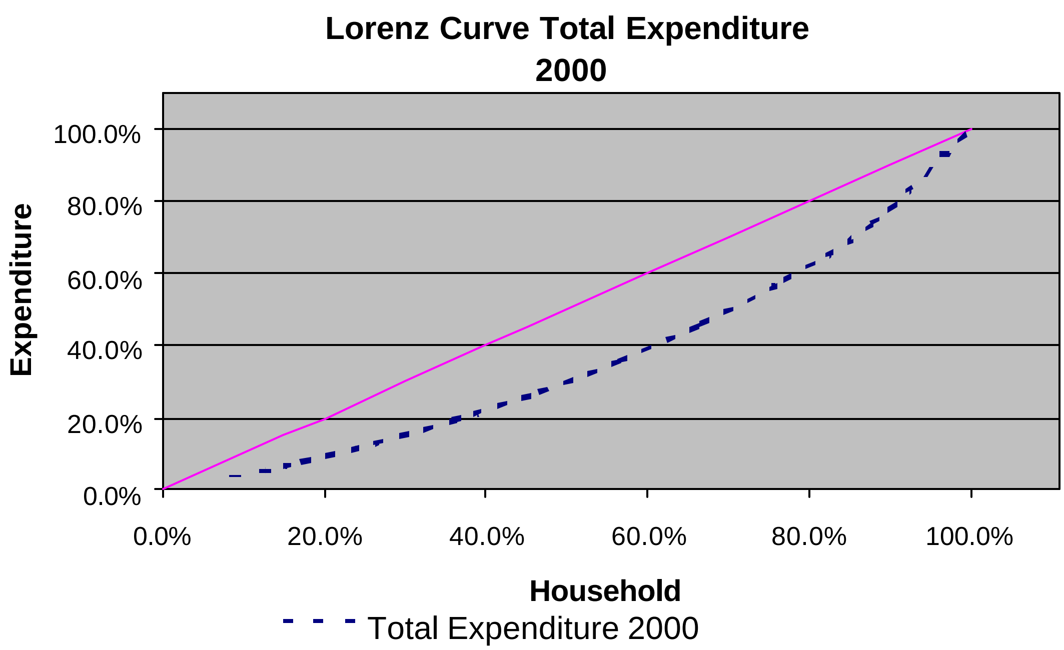
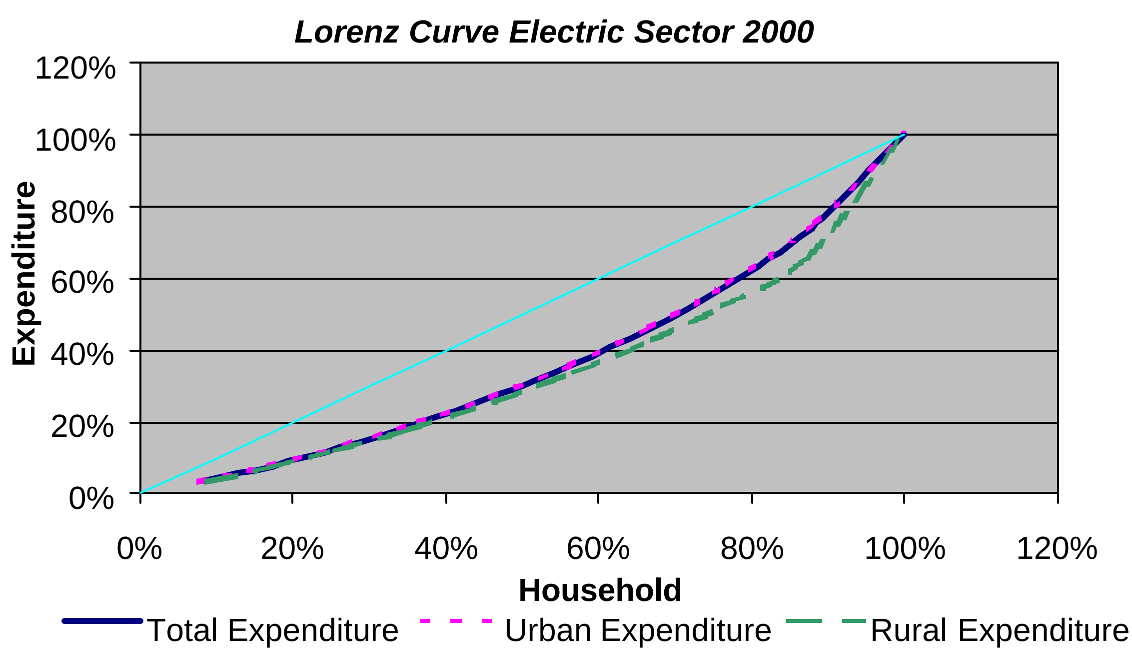


Table 12
Fitted Lorenz Curve
Total Expenditure, 2000

Source	**SS**	df	**MS**	Number of obs = 9	
Model	.320295339	2	.160147669	*F(2, 6)* = 2658.20	
Residua l	.000361481	6	.000060247	*Prob > F* = 0.0000	
Total	.320656819	8	.040082102	*R-squared* = 0.9989 *AdjR-squared* = 0.9985	
				Root MSE = .00776	
Ly	**Coef**	**Std. Err.**	**T**	**P>|t|**	**[95% Conf. Interval]**
lr |	.9326375	.01439378	64.79	0.000	.8974174 .9678575
Lraiz	.891333	.0274742	38.19	0.000	.5696307 .7040845
_cons	-.5550312	.008065	-68.82	0.000	-.5747656 -.5352968

Graph 15



The estimated Gini coefficients for electricity consumption are shown in table 13. Both the Gini coefficient and dominance tests establish that rural consumption is relatively more equal than urban and that total consumption has become slightly more equal between 1992 and 2000.

Table 13

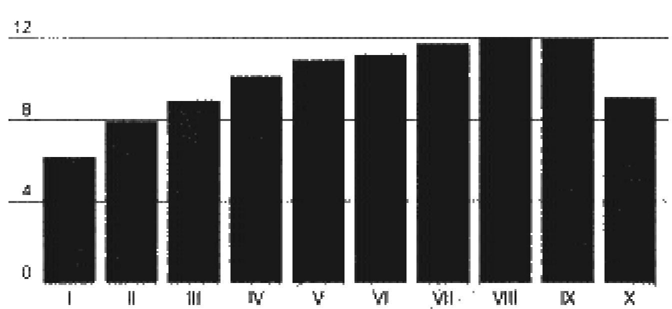
Gini Coefficients for Electricity Expenditures

Year	**Rural**	**Urban**	**Total**
1992	0.48	0.51	0.48
2000	0.47	0.49	0.45

This would point in the right direction if it were not for the fact that, in levels, the concentration of consumption is very high (see table 13). The poorest 20% of the population consumed less than 10% of total electricity consumption in 2000. Even in we look at the poorest 40% of the population, they would consume less than 30% of total consumption. The richest 20% explained around 40% of total consumption in the same year. The latter implies that the incidence of generalized subsidies would be regressive. An estimation of such incidence is shown in graph 16.

Graph 16

Incidence of Subsidies



Clearly, the subsidy structure is not progressive and, indeed, rather regressive. The poorest decile receives only 6% of the total subsidies, whereas the richest 30% of the population receives around 35% of the subsidies.

6. The welfare effects of price changes: Newbery´s Methodology

Several methodologies have been developed to explore distributive impacts of price changes. Some of them are:

i) Construction of price indexes (Deaton y Muellbauer, 1980, p.176)

ii) Cost of life indexes, estimated econometrically through a linear expenditure system (Muellbauer, 1974)

iii) Using (ii) but with household expenditure surveys

iv) Slesnick (1990) applies a methodology similar to (ii) but using a translog demand system and a different social welfare function

An alternative measure has been proposed to test the impact on social welfare of changes in prices. Assuming a social welfare function $W(V^1,...,V^h,...,V^H)$, where agent h has a utility function $V^h = V^h(m^h+g, \mathbf{p})$, that depends on income prior to transfers m^h, government transfers g, and a price vetor $\mathbf{p}$. The change in social welfare given a change in prices for good i is,

$$\frac{\partial W}{\partial p_i} = \sum_h \frac{\partial W}{\partial V^h}\frac{\partial V^h}{\partial p_i} = -\sum_h \boldsymbol{b}^h q_i^h$$

where $\boldsymbol{b}^h = \frac{\partial W}{\partial V^h}\frac{\partial V^h}{\partial g}$ is the marginal social utility of transfering $1 to agent h, q_i^h is the consumption of good i by agent h, and the last equation uses Roy´s identity. Let´s obtain the latter, i.e., Roy´s identity,

$$q_i^h = -\frac{\partial V^h / \partial p_i}{\partial V^h / \partial g}$$

solving for the denominator and multiplying by $\dfrac{\partial W}{\partial V^h}$ we have that

$-\partial W \big/ \partial V^h \; \partial V^h \big/ \partial g \; q_i^h = \partial W \big/ \partial V^h \; \partial V^h \big/ \partial p_i$, and taking summations,

$$-\sum_h \partial W \big/ \partial V^h \; \partial V^h \big/ \partial g \; q_i^h = \sum_h \partial W \big/ \partial V^h \; \partial V^h \big/ \partial p_i$$
$$-\sum_h \boldsymbol{b}^h q_i^h = \sum_h \partial W \big/ \partial V^h \; \partial V^h \big/ \partial p_i$$

Thus, the impact of a change in prices depends on the consumption level and its distribution among the population. To isolate these effects we can calculate the so-called *distributional characteristic* of good *i*,

$$d_i = \frac{\sum_h \boldsymbol{b}^h q_i^h}{\overline{\boldsymbol{b}} Q_i}, \qquad Q_i \equiv \sum_h q_i^h, \qquad \overline{\boldsymbol{b}} \equiv \frac{1}{H} \sum_h \boldsymbol{b}^h$$

where Q is the aggregate consumption of i, $\overline{\boldsymbol{b}}$ is the mean for the H agents of $\boldsymbol{b}^h$, and d_i indicates the concentration of good i in its social optimum. Thus, the social welfare impact of a change in prices is,

$$\frac{\partial W}{\partial p_i} = -\overline{\boldsymbol{b}} d_i Q_i$$

To estimate $\boldsymbol{b}^h$, an isoelastic utility function is defined over real consumption per adult equivalent,

$$u^h = \begin{cases} \dfrac{\left(c^h\right)^{1-\boldsymbol{u}}}{1-\boldsymbol{u}} & \boldsymbol{u} \neq 1 \\ \ln c^h & \boldsymbol{u} = 1 \end{cases}$$

Thus, the social welfare function is $W = \dfrac{1}{H} \sum_h u^h$, y $\boldsymbol{b}^h = \left(c^h\right)^{-\boldsymbol{u}}$, where the last term is the partial derivative of the utility function with respect to consumption. Based on this methodology, we will calculate the distributional characteristic for electricity. In principle, the higher this coefficient, the greater distributional impact a subsidy or tax on such good would have. For relatively lower distributional characteristics, we would expect a subsidy to be regressive.

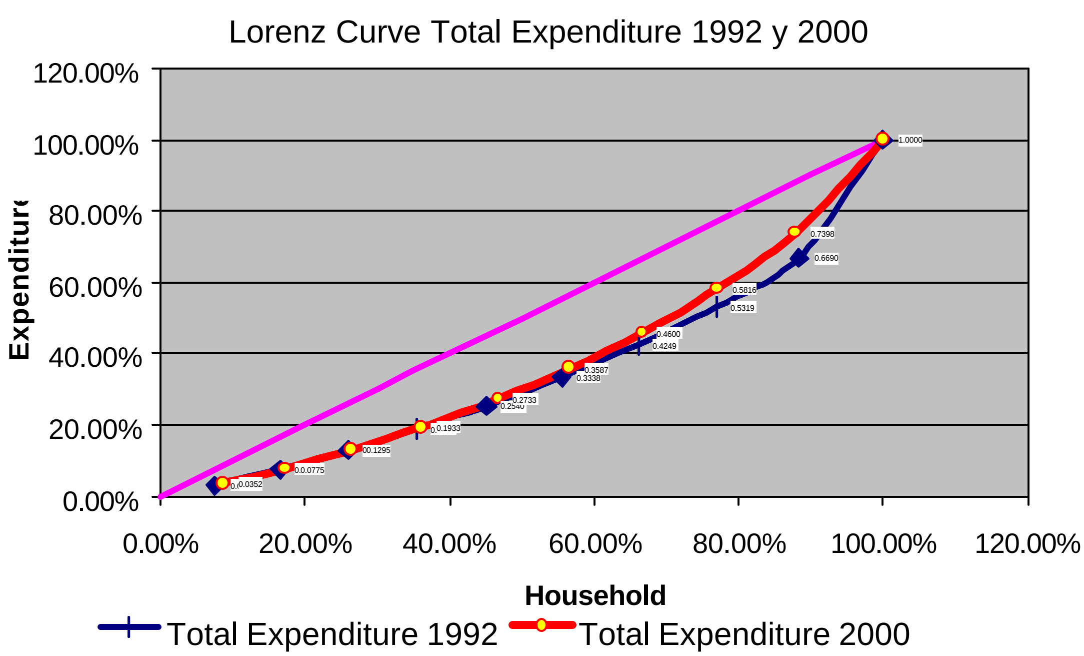
If one wants to determine the impact of changes in prices on social welfare, it is necessary to estimate the following,

$$\frac{\Delta W}{W} = -\frac{\sum_i d_i w_i \Delta p_i}{\sum_i d_i w_i}$$

This equation shows that welfare is given by changes in prices, weighted by its distributional importance w_i, the share of good i in aggregate consumption, and normalizing by the average distributional weight. This equation can be computed for different values of n and for different years. In the case of Mexico no price change has taken place, given that the reform is still under discussion.

Finally, a regression $d_i = f(w_i \Delta p_i)$ can be run to test for correlation between changes in prices and distributional characteristics. If the coefficient is not significantly different from zero, it implies that taxes and subsidies before the reform are not well established to improve income distribution.

Graph 17



Based on the previous methodology, the distributional characteristics for electricity, water and telephone services are calculated below (table 14).

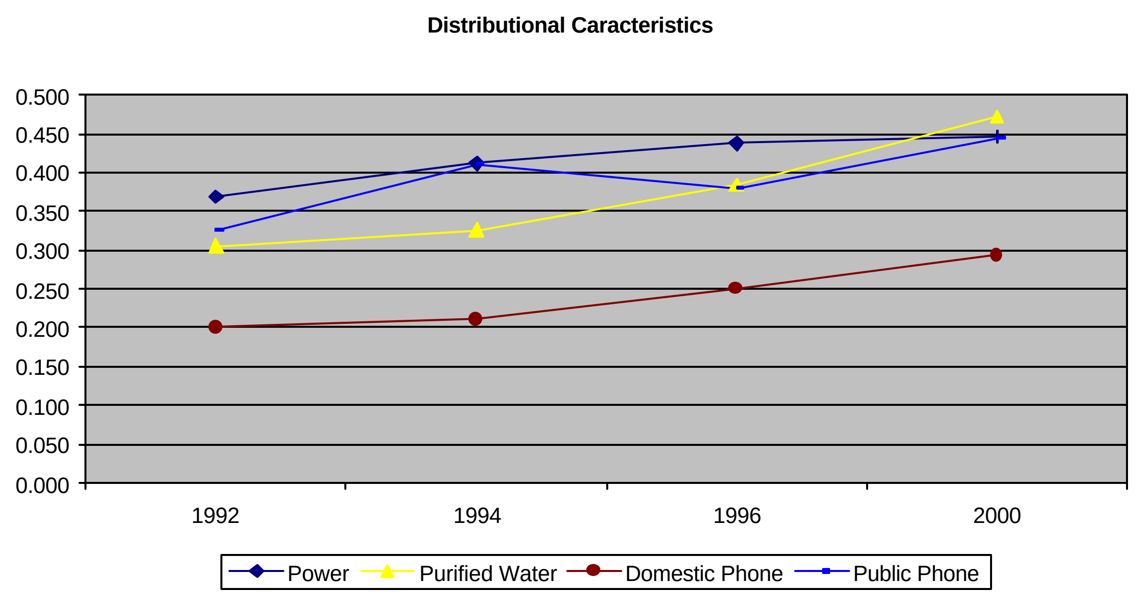
Table 14

Distributional Characteristics

	1992			2000		
Product	**v=1**	**v=1/2**	**V=2**	**v=1**	**v=1/2**	**v=2**
Electricity	0.3690	0.6683	0.0163	0.4460	0.7151	0.0269
Purified Water	0.3046	0.6349	0.0079	0.4721	0.7547	0.0357
Private Telephone	0.2009	0.5099	0.0028	0.2938	0.5978	0.0080
Public Telephone	0.3263	0.6591	0.0073	0.4442	0.7365	0.0189

The evolution of these coefficients is shown in graph 18.

Graph 18



We compare electricity with telephone and purified water, because the difference in access for those services would imply a large difference in distributional characteristics. Given the distortion in prices due to subsidies in electricity, we can see that in 2000 purified water has even a larger distributional characteristic than electricity, which is counter-intuitive given the large differences in access.[6] Also, the distributional characteristic of private telephone jumps by 50% during the period, a period of privatization of the sector, whereas in electricity it only increases 20%. In the case of purified water, the change in the distributional characteristic is more than 50%.

7. Non-linear Tariffs to Induce Self-Selection

The current subsidy structure leads to several distortions, namely: i) regressivity in the allocation of expenditures, ii) locational distortions, iii) inefficient use of energy given that prices do not reflect its economic cost.[7] This is mainly due to the fact that there is no explicit economic rationale in the design of such subsidies. From the economic perspective, subsidies should be: i) progressive, ii) non-distorting in terms of location decisions and energy use, and iii) non-wasteful in terms of the fiscal resources devoted to this purpose. There is a non-linear subsidy structure that can be consistent with those principles and has been successfully applied in other countries, like Chile. Moreover, such scheme is consistent with the existence of a competitive electricity market, at a relatively low administration cost, provided it is correctly designed and calibrated. The scheme will consist on a subsidized basic consumption tariff, established at what we may call "subsistence consumption", and the rest of the tariffs either without a subsidy or with a subsidy that rapidly fades out. Even though this scheme would seem to be simple, the calibration of the basic level has to satisfy two criteria:

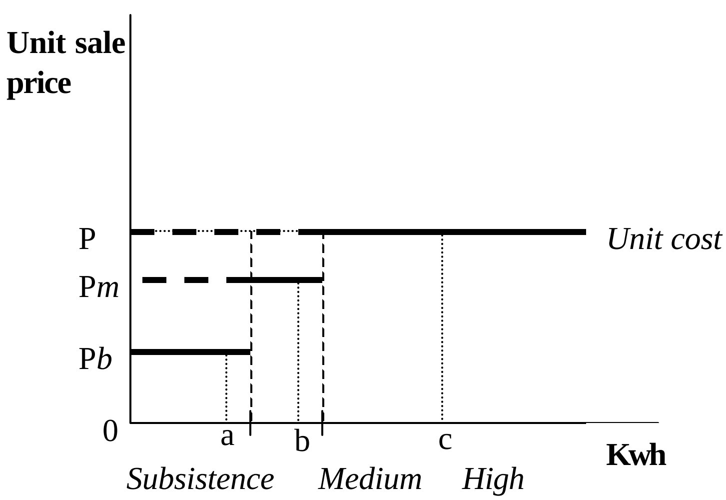
i) The basic level, to which the subsidy will be directed, has to be consistent with the level of electricity consumption of a typical family in the lower income brackets.

[6] Access in terms of running water is around 60%, telephone density is around 20%, whereas electricity access is above 95%.
[7] A review of different subsidy schemes for utilities can be found in Boland and Whittington (2000).

ii) It has to be calibrated so that it is incentive-compatible to choose such contract only for the lower-income families. Otherwise, it would not indice self-selection.

Point ii) is the most difficult, though technically feasible, to establish. Basically, administrative restrictions, like restricting to only one contract per household, as well as random auditing at low-cost, can support the enforcement of the scheme. Also, if properly set, the incentive for high-consumption households to "cheat" would be low, given the transactions costs involved and the obvious reduction in welfare if they decided to reduce electricity demand to benefit from the subsidy. In order for this scheme to induce self-selection, a high correlation between energy consumption and income should be assumed.[8]

Graph 19



Let us look at the example in graph 19. A low-income family consuming *a* Kwh per month, will receive a subsidy of 80% of the cost so that it will pay a bill of

$$b_b = 0.2\ (0Pb * 0a)$$

In the same way, a family consuming in the medium range, say, *b* Kwh per month, will pay $b_m = 0.7\ (0Pm * 0b)$, receiving a subsidy of 30%. A household in the high level will simply pay (0P * 0*c*), receiving no subsidy whatsoever. It is important to distinguish the

[8] For a review of this correlation, see Foster, Tre and Woodon (2000). For a general review of subsidy schemes for the poor in utilities, see Woodon (2000)

latter form the current scheme, in which a family in the medium range would receive 80% subsidy for the first units consumed, and 30% subsidy for the units in excess of the subsistence level. The proposed scheme implies that once a household consumes above the basic level, it will pay the higher price for all the units consumed.

A first simulation applying this scheme results in a distributional coefficient for electricity around 65%, measured in expenditure. Also, the incidence of the subsidy is corrected, and the poorest three deciles will obtain about 80% of the subsidy. Finally, the subsidy is reduced to about half what it currently is as percentage of GDP.[9] For this simulation, the basic consumption was fixed at 150 kwh per month, the medium level up to 220 kwh, and the high level above 221 kwh per month.

8. Final Remarks

Even though the evidence on the benefits of privatization around the world has been established in the literature in a robust manner, public opinion surveys show a widely negative perception of the reform process in Latin America. We argue that a possible explanation for the latter is the fact that the reform mainly affected urban middle classes through the elimination of generalized subsidies. In Mexico, the electricity sector has not been included in the reform process, though the reform for the sector is under discussion. One of the points under debate is the potentially negative impact such reform would bring about from a distributional perspective. We have hereby analyzed such potential impact by looking at the distributional properties of the current scheme. Both regional measures of progressivity and the estimation of distributional characteristics, following previous work by Newbery (1995), show that the current tariff structure is clearly regressive. That would explain why middle and high income classes, which have better means of representation in both public opinion and legislative circles, oppose such reform. The latter is so even without considering the potential effect on labor once labor redundancy programs are implemented.[10] Finally, a framework is proposed to construct non-linear tariffs with a clear distributional rationale, which could also be implemented in a competitive electricity market.

[9] We asume a highly inelastic demand for electricity throughout the income distribution.
[10] As an example, in the case of railroad privatization in México, labor was reduced around 50% as a result of the process (Andalón and López-Calva, 2001).

References

Ajwad, I., C. Anguizola, and Q. Wodon. (2000) 'Estimating the Welfare Impact of Privatization: Electricity in Bolivia', Mimeo, The World Bank Group, Washington, DC

Albouy, Y. and Nadifi, N. (1999) *Impact of Power Sector Reform on the Poor: A Review of Issues and the Literature*, Mimeo, The World Bank Group, Washington DC

Andalon, M. and L.F. Lopez-Calva (2001), "What Happens to Labor When Governments Divest?, The Privatization of Railroads in Mexico," El Colegio de México, *Documento de Investigación* 01-4.

Benitez, D, O. Chisari and A. Estache (2000). *Measuring the Fiscal-Efficiency-Distribution Trade-Offs in Argentina's Utilities Privatization*, Mimeo, World Bank Institute, The World Bank Group, Washington DC and WIDER, Stockholm.

Boland, John and Dale Whittington (2000). 'The political economy of water tariff design in developing countries: increasing block tariffs versus uniform price with rebate', <u>The Political Economy of Water Pricing Reforms</u>, Edited by Ariel Dinar, Oxford University Press, New York.

Deaton, A. and J. Muellbauer (1980), <u>Economics and Consumer Behavior</u>, Cambridge University Press.

Foster, V. and Tre, J.P. (2000) 'Measuring the impact of energy interventions on the poor: an illustration from Guatemala.' Conference Volume '*Infrastructure for Development: Private Solutions and the Poor'*, Private Provision of Infrastructure Advisory Facility (PPIAF), Department for International Development (DIFD) and the World Bank, London, United Kingdom

Foster, V., J.P. Tre, and Q. Wodon. (2000) 'Energy Consumption and Income: An Inverted-U at the Household Level?' Mimeo, The World Bank Group, Washington, DC

Freund, C.L. and Wallich, C.I. (1996) 'The welfare effects of raising household energy prices in Poland', *The Energy Journal*, 17, pp. 53-77.

Jadresic, A. (2000) 'A case study on subsidizing rural electrification in Chile', *Energy Services for the World's Poor*, Energy and Development Report 2000, Energy Sector Management Assistance Program, The World Bank Group, Washington DC.

Kakwani and N. Podder (1989) "Efficient Estimation of the Lorenz Curve and Associated Inequality Measures from Grouped Observations", *Journal of Economterics*.

LaPorta, R. and F. Lopez-De-Silanes (1999), " The Benefits of Privatization: Evidence from Mexico", *Quarterly Journal of Economics*.

Levy, B. and P. Spiller (1997), " , Cambridge University Press.

Lopez-Calva, L.F. (2001), "The Political Economy of Privatization from a Distributional Perspective: Mexico," Institute for International Economics, Washington, DC.

Megginson, W. (2001), “From State to Market: A Survey of Empirical Studies on Privatization,” *Journal of Economic Literature*.

Muellbauer, J. (1974), “Recent UK Experience of Prices and Inequality: An Application of True Cost of Living and Real Income Indices”, *Economic Journal*.

Newbery, D. (1995), “The Distributional Impact of Price Changes in Hungary and the United States,” *The Economic Journal*.

Sheshinski, E. and L.F. López-Calva, 1999, “Privatization and Its Benefits: Theory and Evidence,” *CAER II Discussion Paper No. 35, Harvard Institute for International Development*, Harvard University.

Slesnick, D. (1990), “Inflation, Relative Price Variation, and Inequality,” *Journal of Econometrics*.

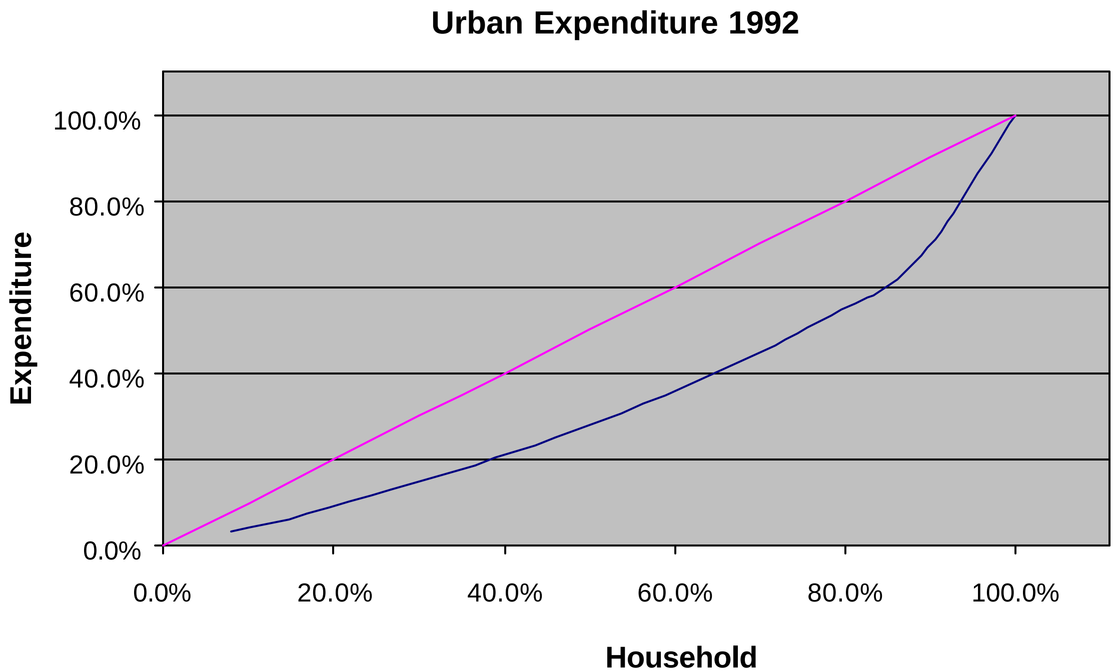
Wodon, Q. (2000) ‘Energy Services and Programs for the Poor’, Mimeo, The World Bank Group, Washington, DC

Appendix 1

	DOMESTIC TARIFFS
TARIFF 1	Domestic Service
TARIFF 1-A	Domestic services for locations with minimum average temperature in summer of 25 °C
TARIFF 1-B	Domestic services for locations with minimum average temperature in summer of 28 °C
TARIFF 1-C	Domestic services for locations with minimum average temperature in summer of 30 °C
TARIFF 1-D	Domestic services for locations with minimum average temperature in summer of 31 °C
TARIFF 1-E	Domestic services for locations with minimum average temperature in summer of 32 °C
	COMMERCIAL TARIFFS
TARIFF No. 2	General service up to 25 kW of demand
TARIFF No. 3	General service for more than 25 kW of demand
	TARIFFS FOR PUBLIC SERVICES
TARIFF No. 5	Service for public lighting in metropolitan zones of the l D.F., Monterrey and Guadalajara
TARIFF No. 5ª	Service for public lighting in the rest of the country
TARIFF No. 6	Service for pumping drinking water and waste water of public service
TARIFF No. 7	Temporal Service
	AGRICULTURE TARIFFS
TARIFF No. 9	Service for pumping irrigation water in low tension
TARIFF No. 9M	Service for pumping irrigation water in medium tension
	GENERAL TARIFFS IN MEDIUM TENSION
TARIFF O-M	Ordinary Tariff for general service in medium tension with demand lower than 100 kW
TARIFF H-M	Hour depending Tariff for general service in medium tension with demand of 100kW or more
	TARIFFS GENERALES DE HIGN TENSION
TARIFF H-S	Tariff Service for pumping irrigation water in low tension general service in high tension level sub transmission
TARIFF H-SL	Tariff hour depending for general service in high tension level sub transmission for long use

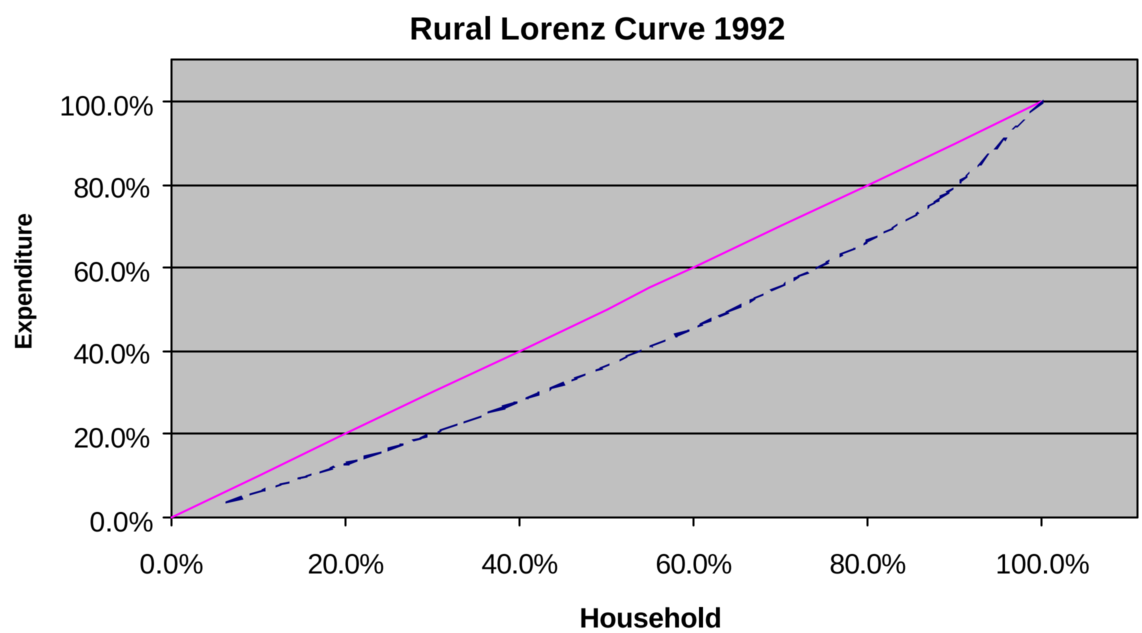
TARIFF H-T	Tariff hour depending for general service in high tension level transmission
TARIFF H-TL	Tariff hour depending for general service in high tension level transmission for long use
	TARIFFS FOR SERVICE SUBJECT TO INTERRUMPTION (Optional)
TARIFF I-15	Tariffs for service interruptible with maximum medium demand larger or equal to 10,000 kW
TARIFF I-30	Tariffs for service interruptible with maximum medium demand larger or equal to 20,000 kW
	TARIFFS OF SUPPORT IN MEDIUM TENSION
TARIFF H-MR	Tariff hour depending for backup service for lack and maintenance
TARIFF HM-RF	Tariff hour depending for backup service for lack
TARIFF HM-RM	Tariff hour depending for backup service for programmed maintenance
	TARIFFS FOR SUPPORT IN HIGN TENSION
TARIFFS HS-R	Tariff hour depending for backup service for lack and maintenance level sub transmission
TARIFFS HS-RF	Tariff hour depending for backup service for lack level sub transmission
TARIFF HS-RM	Tariff hour depending for backup service for programmed maintenance level sub transmission
TARIFF HT-R	Tariff hour depending for backup service for lack and maintenance level transmission
TARIFF HT-RF	Tariff hour depending for backup service for lack level transmission
TARIFF HT-RM	Tariff hour depending for backup service for lack and maintenance level transmission

Appendix 2



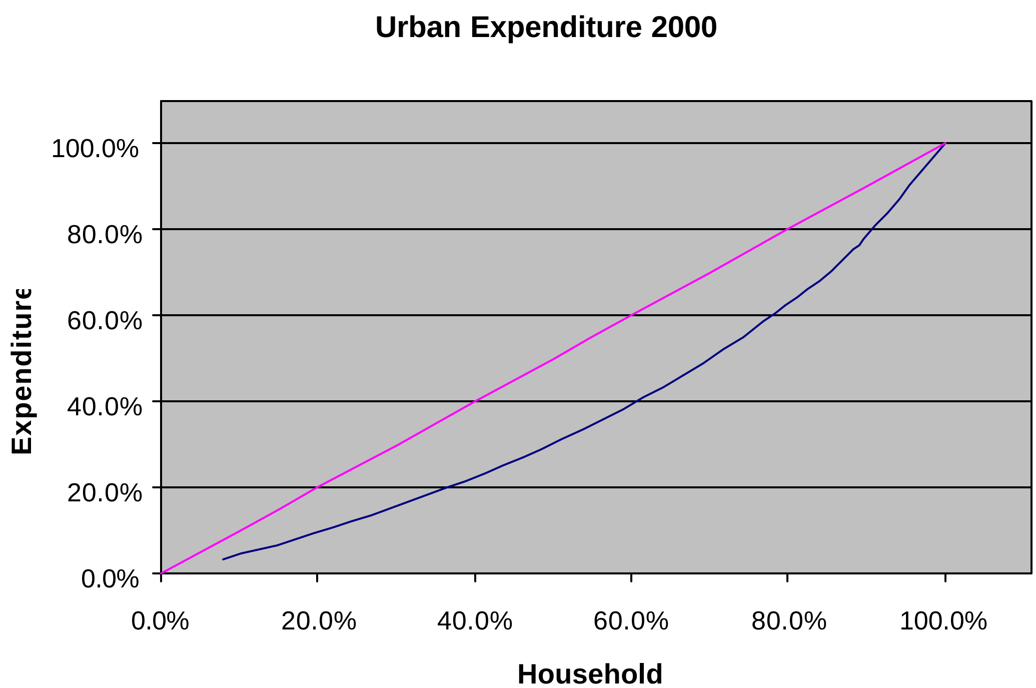
Fitted Lorenz Curve
Urban Expenditure, 1992

Source	SS	df	MS	Number of obs = 9	
Model	.461493435	2	.230746717	*F(2, 6)* = 2059.81	
Residua l	.00067214	6	.000112023	*Prob > F* = 0.0000	
Total	.462165575	8	.057770697	*R-squared* = 0.9985 *AdjR-squared* = 0.9981	
				Root MSE = .01058	
Ly	**Coef**	**Std. Err.**	**t**	**P>|t|**	**[95% Conf. Interval]**	
lr |	.9083443	.0198085	45.86	0.000	.8598746	.956814
lraiz	.6145881	.0365719	16.8	0.000	.5250999	.7040763
_cons	-.5341291	.01125	-47.48	0.000	-.5616568	-.5066014



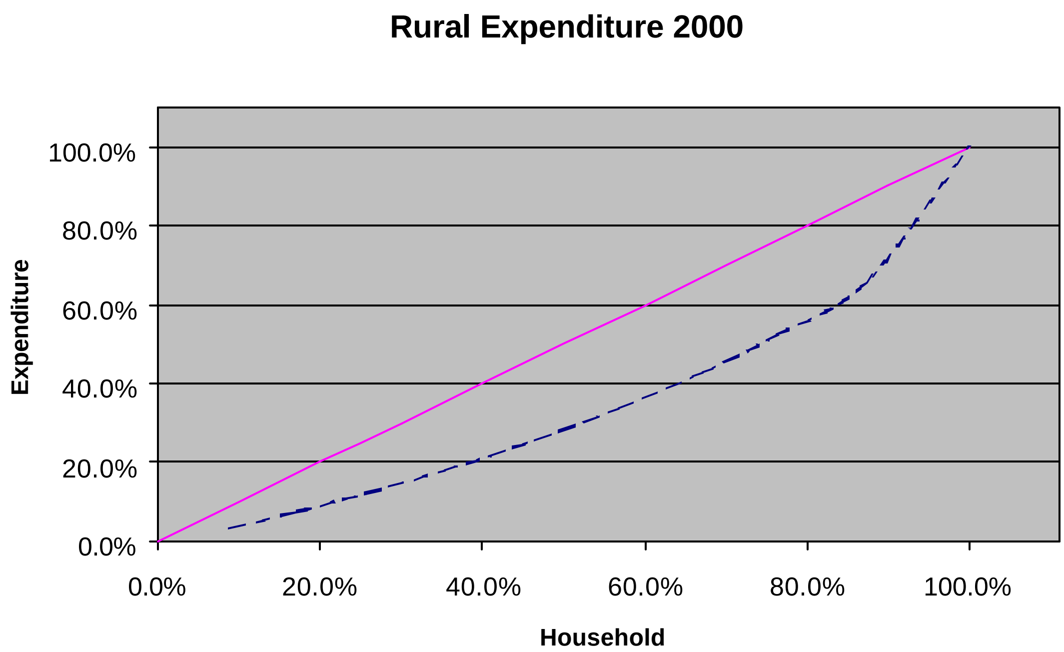
Fitted Lorenz Curve
Rural Expenditure, 1992

Source	SS	df	MS	Number of obs = 9	
Model	.448227412	2	.224113706	*F(2, 6)* = 220.55	
Residua l	.006096961	6	.00101616	*Prob > F* = 0.0000	
Total	.454324373	8	.056790547	*R-squared* = 0.9866 AdjR-squared = 0.9821	
				Root MSE = .03188	
Ly	Coef	Std. Err.	T	P>|t|	[95% Conf. Interval]	
lr |	.878816	.0526522	16.69	0.000	.7499807	1.007651
Iraiz	.6196093	.0856756	7.2	0.000	.4099687	.8292498
_cons	-.7714891	.031109	-24.80	0.000	-.8476102	-.6953681



Fitted Lorenz Curve
Urban Expenditure, 2000

Source	SS	df	MS	Number of obs = 9	
Model	.37598776	2	.18799388	*F(2, 6)* = 1348.26	
Residua l	.000836605	6	.000139434	*Prob > F* = 0.0000	
Total	.376824365	8	.047103046	*R-squared* = 0.9978 *AdjR-squared* = 0.9970	
				Root MSE = .01181	
Ly	**Coef**	**Std. Err.**	**t**	**P>|t|**	**[95% Conf. Interval]**	
lr |	.9782533	.0208663	46.88	0.000	.9271952	1.029311
Lraiz	.9411123	.0337854	27.86	0.000	.8584423	1.023782
_cons	-.5453256	.0118366	-46.07	0.000	-.5742888	-.5163624



Fitted Lorenz Curve
Rural Expenditure, 2000

Source	SS	df	MS	Number of obs = 9		
Model	.391100241	2	.19555012	*F(2, 6)* = 3484.32		
Residua l	.000336737	6	.000056123	*Prob > F* = 0.0000		
Total	.391436978	8	.048929622	*R-squared* = 0.9991 *AdjR-squared* = 0.9989		
				Root MSE = .00749		
Ly	**Coef**	**Std. Err.**	**t**	**P>|t|**	**[95% Conf. Interval]**	
lr |	.8917901	.0151308	58.94	0.000	.8547664	.9288139
Lraiz	.6368576	.0274742	23.18	0.000	.5696307	.7040845
_cons	-.5424275	.0084644	-64.08	0.000	-.563139	-.5217159