DISTRIBUTIONAL ASPECTS OF PUBLIC UTILITY PRICING WITH REFERENCE TO BRAZIL

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FOREWORD

No substantive economic literature on public utility pricing exists in Brazil. The little the studies do is to treat summarily with the theoretical aspects of such pricing and the objectives those prices are supposed to reach. This thesis attempts to fill this gap: it is aimed at deriving price schedules subject to specific social objectives and appraising their distributional content.

Chapter 1 describes the institutional characteristics of the Brazilian experience on public utility pricing and investigates the possible distributional impact of these prices. Using evidence taken from a sample survey made by a water/sewage company, it is shown that its progressive marginal prices for larger consumptions turn out to be regressive for low income households and that its cross-subsidy scheme results in the poor paying a higher price than the non-poor. This means that the assumption implicitly adopted in its price schedule (and in those of other public utilities) of a positive relationship between individual household income and individual household consumption of public utility services does not hold and cannot be taken for granted if the objective is to set prices that are progressive in income terms.

Chapter 2 surveys the relevant bibliography, discusses the main issues and describes the main tools to be used in the subsequent chapters. Since we are interested in deriving discriminatory prices, we first investigate the concept of price discrimination, the conditions for its existence, and the different types of price discrimination in use. Later, we review the bibliography on public utility pricing; we found that the distributional aspects of public utility pricing have attracted less interest than the efficiency objectives and that the main type of discrimination the authors investigate is of the second-degree and not of the third-degree discrimination, the object of our concern.

In chapter 3 we derive prices in a social welfare maximization context, discuss how optimal discriminatory prices are sensitive to different social welfare weights attributed to households, and estimate these weights for the currently used price schedules. In an appendix to this chapter, we remove the assumption that public services are provided by state-owned enterprises and we derive discriminatory prices when the firm's objective is maximization of profit subject to regulatory constraints; we discuss some distributional aspects of these prices and compare them with those prices that maximize welfare. We also examine in this chapter the public utility's capacity of production constraint in its effect upon the determination of optimal discriminatory prices and how the decision to expand the capacity of production is related to the welfare weights being used.

In chapter 4 we assume that the government adopts a paternalistic approach towards public utility pricing by setting a minimum entitlement constraint to be satisfied in the derivation of discriminatory prices. The idea is that these prices should be set in such a way that the price the poor should pay allows them to consume at least a minimum socially desirable quantity. In the last section of this chapter we discuss the implications of the Brazilian government adopting such a pricing policy and we conclude that its implementation would probably require a mixed strategy of funding the additional required subsidy with more resources transferred by the government and higher prices charged to the non-poor, plus a less ambitious level of minimum entitlement.

We also examine in chapter 4 how prices should be set when the social objective is the minimization of poverty. Given the present high level of absolute and relative poverty in Brazil, this topic is very relevant. We first present different concepts and measures of poverty; then, we derive a set of prices that minimize poverty, as appropriately defined. We discuss the limits that constrain the choice of a lower price to be paid by the poor under this objective, noting that in addition to the cost of production, the possibility of cross-subsidization is crucial in defining these prices.

In chapter 5 is shown how to translate the income-price schedules derived in former chapters into consumption-price ones, the traditional way of setting prices, currently used by public utilities. In this type of price discrimination, the occurrence of adverse selection by the non-poor may occur; thus, we first discuss how the self-selection mechanism would produce this problem and later we show how the problem can be solved in a second-degree price discrimination pricing scheme. In this chapter we examine how the choice between a price-quantity schedule and a price-income scheduele is affected by errors of classification of households' social conditions and by the degree of aversion to inequality being used to derive the price-income schedule.

Chapter 6 summarizes the findings of this thesis, advances two lines of future work and discusses policy implications.

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CHAPTER 1

PUBLIC UTILITY PRICING IN BRAZIL: DISCUSSION OF ITS GOALS, INSTITUTIONAL ASPECTS AND EFFICACY.

1.1 - *Introduction*

The objective of this chapter is to examine the experience of Brazilian public utilities in adopting price schedules that charge lower tariffs to poor households. Such schedules are one of the several ways the government uses to attempt to redistribute real income. Section 1.2 is an introductory one, where the idea of using the pricing system as a distributional instrument is discussed. Section 1.3 deals with institutional aspects of the Brazilian case. Finally, the last section makes a general assessment of the distributional efficacy of the discriminatory price schedules used by public utilities in that country.

1.2 - *The Attainment of Distributional Objectives through Pricing*

The objective of this section is to describe the problem of income concentration in Brazil, its evolution in recent decades and how discriminatory prices charged by public utilities fit in with the policies to redistribute incomes and alleviate poverty in that country.

The level of inequality in the Brazilian income distribution was already one of the highest in the world in the sixties. A number of reasons for this inequality have been put forward: the rapidly growing economy of the South and the stagnating North; the differences in qualification of the work force and a virtually unlimited supply of uneducated workers; state interventions in the factor markets in favour of capital; and a very large inequality in the distribution of wealth.

Although the inequality in the income distribution was an important problem and was the justification for the implementation of several governmental programmes, the general attitude in the past was that the income inequalities were inherent to the initial stages of economic growth; economic growth would bring about changes in the structural causes of inequality, eventually reversing the process of concentration. The idea implicit in this reasoning was the well-known Kuznets' inverted U-curve linking different levels of national incomes with a measurement of income inequalities.

Growth-promotion policies of the sixties and the seventies were implemented with the idea that economic growth was the main objective to be pursued since any effective policy towards distribution was not only premature and unnecessary but also undesirable since it would divert resources from efficient allocation to attain equity goals.

The economic growth of the country was impressive, even after the oil price shocks of 1973 and 1979. However, income inequalities already very large, instead of decreasing, grew larger: Table 1.1 shows indicators of the income distribution in Brazil in selected years.

Table 1.1: Brazil: Selected Indicators of the Income Distribution for the Economic Active Population with Positive Earnings (1960/1990)

Percentage share	% income 1960	% income 1970	% income 1980	% income 1990
Lowest 20%	3.5	3.2	3.2	2.3
2nd.quintile	8.1	6.8	6.6	4.9
3rd.quintile	13.8	10.8	9.9	9.1
4th.quintile	20.2	17.0	17.1	17.6
Highest 20%	54.4	62.2	63.2	66.1
Highest 10%	39.7	47.8	47.8	49.7
Highest 5%	27.7	34.9	34.9	35.8
Highest 1%	12.1	14.6	18.2	14.6
Gini coeffic.	0.500	0.568	0.590	0.615

Source: Bonelli,R. and Ramos,L. 1993. *Distribuicao de Renda no Brasil: Avaliacao das Tendencias de Longo Prazo e Mudancas nas Desigualdades desde Meados dos Anos 70*. Rio de Janeiro: Instituto de Pesquisa Econômica Aplicada, Textos para Discussão n.288.

Data in that table show that the relative gain was made by those in the highest quintile: their share in total income was already very large in 1960, 54.4%, increasing to 63.2% in 1980. The Gini coefficient expanded from 0.5 to 0.59 in the period. It can be shown, as Bonelli and Ramos (1993,p.6) do with Lorenz curves, that actually all quintiles improved their incomes in absolute terms, but in relative terms the distribution in 1980 was worst than 20 years before.

The need for a late adjustment to the oil shock in the second half of the seventies and the external debt crisis brought recession to the Brazilian economy as result of policies implemented to cut the effective demand, with perverse effects in distributional terms: growth in unemployment, cuts in government expenditures, soaring inflation rates, higher interest rates, are all elements that play against those members of society less able to protect themselves. Table 1.1 shows that the Gini coefficient was even worst in 1990.

Although the problem of intense immigration towards the main urban centres is not a new phenomenon in the Brazilian context, the present situation is worse: the economic recession, besides causing labour redundancies in these centres, hinders the possibility of absorption of the newcomers in productive activities in the traditional destinations taken by the immigration flows, the main metropolitan and the medium-sized urban centres. As should be expected, social problems in these centres grew bigger in last decade; it is estimated that 45 million inhabitants out of 140 million are below the poverty line in Brazil.[1]

The Brazilian government has been using several instruments to try to alleviate the country's distributional problem. These instruments span from redistribution in kind (provision of social services such as health and education, for instance), redistribution in cash (social security benefits), price manipulation (subsidies), wages policy (legal minimum wage and labour regulation), income taxation, expenditure taxation (differential value-added tax and

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[1] See chapter 4 for other poverty measurements for Brazil.

excise taxes) to broader instruments such as regional and urban development policies and land settlement programmes. However, despite their intended distributive characteristics, some of these instruments have been rather ineffective in its goals, actually being regressive in income terms.

We know that there are limits to the level of redistribution that can be reached in a redistributive process.[2] These limits are more or less severe according to the particular social, political and economic characteristics of the country; in developing countries such as Brazil these limits seem to be tighter than in advanced countries since the extension of the absolute and relative poverty problem is very large. One of these limits is the consequent loss of output that the redistributive policy may entail when transferring income from the more productive and enterprising to the less productive and enterprising; the trade-off may be too high to hinder its implementation. Another limit is the fact that the redistribution will be affecting the level of welfare of the non-poor and they may resist this loss in welfare since they may be not interested in sacrificing their leisure by working more. Differences in political power among individuals, biased in favour of non-poor, and the self-interest of the electors (who tend to support distributive policies as long as they do not affect adversely their well-being) are political limitations. The amount of government expenditure also limits redistribution: the higher this amount, the smaller the possibility of granting tax exemptions and subsidies to the needy since may be impossible to finance them with higher taxes. One cannot also forget that individuals tend to understate their income, wealth and ability when they know that they are subject to a differential taxation; then, the distributive policy will operate over imperfect information, with less success.[3]

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[2] For several studies that analyze various of these limits, see Collard, Lecomber and Slater (1980).

[3] See in chapter 5 how errors of classification of the household's social condition induced by imperfect information affect the choice between a price-income regime and a price-quantity regime.

Taxation is usually considered as the most important instrument to redistribute income. In the case of less developed countries, however, there is some doubt that this instrument alone can have the impact on income distribution that is required. Several economists that have examined the particular economic and political realities of these countries are sceptic about the effects that a fiscal policy may have upon inequality and poverty. For instance, Harberger (1977) relates several constraints on tax policy in LDCs for income redistribution:

i) factors of production, including capital, may to leave the country to escape from local taxation;

ii) the affected factors of production may shift to other activities (in which lower taxes are paid) within the country, not necessarily those that lead to an improvement in the income distribution;

iii) the taxes in question may be evaded;

iv) the self-interest of civil servants and medium and upper-class individuals may have the political power to prevent the taxes in question being levied in the first place; and

v) the taxes may be levied but their incidence has not the desired effect as result of the former constraints.

It should be noted that, although Harberger finds that these limitations are severe, this does not mean that a tax policy should not be used in promoting greater equity. Goode (1984) is of opinion that the fiscal impact on relative disposable income shares in the income distribution is unlikely to be impressive; he thinks that although the relative position of the poor in LDCs may be improved, their absolute consumption cannot be increased by progressive taxation alone. He finds that fiscal instruments can serve the objective of an equitable distribution, but that they are not well suited for bringing about big changes quickly; he advocates government complementary policies to supplement private consumption and the earning capacity of the beneficieries to further the objective. Todaro (1989) lists several policy instruments that Third World governments may use to alleviate poverty and income inequalities, among them the use of progressive income and wealth taxation and the use of direct transfer payments and the public provision of goods and services; however, he calls the attention to the fact that in many developing countries progressive tax structures on paper often turn out to be regressive and the reason for this is that while the poor are taxed at the source of their income or expenditures, the rich derive the largest part of their income from unreported sources.

In the Brazilian case, in addition to the problem of large tax evasion, there is doubt that it can play a important role in redistributing income: the federal government's revenue needs are very large to allow a distributive goal to be effectively introduced in the income tax legislation. Tolosa (1992) thinks that the Brazilian government's inefficiency in collecting taxes and its voracity for additional revenues in a prolonged recession context are factors that restrain the use of fiscal policy for redistribution.[4] Simonsen (1974) calls the attention to the fact that the limit imposed by the incentives on labour and on savings to reach a critical redistributive objective has been cited as an obstacle to this policy since the required high taxes to finance the amount of income transferences could heavily affect output and the investment rate in Brazil. And we should not forget that it is the primary distribution of such factors as assets and lack of opportunities to social mobility which generates the inequalities in income distribution. According to Sundrum (1990), it cannot be assumed that an improvement of the secondary distribution of income will necessarily also improve the primary distribution in less development countries.[5]

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[4] This view is shared by Cardoso and Helwege (1990).

[5] Sundrum cites the following reasons to justify his statement:

i) redistribution of income increases the demand for commodities such as food, causing the expansion of the agricultural sector. The pattern of income generation in this sector in LDC is very unequal due to the dominance of rent and profit incomes accruing to the non-poor;

ii) reduction of the disposal income of the non-poor will reduce their demand for services, some of them provide by the poor. Sundrum mentions studies for several countries which indicate that this effect may make the primary distribution more unequal than in the initial situation.

It should be noted that in the Brazilian case, as is the case of several developing countries, the social security system does not provide adequate support to the poor; for instance, in the Brazilian case, the financial help given by the unemployment benefit is valid for a very small period of time (few months) to those workers of the formal sectors of the economy. This means that the low level of protection given by this benefit is not available to half of the workers, those in the informal sector, those most in need of this protection. Another problem is the fact that Brazil has not a system equivalent to negative income taxation, that is, there is no income support benefit (except for the poor that is old aged) or any financial help to support the basic needs of the poor.[6] Thus, the task of alleviating the problems of income inequality and poverty surpasses what can be reached with taxation and the government has to rely on additional instruments that can contribute to redistribution, particularly social programmes to favour those in need.

Since the Brazilian government, as also happens in other developing countries, owns a large number of public enterprises, there is no reason not to use them as instruments for income redistribution if the efficient way of using the tax system is not feasible or is not able to have the impact required on income inequalities and poverty, as reported above. Actually, as Ramanadhan (1988,p. 7, 109, 110) notes, the major objective of a public enterprise in some countries is to promote redistribution of income and wealth; although he thinks that the use of a public enterprise is less effective for income redistribution as compared to direct government expenditures, he finally admits that it would be unwise for the government to disregard their role as instruments of such policy. The government can intervene in the commodity markets as a redistributive device to maintain the price of wage goods at a low level; the idea is that since it cannot or does not have the means of affecting money wages, it can change real wages by altering their

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[6] The benefit paid to the old aged in Brazil is equivalent to the monthly legal minimum wage, an amount clearly below that which would allow the poor to consume a minimum socially desirable; it should, then, be understood as just a financial help since the old aged that is poor continue to depend on relatives, friends and charity to live.

prices. Since the government owns several enterprises, this kind of intervention is facilitated by appropriate definition of the objectives of these public enterprises.

Given the current scarcity of public funds in Brazil and the high opportunity cost of existing resources, there is a need to improve their efficient use. Thus, the public utility's pricing policy should be examined to improve the quality of its results in terms of their distributional objectives. The purpose of this dissertation, is to sharpen these instruments. Besides being an instrument to generate revenues to finance the public utility's operations, it also should be an adequate device to fulfill the redistributive aspirations of the society.

Before going deeper in our analysis, we should consider the arguments usually noted in favour of the implementation of income redistribution as a government policy. These arguments can be grouped in two following sets of objectives:

i) *Maximization of Social Welfare.*

This objective is either related to:

a) the utilitarian ideas of measurable and comparable individual utilities, diminishing marginal utilities, and then, the possibility of maximizing social welfare by inducing changes in the income distribution up to the point that all individuals' incomes have the same level of marginal utility, or

b) the idea that the community's social welfare, instead of being the sum of individual utilities, is simply a concave function of their utilities, with implicit weights being related to how society evaluates the individuals' change in welfare consequent of a modification in the income distribution.

ii) *Attainment of Non-Global Social Objectives.*

The idea is that besides inducing the attainment of efficiency in the economic activities, some of the government policies should take into account the need to redistribute income to reach social objectives. Some of these objectives are generally expressed under the following sets of specific goals:

a) The *minimum base* objective has to with the idea of ensuring a minimum standard of living to all individuals in society, that is, redistribution of income is justifiable to allow individuals with sub-standard levels of living to improve their social conditions. In chapter 4 of this thesis, for instance, we will be examining how pricing in public utilities should be used to allow households to consume at least a minimum quantity of their services;

b) The *subsidiary equalization* objective is associated with the conception that certain government policy, whatever its role, should also contribute to alleviate distributional problems; for instance, taxation, besides collecting revenues to the government, helps to change the income distribution.

c) The *promotion of meritocracy* objective deals with the idea of supporting equality of opportunity to better incomes of all members of the society; it principally aims to give members access to investments in human capital thereby improving their chances of earning higher incomes.

The use of pricing in public utilities as a distributional device has primarily to do with the *subsidiary equalization* objective, at least in the Brazilian case. Setting prices for these public enterprises is a way of financing principally their costs and this is the main role for these prices. However, by intentionally setting discriminatory prices in such a way to favour those households with lower levels of consumption, (presumably, the poorest households), besides collecting revenues for the public utility, it also contributes towards the improvement of the level of social welfare.[7]

The *minimum base* objective can be argued for a pricing policy that establishes a minimum consumption requirement for the poorest households or for those at or below some poverty line. Although the public enterprise should pay attention to the revenue it can collect from consumers to finance its expenditures, the public utility may be

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[7] This does not mean that setting a unique price to be charged to all households has no distributional effect.

making its contribution to the general government policy of assuring a minimum standard of living to all households.[8]

It should be noted, however, that the use of the price system for redistributing income is not out of dispute. Some authors argue that if the objective is redistribute income, why not simply redistribute income ? We think we have answered this question when we saw that taxation alone may not sufficient to alleviate the distributional problems we observe in countries of the Third World. Then, a distributional public utility pricing should be considered as a complementary policy to bring about the changes we would like to see in the income distribution of these countries. Faulhaber (1983,p.14) is against the use of pricing with this purpose and his objection is based on two reasons: first, charging prices that are not the efficient ones causes misallocation of resources and waste; second, favoured prices may have unintended subsidy effects; he calls attention to the fact that charging a lower price to low consumers is a subsidy to low consumption, not a subsidy to a poor household.[9] Rosenthal (1983,p.80) shows that a price reduction subsidy is a more costly method of achieving an improvement in welfare than a simple cash transfer, that is, in efficient terms it better to use cash transfer.[10]

1.3 - *Institutional Aspects of Public Utility Pricing in Brazil.*

The improvement of the social conditions of the population is

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[8] In chapter 4 we will consider the idea of determining a price schedule that satisfy a minimum consumption requirement for households.

[9] Empirical data in section 1.4 is a confirmation of Faulhaber's idea about the possibility of unintended income regressive effect of discriminatory price schedules that charge according to the quantity consumed. See chapter 5 for the discussion about the adverse selection problem and its regressive effect.

[10] However, Rosenthal also shows that when the intention is to achieve a target level of consumption, the price reduction subsidy may be a less costly method of allowing that consumption than the cash transfer method.

considered in the Brazilian federal Constitution enacted in 1988 as a fundamental principle by which the government should orient its actions. This social preoccupation could also be found in the former constitutions and as the primary source of the principles used to regulate these public enterprises in Brazil.

The Brazilian Constitution (in its article 175) states that public services will be provided either directly by public enterprises or indirectly thorough private enterprises by concession or permission given by the government, and that its pricing policy will be regulated by a federal law. Public utilities such as water/sewage, electricity and street (piped) gas in Brazil are provided by public enterprises and given their industrial characteristics are public monopolies. Most of these public enterprises came into being by replacing other public or private (some of them foreign) enterprises in the 60's and 70's when the Brazilian government invested heavily in increasing its entrepreneurial activities as a strategic instrument to promote the country's economic growth; the justification for this was the need to fill gaps in the economic infrastructure with investments for which the private sector had not enough financial resources or was discouraged to make due to past experiences of price controls that adversely affected profits. This was the case of several of foreign companies that supplied public services: the deterioration of the quality of the service and the lack of interest in expanding the capacity of production was hindering new industrial investments.[11]

In setting the pricing guidelines to be followed by these public utilities the original governmental intention was to establish the so-called "true tariff" ("verdade tarifária"), that is, to make the consumer pay the true cost of producing that service. The idea was to avoid the traditional accumulation of deficits observed in the past by these enterprises and to attempt to guarantee an adequate margin of profit to be used in the expansion of their capacity of

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[11] The coincidence of the ending of concession for several of these foreign-owned public utilities and the ideological popular outcry against these monopolies made easy the state takeover and expansion of the system.

production, both in order to alleviate their financial demands over fiscal revenues.

The difficulties in implementing an adequate pricing schedule to meet both objectives can be explained by basically two types of problems, both of them linked to the inflationary process that has afflicted the Brazilian economy for a long time:

i) high and increasing inflation rates make cost management in any type of firm, private or public, a very hard task, not only for keeping operational costs in line with a balanced planned budget, but also for making the adequate assessment of the future costs of capacity expansion;

ii) public utilities in Brazil have difficulties in adjusting their rates: the government subordinates these rates definition and their monetary adjustments to its anti-inflationary policies since public prices have an important participation in the retail price index.[12]

The outcomes of those above problems are price schedules that are not capable of attaining the objective of producing the public utilities financial equilibrium as evidenced by their continued dependency upon resources provided by the Treasury to finance their activities, and are unsatisfactory in terms of their effects as an instrument of redistribution of income, as we shall see below.[13]

The enterprises supplying those public services in Brazil generally belong to the regional state governments (the Brazilian Republic is a federation of states) that are responsible for their management. The federal government, through its specialized agencies,

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[12] The Financial Times reported in its edition of 26/3/93, page 8, that electricity rates in Brazil had not increased in the last two months despite inflation of around 27 per cent a month, that is, about 61 per cent compounded. The newspaper also reported that the President of Brazil had just annouced a 30 per cent limit on electricity price increases and imposed a limit of 5 per cent above inflation per month for the following five months; this regulation was a setback to the energy policy implemented in January to allow the distribution companies to decide their own electricity tariffs.

[13] By appointing those two problems that adversely affect the public utilities' financial condition, we are not ruling the possibility of mismanagement.

regulates these public utilities, including their pricing policies, as stated in the Federal Constitution. These regulations express, among other objectives, the objective of favouring the less fortunate consumer by recommending the definition of a lower rate to be charged to the consumer who demands the lowest quantities, assumed to be the consumer with lower incomes.[14]

One sector in which these regulations are more detailed is the water/sewage service, a further reason we prefer to concentrate our attention in describing them. These regulations state that the tariffs should be defined taking into account both the consumers financial circumstances and the resource needs of the firm; this general principle tries to compromise between the need of charging a fair price to consumers and to finance adequately the functioning of the public utility. In order to reach the financial objective, the public utility should define tariffs in a way that its average rate is enough to cover both the running and the investment costs. Besides recommending different average tariffs for residential, commercial, industrial and public consumers, the federal regulation sets guidelines for the residential sector such as:

i) the monthly bill, for those households that consume up to 10 m^3 cannot exceed 50% of the value of the Treasury Bonds, being reduced to 35% if the house is not linked to the sewage network; [15]

ii) the rates per m^3 must increase as consumption increases, that is, the price schedule must show marginal rates increasing with consumption; the idea is to cross-subsidize the lower consumption levels;

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[14] As we shall see in section 1.4 (Table 1.4), this assumption is not empirically confirmed to individual households, although the average household consumption grows with household income.

[15] It is not known the reason for choosing to link the value of the bill with the value of the Treasury bonds; the value of the latter depends on the monetary policy implemented in the short-run by the federal government of Brazil and has nothing to do with the consumer's social condition.

iii) the household that pays the stated minimum amount for the monthly bill has the right to consume a given amount of m^3 of water. This amount varies amongst these companies, being 10 m^3 the lowest minimum quantity we found for the main water/sewage utilities since some of them establish higher quantities, as shown in Table 1.2.

The water/sewage, electricity and street gas public utilities use a price schedule defined in terms of blocks of consumption; there are no rules either for the number of blocks, or for the size blocks-ranges; the same can be said in relation to the rate of progressiveness of the tariffs: it is up to the state public utilities to define these parameters. Table 1.2 gives examples of some price schedules for residential water consumption in use by regional state public utilities in Brazil.[16]

The electricity companies also use a block tariff for charging their consumers. The main difference in comparison with what is done for the water/sewage companies is that the federal regulatory body for electricity sets the rates for all of them and for this reason we see no discrepancy in prices or in the water consumption block ranges as was found in Table 1.2 for water/sewage services. Actually, the regulatory agency (Departamento Nacional de Aguas e Energia Eletrica-DNAEE) sets the basic rate per MWh consumed, but with the following reductions in that rate :

for consumption up to 30 kWh: 70% ;
for consumption from 31 to 100 kWh: 40% ;
for consumption from 101 to 200 kWh: 35% ;
for consumption from 201 to 300 kWh: 5% ;
for consumption of more than 300 kWh: 0% .

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[16] The data cited in this chapter is taken from SANEPAR (1987), a study prepared for this water/sewage company in the State of Paraná, Brazil, to examine the distributional impact of its price schedule and other aspects affecting the quantities consumed by households, and industrial and commercial firms. This data comes from a large sample survey made in several urban centres of that State to collect primary informations about the customers' characteristics.

Table 1.2: Rates for Residential Consumption of Water in some Selected Regional State Companies in Brazil (1987)

Regional State Company	Monthly Household Consumption of Water (in m^3)	Rate per Unit of Consumption (in Cr$) (*)
SANEPAR (Parana State)	0 to 10	1.37
	11 to 15	1.45
	16 to 25	1.87
	26 to 50	2.59
	more than 50	3.61
COPASA (Minas Gerais State)	0 to 10	1.27
	11 to 15	1.28
	16 to 20	1.37
	21 to 25	1.46
	26 to 30	1.57
	31 to 40	1.68
	41 to 50	1.79
	51 to 75	1.92
	76 to 100	2.02
	101 to 200	2.20
	more than 200	2.35
CAER (Roraima State)	0 to 20	0.82
	21 to 30	1.09
	31 to 40	1.35
	more than 40	1.77

Source: SANEPAR(1987). *Avaliacao das Normas e Criterios de Fixacao de Tarifas no Setor de Saneamento: Uma Analise dos Objetivos de Equidade*, mimeo.
(*) Rate to be charged to each unit of consumption that exceeds the former consumption bracket.

It should be noted that in both services consumers should pay a minimum bill each month even if there is no consumption; for instance, for the water companies, this minimum bill allows consumption up to 10 m^3, or 15 m^3, or even 20 m^3 of water, the upper limit of the first bracket in their price schedules. As we shall see later, this mandatory bill is one of the reasons why the price schedules do not possess the distributional qualities expected by the policy-makers.

Another point worth mentioning is that the quantity supplied of these services to households is not that the quantity actually being charged. These companies have to resort to consumption estimates or other sorts of way of charging when there is no meter in the houses: for electricity, for instance, the supply in slums is measured by a meter that gauges all consumption made by a group of houses with which that meter is linked; to avoid applying an increasing rate to their consumption, a constant rate is used. For water, the measurement of consumption is less widespread than in case of electricity and thus there is a need to estimate the household consumption.[17] In Brazil, each regional state company has its own method of estimating the household consumption of water, but generally they use the following criteria: number of bedrooms; area of the house; physical quality of the building; number of "points" (sources of consumption); and a combination of the former criteria. Some water companies (12 out of the main 26) prefer not to estimate household consumption and adopt a procedure of charging that minimum mandatory quantity already mentioned, that is, the quantities 10, 15 or 20 m^3.[18] Problems with the measurement of the effective quantity consumed of these services by the household may frustrate the distributive objective these prices schedules are supposed to have since we will not be sure that lower and higher prices are being charged to the right households, unless the estimation "proxy" is perfectly correlated to consumption.

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[17] Almost all (99.98%) of the water connections in the State of Parana are metered; in the State of Sao Paulo, 95% ; in the more developed Brazilian regions, this percentage is generally above 70% and in the less developed, ranging from 23% to 70%; the striking case is the situation of the State of Rio de Janeiro, where the consumption is estimated for about 86% of the connections.

[18] The SANEPAR study has important data that can be used to show how household consumption is underestimated by all those estimation criteria and how revenue is sacrificed by charging the minimum bill to all connections not metered.

1.4 - *Analysis of the Redistributive Efficacy of the Public Utilities Pricing Policy.*

As mentioned above, the implicit assumption in the price schedules used by public utilities in Brazil is that of a positive relationship between household income and its consumption of these public services, that is, the larger its income, the larger is the quantity bought by household. Since the household income is not generally an observable variable and its consumption of water, electricity or gas can be metered or somewhat estimated, that assumption is fundamental for trying to attain the distributional objective through a price schedule defined in terms of blocks of consumption with increasing marginal prices.[19] Then, in principle the redistribution effect of the price schedules used by the water and electricity companies in Brazil would be guaranteed since they show higher rates for higher levels of consumption; perhaps one could argue about their degree of progressiveness, but this is not an issue that can be solved by economic theory since it depends on a political choice to be made by the government.

The analysis of the discriminatory prices paid by households with different incomes require, of course, the knowledge of the earnings of these households. This data are not available in these companies data bank since their current procedure for calculating their bills does not take into account the households' incomes; only specific surveys can inform us both the amount consumption of these services and the household income.[20]

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[19] See in chapter 5 how this translation can be made and the adjustment needed in the price schedule if the problem of adverse selection occurs.

[20] The FIBGE (Fundacao Instituto Brasileiro de Geografia e Estatistica) applied a survey on household expenditures in 1985: there are no data on the physical quantities consumed, only the household outlays. To estimate the consumption, one would need: first, to use the administrative records held by the public utilities to verify how each household was charged (by metered consumption, or a minimum compulsory bill, or by an "averaging" method); second, to calculate the quantity consumed using the price schedule in use in the date the outlay was registered (the price schedule changes several times a

In 1986, due to a contract signed between the National Bank for Housing (Banco Nacional da Habitação-BNH) and SANEPAR (Companhia de Saneamento do Parana), a survey was made of 5,434 households in a sample of cities in the Parana state with the specific purpose of assessing the redistributive and other characteristics of SANEPAR's price schedule. The present author worked in the definition of the questionnaire applied to the households and on writing a part of the final report. What follows is a summary of the results obtained with that sample concerning the redistributive aspects that are relevant to the present thesis.[21]

Since in a block-tariff schedule the rate or the unit price varies with the quantity consumed by the household, we are going to define the *unit price* paid as the *average* price, that is, the total bill paid by the household divided by the quantity consumed of water.

As we saw in Table 1.2, SANEPAR's price schedule, (as that of other companies) charges a minimum consumption of 10 m^3 irrespective of the actual household consumption below this level. This minimum bill may be considered as the entry fee to the system, charged to all households regardless of their incomes and, as such, represents a regressive burden in income terms: this burden, as a proportion of income, decreases in value terms for larger incomes.[22]

Figure 1.1 is a graph of the SANEPAR's price schedule: the total bill curve has a constant value up to 10 m^3 and it becomes progressively steeper to show the growing discriminatory prices

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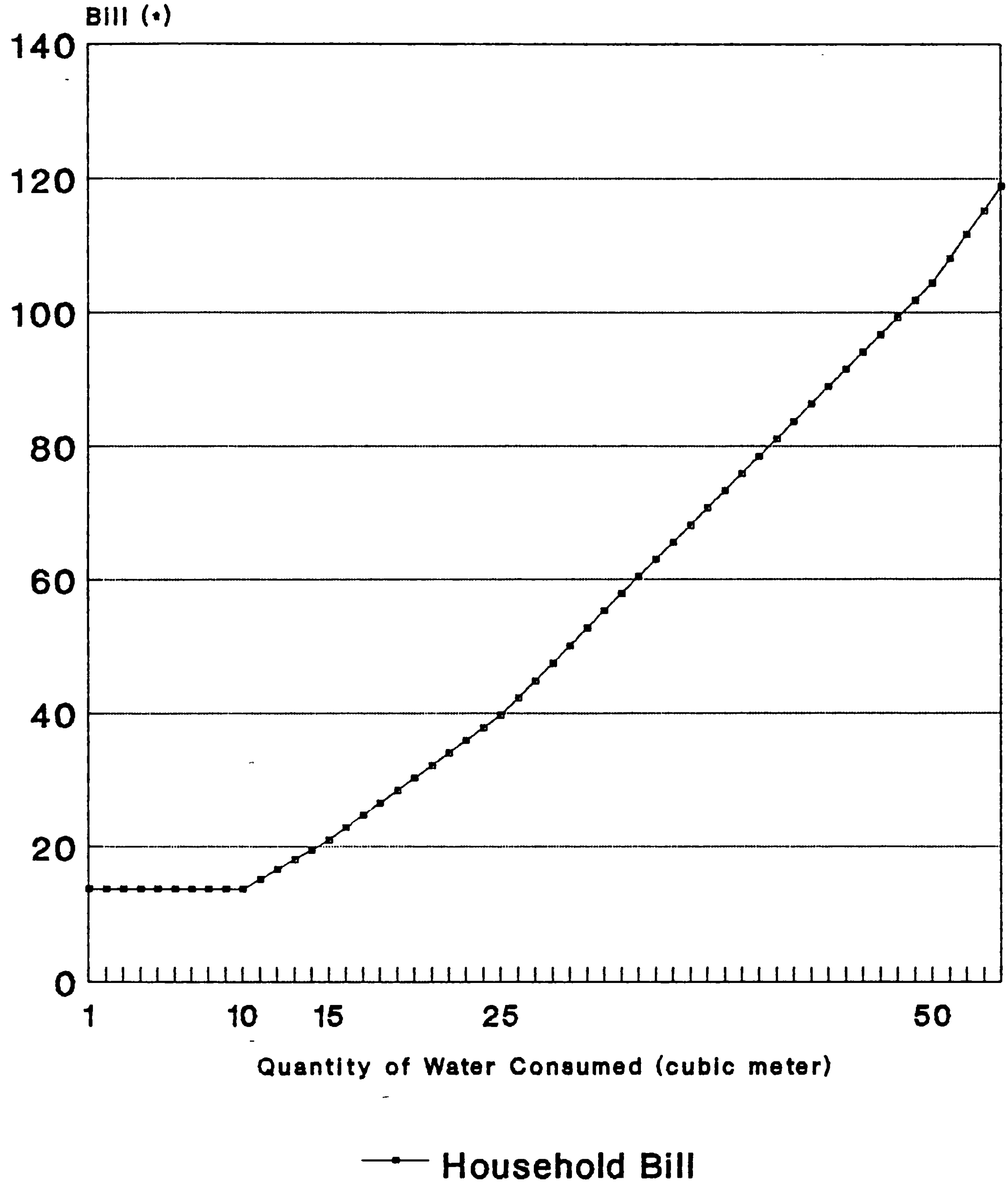
year in an inflationary context as the Brazilian one).

[21] A larger number of households were investigated by SANEPAR, but since we were interested in having a metered information about the individual consumption of water in the household, the data for apartment houses and other collective dwellings are not considered; the SANEPAR's sample also contains information on commercial and industrial consumption.

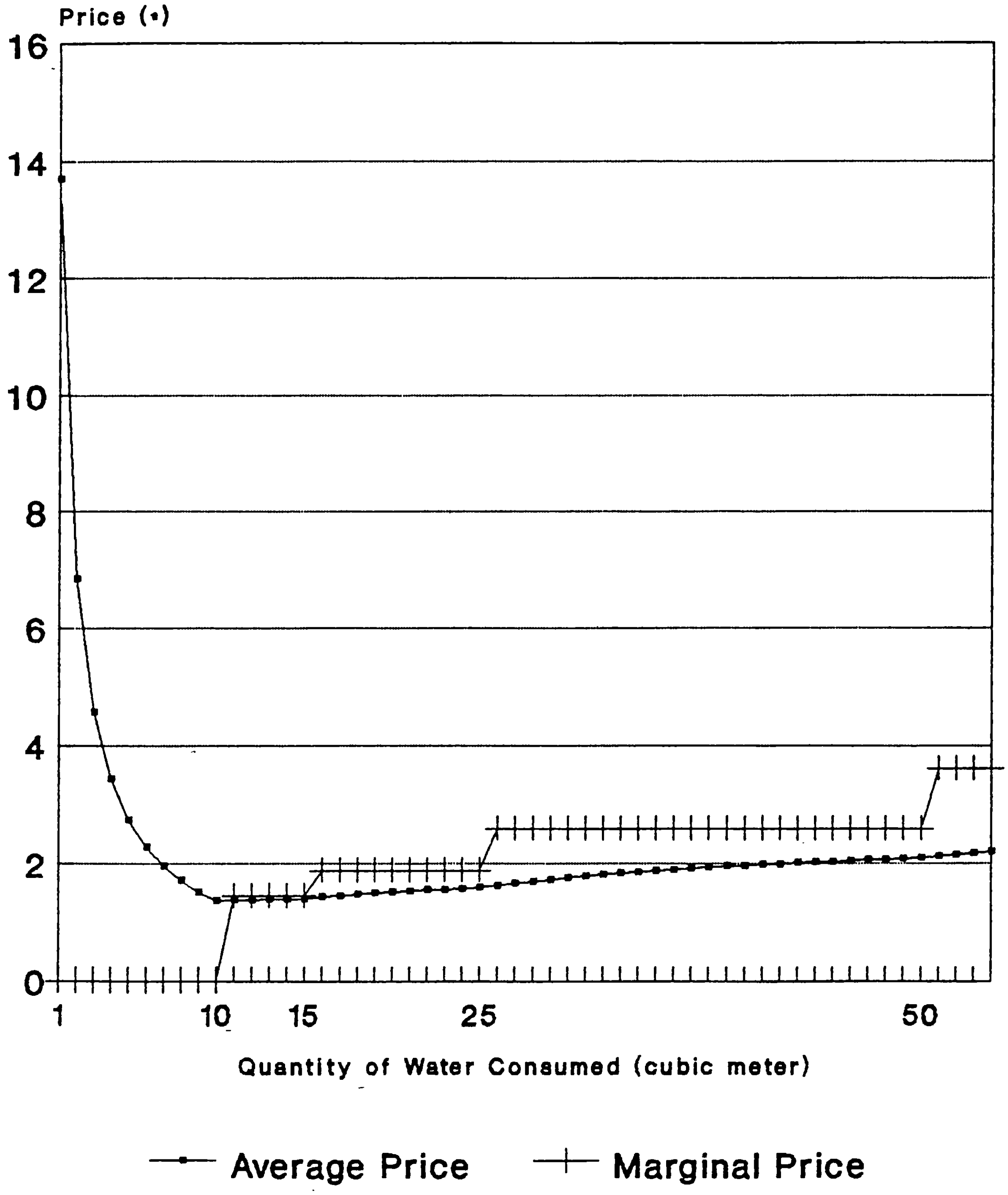
[22] Feldstein (1972b) shows how this regressive burden of an entry fee (the equity aspect of this type of pricing) is interrelated with the efficient aspect (marginal cost pricing) in a two-part tariff when one wants to derive an optimal price that makes a compromise between the equity and the efficiency aspects.

Figure 1.1
SANEPAR's Household Bill



(•)In Cr$ (April/86)

Figure 1.2
SANEPAR's Average and Marginal Prices



(•)In Cr$ (April/86)

consumers should pay for higher quantities consumed of water. Figure 1.2 shows the average and the marginal prices paid by the consumer for different quantities consumed; since the total bill is constant for any quantity consumed up to 10 m^3, the average price is a declining value up to this quantity, becoming infinite when the household has no consumption at all and declining to Cr$ 1.37 for 10 m^3; after this quantity, the average price rises smoothly, tending to Cr$ 3.61 when consumption tends to infinity.

Table 1.3 shows the sample statistics of the average price for the residential consumption of water in Parana. In that table we separated the class 0-10 m^3 into three classes, 0-3 , 4-6 and 7-10 m^3 to see how lower was the consumption of those households being charged for consumption not effectively made.[23]

Table 1.3: Average Price, its Standard Deviation and Lower and Upper Values for Monthly Water Consumption Classes for Households in Parana in 1986.

Household Consumption (m^3)	Number of Households	Price (Cr$ per m^3)			
		Average	Standard Deviation	Lower Value	Upper Value
0 - 3	381	7.80	3.81	4.57	13.70
4 - 6	558	2.82	0.46	2.28	3.43
7 - 10	1,284	1.57	0.22	1.37	1.96
11 - 15	1,351	1.50	0.05	1.42	1.58
16 - 25	1,173	1.79	0.10	1.64	1.97
26 - 50	518	2.31	0.21	2.03	2.76
> 50	169	3.26	0.39	2.80	4.43
Total	5,434	2.29	1.89	1.37	13.70

Source: SANEPAR's sample data

[23] Actually, the mandatory minimum consumption bill is the entry fee of the system: this is the bill any consumer has to pay to have access to service. As such, it has nothing to do with the actual consumption made by the consumer; the entry fee is a form the producer has to capture some of the consumer's surplus or a way of covering the producer's fixed costs.

We see that 939 households (about 17% of total) consume up to 6 m^3 a month and pay 10 m^3, the reason why the average prices they effectively pay (Cr$ 7.80 and Cr$ 2.82) are higher, as expected, than the total average paid by all households (equal to Cr$ 2.29). We see that those households supposed to be the poorest ones (those that have their consumption in the consumption class 0-3 m^3) pay the highest prices, in the range Cr$ 4.57-Cr$ 13.70. It is also important to note that the average price declines up to the fourth class of consumption and after that it increases up to the price Cr$ 3.26 per m^3.[24]

We saw in Table 1.2 that there are some water companies that charge for a minimum mandatory quantity higher than the 10 m^3 charged by SANEPAR; some charge for 15 m^3 and even 20 m^3, and as such we should expect to see a more severe distortion of higher prices being paid by those assumed to be the poorest consumers.

It should be noted that the implicit assumption made by the policy-makers concerning a positive relationship between the households' incomes and their consumption of water or any other utility is not inappropriate. These services may be considered as normal goods and as such we should expect their quantities consumed to increase with households' incomes. Actually, this assumption is confirmed by the SANEPAR sample, as we can see in Table 1.4.

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[24] Since Cr$ 3.61 is the marginal price charged by SANEPAR to a consumption that exceeds 50 m^3, this value is the limit for the average price for these class of consumers when their consumption tends to infinity.

Table 1.4: Average Monthly Household Consumption of Water by Household Income Class in 1986.
(in cubic meters)

Household Income Class (*)	Number of Households	Quantity of Water Consumed	
		Mean	Standard Deviation
0 ⊢ 1	338	10.4	12.3
1 ⊢ 2	806	11.0	7.7
2 ⊢ 5	1,969	12.3	7.5
5 ⊢ 10	1,228	15.7	11.0
10 ⊢ 20	674	22.5	18.5
> 20	419	32.3	24.6
Total	5,434	15.5	13.8

Source: SANEPAR sample data.
(*) in units of the legal minimum-wage.

Data in the above table and Figure 1.3 show what is expected, that is, growing average quantities consumed of water for rising incomes. However, the relationship is not strong: using the mid point of each household income class (and assuming that the mid point of the open class is 25 minimum wages) we calculated the sample correlation coefficient to be equal to 0.21, what means that the population correlation coefficient is in the interval 0.16 - 0.23 for a 99% confidence interval.[25] We then can say that there is a positive association between household consumption of water and household income, but this association is relatively weak. Then, it is improper to use the quantity of water consumed by a household as a proxy for its income; if we want the public utilities rates to show progressiveness in terms of the households' incomes, we must derive this discriminatory prices directly using the household income as the discriminant variable (as we shall be doing in chapter 3) and not the household consumption of the commodity.

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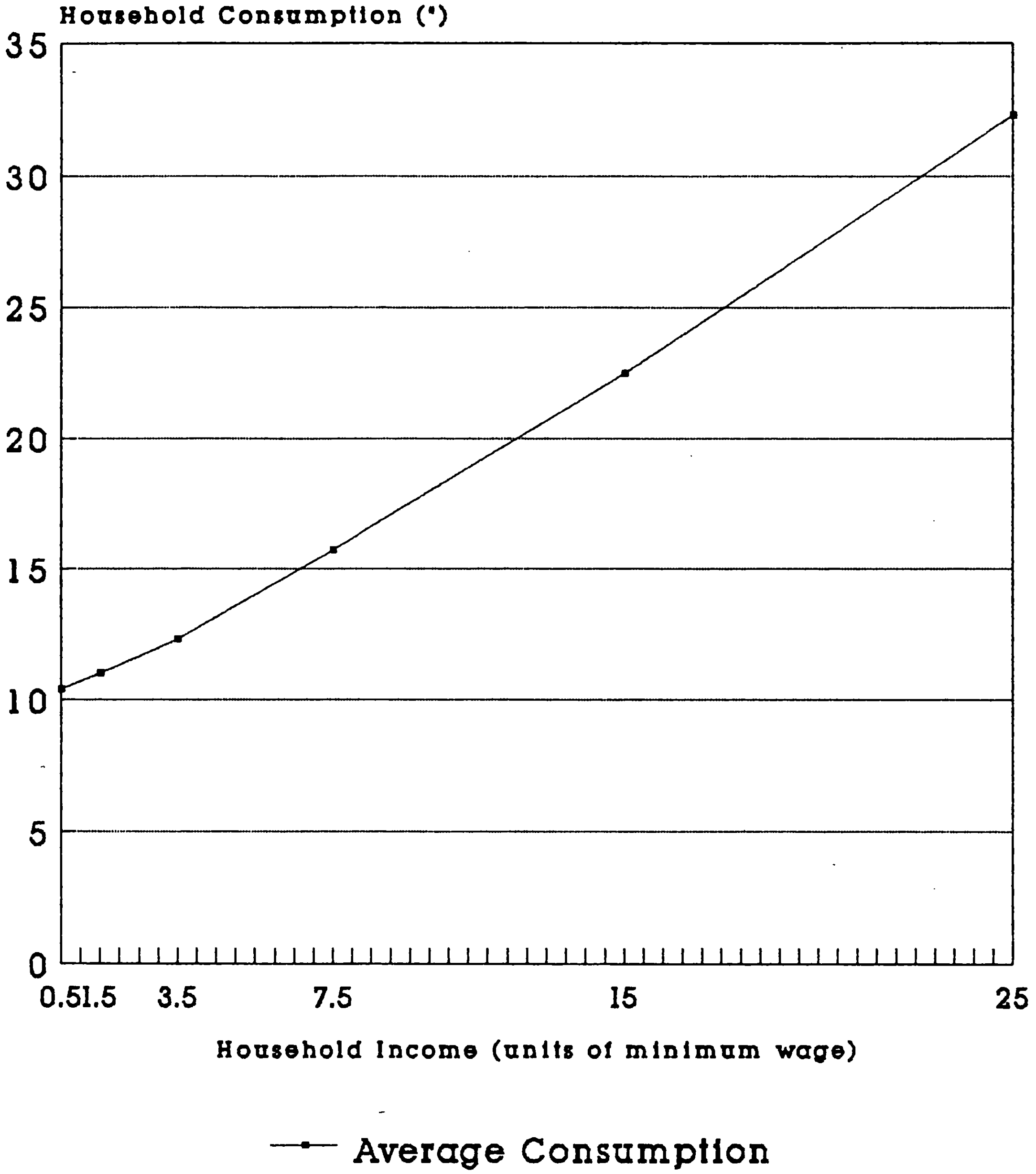
25 These statistics do not change substantially for different assumptions concerning the value of the mid point of the open class since the relative number of households in this class is small.

Figure 1.3
Average Consumption of Water



(*)in cubic meters/month.
Source: SANEPAR sample data

Since we are interested in assessing how the price of water charged by SANEPAR differs among consumers with different incomes in order to see if its designed progressiveness in terms of income occurs, Table 1.5 provides with the data obtained in the sample already referred. We define a price schedule as progressive when the average price paid for the quantities consumed of the service increases with the household income; the price schedule will be regressive when this average price lowers for higher incomes. The average price is calculated as the household's expenditure (monthly service bill) divided by the quantity consumed.[26]

We see in that table that actually the price schedule used by SANEPAR is not monotonically progressive: actually, the redistribution of income occurs in a regressive way since the poor pay the highest average price among all other consumers. In the sample, those 338 households with monthly earnings up to 1 minimum wage pay Cr$ 2.80 per m^3 of water effectively consumed; this price is 22% higher than the overall average, Cr$ 2.29. For the following income classes, the average price follows a declining path (Cr$ 2.59, Cr$ 2.23, Cr$ 2.12) up to the forth class and rises for the two higher classes (Cr$ 2.13 and Cr$ 2.34).

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[26] Since our data refer only to metered consumption of non-collective houses, there are no measurement problems that could distort the value of this average price.

Table 1.5: Average Price of Water by Household Income Class in Parana , 1986.

Household Income Class (in units of minimum wage)	Number of Households	Average Price (*)	
		Mean	Standard Deviation
0 ⊢ 1	338	2.80	2.63
1 ⊢ 2	806	2.59	2.46
2 ⊢ 5	1,969	2.23	1.98
5 ⊢ 10	1,228	2.12	1.50
10 ⊢ 20	674	2.13	1.26
> 20	419	2.34	1.12
Total	5,434	2.29	1.89

Source: SANEPAR sample data.
(*) in Cr$ per m^3 consumed.

An alternative way of showing that the intention of having a progressive rate does not occur when SANEPAR (as all the other water utilities do) applies its price schedule is to compare the relative share of each income class in both the total revenue and the total household consumption. Table 1.6 makes this comparison.

We can see shows that the poorest households generate a revenue larger than their participation in the total consumption. These result can be observed for the two lowest income classes: those households in the two lowest classes produce a revenue 24% and 14% larger than their participation in total consumption, respectively, while all others households make a contribution to the revenue about of the same order of their share in the total consumption.

Table 1.6: Distributions of the Total Household Consumption of Water and of the Total Revenue, by Household Income Class in Parana, in 1986.

Household Income Class (in units of minimum wage)	Share in the Total Consumption (a)	Share in the Total Revenue (b)	b/a
0 ⊢ 1	4.16	5.14	1.24
1 ⊢ 2	10.47	11.97	1.14
2 ⊢ 5	28.62	28.16	0.98
5 ⊢ 10	22.77	21.32	0.94
10 ⊢ 20	17.94	16.86	0.94
> 20	16.04	16.55	1.03
Total	100.00	100.00	1.00

Source: SANEPAR sample data.

We can conclude that the intended progressiveness in the rates is not reached when a water company adopts the same price schedule as that adopted by SANEPAR. Actually, this schedule is largely regressive for the lowest household income classes, that leads the price system to produce an adverse result in terms of redistribution of income. The main reasons for this undesirable result rest on:

i) the poorest households are being charged for a very large quantity of water they effectively do not consume: the minimum mandatory quantity of 10 m^3 (or even 20 m^3 in some water utilities) for which they are charged distorts the redistributive role of the price schedule;

ii) the implicit assumption of a linear positive relationship between individual household income and individual household consumption cannot be accepted: poor households may consume larger quantities and rich households may consume smaller quantities. Then, pricing according to the quantity consumed may, as is the case, produce a result socially undesirable.

1.5 - *Conclusions*

The practice of using a consumption block-tariff for charging consumers is widespread amongst public utilities in Brazil. These price schedules are set with increasing marginal prices for higher quantities consumed; the declared purpose of such pricing policy is to cross-subsidize the consumption of the poor households.

This pricing policy's basic assumption is that there is a positive association between household consumption of these public services and households' incomes.

Empirical data collected in SANEPAR's sample survey shows that that association is true for average consumption, but that there is a large dispersion for individual household consumptions, mainly in the case of low-income households. Thus, this means that individual household consumption is not a good proxy for household income, as assumed by that pricing policy.

The same data also shows that the average price paid by consumers of water has an inverted J-form; the highest average prices are paid by the households with the lowest incomes, what means that instead of being progressive, the price schedule is effectively income regressive. This fact is reinforced by the finding that the relative share of the lowest income classes in the total SANEPAR's revenue is slightly higher than their share in total consumption.

We cannot generalize our findings of regressiveness concerning the water/sewage sector (here represented by SANEPAR's price schedule), extending them to the electricity and piped gas services, for instance. We have to wait for empirical data on households' consumption and income to be available to allows us to assess the possible regressive impact of their price schedules. However, we have shown empirically in this chapter that the idea that setting a nonlinear progressive price schedule defined in terms of blocks of the quantity consumed by the household is not a guarantee that effective average prices will be necessarily progressive in household income terms. Our point of view is that the distributional aspect of the pricing policy should be explicitly embodied in the derivation of these prices. This is the reason why the prices schedules derived in the forthcoming chapters use the households' incomes as the discriminatory variable; the difficulties of implementing a means-tested income-price schedule may require later the translation of these progressive schedules into a consumption-price one; the technical feasibility of this transformation is considered in chapter 5.

CHAPTER 2

PRICE DISCRIMINATION AND DISTRIBUTIONAL GOALS: A SURVEY OF THE MAIN ISSUES.

2.1 - *Introduction*

The objective of this chapter is to survey the main issues related to the determination of an optimal price schedule when distributional goals are specified. In section 2.2 we will be examining the concept of price discrimination, the conditions that allow its existence, the three types of price discrimination, and the possibility of imposing progressiveness or regressiveness in such pricing policy. In section 2.3 we are interested in the focus of this thesis, that is, in the use of price discrimination by public utilities: first we examine the current pricing practices adopted by these companies; in sub-section 2.3.2 we describe the relevant works in the economic literature on public utility pricing in which a distributional goal is considered or could be introduced; and finally, in sub-section 2.3.3 we review the sparse Brazilian literature on the subject. In an appendix to this chapter we examine the properties of the analytical instruments we will be using throughout this thesis, i.e., the social welfare and the utility functions.

2.2 - *Discrimination and Pricing*

Price discrimination is a general commercial practice. It has been used in several different contexts, including in public utility pricing with a distributional purpose, as we saw in chapter 1. The objective of this section is to examine the meaning of price discrimination and its implications since this thesis is interested in improving the distributional characteristics of the currently used discriminatory price structures practiced by Brazilian public utilities. In this section we are going to address:

1) discuss the problem of finding an acceptable definition of price discrimination;

2) review the conditions that allow such discrimination;

3) examine the types of price discrimination currently in use in Brazil and elsewhere; and

4) consider the level of progressiveness (or regressiveness) of such price discrimination policies.

2.2.1 - *Definition of Discrimination*

Price discrimination occurs when different units of the same commodity are sold at different prices, either to the same or different consumers.

One can say that the problem with the above definition rests with the words "same commodity". In reality, some of those commodities being sold at different prices are not the same ones in the strict sense. Phlips (1983,p.6) cites Debreu (1959,p.33) to argue that the same good sold at different places is a different economic good at each of these locations to stress the fact that what matters is the total cost of producing and distributing the commodity.

George and Shorey (1978,p.126) agree with the idea of first examining the differences in costs before saying that there is price discrimination. For them price discrimination exists when commodities, whose costs are the same, are charged at different prices, or when the price differences do not correspond to cost differences. This is also the understanding of Varian (1989) who cites Stigler (1987) to say that price discrimination exists when a good is being sold at prices that are in different ratios to marginal costs. What is interesting in their definition, besides calling attention to the cost differences, is that it mentions the possibility of the differences in prices being larger than the differences in the costs of production, which in some cases may imply an intentional attitude of the seller to establish discrimination among its customers.

Price discrimination is usually thought of as a device used by a seller to maximize its profits. For instance, Phlips(1983,p.7) is thinking of a private enterprise when he emphasizes that what is typical for discrimination is the fact that the seller is looking for maximization of his overall profits when he sells to several markets at different prices. However, price discrimination can be used and has been used by government-owned public utilities in developing countries with a non-profit oriented objective, as is the case of the Brazilian public utilities we examined in chapter 1. In this case price discrimination is used to satisfy a social objective other than profit maximization.

2.2.2 - *Conditions for Discrimination*

Price discrimination is not always possible; for its existence some preconditions are necessary. Three usually cited requirements are:

i) resale of the commodity must be impossible or preventable; that is, nontransferability of the commodity between customers (in greater or lesser degrees) is a condition to avoid failure in the discrimination process;

ii) the seller must have the ability to sort customers;

iii) the seller should have some market power.

Most authors cite the nontransferability of the commodity among consumers as an important requirement for discrimination, but fail to mention that the transferability of the demand can cause the failure of a discriminatory pricing policy. We know that this transferability occurs when a consumer chooses a pricing option that was not meant for him, as is the case of a rich commuter preferring to travel in the second class when he was supposed to choose the first class. In the case of public utilities, the distributional device built in their price schedules assumes that rich households (that is, the high demand consumers) will pay the higher prices charged to higher consumption. The empirical evidence shown in chapter 1 revealed that this assumption is not always fulfilled and that the adverse selection made by some households precludes the adequate operation of the discriminatory pricing policy. In chapter 5 we will be examining how the self-selection mechanism used by consumers should be taken into account in order to avoid frustration of the distributional intentions imposed upon the price schedule.[1]

The above requirements for price discrimination are usually thought as applying to a private enterprise. However, they are equally important for a public enterprise (usually a monopoly) that uses price discrimination as a device for income redistribution.

2.2.3 - *Types of Price Discrimination*

Pigou (1920) discerns three basic types of price discrimination:

i) *first-degree discrimination*: the seller charges a different price for each unit of the commodity; this price is exactly the demand price, that is, the buyer's reservation price for that unit. This type of discrimination is called "perfect" to characterize the fact that each unit of output has its price and this price equates the value the buyer evaluates that unit; in the case of first-degree discrimination, the whole consumer surplus is extracted by the seller.

ii) *second-degree discrimination*: this type of discrimination is a variant of the first-degree type since the

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[1] It has been mentioned that the transferability of commodity prevents discrimination, while the transferability of demand may induce the producer to increase the discrimination. However, if the demand is being transferred to a lower lever of consumption and, consequently, to a lower price because the price differential is too high (this is the case examined in chapter 5), the solution is to diminish the discrimination and not to increase it.

different prices relate to blocks of units sold; instead of changing the price for each unit sold, the seller charges the same price for the quantity of units that falls within a given interval of commodity quantities, setting this price equal to the demand price the buyer is willing to pay for that quantity; as a result of this procedures, the seller charges different prices for different blocks of units bought by the consumers. The seller uses a second-degree discrimination because he has incomplete information (in the case of first-degree he must have complete information) about individual preferences, thus he is only able to extracted consumer surplus imperfectly, resorting to a pricing policy that takes into account the consumers' self-selection mechanism.[2]

Second-degree discrimination is the type of price discrimination usually used by public utilities, sometimes with increasing marginal prices according to household's consumption, sometimes with decreasing marginal prices, that is, with quantity discounts. This type of price discrimination is usually implemented with the use of nonlinear pricing procedures we describe in sub-section 2.31.[3]

third-degree discrimination : This type of discrimination is based upon the possibility the seller has to separate its customers in different groups according to their ability to pay different prices. This is the most common form of discrimination and examples of it can be found in the discriminatory prices charged to young and senior people and those paid all by the other consumers. This is the form of price discrimination we will be primarily interested in throughout this thesis, that is, charging differently households according to their socio-economic status. In other words,

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[2] See section 5.3 in chapter 5 for the description of the self-selection mechanism and for an analysis of the role its plays in inducing the consumer to choose the best alternative among different prices of a commodity.

[3] Brown and Sibley (1986) appraise the practice of nonuniform pricing by public utilities.

we will be deriving discriminatory prices that should be charged to heterogeneous groups of households, their difference being the income they earn or other socio-economic characteristics. This kind of price discrimination requires the identification of the household's socio-economic status in order to separate the different "markets" for pricing purposes. This separation can be done by a means-test, although the administrative costs of such practice cannot be disregarded. To cope with this problem, we show in chapter 5 how a price discrimination of the third degree can be transformed into a second-degree, preserving the distributional characteristics that were taken into account in the derivation of prices in the former type of discrimination.

Since in this thesis we are primarily interested in third-degree price discrimination, a question examined by Varian (1989) is very pertinent: is total welfare higher or lower when third-degree price discrimination is present than it is not ? He derives the conditions for increase in welfare: the necessary condition is that output increases, and the sufficient condition is that the sum of the weighted output change occurred in each market is positive, with the weights given by price minus marginal cost. Thus, change in output is the general condition for welfare change. As to whether output changes or not in each market, the answer depends on particular properties of the demand function.[4]

2.2.4 - *Price Discrimination and Degree of Progressiveness or Regressiveness.*

Charging different prices to customers of a public utility in some instances means having a price schedule with declining rates for increasing quantities consumed: Phlips (1983,p.148) cites the example of the Belgian residential tariff in 1976, whose rates were the following:

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[4] See Varian (1989,pp.622-623) for a list of authors that have contributed to this question.

for the first 450 kWh per year, 1.75 BF per kWh
for the next 270 kWh per year, 1.10 BF per kWh
for all excess over 720 kWh per year, 1.02 per kWh.

The aim, at that time, was to stimulate the consumption of electricity through a price reduction of this source of energy. In the case of Brazil, as we saw in chapter 1, the marginal prices charged by public utilities show increased values, that is, prices change positively for additional amounts of consumption.

An important theoretical point is the appropriate level of progressiveness (or regressiveness, if this is the case) these price schedules should have in accordance with an optimal determination of public utility prices.

The issue of the level of progressiveness in pricing is akin to the same question discussed in studies of optimal income taxation. The idea that persons should contribute differently to the government financial needs contingent upon their incomes is widely accepted under the assumption that income shows a decreasing marginal utility and that each contribution should entail the same sacrifice in utility. Income-tax legislation usually defines increasing marginal rates for higher income bracket. Atkinson's (1972) article is addressed to examine the question of progressivity in income taxation. In this article he is firstly interested in showing that the theory of minimum sacrifice and its implicit utilitarian framework of analysis are not adequate instruments for examining the problem. Secondly, he shows that Mirlees' (1971) results are dependent on the specific functional forms adopted in his article and on the assumed values taken by important parameters, particularly ρ, the degree to aversion to income inequality. He also shows that when the progressiveness of the income-tax is thought as a instrument to diminish income inequalities, greater care should be paid to the choice of the index of inequality and its implicit theoretical requirements. His final conclusion is that the question of how progressive should the income-tax be has not a simple answer and that this answer is dependent upon a better definition of the government's social objectives.

Similarly, we may say that the level of progressiveness in public utility's price schedules should be left to the exercise of finding the optimal prices to be charged when a given social objective is maximized; the degree of progressiveness will be dependent upon the values taken by demand and supply parameters and upon the social welfare weights applied to different consumers.

2.3 - *Public Utility Price Discrimination*

Public utilities in several countries have been using discriminatory prices for quite a long time. The objective of this section is to describe this practice, and to survey the economic literature on the subject of attaching distributional goals upon the price schedules adopted by these firms.

2.3.1 - *The Practice of Public Utility Pricing*

Although the economic literature refers to marginal cost as the efficient price to be charged by firms, the general practice is not marginal cost pricing. This is due to the difficulties of implementing it, in some cases not only because of the problems of adequately measuring the marginal cost, but also because of the problems of charging it.[5]

One of these problems has nothing to do with the physical or technical possibility of charging the consumer, but is related to the financial consequences of using marginal cost as the basis for pricing. In the presence of economies of scale, marginal cost is a decreasing function of the quantity produced, which means that

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[5] See in Saunders et al.(1977) alternative definitions of marginal cost that take into account the need to minimize price fluctuations in the presence of indivisibilities and that signal the timing for new investment.

charging according to the marginal cost will generate a financial deficit for the firm; to avoid this deficit, price should be higher than the marginal cost, or some kind of a subsidy should be used to cover the cost of production.

The most commonly used alternative to marginal cost pricing by public utilities is thought to be the solution to the above mentioned problem. This pricing alternative is what in the literature is known as *nonlinear pricing*, a form of pricing in which price varies according to the quantity consumed.[6] In other words, as Brown and Sibley (1986) call it, this is a *nonuniform pricing* practice to mean that the consumer's total outlay does not change proportionately with the quantities he purchases, allowing not only quantity discounts, but also cross-subsidization within the price schedule. Usually, nonlinear prices schemes are formulated in terms of block-tariff pricing schedules, where there is an entrance fee (a fixed charge that is independent of the quantity the consumer purchases) and an additional charge related to the amount of the commodity consumed; this additional charge may be proportional to the amount consumed, meaning that the tariff is the same whatever the amount consumed (two-part or block tariff), or non-proportional, when prices vary for each block of quantity consumed (multi-part or block tariff). The basic idea is that this additional or incremental charge should be related to the marginal cost and the fixed charge or entrance fee is used to capture the consumer surplus enjoyed by the consumer and to finance the firm's eventual operational deficit.[7]

The optimality of the nonlinear pricing schemes used by

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[6] We saw in chapter 1 that this is the form of pricing used by public utilities in Brazil.

[7] This is the suggested Coase (1946) two-part tariff to take into account the fact that consumers have different tastes; he proves that such an optimal tariff eliminates the deadweight loss of an average price scheme to cover total cost and induces the efficient level of consumption. See this same reasoning in Oi (1971). However, some departure from marginal cost for the user charge will be needed if the entrance fee is too high and induces some consumers to drop out of the market.

public utilities depends not only on setting a fixed charge that is in accordance with each individual consumer's surplus, but also correctly measuring the marginal cost involved in supplying this consumer the amount of the good or service he demands.[8] Although not necessarily being the sole determinant of the optimal price, the marginal cost plays an important role in the determination of the price that should be charged either by a state-owned or a private enterprise. There has been a long discussion about how to measure marginal costs in specific situations and for particular public services.[9] One of the questions frequently discussed is whether we should use the short-run or the long-run marginal cost in the price determination. According to Rees (1979), the long-run marginal cost is only relevant at the planning stage of the capacity of production; this is the stage at which the capital costs are variable. Once the capacity is chosen and installed, what matters for current decisions on output and pricing is the short-run marginal cost. It may be the case that the current price is not enough to cover the capital costs incurred to build the existing capacity and the firm is running into a deficit, as is the case in decreasing marginal cost industries. In a deficit situation like this, the problem is how to finance the losses and the solutions have been either to depart from marginal cost pricing by charging a price that deviates from it just enough to cover costs, or to use a nonlinear price schedule with an entrance fee that covers the deficit (as just mentioned in the former paragraph), or governmental subsidization. Another source of deficits is overestimation of demand and indivisibilities in capacity expansion. In this case, there is no reason to restrict the utilization of the capacity of production if it is possible to sell additional quantities at a

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[8] Among the most cited works on nonlinear pricing are the analyses made by Spence (1977), Willig (1978), Roberts (1979) and Goldman, Leland and Sibley (1984). For alternative ways of deriving optimal price schedules, see Brown and Sibley (1986,pp.202-215).

[9] See, for instance, in Meyer (1983) a selection of readings on pricing for electricity, roads, port services, water, and public transportation.

price that is at least equal to the marginal (short-run) cost, making better use of the resources. Heady (1989) is in accordance with the above ideas when he discusses the appropriate concept of marginal cost, basically whether capital costs should be included in the definition of marginal costs or not.[10] He emphasizes the advantages of using short-run marginal cost either when there is excess or insufficient capacity of production, but also calls the attention to its main disadvantages, that is, price variability and its related problems: the administrative and political costs for price changes and the consumers' uncertainty in relation to the price they will be charged.[11] He also discusses how the decisions concerning the timing of new investments is affected by short-run or long-run marginal cost pricing.

Of course, the price schedules in use are just a compromise between what is desirable in theoretical terms and the feasible way of implementing it. Phlips (1983) reports several business practices of nonlinear pricing applied for price discrimination in the context of spatial, time, income and quality differences. Bird (1976) mentions that in pricing public services a more common practice is to charge a "full" or average-cost price; of course, we know that this is not a correct way of pricing, being allocatively inferior to other alternatives and, for this reason, should be considered as the last solution to be implemented.[12]

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[10] Heady's paper was prepared for the World Bank; he mentions that the World Bank has a non-uniform practice and cites the works by Walters (1968) that recommends the use of short-run marginal cost for road user charges and by Munasinghe (1981) that suggests the use of long-run marginal cost for electricity charges.

[11] Julius and Alicbusan (1989) report that for water supply projects, the price variability caused by capital indivisibility was the main justification given by Saunders et al. (1977) to propose to the World Bank the use of a proxy for the long-run marginal cost, the long-run average incremental cost, that is, the discounted value of future supply costs divided by the discounted amounts of additional water.

[12] We should not forget the practice in some countries of supplying public services free of charge, the costs of production being financed out of taxes. The allocative waste of resources and the

2.3.2 - *Pricing, Optimal Differential Commodity Taxation and Distributional Objectives.*

Pricing efficiently in a first-best economy is identified with marginal cost pricing: the idea is that consumers should pay the true cost of producing the commodity. It can be proved that if a firm produces a good and sells it in m markets, the prices that maximizes consumer surplus plus producer surplus are the prices for which there is an equality of price and marginal cost in each market. In a second-best economy, that is, when the efficient prices should satisfy a firm's break-even constraint, these prices diverge from marginal cost: it can be shown that the firm's price-cost margin in market i should be equal to λ/ε_i , where λ is a constant and ε_i is the demand price elasticity for that good in market i; the constant λ adjusts the price-cost margin in all markets to make the firm satisfy the break-even constraint. This pricing rule has been termed as the *inverse elasticity rule* since the price-cost margin in each market should be inversely related to its demand price elasticity, then, in markets which the demand is less sensitive to price changes that margin can be higher than the margin that should be used in markets very sensitive to price changes.[13]

The article by Ramsey (1927) anticipated the inverse elasticity rule when he derived the taxes on commodities that would increase revenue with a minimum distortionary cost: since these taxes add to the producer price, choosing the optimal taxes is equivalent to choosing the consumer prices. Ramsey found that the optimal commodity taxes in a single-person economy are inversely proportional to the demand price elasticities for these commodities

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possible distortionary effects of increased taxation do not recommend this practice.

[13] For the mathematical derivation of these results, see, for instance, Brown and Sibley (1986,pp.194-197).

when the demands are independent.[14]

When the government has a concern for income distribution, as in the case of less developed countries such as Brazil, the implementation of Ramsey rule based on the single-person economy and independent demands may have a perverse distributional result: commodities with low demand price elasticities tend to be necessities, while those with high elasticities tend to be luxuries; then, necessities would be taxed (priced) at higher rates than luxuries, a result opposite to the idea of favouring the poor. This means that the idea of using a differential optimal rates (for commodity taxation or commodity pricing) may produce undesirable results in distributional terms.

Atkinson and Stiglitz (1976) prove that nothing better can be obtained with differential commodity taxation that could not be reached more efficiently with income taxation both in revenue terms and in distributive terms; this is equivalent to saying that differential pricing is not worthwhile and that income taxation should be used instead for income redistribution. However, Heady (1988,p.206) lists the following cases where differential commodity taxes could be superior to income tax because the overall tax burden could be made non-linear in income:

1) when the objective is to redistribute income between different groups with equal incomes but different consumption patterns; and

2) when administrative difficulties prevent the implementation of a non-linear income tax system and some goods have non-linear income-consumption (Engel's) curves.

In section 1.2 of this thesis we listed several obstacles to using properly income taxation in less developed countries, in particular Brazil, as the sole instrument for redistribution of

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[14] For the derivation of the Ramsey rule, see Sandmo's (1976) survey on optimal taxation. Heady (1988,p.212) calls the attention to the restrictive assumptions under which the Ramsey rule was obtained; see also his reference for calculating an optimal commodity tax structure for numerically simulated values taken by the constant of proportionality and when the elasticities of demand vary with prices.

income. This means that conditon 2 occurs in these countries, given the difficulties of implementing a income tax that could have both the allocative and distributive roles assumed in Atkinson and Stiglitz's article. Thus, we can think that differential commodity taxation and differential public utility pricing may work as complementary instruments of redistribution.

Feldstein (1972a) observed that the pricing of public enterprises has an important role to play in the process of redistributing income. The definition of their rates should take into account that their values will affect directly the well-being of all households, thus being an instrument to improve society's welfare. However, he finds that most of the studies of optimal pricing in the literature are interested only with the Paretian efficiency, that is, with the optimal allocation of resources for a given income distribution. Feldstein calls the attention to the fact that several articles that discuss the theory of public pricing and taxation do not address the question of the distributional aspects of public pricing.[15] His alternative is to introduce income distribution considerations into the search of an optimal price for a public enterprise by using what he defined as "the distributional characteristic of a good" (R_i). This parameter is a weighted average of the marginal social utilities, where each household's marginal social utility is weighted by the quantity he buys of that particular good.[16] When a good is a necessity, the social weights are

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[15] He mentions Baumol and Bradford (1970), Lerner (1970), Dixit (1970), Ramsey (1927) and Boiteaux (1971).

[16] In mathematical terms, the distributional characteristic of good i is defined as:

$$R_i = \frac{N}{Q_i} \int_0^\infty q_i(y)\; u'(y)\; f(y)\; dy$$

where N is total number of households; q_i is the quantity of good i purchased by a household with income y; u'(y) is the marginal social utility of a dollar to a household with income y; and Q_i is the total quantity sold of good i. See Feldstein (1972a,p.35).

high for the households that consume a large proportion of that good and the value of R_1 is high; for luxury goods the social weights are low for households that are responsible for large shares of their consumption and then R_1 is low. The use of R_1 to derive discriminatory prices, however, do not generate price discrimination amongst consumers: the values of R_1 have an important role in the determination of two goods relative price ratio, but it plays no role for price discrimination in the sense we are interested in this thesis, that is, different prices for the same commodity being charged to different consumers. In Feldstein's model all consumers pay the same price. His distributional parameter has just the role of making lower the relative price of a necessity in terms of the relative price of other good produced by the public enterprise.

In two other articles, Feldstein uses again the distributional characteristics of a good for the determination of public prices: in Feldstein (1972b), where he is interested in studying equity and efficiency in the context of a two-block price schedule, his findings again, as expected, cannot be transposed to justify price discrimination since the optimal price he derives from his model is the same for all consumers of the same good; in Feldstein (1972c), he uses a model that allows price discrimination between households and private producers, but not amongst households.

It seems that the best idea for taking into account distributional aspects in the process of finding an optimal price schedule for public utilities is to introduce explicitly different weights for different households using a social welfare function.[17] Then, sensitivity analysis can be done to see how the optimum changes in response to changes made in those weights and in the social welfare functions used, as suggested by Atkinson and Stiglitz (1980,p.352).

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[17] In the appendix to this chapter we make a description of the different social welfare functions that can be used with this purpose. In chapters 3 to 5 we derive different price schedules that show sensitivity to alternative social welfare weights applied by the policy-maker.

The article by Roberts (1979), although dedicated to nonlinear pricing, that is, to derive optimal prices that vary according to the amounts purchased by consumers, its findings allow the determination of prices according to the consumers' socioeconomic conditions, i.e., in respect to distributional objectives: it shows how prices should diverge from marginal cost, being influenced by several economic parameters. Since the model we develop in chapter 3 shares some of the characteristics of Roberts' model, being simpler and using a less complex methodology, we postpone the explanation of these factors that generate price discrimination in income terms. We must say that Robert's model works with a continuous income distribution, while our model prefers to use this distribution in discrete sections or groups; our maximization exercise is made using the Kuhn-Tucker conditions, while Robert's model is maximized with the Pontyryagin's Maximum Principle; and our model uses the price to be paid by a household with income Y_j, that is, P_{1j}, as the control variable, while the approach taken by Roberts is maximizing with respect to an expenditure function and the marginal price.

In an article written some years before Roberts' contribution, Le Grand (1975) advanced some of the important findings of that article. Le Grand's study is directed towards answering the question of how price discrimination (in Pigou's sense) comes out of a model of welfare maximization for the determination of the price of a good produced by a public enterprise when different social welfare weights are attached to household's utility. Some of the theoretical results we obtain in chapter 3 coincide with Le Grand's findings since his and our models have a lot in common: a social welfare function is defined by the aggregation of the households' utilities and then this function is maximized subject to the public utility's balance between costs and revenues. What distinguishes our model is the fact that our assumptions allow additional understanding of the role some important variables play in the price discrimination process, such as the households' income inequalities, the aversion to income inequality, the production function's returns to scale parameter, and the number of households, not examined in Le Grand's article and, some of them, not examined in Roberts' article.

Markandya and Pemberton (1989) had the intention to derive marginal discriminatory prices for electricity consumption, under the constraint that all households have a certain minimum level of consumption and that prices could cover costs, including the costs for expansion of capacity. Their idea was to allow marginal prices to deviate the least possible from marginal cost to reach these objectives, that is, they want to derive these prices by minimizing the aggregated deadweight loss. Thus, their model would determine two discriminatory prices: a lower one (below marginal cost) to be charged for a household consumption up to that minimum required level, and a higher price (above marginal cost) for a larger consumption. In the formalization of their model, the authors did not considered, however, the possibility of aggregating the households' deadweight losses taking into account different social welfare weights being attributed to each deadweight loss to allow distributional objectives to be introduced into the analysis.[18] It should also be mentioned that although the authors allude to the objective of deriving prices that cover costs, they did not include this constraint in their model.

A recent article by Sharkey and Sibley (1993), addressed to derive optimal nonlinear prices for different types of consumers, intends, among other objectives, to examine how price schedules are affected by different social welfare weights. They found that the traditional result that the marginal price paid by the largest customer type should equal to the marginal cost is only true if the regulator uses a decreasing set of social welfare weights; if the set of weights is increasing, the marginal price can be less than marginal cost. The problem of their approach is to define costumer type in terms of volume of use. As we saw in chapter 1, volume of use is not a perfect discriminant for household type, if we mean, household socio-economic condition, that is, if we are interested in

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[18] In chapter 4 of this thesis we derive discriminatory prices under a minimum entitlement constraint, allowing social welfare weights vary amongst households.

distributional aspects of pricing.

The World Bank has been the main source of financial resources to help developing countries building their economic and social infrastructure, and Brazil is one of its main borrowers. In recent decades, it is hard not to see the lending resources of the Bank being applied throughout the country in development projects, complementing local resources, most of the time in a decisive way. As such, the Bank has some leverage in inducing the way projects are designed and implemented in Brazil and other Third World countries. In the case of public utility pricing, the Bank's policy is defined in an internal guideline that sets out a two-step procedure: first step, efficient prices should be calculated; and second step, adjust these prices to incorporate non-efficient objectives. Efficient prices for the Bank are marginal costs plus any additional amount required to clear the market; as to the non-efficient objectives, they related to:

1) income distributional aims: subsidies targeted to favour low income consumers, and other types of subsidies,

2) fiscal aim: prices being used to raise public revenue, and

3) financial aims: mainly the enterprise to be able to raise funds to meet the needs of self finance future investments and to break even.[19]

In reviewing 149 projects and other staff working papers and World Bank reports, Julius and Alicbusan (1989) examined how the recommended Bank approach to public sector pricing has been followed. Since our interest in this thesis is with the distributional aspects of the public utility's pricing policy, we are going to summarize only their findings related to this non-efficiency objective. Basically, what they found was that in the

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[19] Heady's (1989) paper, already mentioned, examines the way in which the Bank's two-step procedure should take into account fiscal and financial objectives.

case where distributional objectives had been taken into account, the first-step of the Bank's procedure was usually ignored, that is, the efficient prices were not estimated. They also found that, although the Bank's manual on economic evaluation of projects recommends the use of differential weights to be applied to different beneficiaries of the projects, no explicit distributional weights were used either to derive prices or to evaluate projects; the alternatives used were some measurement of the percentage of project beneficiaries below some poverty line and a rule of thumb for price affordability , such as the commonly applied 5% of income that a poor household could devote to water services and 20-25% of their income on shelter. One fourth of the power projects and 64% of the water supply projects used some type of increasing block tariff structure for distributional purposes. However, Julius and Alicbusan state that this type of price schedule (based on consumption) did not always achieve the intended distributional objectives; this is an additional confirmation of our analysis made in chapter 1.

It is worth mentioning that the analysis we make in chapter 5, in which we discuss public utility pricing in relation to poverty objectives, may contribute to a better design and evaluation of projects being considered by development agencies such as the World Bank and the Inter American Development Bank.

2.3.3 - *Distributional goals in the Brazilian literature on public utility pricing.*

The Brazilian economic literature on public pricing is strongly concentrated on competitiveness, financial and macroeconomic analyses of the sectors in which the state has a predominant presence, such as the oil and steel industries, telecommunication and power generation and distribution. Examples of this literature are the works by Rodrigues (1984), Portugal (1988), and Batista and Correia (1991). The distributional aspects of their pricing and investment policies have not been considered in these studies.

Pricing of public utilities in Brazil has been treated in an ad-hoc way, being the official policy mainly focused in terms of the need to adjust their rates in such a way as not to lead to additional inflation and to allow the poor to pay for the services they consume. We were not able to find any study that represents analytical effort to derive prices that are consistent with the efficient management of these public enterprises and the distributional objectives set by the Brazilian government. This is the reason for the importance of the present thesis as the first contribution to the subject.

The studies we are going to review now are examples that public utilities prices in Brazil were not adequately studied from a theoretical point of view in respect to their distributional role.

The article by Dornas et al. (1977), prepared for COPASA, the water and sewage company in the State of Minas Gerais, aimed to redefine the price schedule used by that enterprise in order to make it compatible with the income distribution of its customers. The basic idea was that, since the household water consumption is a function of the household income, the distribution of consumption should be equal to distribution of income. Of course, this a wrong idea since there is no theoretical justification for this assumption; if the the assumption were true, 40% of the cars sold in Brazil should be priced as to be owned by the poor, about 40% of the population. The article continues by adjusting a mathematical function that forces the coincidence of those two distributions, constrained by the given level of the public utility's revenue.

The study prepared by Acqua-Plan (1980) for FIDEM, the regional state agency for the development of the Recife's metropolitan region, examines how several public services are provided in that region, finds examples of income regressive prices being charged, and sets some guidelines to be followed in pricing these services, such as what the study calls "equalitarian access to the population" (what means affordability to all), redistribution of real income, and the public utility's financial break even. The study proposes a price function that shows initially decreasing rates to induce consumption up to a certain level considered important from a social point of view and, after this point, increasing rates as a way of penalizing a large consumption.However, Acqua-Plan made no effort to derive any price schedule that would follow the guidelines advanced in its study.

The work written by Castanhar (1983) is the first one to collect information about policies and practices of public services pricing in Brazil. It is not a theoretical study, it is a descriptive study of the general norms applied by public enterprises in sectors such as water and sewage, public transportation, and electricity.

The paper by Andrade (1984) is the precursor of our present thesis. In this study we estimated an Engel function for household water consumption and applied the price schedules used by the water companies of the states of Rio de Janeiro and Parana to calculate the households' outlay with that service, by household income. The idea was to test the possibility of income regressiveness generated by their price schedules, what was confirmed by our findings. The second part of the paper was dedicated to simulated alternative price schedules for different levels of progressiveness in prices. SANEPAR's (1987) work gave us the opportunity to repeat our exercise without having to estimate the household's consumption: the sample data collected by SANEPAR contain not only the metered household consumption, but also the informed household income. Although both studies are good illustrations of the fact that the intended distributional objectives these price schedules should pursue were not achieved, however, they share the same problems concerning the simulations performed: first, the implicit assumption of perfect inelasticity of the demand is inappropriate; and second, the imposition of a given level of price progressiveness is arbitrary, without a theoretical justification.

APPENDIX TO CHAPTER 2

SOCIAL WELFARE, UTILITY AND DEMAND FUNCTIONS

The Pareto optimal criteria are not sufficient to define an desirable resource allocation when the state wants to introduce value judgment into the analysis in respect to the distribution of welfare. When there is a social preference ordering concerning some sets of states of welfare distribution, this preference should be explicitly considered and the Pareto criteria adapted to allow explicit interpersonal comparisons of well-being. This is the case when the government establishes norms as to how these public utilities should depart from charging a single price to their consumers in order to subsidize or cross-subsidize them , as is the case in Brazil and some other developing countries.

One of the ways of introducing value judgments in the process of designing a government policy is to use a social welfare function that makes explicit the policy-maker's preferences. A social welfare function (SWF) is, although not necessarily, a mathematical ordinal function on individuals' utilities that aggregates in a single value the total society's well-being over specific social states.

Boadway and Bruce(1984) mention that the concept of the SWF was formulated by Bergson (1938) and that the most general form of it is the Bergson-Samuelson SWF :

$$W(x) = F\,[\,u_1(x)\;,\;u_2(x)\;,\ldots,\;u_h(x)\,] \qquad (2.1)$$

where $u_i(x)$, $i=1,\ldots,h$, is the utility of the individual i in relation to the consumption of the vector of commodities x .

It is important to assume that the SWF is differentiable and that it has the following properties:

i) The SWF increases in value for increasing individual's utility;

ii) The social welfare indifference curves associated with a given SWF are negatively sloped;

iii) Those social welfare indifference curves further located in relation to the origin measure higher levels of welfare;

iv) The social indifference curves are concave or quasi-concave.

Boadway and Bruce(1984) relate that a Bergson-Samuelson SWF is a very demanding function in terms of informational requirements. There is another family of SWF, less demanding and more specific in functional form, the isoelastic SWF:[20]

$$W = \frac{\sum_{i=1}^{h} a_i (u_i)^{1-\rho}}{1 - \rho} \qquad \text{for } \rho \neq 1 \tag{2.2}$$

and

$$W = \sum_{i=1}^{h} a_i \ln u_i \qquad \text{for } \rho=1 \tag{2.3}$$

where $1-\rho$ is the constant elasticity of the marginal social utility and ρ measures the degree of aversion to inequalities in utilities.

From the general isoelastic SWF we can derive:

i) the *generalized utilitarian* SWF (for $\rho=0$):

$$W = \sum_{i=1}^{h} a_i u_i \tag{2.4}$$

where a_i are different weights applied to the individual's utilities to express the policy-maker's preferences concerning their gains in utility. When the $a_i = 1$, we have the "Benthamite" SWF, where society's welfare is simply the sum of the individuals' utilities.

ii) the *Bernoulli-Nash* SWF:

$$W = \prod_{i=1}^{h} u_i \tag{2.5}$$

where the social welfare is the product of the individual's

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[20] Such a function is also known as the Atkinson SWF after his article on income inequality. See Atkinson(1970).

utilities.

iii) the *generalized Bernoulli-Nash* SWF:

$$W = \prod_{i=1}^{h} (u_i)^{a_i} \qquad (2.6)$$

iv) the *Rawlsian* SWF :

$$W = \min \left[u_1, u_2, \ldots, u_h\right] \qquad (2.7)$$

that interprets Rawls' political ideas of social justice by measuring the social welfare in terms of the utility of the worst-off individual or group.

It can be proved that the Rawlsian SWF can also be derived from the general isoelastic SWF: monotonic transformations made in expression (2.2) (that is leaving undisturbed its ordinal property) and assuming $a_i=a_j$ for all i and j, allows us to write that social welfare function as:

$$W = \left[\sum_{i=1}^{h} u_i^r\right]^{1/r} \qquad (2.8)$$

where $r=1-\rho$.

When $r<0$ and u_1 is the minimum of $(u_1,u_2,\ldots,u_h)$, as in the Rawlsian case, it can be proved that:

$$\left[\sum_{i=1}^{h} u_i^r\right]^{1/r} \geq 2^{1/r} u_1 \qquad (2.9)$$

and that

$$u_1 = \lim_{r\to\infty} \left[\sum_{i=1}^{h} u_i^r\right]^{1/r} \qquad (2.10)$$

what proves that the isoelastic SWF, expression (2.2), is also a Rawlsian SWF .

A social welfare function operates on individuals' utilities to evaluate total society's well-being. Those utilities are expressions of the individuals' utility functions that assign values to consumer preferences; in other words, a utility function is usually assumed to be a continuous mathematical function that assigns a number to given consumption bundles, attributing a higher value to the most preferred one and smaller values to the less-preferred bundles, in an ordinal scale.[21]

There are several mathematical specifications for a utility function. However, some theoretical studies use a general form to express the utility function; for instance :

$$U_j = U_j\ (x_j^1,\ x_j^2\ ,\ldots,\ x_j^n\ ) \tag{2.12}$$

where some of the x_j's are the quantities of the commodities consumed by the individual or household j and some other x_j's measure his effort in obtaining them (the amount of work or, in the reverse, his time availability for leisure).

The most commonly used utility function is the *Cobb-Douglas* because of both its mathematical tractability and its empirical relevance; its general form for a group of n commodities can be expressed as:

$$U(x_1,\ldots,x_n)= x_1^{\alpha_1}\cdot x_2^{\alpha_2}\ldots x_n^{\alpha_n} \tag{2.13}$$

where α_i , for i=1,...,n , are parameters ; sometimes it is useful to assume that $\alpha_1+\alpha_2+\ldots+\alpha_n = 1$. It should be noted, however, that the choice of the utility function to represent consumers' preferences should be based on their observed behaviour, that is, on empirical demand conditions.

It can be proved that the Marshallian demand functions for x_i in the case of a Cobb-Douglas utility function can be derived from the conditions of maximization of that function subject to the consumer's budget restriction, that is , $p_1x_1 + p_2x_2 +\ldots+ p_nx_n = y$, where $p_1\ ,p_2,\ldots,p_n$ are the prices for each of the n commodities, and y is the consumer's income. These demand functions are expressed

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[21] It can be proved that this utility function's existence depends on the consumer's preference being complete, reflexive, transitive, continuous, and strongly monotonic. Deaton and Muellbauer (1980, pp.26-30) list a more complete set of axioms of choice, but call the attention that not all of them are equally important: reflexivity, completeness, transitivity, continuity, nonsatiation and convexity.

as:

$$x_i(p_1,p_2,\ldots,p_n,y) = \frac{\alpha\, y}{p_i} \quad \text{for } i=1,\ldots,n. \tag{2.14}$$

what means that the price and income elasticities are unitary.

The indirect Cobb-Douglas utility function (that is, that one that expresses consumer's utility not in terms of the quantities consumed of the commodities, but in terms of the commodities prices and consumer's income) is found by replacing x_1, $x_2,\ldots,$ x_n in expression (2.13) by expression (2.14). By doing that we get:[22]

$$v(p_1,p_2,\ldots,p_n,y) = \frac{y}{k\, p_1^{\alpha_1}\, p_2^{\alpha_2}\ldots p_n^{\alpha_n}} \tag{2.15}$$

where $k = \alpha_1^{-\alpha_1}.\alpha_2^{-\alpha_2}\ldots.\alpha_n^{-\alpha_n}$.

In this thesis we will be using the general form of the isoelastic social welfare function [expression(2.2)] and the Cobb-Douglas utility function [expression (2.13)] in chapter 3 to illustrate how we can estimate the social welfare weights being implicitly used in current public utilities' price schedules. Both functions are also used in the same chapter to make a illustrative study of how price differentials are sensitive to different social welfare weights being attributed to households' individual welfare.

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[22] The Marshallian demand functions can be derived from the indirect utility function using the Roy's identity: $x_i = (\partial v/\partial p_i)/(\partial v/\partial y)$, for $i=1,\ldots,n$.

CHAPTER 3

PUBLIC UTILITY PRICING AND SOCIAL WELFARE MAXIMIZATION

3.1 - *Introduction*

As we described in chapter 1, public utilities in Brazil have been using price discrimination for quite a long time with the purpose of helping those households with lower incomes to have better access to the public services they provide. When we surveyed the literature on public pricing, as examined in chapter 2, we could not find any study dealing with the economic principles that were used to derive the current price schedules in use in Brazilian public utilities. The purpose of this chapter is to fill this gap by deriving discriminatory prices taking into account distributional goals set by the government. This chapter also intends to show:

1) how these discriminatory prices must be adjusted in response to economic changes that alter the income distribution;

2) how to estimate the implicit welfare weights used by the public utilities in their current price schedules; and

3) how prices are sensitive to different welfare weights used by the government.

The main theoretical developments are in section 3.2. The analysis of the adjustments required in the discriminatory prices caused by changes in the income distribution is made in section 3.3. In section 3.4 we assess the implicit weights being used by public utilities in Brazil and in section 3.5 we examine the sensitivity of the optimal prices to different welfare weights; it should be noted that the findings of the analyses made in those two sections are only valid for the special case of a Cobb-Douglas utility function. The idea of examining this particular case was to illustrate the analytical potential of the model developed in this chapter; the implementation of such analyses in a real case will require an additional research to estimate the appropriate utility function to be used. The optimal prices derived in section 3.2 are found under the assumption that there is no quantity restriction on the level of the output produced by a public utility. We remove this assumption in section 3.6 and we derive prices that take into account the possibility of a fixed capacity constraint in the production of the commodity; in the same section we examine the conditions under which a capacity expansion is warranted and how the welfare weights affect the decision to invest. The final section highlights this chapter's main findings.

In an appendix to this chapter we examine price discrimination when the provision of public services is made not by a state-owned enterprise but by private firms. We derive prices under the assumptions that: i) the firm is not price-regulated; ii) prices are set in such a way that a required minimum level of social welfare is satisfied; iii) the regulatory body imposes a maximum rate of return; and iv) a price-cap regulation is used. This appendix is just a progress report of our work on the distributional aspects of these prices. This is one of the areas we intend to explore more deeply in our future work.

The theoretical part developed in this chapter shares the main area of discriminatory prices already explored in the articles written by Le Grand (1975), Roberts (1979), and Sharkey and Sibley (1993). However, the analysis made here advance their findings by investigating how these prices are affected by different demand characteristics of the consumers, by alternative levels of discrimination and by the number of low income households.

3.2 - *Discriminatory Prices in a Maximization of Welfare Context.*

The objective of this section is to derive discriminatory prices to be charged to households that consume services provided by a public utility under a general objective of maximization of society's welfare and subject to a financial balance constraint.

To simplify the analysis, let us make the following assumptions:

Assumption 3.1: the economy produces two kinds of commodities: commodity 1 is produced by a public utility and sold to consumers at a discriminatory prices; commodity 2 is a composite good comprising all others goods sold in this economy.

Assumption 3.2: n-households grouped in K homogeneous subsets according to their monthly income ; the same income Y_j is earned by each of the n_j households which are components of group j, where j=1, ...,K.

Assumption 3.3: All households have the same set of preferences given by a utility function

$$U_j=U(X_{1j},\ X_{2j}) \tag{3.1}$$

where X_{1j} and X_{2j} are the quantities each household chooses to consume of commodities 1 and 2 according to its preferences and the budget constraint set by the prices of both commodities and the household income Y_j. This means that the choices of the poor are the same of the non-poor should the income of the poor become equal to the income of the non-poor, and vice-versa.

Assumption 3.4: The government wishes the public utility to set prices that maximize the social welfare function

$$W = W\ (\ U_1^1,\ldots,U_1^{n_1},U_2^1,\ldots,U_2^{n_2},\ldots,U_k^1,\ldots,U_k^{n_k}) \tag{3.2}$$

subject to the constraint that its cost minus revenue,i.e. deficit, equals a fixed amount $\bar{D}$.[1]

Assumption 3.5: The public utility's cost is a function of the total quantity of commodity 1 produced, that is:

$$C\ =\ C(X_1) \tag{3.3}$$

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[1] In this thesis we assume that the value taken by $\bar{D}$ is exogenously determined; we make no attempt to derive its size. An optimal size for $\bar{D}$ would be derived from a general equilibrium model in which all the alternative allocations for public expenditures would be considered.

where $$X_1 = \sum_{j=1}^{K} n_j X_{1j} \quad , \text{ and} \tag{3.4}$$

$$X_{1j} = X_{1j}(P_{1j}, P_2, Y_j) \tag{3.5}$$

is the quantity of commodity 1 bought by household type j, where P_{1j} and P_2 are the prices paid for both commodities.

Since the government's objective is that commodity 1's prices should be determined in such a way that the social welfare be maximized subject to the constraint that the government's transference of financial resources to cover any deficit should not exceed a specified amount, we can write that the function to be maximized as

$$L = W + \mu \left[\bar{D} - C(X_1) + R(X_1, P_{1j})\right] \text{ for } j=1,\dots,K \tag{3.6}$$

where $R(X_1, P_{1j})$ is the public utility's revenue and μ is the Lagrange multiplier for the financial balance constraint.

Assuming that L is a concave function, the Kuhn-Tucker conditions for a maximum of L are:[2]

$$\partial L/\partial P_{1j} \le 0 \ , \tag{3.7}$$

$$P_{1j} .\ \partial L/\partial P_{1j} = 0 \quad \text{for } P_{1j} \ge 0, \tag{3.8}$$

$$\partial L/\partial \mu \ge 0 \quad \text{and} \tag{3.9}$$

$$\mu .\partial L/\partial \mu = 0 \text{ for } \mu \ge 0 \tag{3.10}$$

Let us call $\partial W/\partial U_j = w_j$ (the welfare weight attributed to household type j's gain in utility). We also know that

$$\partial U_j/\partial P_{1j} = -\lambda_j X_{1j} \tag{3.11}$$

where λ_j is the marginal utility of income for household type j. Then we can write that the first-order conditions for a maximum are:

$$\frac{\partial L}{\partial P_{1j}} = - n_j \sigma_j X_{1j} + \mu n_j \left(-m \ . \ \frac{\partial X_{1j}}{\partial P_{1j}} + (X_{1j} + P_{1j} \frac{\partial X_{1j}}{\partial P_{1j}})\right) \le 0 \tag{3.12}$$

for $j = 1, \dots, K$, where $m = \partial C/\partial X_{1j}$, the marginal cost of

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2 The concavity of L is resulting from the assumed concavity of the social welfare function and the convexity of the cost and the revenue functions.

production, and σ_j ($\sigma_j = w_j.\lambda_j$) is the j's marginal social utility of income.[3]

$$\frac{\partial L}{\partial \mu} = \bar{D} - C(X_1) + \sum_{j=1}^{K} n_j X_{1j} P_{1j} \geq 0 \quad \text{for } j=1,\ldots,K \tag{3.13}$$

For a non-negative P_{1j} we must have $\partial L/\partial P_{1j}=0$. Then equating expression (3.12) to zero, dividing it by n_j and X_{1j}, we find that the marginal social utility of income is:

$$\sigma_j = \mu\left[\frac{m\varepsilon_{1j}}{P_{1j}} + 1 - \varepsilon_{1j}\right] \qquad j=1,\ldots,K \tag{3.14}$$

where $\varepsilon_{1j} = -\frac{\partial X_{1j}}{\partial P_{1j}}.\frac{P_{1j}}{X_{1j}}$ (that is, the demand price elasticity of good 1 for household j).

Expression (3.14) can be used to define the price P_{1j} and the price ratio P_{1i}/P_{1j} respectively as:[4]

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[3] We saw in section 2.3.1 that the concept of marginal cost being used here can be one which incorporates capital costs or not, that is, long-run or short-run marginal cost and cited a literature that dicusses the advantages and disadvantages of using one or the other concept. In this chapter, since we assume that capacity of production is adjusted instantaneously to quantity demanded (there is no shortage of capacity) when this adjustment is required, the marginal cost will be the long-run one when capital costs are being incurred by the public utility to expand its capacity. See in section 3.6 the analysis of how the price schedule changes when capacity of production becomes a constraint.

[4] Expressions (3.15) is identical to Le Grand's (5) since the first-order condition $\partial L/\partial P_{1j}=0$ is not dependent on the number of households in each group. It should be noted that the solution for P_{1j} (that is, those prices that satisfy also the public utility financial restriction) requires replacing both P_{1j} and X_{1j} in expression (3.13) by expression (3.15) and by the consumer j's demand function for commodity 1, respectively, and solving it in terms of P_{1j}.

$$P_{1j} = \frac{m}{1 + \dfrac{\sigma_j - \mu}{\mu\, \varepsilon_{1j}}} \qquad \text{for } j=1,\ldots,K \tag{3.15}$$

$$\frac{P_{1i}}{P_{1j}} = \frac{1 + \dfrac{w_j \lambda_j - \mu}{\mu\, \varepsilon_{1j}}}{1 + \dfrac{w_i \lambda_i - \mu}{\mu\, \varepsilon_{1i}}} \tag{3.16}$$

Expression (3.15) shows that the optimal price to be charged to household j can be equal, below or above marginal cost depending on whether $\sigma_j \gtreqless \mu$.[5] Since $\sigma_j = w_j\ \lambda_j$, that is, since the marginal social utility of income can be modified by the weight the planner puts of j's marginal utility of income λ_j, actually the determination of whether P_{1j} is equal, greater or smaller than the marginal cost is dependent on the value attributed to w_j, that is, the price derived for households type j according to the welfare weight attibuted to their gain in utility. The possibilities are:

$$\left.\begin{array}{l} \text{i) if } w_j > \mu/\lambda_j \text{ , then } P_{1j} < m \text{ ;} \\ \text{ii) if } w_j < \mu/\lambda_j \text{ , then } P_{1j} > m \text{ ; and} \\ \text{iii) if } w_j = \mu/\lambda_j \text{ , then } P_{1j} = m \text{ .} \end{array}\right] \tag{3.17}$$

It is important to note that the role played by the demand price elasticity: in case *i*, increasing values for ε_{1j} makes P_{1j} smaller, while in case *ii* , increasing values for ε_{1j} makes P_{1j} greater. This means that the less essential is the service for household j, the smaller is the price P_{1j} relative to the marginal cost if $w_j > \mu/\lambda_j$, and greater P_{1j} if $w_j < \mu/\lambda_j$. In case *iii* , increasing elasticities

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[5] See in section 4.2.2 how expression (3.15) relates to a price formula [expression (4.20)] that takes into account a minimum entitlement pricing policy such that $X_{1j} \geq X_o$, where X_o is a minimum consumption exogenously defined.

does not affect the optimal price since its value will be always equal to the marginal cost.

Expression (3.16) allows us to examine how different values taken by the households' demand price elasticities for this commodity and their welfare weights affect the prices ratio P_{1i}/P_{1j}. Let us examine the following four cases concerning the possible values taken by the households i and j's demand price elasticities and the relative weights $w_i/w_j = 1$ and $w_i/w_j > 1$. In the second case ($w_i/w_j > 1$), we are assuming that the government decided to attribute to household i a higher welfare weight in relation to that attributed to j in order to favour i in the price schedule used by the public utility; household i (the poor) has a marginal utility of income greater than household j (the non-poor), that is, $\lambda_i > \lambda_j$.

Demand Price Elasticities	Weights	
	$w_i = w_j$	$w_i > w_j$
$\varepsilon_{1i} > \varepsilon_{1j}$	Case A	Case B
$\varepsilon_{1i} < \varepsilon_{1j}$	Case C	Case D

It should be noted that the difference in demand price elasticities between households i and j is explained by their different incomes, that is, $\varepsilon_{1j}=f(Y_j)$.

Cases B and D, in comparison with cases A and C, are situations in which we assumed that the welfare weight of the poor has been increased; hence, by expression (3.16) it is clear that the higher is w_i, when everything is constant, the smaller will be the price ratio P_{1i}/P_{1j}, that is, the smaller P_{1i} relative to P_{1j}.

Let us first examine cases A and C:

<u>Case A</u>:

If

$$\frac{w_j\lambda_j-\mu}{\mu\ \varepsilon_{1j}} = \frac{w_j\lambda_i-\mu}{\mu\ \varepsilon_{1i}} \tag{3.18}$$

then $P_{1i}=P_{1j}$. But for $P_{1i}= P_{1j}$ we need to have

$$\frac{w_j\lambda_i-\mu}{w_j\lambda_j-\mu} = \frac{\varepsilon_{1i}}{\varepsilon_{1j}} \tag{3.19}$$

This equality is impossible since $\lambda_i>\lambda_j$ and $\varepsilon_{1i}< \varepsilon_{1j}$. Then, both prices cannot be equal.

We can prove that P_{1i} cannot be greater than P_{1j} for the same reason. The only possible result is the price of the poor being smaller than the price paid by the rich.

As we mentioned before, for case B, this smaller price charged to the poor can be lowered by increasing the welfare weight attributed to them.

<u>Case C</u>:

For this case we have that $\varepsilon_{1i}/\varepsilon_{1j}>1$. In this case we can have either $P_{1i}=P_{1j}$, or $P_{1i}>P_{1j}$, or $P_{1i}<P_{1j}$; the equality or the inequality of these prices depends on the values taken by the ratios

$$\frac{\varepsilon_{1i}}{\varepsilon_{1j}} \quad \text{and} \quad \frac{w_j\lambda_i-\mu}{w_j\lambda_j-\mu} \tag{3.20}$$

If λ_i being greater than λ_j makes the latter ratio equal to the elasticities ratio, both prices will be equal. If that ratio is greater than the elasticity ratio, the price paid by the poor will be smaller; if smaller, P_{1i} will be greater.

Note that increasing the welfare weight attributed to the poor (case D) will affect these results in the following ways:

if $P_{1i}= P_{1j}$: the price paid by the poor will become smaller if

$$\frac{w_i\lambda_i-\mu}{w_j\lambda_j-\mu} > \frac{\varepsilon_{1i}}{\varepsilon_{1j}} \tag{3.21}$$

if $P_{1i} < P_{1j}$: the smaller price paid by the poor will be lowered if the government increases their welfare weight; this result is explained by the fact that that the ratio that contains their welfare weights will have its value increased in relation to the elasticities ratio.

if $P_{1i} > P_{1j}$: the price paid by the poor will lowered; eventually this price can become smaller than that paid by the non-poor. This change depends on the value taken by w_i and how it affects the value taken by the ratio where it appears, in comparison with the elasticities ratio.

3.2.1 - *Analysis of a Special Case: The Cobb-Douglas Utility Function*

Some important relationships can be made explicit in this analysis when one specifies the consumer's utility function mentioned in Assumption 3.3. Let that utility function be represented by a Cobb-Douglas function

$$U_j = X_{1j}^{\alpha}.X_{2j}^{1-\alpha} \text{ , for } j=1,\ldots,K \tag{3.22}$$

where X_{1j} and X_{2j} are the quantities consumed of commodities 1 and 2 by the household type j and α is a function parameter that measures the importance of commodity 1 (the publicly produced commodity), where $0< \alpha< 1$. As we saw in the appendix to chapter 2, this utility function implies an indirect utility function of the form

$$V_j = Y_j/(r \;\; P_{1j}^{\alpha} \; P_2^{1-\alpha}) \quad \text{for } j=1,..,K \tag{3.23}$$

where $r =(1-\alpha)^{\alpha-1}/ \alpha^{\alpha}$.

Using Roy's identity, the demand function for X_1 is derived as

$$X_{1j} = (\alpha Y_j)/P_{1j} \tag{3.24}$$

and, thus, we have $\varepsilon_{1j}=1$, a drawback of the Cobb-Douglas utility function.

The social welfare function (SWF) is of the isoelastic form, here representing the SWF mentioned in assumption 3.4, that is:

$$W = \sum_{j=1}^{K} n_j \frac{V_j^{(1-\rho)}}{1-\rho} \tag{3.25}$$

where ρ is the aversion to welfare inequality parameter.[6]

The planner's evaluation of consumer j's utility gain or its welfare weight, w_j, is the first derivative of social welfare function in respect to the j's utility. Then,

$$w_j = \partial W/\partial V_j = \left(\frac{1}{r\, P_2^{1-\alpha}}\right)^{-\rho} Y_j^{-\rho}\, P_{1j}^{\alpha\rho} \tag{3.26}$$

The public utility cost function, mentioned in assumption 3.5, will be assumed to be of the form

$$C(X_1) = F + mX_1^{\theta} \tag{3.27}$$

where F is the fixed cost, m is a constant and θ is the production function returns to scale parameter. The marginal cost is $\theta\, m\, X_1^{\theta-1}$; when $\theta=1$, the marginal cost is m.

The maximand function is the same expression (3.6) and the first-order conditions for a maximum are:[7]

$$\frac{-\alpha\, n_j\, Y_j^{(1-\rho)}\, P_{1j}^{[-\alpha(1-\rho)-1]}}{[\, r\, P_2^{(1-\alpha)}]^{(1-\rho)}} = \mu\left[\alpha\, \theta\, m\, n_j\, X_1^{(\theta-1)} Y_j\, P_{1j}^{-2}\right] \tag{3.28}$$

$$\bar{D} = F + m\,\alpha^{\theta}\left[\sum_{j=1}^{K} (\, n_j\, Y_j\, P_{1j}^{-1}\,)\right]^{\theta} - \alpha \sum_{j=1}^{K} n_j\, Y_j \tag{3.29}$$

for j=1,...,K.

Price P_{1i} for i = 1,...,K can be found solving (3.28) and

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6 The value of ρ is in the interval $[0,+\infty]$. As explained in the appendix to chapter 2, according to the value taken by this parameter, expression (3.25) represents an utilitarian, or a Bernoulli-Nash, or a Rawls SWF. This function is strictly concave when $\rho>0$ since it implies declining welfare weights attached to the social welfare function.

7 The derivative $\partial R/\partial P_{1j}$ is equal to zero since $\varepsilon_{1j}=1$.

(3.29):

$$P_{1i} = \frac{m^{1/\theta}\ \alpha\left[\sum_{j=1}^{K} n_j\ Y_j^{\frac{(1-\alpha)(1-\rho)}{(1-\alpha)+\alpha\rho}}\right].Y_i^{\frac{\rho}{(1-\alpha)+\alpha\rho}}}{\left[\bar{D} - F + \alpha\sum_{j=1}^{K} n_j Y_j\right]^{1/\theta}} \qquad (3.30)$$

The level of consumption by household i at price P_{1i} is found using expression (3.30) in the demand function $X_{1i}=\alpha Y_i P_{1i}^{-1}$:

$$X_{1i} = \left[\frac{\bar{D} - F + \alpha\sum_{j=1}^{K} n_j Y_j}{m^{1/\theta}\sum_{j=1}^{K} n_j Y_j^{\frac{(1-\alpha)(1-\rho)}{(1-\alpha)+\alpha\rho}}}\right].Y_i^{\frac{(1-\alpha)(1-\rho)}{(1-\alpha)+\alpha\rho}} \quad \text{for } i=1,\ldots,K \qquad (3.31)$$

Note that the price and the quantity formulas are two exponential functions dependent, among other factors, upon the value taken by the aversion to inequality parameter ρ. The exponents in expressions (3.30) and (3.31) are ratios with the same denominator $(1-\alpha)+\alpha\rho$. This denominator is positive since $0<\alpha<1$ and $\rho\geq0$. Then, the sign of the exponent's numerator depends on the value of ρ. It easy to see that P_{1j} is a constant function when $\rho=0$ (the same price for all Y_j) and an increasing function of the incomes for $\rho\neq0$ (prices increase with households' incomes. As to the quantity function, expression (3.31) shows that this function can be either constant (the same quantity demanded for all Y_j) when $\rho=1$, or an increasing function (quantities demanded increasing with incomes) when $\rho<1$, or a decreasing function (smaller quantities demanded with larger incomes) when $\rho>1$.[8]

Using expression (3.30), we can derive the price ratio

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[8] In the following chapter, in section 4.2, we are to use this quantity function with $\rho<1$ to illustrate the problem of households demanding a quantity smaller that the quantity socially considered desirable.

P_{1i}/P_{1j} as

$$\frac{P_{1i}}{P_{1j}} = \left[\frac{Y_i}{Y_j}\right]^{\frac{\rho}{(1-\alpha)+\rho\alpha}} \qquad (3.32)$$

and we see that if $Y_i<Y_j$, then $P_{1i}<P_{1j}$ since the exponent in expression is positive.[9] In other words, the price differentials are a function of the income inequalities: the larger this inequality (Y_i smaller than Y_j), the smaller should P_{1i} in relation to any P_{1j}.

It is clear from expression (3.30) that increasing returns to scale would allow smaller prices to be charged and that decreasing returns to scale would require higher prices as compared to those that would be set at constant returns; assuming constant returns to scale (θ=1) and no aversion to inequality (ρ=0) in the price formula (3.30), the optimal price will be the same for all households, equal to :

$$P_{1i} = P_{1j} = \frac{m}{1 + \dfrac{\bar{D} - F}{\alpha \sum_{j=1}^{K} n_j Y_j}} \qquad \text{for } i \neq j \quad i,j=1,\ldots,K \qquad (3.33)$$

and we can see that the traditional prescription of charging a price equal to the firm's marginal cost would be relevant only if $\bar{D} - F = 0$. For any $\bar{D} > F$, the price should be smaller than the marginal cost.

The mathematical expressions (3.30) and (3.32) are useful to show that a price discrimination schedule designed by a public monopolist may be a necessary instrument for social welfare maximization: unless the social welfare function is a utilitarian one (that is, ρ=0, what implies that the price ratio in expression (3.33) is equal to 1 and $P_{1i} = P_{1j}$ for any j, no matters how unequal are

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[9] It can be shown that the right-hand side of expression (3.32) tends to $(Y_i/Y_j)^{1/\alpha}$, a positive value, when ρ tends to ∞, and tends to 1 when ρ tends to 0.

households incomes), prices should differ among consumers.[10]

In the presence of large income inequalities in a population one should expect that the government uses a social welfare function that aggregates individual utilities applying declining weights as households incomes gets larger. In this case, that is, when $\rho \neq 0$, contrary to the Ramsey rule, prices should differ despite the fact that both consumers have equal demand price elasticities, equal to 1, as shown by expression (3.32).

In the case of adoption of a Rawlsian social welfare function ($\rho=\infty$) by the public utility, the price to be charged to a poor household (those that earn income Y_1, where $Y_1<Y_2<...<Y_K$) will be smaller than determined by an utilitarian SWF, as expected: expression (3.32) shows that the price ratio will be greater when ρ = 0 (the utilitarian function) than when $\rho = \infty$, since in the first case P_{1i}/P_{1j} = 1 and in the second $P_{1i}/P_{1j} = (Y_i/Y_j)^{1/\alpha}$, a value smaller than 1.[11]

It is clear that, as expected, the greater the value of the subsidy $\bar{D}$ given by the government, the lower can be the prices for all consumers. Of course, any financial crisis that hits the government budget can affect the public utility source of resources, which will require price increases for all consumers.

It is interesting to note that in the particular case of the Cobb-Douglas utility function, the cost function characteristics play no role in the determination of the households' relative prices; it depends only on the households income ratio and on the parameters α and ρ, as seen in expression (3.32). However, the cost characteristics affect the absolute price level since $\partial P_{1j}/\partial\theta>0$, as can be seen in expression (3.30). Thus, an increase in production that requires a larger inputs ratio for any input (e.g., an expansion

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[10] As shown by expression (3.16), this equality $P_{1i}=P_{1j}$ when $\rho=0$ for $Y_i \neq Y_j$ will not hold for utility functions for which $\varepsilon_{1i} \neq \varepsilon_{1j}$.

[11] The higher the inequality aversion parameter ρ, the smaller should be the price paid by household i since $\partial P_{1i}/\partial\rho$ <0.

of the capacity of production that brings about an increase in the fixed costs) will demand a proportional rise in all households' prices, keeping their prices ratios unchanged.[12]

3.3 - *Evolution of Public Utility Prices: Development Implications*

As shown in the section 3.2, a policy of price discrimination set by a public utility can be theoretically justified when the economy shows inequalities in the income distribution and the government wants to apply different weights to aggregate consumers' welfare. If economic development reduces income inequalities, then the economic justification for price discrimination would become less important and one should expect that these income redistribution policies give place to social programmes whose primary aim is only the relief of destitution and provide for incapacity.[13]

Current development problems found in Third World countries, particularly in Brazil, caused by economic recession and severe inflation rates make the management of the public utility's pricing policy financially more complex:[14]

i) in case of inflation, there is a tendency to avoid

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[12] See in section 3.6 the analysis of the influence of the capacity of production upon the determination of the public utility's price and its resulting distributional impact.

[13] According to Barr (1987,p.46), for those that share the libertarians views of society, like Friedman and Hayek, this is the only distributional role the government should have in any situation.

[14] According to Silva et al.(1992,pp.33-37), these are some of the economic indicators of the inflationary process and of the recession that have plagued Brazil in the recent period: inflationary rates that fluctuate between 20 and 30 percent per month; continuous fall in the per capita income since the beginning of the 1980s, since the population increased 25 % in the period while gross domestic product increased 19 %; investment rate lowering from the 23 % in 1976 to 9 % in the beggining of this decade; and the private per capita consumption in 1992 returned to its observed level in 1976. According to Table 5.1 in the chapter 5 of this thesis, the percentage of the Brazilian population in poverty has grown to 41 %, of which 19 % live in extreme poverty.

the necessary changes in public prices not only because this is unpopular, but also because the tariff adjustment feeds the inflationary process. Of course, by not undertaking the required adjustment, the public utility will run at a greater deficit to be financed out of government revenues, which also may cause more inflation, perpetuating the need to raise the public utility prices. Inflation and recession are problems that hit households incomes and the resulting outcome of this situation is a process of enlargement of the segment of poor families in the population, with perverse effect on the public utility's revenue;

ii) recession means not only increased unemployment, business failures, and its social consequences, but also less public resources to expand public services in urban areas where is concentrated a large percentage of the population of these countries; it is also known that intermediate and large urban centres of Third World countries have exerted a powerful attraction for migrants from backward areas, expanding the need to satisfy the demand for basic public services to be provided to consumers with low incomes .

All the above problems, by enlarging the number of poor consumers to be served by a public utility, require adjustments to be made in the public utility's price schedules in order to maintain their financial stability. Let us examine the conditions under which prices should or should not change when the number of poor households is increasing; let Y_P, n_P, P_{1P} be the income of the poor households, their number, and the price they are charged for consuming commodity 1, respectively. Our conclusions will be based upon the analysis allowed by expressions (3.30), (3.32), and (3.33), that were derived assuming that the utility function is a Cobb-Douglas one.

a) *Conditions that lead to the constancy of* P_{1P}:

The price P_{1P} should not change if it equals the marginal (and the average) cost of production. This situation occurs when there is constant returns to scale ($\theta = 1$), the social welfare function is utilitarian (ρ = 0, then $P_{1P} = P_{1j}$) and the public utility receives a financial transference from the government that equals its fixed cost, ($\bar{D} = F$), in these circunstances, $\partial P_{1P}/\partial n_P = 0$.

What makes this outcome unlikely is less the possibility of the coincidence of all this conditions, but the unreliable assumption that the government is applying equal welfare weights to different groups when their income inequalities are getting larger.

b) *Conditions that require change in price P_{1P}:*

i) P_{1P} should increase if this price is smaller than the marginal (and the average) cost of production. This happens in the same circumstances mentioned in a, except that the government pays a subsidy larger than the public utility fixed cost ($\bar{D} > F$). which causes $\partial P_{1P}/\partial n_P > 0$. The need to increase the public utility price is clear: the deficit grows larger with expanded n_P, $\bar{D}$ being held constant;

ii) If the conditions are equal to those mentioned in **i**, but $\bar{D} < F$, then price P_{1P} is higher than the marginal cost (that is, prices are covering not only the variable costs but also part of the fixed cost). In this case, the increased quantity of consumers allows the decrease in prices, that is $\partial P/\partial n_P < 0$;

iii) In case of increasing marginal cost of production ($\theta>1$), we have $\partial P_{1P}/\partial n_P>0$ since the numerator of P_{1P} in expression (3.30) will grow larger than the denominator, which will require a rise in that price, other things been constant. This result is also very clear: the increased cost should be met by higher revenue, that is, higher price.[15]

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[15] One possible reason for this increasing marginal cost may be the fact that in general the expanded population in these urban centres tends to live in peripheral areas, very far from the existent networks of public services; the extension of these networks is costly and would supply less densely populated areas of the city.

Our above conclusions are referring to effects upon P_{1P}, but since all the public utility's prices are interconnected, as shown in expression (3.32), when that price needs to be changed, all the others will also change; this change is required to maintain constant the value taken by the price ratio P_{1i}/P_{1j}, whose value depends on the incomes ratio Y_i/Y_j and the values taken ρ and α, the parameters for the aversion to inequality and the importance of the commodity 1 in the households' welfare, respectively, kept unchanged.

As just seen, economic problems and demographic changes that affect the income distribution may have important impacts upon the financial health of a public utility, demanding extra funds from the government (a larger $\bar{D}$) and/or from its consumers (higher prices) to finance a larger deficit. These higher prices will demand adjustments in the quantities consumed, decreasing the level of welfare enjoyed by the households. In distributional terms, this reduction in the total social welfare will be due more to the diminished level of welfare obtained by the poor, forced to adjust to a lower level of consumption.

3.4 - *Price Schedules and Implicit Welfare Weights.*[16]

The price discrimination policies operated by public utilities in Brazil result from general rules established by normative federal agencies and from the consensus among public policy-makers that such policy is socially justifiable faced with the low income levels earned by a large segment of the population.

One cannot find any written justification for the price schedules adopted by these public enterprises, as we mentioned in sub-section 2.3.3 of chapter 2. It seems that the decision to set

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[16] In the introductory section to this chapter we alerted that the use of a Cobb-Douglas utility function in this section and in the following one has the purpose of illustrating the way implicit welfare weights in a price schedule can be unveilled and how a price sensitivity can be made; of course, the results reported in both sections are dependent upon the particular properties shown by that utility function, mainly its unitary demand price elasticity.

their rates was made in an arbitrary way in the past, taking only into account the financial aspects of the question, without using a clear, well-stated set of social welfare objectives to be reached. There are no explicit welfare weights one can question and the only way to analyze them is to guess their values by calculating the weights implied by the price differentials. The objective of this section is to apply the theoretical results of this chapter to estimate the weights used by electricity and water/sewage companies in Brazil. We are going to use the price differentials shown by the price schedules for water/sewage and electricity services we reported in chapter 1.

Consistency of the government's purposes would require the use of the same set of welfare weights to groups of the population when the programmes share the same nature; the degree of aversion to inequality (ρ) shown by the government should not vary across these kind of programmes. Actually, this is a parameter to be monitored by the government, allowing it to diminish in value when the economic development makes the problem of income inequality less important. We see no reason to use different sets of weights for essential urban public services such as residential electricity and water and sewage disposal when the income conditions of their consumers do not vary.

We shall illustrate how the welfare weights ratio can be estimated using the weights ratio implied by the Cobb-Douglas utility function. Then, using expression (3.29), we can write the welfare weights ratio as

$$\frac{w_i}{w_j} = \left[\frac{Y_j}{Y_i}\right]^{\rho} \cdot \left[\frac{P_{1i}}{P_{1j}}\right]^{\alpha\rho} \tag{3.34}$$

The ratio w_i/w_j is affected by two factors, the income ratio Y_j/Y_i (where, by assumption, $Y_i<Y_j$) and the price ratio P_{1i}/P_{1j}, and by the parameters ρ and α. Its income ratio elasticity is determined by the value of ρ, the aversion to inequality parameter: the higher the aversion to inequality, the higher is the change in the relative weight given to household i's gain in welfare in relation to that attributed to j's gain, given an unity percentage change in that income ratio. Its price ratio elasticity is equal to $\alpha\rho$; again, the parameter ρ plays the same role in affecting the weights ratio, yet

its influence is altered by α ($0<\alpha<1$), the parameter that measures the importance of that commodity in the determination of the household's welfare; then, the w_i/w_j 's price ratio elasticity in expression (3.34) will be a value between 0 and ρ, excluded these extremal values.

It should be noted that, for a given price ratio (for instance, 1.37/3.61 = 0.38 in SANEPAR's price schedule, or 0.30/1.00 = 0.30 in DNAEE's) and for constant values for α and ρ, expression (3.34) is an exponential function. As such, the value of w_i/w_j changes positively as Y_j/Y_i: i) in the same proportion, if $\rho=1$; ii) less than proportionate, if $0<\rho<1$; and iii) more than proportionate, if $\rho>1$.

Using expression (3.34) and since we know that $0<\alpha<1$ and assuming that $P_{1i} < P_{1j}$, we can estimate that the welfare weights ratio applied by those public utilities in Brazil are in the following interval:[17]

$$\left[\frac{Y_j P_{1i}}{Y_i P_{1j}}\right]^{\rho} < \frac{w_i}{w_j} < \left[\frac{Y_j}{Y_i}\right]^{\rho} \tag{3.35}$$

Table 3.1 shows the calculated values for the above welfare weights interval for selected income ratios and for some aversion to inequality levels, if the price ratio is equal to 0.38 (SANEPAR) and to 0.30 (DNAEE).

Let us assume that the importance of the public utility's service in the household's welfare (α) can be measured by its relative participation in the household total monthly expenditure. Then, experience shows that the average value for α for public utility's services as water/sewage and electricity is quite low, a value ranging from 0.001 to 0.03, hence, quite close to zero.[18] Then,

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[17] This interval is dependent on the assumptions made of households having a Cobb-Douglas utility function and the government using an isoelastic social welfare function; of course, its estimation will depend on which function most properly represents the behaviour of the households and how the government assesses their welfare.

[18] According to the 1985 national budget survey data, the water/sewage

we can use the extreme lower interval estimates for w_i/w_j shown in Table 3.1 as approximations of the welfare weights ratio used implicitly by SANEPAR and by DNAEE.

Table 3.1: Estimated Values for the Implicit Welfare Weights Ratio in SANEPAR's and DNAEE's Price Schedules for Selected Households' Income Ratios(Y_j/Y_i) and Aversion to Inequality Levels.(*)

(in interval estimate:the lower estimate refers to α=0;the upper estimate refers to α=1)

Y_j/Y_i	Level of Aversion to Inequality			
	ρ=0.1	ρ=0.5	ρ=1.0	ρ=2.0
SANEPAR:				
1	0.90-1.00	0.61-1.00	0.38- 1.00	0.14- 1.00
5	1.06-1.17	1.37-2.24	1.90- 5.00	3.61- 25.00
10	1.14-1.25	1.94-3.16	3.80-10.00	14.44-100.00
15	1.19-1.31	2.38-3.87	5.70-15.00	32.49-225.00
20	1.22-1.35	2.75-4.47	7.60-20.00	57.76-400.00
25	1.25-1.38	3.08-5.00	9.50-25.00	90.25-625.00
DNAEE:				
1	0.88-1.00	0.54-1.00	0.30- 1.00	0.09- 1.00
5	1.04-1.17	1.22-2.24	1.50- 5.00	2.25- 25.00
10	1.11-1.25	1.73-3.16	3.00-10.00	9.00-100.00
15	1.16-1.31	2.12-3.87	4.50-15.00	20.25-225.00
20	1.19-1.35	2.44-4.47	6.00-20.00	36.00-400.00
25	1.22-1.38	2.73-5.00	7.50-25.00	56.25-625.00

(*) for SANEPAR's and DNAEE's price ratios of 0.38 and 0.30, respectively.

We can see in table 3.1 that:

i) The estimates for w_i/w_j implicitly used by those Brazilian agencies are quite similar, as should be expected, since the difference in their price ratios (0.38 and 0.30) is too small to affect the estimate;

ii) When the government shows almost no aversion to

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expenditure represents between 0.1 and 1.2% of the total expenditure of a household in Rio de Janeiro,Brazil; for electricity, its expenditure ranges from 1.2 to 3.2%. Source: Fundacao Instituto Brasileiro de Geografia e Estatistica, *Pesquisa de Orcamentos Familiares*, special tabulations.

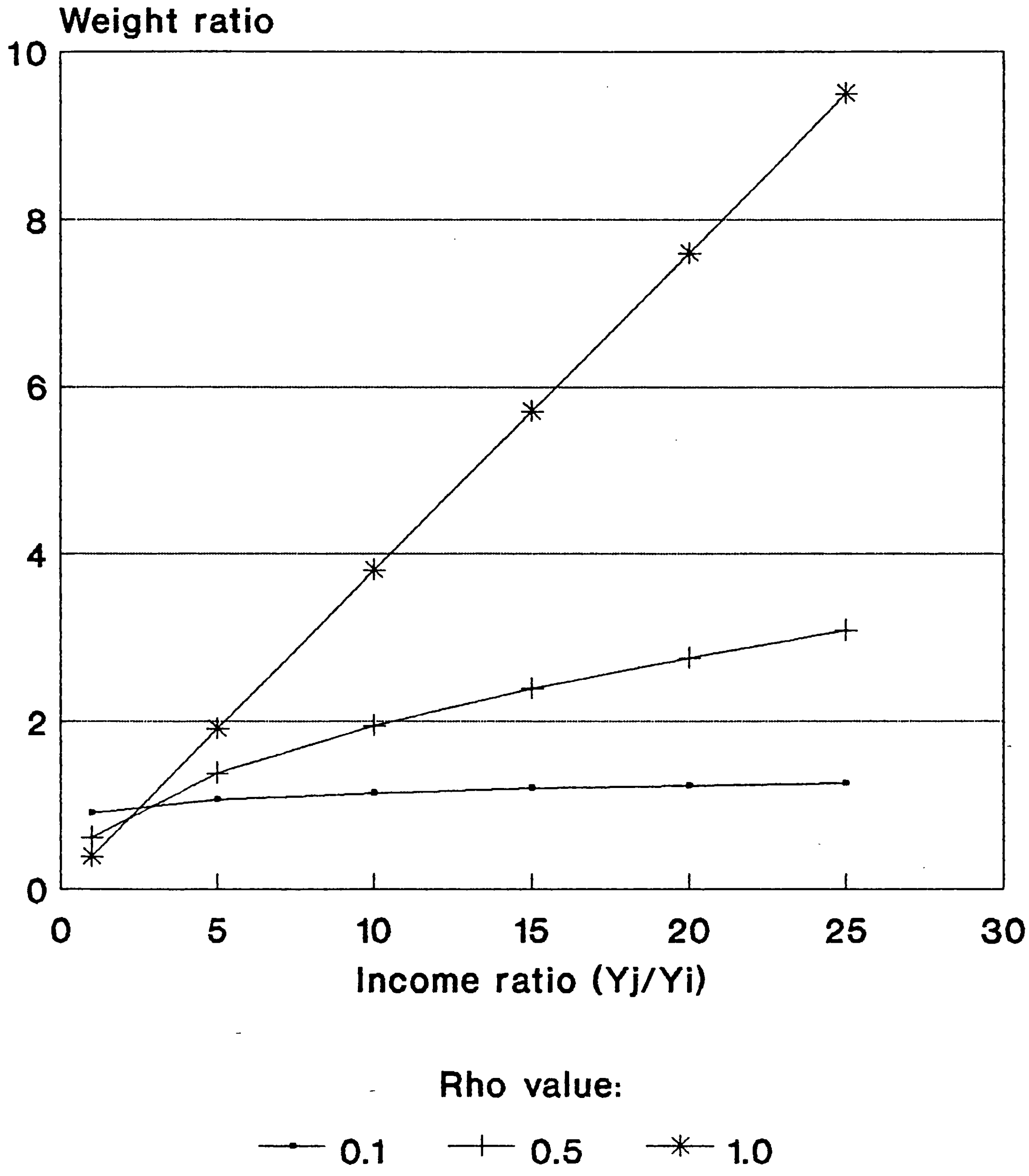
inequality (that is, ρ=0.1), the relative implicit welfare weight varies from about 0.9 (when households' incomes are equal) to 1.25 for SANEPAR and 1.22 for DNAEE (when their income ratio is 25). This means that the government evaluation of their extremely large income inequality (equal to 25) in term of the difference in prices the public utility charges the poorest and the richest households implies only a 25% higher weight given to the poorest one in SANEPAR case;

iii) When the aversion to inequality parameter assumes values between 0.5 and 2, the interval's amplitude becomes larger, the estimates getting closer to 0 for equal households' incomes and getting larger for large income differentials, as aversion to inequality increases. For instance, again for the highest income ratio (Y_j/Y_i=25), the SANEPAR implicit relative welfare weight changes from 3.08 (for ρ=0.5) to 9.50 (for ρ=1) and to 90.25 (for ρ=2). This shows how sensitive the measure of relative social weight is in relation to the value of ρ, the aversion to inequality coefficient. Even for a moderate value of ρ (for instance, ρ=0.5), the price ratio 0.38 implicitly means that SANEPAR is attributing to the poorest household's consumption a welfare weight 208% higher than that given to a household that earns an income 25 times larger.

Figures 3.1 and 3.2 are plots of Table 3.1 data for SANEPAR price ratio for two sets of levels of aversion to inequality (ρ equal to 0.1, to 0.5, and to 1.0) and for a higher level (ρ equal to 1.0 and to 2.0), respectively. Both figures show how the welfare weights ratio changes as income differentials become larger and how it diverges for different values taken by ρ. Those figures are also useful to give an approximated value for w_i/w_j for those intermediate values of Y_j/Y_i not shown in Table 3.1.

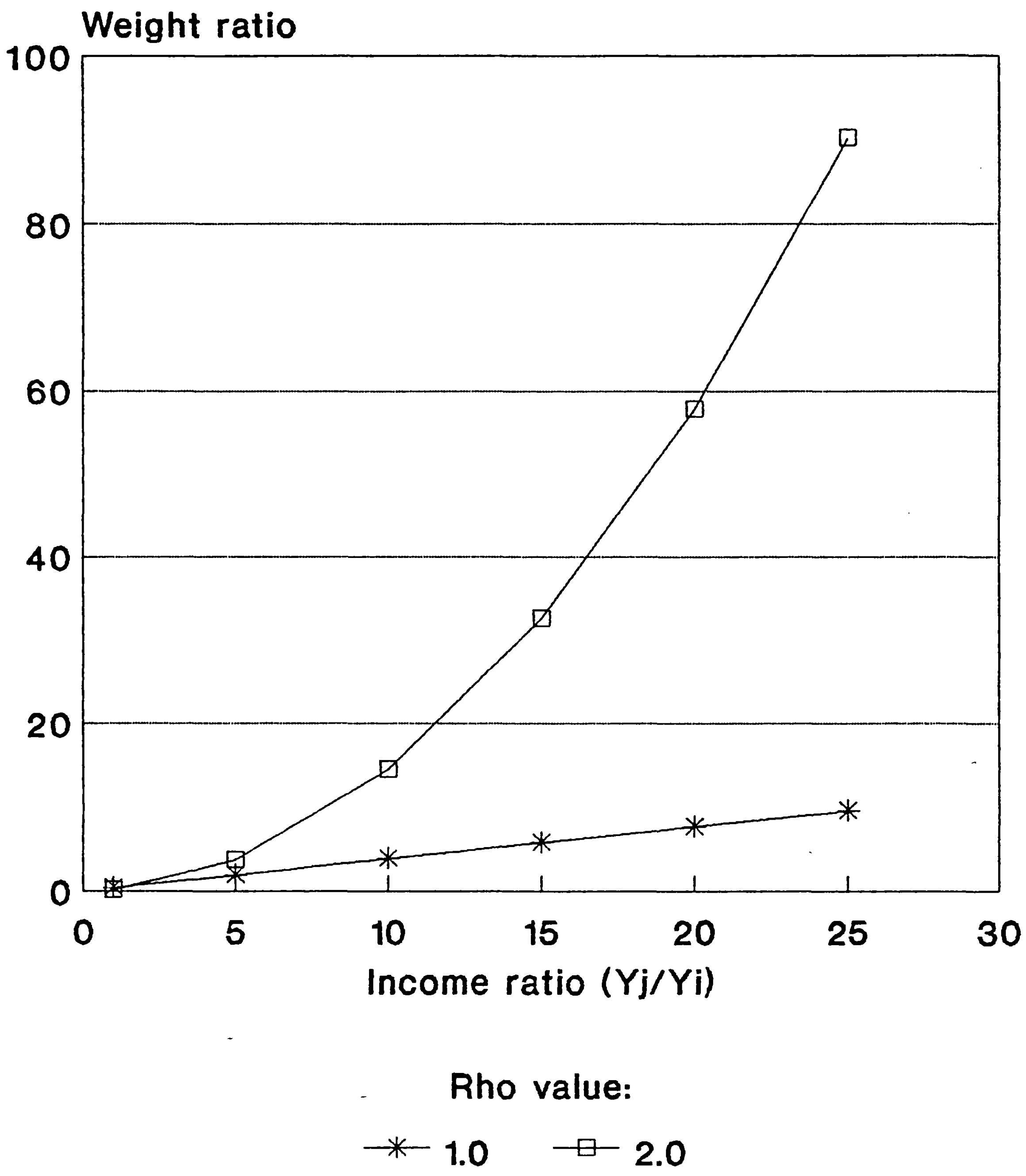
Those estimated values for the implicit welfare weights ratios were calculated using a Cobb-Douglas utility function, a function that implies a demand price elasticity equal to 1 to all households. In a real situation, the values taken by these elasticities may differ. Let assume, for instance, that a rich household has an almost inelastic demand for a public service as those being considered here, while the demand for a poor household is price elastic. In this case, an increase in the price charged to the rich (to make their price ratio departs from equality) increases the public utility's revenue and allows a lower price to be charged to the poor since it is assumed the amount of subsidy is fixed

Figure 3.1
Welfare Weight Ratio (*)



(*)for SANEPAR price ratio of 0.38.

Figure 3.2
Welfare Weight Ratio (*)



(*)for SANEPAR price ratio of 0.38.

(assumption 3.4). Then, in this case a given price ratio implies a higher relative social weight than those that appear in Table 3.1.

3.5 - *Distributional Objectives and Price Sensitivity*

Optimal prices are very sensitive to the distributional objectives set by the government. The objective of this section is to confirm this statement by examining how prices vary in function of selected values taken by the aversion to inequality parameter.

To make the analysis simpler, let assume that households i and j have the same demand price elasticity, equal to 1, and that their welfare weights are different, being larger to households i (the poor), that is , $w_i > w_j$. Note that this is the case B examined in section 3.2.

Let us assume that the price differential paid by SANEPAR consumers (Cr$1.37/ Cr$3.61), as seen in chapter 1, is related to an income ratio of 0.04, that is, those households that pay the highest rate earn an average income 25 higher than that the average earned by the low-consumption households.[19]

To calculate the price ratio compatible with a given value taken by the aversion to inequality parameter we can write expression (3.32) as:

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[19] The values Cr$ 1.37 and Cr$ 3.61 are, respectively, the lowest and the highest marginal rate in the SANEPAR's price schedule. As to the assumption of household income differential, it seems to be reasonable when one fits the following SANEPAR (1987,p.96) information on household income and water consumption into its price schedule :

Income, in number of monthly minimum wages	Monthly consumption of water, in m^3
Up to 1	10.4
1- 2	11.0
2- 5	12.3
5- 10	15.7
10- 20	22.5
More than 20	32.3

$$\frac{P_{1i}}{P_{1j}} = \left[0.04 \right]^{\frac{\rho}{(1-\alpha) + \alpha\rho}} \qquad (3.36)$$

Table 3.2 shows the calculated price ratios for different welfare weights attributed to the households' welfare.

Table 3.2: Price Ratio for Selected Values for the Aversion to Inequality Parameter (ρ) and for the Commodity Importance in Generating Household Welfare (α). (for Y_i/Y_j equal to 0.04)

α	Aversion to Inequality Level			
	ρ=0.1	ρ=0.5	ρ=1.0	ρ=2.0
0.005	0.724	0.199	0.04	0.0016
0.01	0.723	0.198	0.04	0.0017
0.02	0.720	0.196	0.04	0.0018
0.03	0.718	0.195	0.04	0.0019
0.04	0.716	0.193	0.04	0.0020
0.05	0.714	0.191	0.04	0.0021
0.06	0.711	0.190	0.04	0.0023
0.07	0.709	0.188	0.04	0.0024
0.08	0.707	0.187	0.04	0.0025
0.09	0.704	0.185	0.04	0.0027
0.10	0.702	0.183	0.04	0.0028

(*) $P_{1i}/P_{1j} = \left[Y_i/Y_j\right]^{\frac{\rho}{(1-\alpha) + \alpha\rho}}$

Using P_{1j}= Cr$ 3.61 and the calculated price ratios from the above table, we can say that (assuming that $0.005<\alpha<0.10$):[20]

i) if the government chooses to adopt a low value for ρ (let us say, ρ=0.1), then the SANEPAR's lowest rate should be in the interval (Cr$ 2.53-Cr$ 2.61), instead of Cr$ 1.37;

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[20] Since we are fixing the value of P_{1j} equal to Cr$ 3.61, any P_{1i} smaller than Cr$ 1.37, as examined with data taken from Table 3.2, would require a larger subsidy given by the government.

ii) For ρ=0.5, its lowest price should be between Cr\$ 0.66 and Cr\$ 0.71;

iii) For ρ=1, its lowest price should be equal to Cr\$ 0.14, irrespective of the value taken by α;

iv) for ρ=2, the price P_{1i} should be very small, a value between Cr\$ 0.005 and Cr\$ 0.01.

If the aversion to inequality is of the Rawlsian type, that is, $\rho=\infty$, then the price ratio would be equal to $P_{1i}/P_{1j}=0.04^{(1/\alpha)}$. Since the income ratio has a very low value and the exponent is positive, the above expression calculates a price ratio very close to zero for any α. In this case, the actual lowest price to be charged by SANEPAR would be zero .

Data in Table 3.2, as well the above example, allow us to see how increased values taken by the aversion to inequality parameter generate larger discrepancies between the lowest and the highest rates that should be charged by a public utility. It is clear the high sensitivity of the price ratio to the distributional objectives defined by the government.

3.6 - *Public Utility Pricing and Plant Capacity*

In section 3.2 we derived optimal discriminatory prices under the assumption that there was no quantity restriction in the level of the output produced by the public utility to match the total quantity demanded by households. The objective of this section is to remove that assumption by admitting differences between the total quantity demanded and the maximum output available as a result of the public utility's fixed capacity of production. Thus, this section deals with the questions of how capacity and its expansion enter in the determination of optimal discriminatory prices in a welfare maximization context.

A number of authors, such as Rees (1984) and Kahn (1988) have examined the effect of the capacity constraint upon price determination. However, most of the studies that take into account the limitations imposed by the fixed capacity of production are mainly interested in discussing the problem of peak-demand pricing as a way of dealing with congestion costs. In contrast, the focus of this section is concentrated on the distributional effect that the public utility's capacity constraint imposes upon households by requiring higher prices to ration the quantity demanded.

The discussion of the problem of public utility pricing and capacity constraints is very important in the Brazilian context because:

i) the very large population growth of the Brazilian cities poses the need to expand capacity more frequently than that observed in other countries. This growth in population has a large component of poor immigrants, potential candidates to have their consumption of public services subsidized by the other consumers and by the government;

ii) as mentioned before in this thesis, public utilities' rates are a significant component in the Brazilian inflation indices. Hence, the government tries to control inflation by controlling these rates, allowing price adjustments below the past inflation level. This means that their prices will not be able to cover their costs of production and in addition to be able to generate the required resources to expand capacity. Up to May,1993, due to past investments, it has been possible to follow this policy, but the quality deterioration in public services are already visible, as is the case in telecommunications sector.[21]

iii) recently, the government adopted what has been termed "the social public utilities' pricing policy"; in practical terms this means adjusting the lower component of the price schedule (those supposedly paid by the poor consumers) below the inflation rate. This implies that someone else will be called to cover the deficit this measure causes, either the population paying higher

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[21] The weekly magazine VEJA, in its issue of 12/May/1993, page 13, made fun about the "silence" of the telephones, that is, the difficulty in making connections with them.

taxes, public expenditures being transferred from other sectors, higher prices charged to other consumers of that service, or cuts being made in planned expansion of capacity. Since the line of resistance in the short run seems to be least in the latter category, by delaying investments, capacity constraints will soon start operating, reducing the availability and the quality of the public services.

To analyze the role that physical capacity of production plays in the determination of optimal prices requires us to distinguish two components of the total cost, the variable cost $C_1(X_1)$ for $X_1 \leq \bar{X}_1$, and the fixed cost $C_2(\bar{X}_1)$, where X_1 is the total quantity demanded of commodity 1 and $\bar{X}_1$ is the fixed capacity of production. The variable cost has to do with expenditures made by the public utility to pay for labour, raw materials and other inputs whose quantities vary with output; let us assume that its marginal cost is constant, equal to m, for $X_1 \leq \bar{X}_1$. The fixed cost of production is related to all inputs that do not vary with output in the short-run, including the plant capacity. Capacity of production is fixed in the analysis that follows, then m has only to do with the variable inputs we mentioned above and m is the short-run marginal cost since there is no capital costs involved in its definition.[22]

To derive the optimal prices that takes into account the output restriction, we should replace the former cost assumption we have been using by one that states that the total cost of production (TC) is equal to $C_1(X_1) + C_2(\bar{X}_1)$. Now we have to maximize total welfare W subject to the restrictions

$$C_1(X_1) + C_2(\bar{X}_1) - R(X_{1j}, P_{1j}) \leq \bar{D} \tag{3.37}$$

and

$$X_1 \leq \bar{X}_1 \tag{3.38}$$

where R is the public utility's revenue, $\bar{D}$ is the government subsidy, X_{1j} is the quantity consumed of commodity 1 by household type j , and P_{1j} is the price it is required to pay.

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[22] See section 2.3.1 for the literature that discusses the use of short-run and long-run marginal costs in pricing.

The social welfare function is of the following general form:

$$W = W\left[U_1^1,\dots,U_1^{n_1}, U_2^1,\dots,U_2^{n_2},\dots,U_K^1,\dots,U_K^{n_K}\right] \tag{3.39}$$

where

$$U_j = U(X_{1j},X_{2j}) \tag{3.40}$$

is the household's j utility level for consuming quantities X_{1j} and X_{2j} of commodities 1 and 2, respectively.

The maximand function is:

$$L= W + \mu_1 \left[\bar{D} - C_1(X_1) - C_2(\bar{X}_1) + \sum_{j=1}^{k} P_{1j}X_{1j} \right] + \mu_2(\bar{X}_1 - X_1) \tag{3.41}$$

where μ_1 and μ_2 are the Lagrange parameters for the financial balance and for the fixed capacity constraints, respectively.

The Kuhn-Tucker necessary conditions for a maximum are:[23]

$$\partial L/\partial P_{1j} \leq 0 \tag{3.42}$$

$$P_{1j}(\partial L/\partial P_{1j}) = 0 \tag{3.43}$$

$$\partial L/\partial \mu_1 \geq 0 \tag{3.44}$$

$$\mu_1(\partial L/\partial \mu_1) = 0 \tag{3.45}$$

$$\partial L/\partial \mu_2 \geq 0 \tag{3.46}$$

$$\mu_2(\partial L/\partial \mu_2) = 0 \tag{3.47}$$

for $P_{1j} \geq 0$, $\mu_1 \geq 0$ and $\mu_2 \geq 0$.

We have that:

$$\partial W/\partial P_{1j} = \partial W/\partial U_j \ . \ \partial U_j/\partial P_{1j} = -n_j \ \sigma_j \ X_{1j} \tag{3.48}$$

where σ_j is the household j marginal social utility.

$$\partial TC/\partial P_{1j} = \partial C_1/\partial P_{1j} + \partial C_2/\partial P_{1j} = n_j.m.\partial X_{1j}/\partial P_{1j} \tag{3.49}$$

since $\partial C_2/\partial P_{1j}=0$

$$\partial(\bar{X}_1 - X_1)/\partial P_{1j} = -n_j \ \partial X_{1j}/\partial P_{1j} \tag{3.50}$$

since $X_1 = \sum_{j=1}^{K} n_j \ X_{1j}$.

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[23] Assuming that W is a concave function and the functions that enter in the restrictions are convex, these are the necessary and sufficient conditions for a maximum.

Using the above derivatives, we can write that the first-order conditions for a maximum of L are:

$$\frac{\partial L}{\partial P_{1j}} = - n_j \sigma_j X_{1j} - \mu_1 n_j \left[m \frac{\partial X_{1j}}{\partial P_{1j}} - (X_{1j} + P_{1j} \frac{\partial X_{1j}}{\partial P_{1j}}) \right] -$$

$$- \mu_2 n_j \frac{\partial X_{1j}}{\partial P_{1j}} \leq 0 \qquad (3.51)$$

$$\frac{\partial L}{\partial \mu_1} = \bar{D} - C_1(X_1) - C_2(X_1) + \sum_{j=1}^{k} P_{1j} X_{1j} \geq 0 \qquad (3.52)$$

$$\frac{\partial L}{\partial \mu_2} = \bar{X}_1 - X_1 \geq 0 \qquad (3.53)$$

Since P_{1j} should be non-negative, we must have $\partial L / P_{1j} = 0$. Then, using expression (3.51) and rearranging its terms, we can define P_{1j} as:

$$P_{1j} = \frac{m + \dfrac{\mu_2}{\mu_1}}{1 + \dfrac{\sigma_j - \mu_1}{\varepsilon_{1j}\ \mu_1}} \qquad \text{for } j=1,\ldots,K \qquad (3.54)$$

where ε_{1j} is household's j demand price elasticity for commodity 1, that is, $\varepsilon_{1j} = - X_{1j}/P_{1j} . \partial X_{1j}/\partial P_{1j}$.

We see in expression (3.54) that the fixed capacity constraint introduces a new element in the formula of the optimal price that we derived in section 3.2 : we have now an additional term in the numerator, μ_2/μ_1, that disappears when output capacity is sufficient to satisfy the total quantity demanded (which makes $\mu_2=0$) or that adds something to those already derived prices (when $\mu_2>0$, since $\mu_1>0$) in order to check quantity demanded being larger than the feasible output.

The price increase that occurs in case of insufficient capacity of production is a rationing device. Its level depends upon the level of the excess quantity demanded at the existing price and it will be permanent as long as the conditions do not change, that is, the aggregate demand for commodity 1 and the public utility's capacity constraint are the same. In the short run, rationing by price is the efficient way of limiting the quantities since it takes into account consumers' preferences. However, it can be not efficient in the long run when the higher rationing price induces substitution that is not efficient once the rationing process is removed. Price rationing is undesirable in terms of total welfare and should be avoided: those price increases will lower total welfare since they will require adjustments in the quantities consumed not only of commodity 1 (the commodity produced by the public utility), but also in the other goods consumed by the households.[24]

Rationing can also be done by means of non-price mechanisms, such as points rationing (coupons), queuing(congestion) and random rationing (supply interruptions). However, these means are not Pareto-efficient since the allocation of the quantities provided by these non-price mechanisms is arbitrary and has nothing to do with consumers preferences. These mechanisms tends to be regressive since the non-poor, by having a higher income, being better informed and having better access to social influence than the poor, can solve its rationing problem without having necessarily to change its consumption pattern.

Since the aggregate demand for the commodity produced by a public utility tends to grow, either because households' incomes are growing and/or the population is getting larger, the case of insufficiency of capacity of production will appear and then one has to consider adjusting this capacity to the quantity required by consumers. Let us first examine whether the capacity expansion would be warranted or not. Expression (3.54) helps us to give an answer : when the fixed capacity constraint μ_2 is binding, the price that should be charged to household j is $P_{1j} = \dfrac{m + \mu_2/\mu_1}{1 + \dfrac{\sigma_j - \mu_1}{\varepsilon_{1j}\,\mu_1}}$, where $\mu_2 > 0$.

Then, by rearranging the terms,we can express the optimal value for μ_2 as:

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[24] Actually, rationing is undesirable not only from a welfare point of view, but also because it affects the reliability of the service.

$$\hat{\mu}_2=[P_{1j}\ (1 + \frac{\sigma_j - \mu_1}{\varepsilon_{1j}\ \mu_1}) - m]\ \mu_1 \tag{3.55}$$

We know that μ_2 is the shadow price for capacity, that is, its value measures how the maximized value for the total welfare would change in response to an infinitesimal change in capacity. Let us assume that the marginal cost of increasing the capacity is constant, equal to m_1. Then, as long as $\hat{\mu}_2 \geq m_1$, the capacity expansion would be justified since there will a positive net gain in total welfare with the new capacity; if $\hat{\mu}_2 < m_1$, the public utility capacity of production should be kept unchanged and the rationing of the quantities demanded of commodity 1 will follow this decision.

An interesting point to be examined is the effect that welfare weights have upon the decision of the public utility to expand its capacity of production. Let us assume that the government decides, for instance, to increase the welfare weight attributed to the poor's utility, and consequently, to charge them a lower price, that is, let us assume that the government decides to increase the distributive characteristic of the public utility's price schedule. What would be the consequence of this change in terms of the public utility's investment decision ? Expression (3.55) helps with the answer to this question. Let us first study the sign of the derivative $\partial\hat{\mu}_2/\partial\sigma_j$.[25] This derivative is:

$$\frac{\partial\hat{\mu}_2}{\partial\sigma_j} = \left[P_{1j}\ (1 + \frac{\sigma_j - \mu_1}{\mu_1\varepsilon_{1j}}) - m\right].\frac{\partial\mu_1}{\partial\sigma_j} +$$

$$+ \mu_1.\frac{\partial}{\partial\sigma_j}\left[P_{1j}(1 + \frac{\sigma_j - \mu_1}{\mu_1\varepsilon_{1j}}) - m\right] \tag{3.56}$$

Now examine the derivative of the second term of the

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[25] An increase in the welfare weight w_j increases the marginal social utility of income σ_j for a given marginal utility of income λ_j, for $j=1,\ldots,K$, since $\sigma_j = w_j\lambda_j$.

expression (3.56):

$$\frac{\partial}{\partial\sigma_j}\left[P_{1j}(1 + \frac{\sigma_j - \mu_1}{\mu_1\varepsilon_{1j}}) - m\right] = \frac{P_{1j}}{\mu_1\varepsilon_{1j}} + (1 + \frac{\sigma_j - \mu_1}{\mu_1\varepsilon_{1j}}).\frac{\partial P_{1j}}{\partial\sigma_j} \qquad (3.57)$$

We know that $\partial P_{1j}/\partial\sigma_j<0$ and that the expression that multiplies this derivative in (3.57) is positive. Since the first term in expression (3.57) is positive, then this derivative can have any sign. This means that the derivative $\partial\hat{\mu}_2/\partial\sigma_j$ has an indetermine sign since it depends on several circunstances that can produce a positive, or negative or a null sign.[26]

It is easy to understand the reason why that derivative can be positive, negative or null. Let us assume that capacity is sufficient and that the government increases the welfare weight attributed to the poor: the price they should pay decreases and the price the non-poor should pay increases because of the public utility's financial balance constraint. The quantities of commodity 1 demanded by poor and non-poor may change or not, depending on their demand price elasticities for this commodity. The overall quantity demanded can be:

Case a: equal to the former overall quantity demanded by these households. If there was sufficient capacity to satisfy the quantity demanded, now the situation has not changed and there is no reason to expand capacity. Then, the change in the social given to the poor will not affect the decision of investment. In this situation $\hat{\mu}_2=0$ and there is not reason to expand capacity. If capacity was insufficient before that change in the social weight,

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[26] In case of sufficient capacity, we have that

$$P_{1j}(1 + \frac{\sigma_j - \mu_1}{\mu_1\varepsilon_{1j}}) - m = 0 \qquad (3.58)$$

as shown by expression (3.54), since $\hat{\mu}_2=0$. Then, the sign of $\partial\hat{\mu}_2/\partial\sigma_j$ depends on the signs of μ_1 (we know that $\mu_1\geq0$) and on the sign of expression (3.57), which means that $\partial\hat{\mu}_2/\partial\sigma_j \lesseqgtr 0$.

the decision to invest keeps depending on $\hat{\mu}_2$ being greater or smaller that m_1.

Case b: the new overall quantity demanded by households is greater than before. In this case we have three possibilities:

b1: capacity was sufficient and continues to be sufficient, that is, $\hat{\mu}_2$ was equal to zero and keep being equal to zero with the change in the social weight attributed to the poor. The decision, then, is not to expand capacity;

b2: capacity was sufficient (then $\hat{\mu}_2=0$), but now the change in the overall quantity demanded makes the capacity insufficient. This means that the change in the social weight will make $\hat{\mu}_2$ to become greater than zero. The decision to expand capacity will depend on this value for the shadow price for capacity being greater than the marginal cost of expansion;

b3: capacity was insufficient (then $\hat{\mu}_2>0$ and the change in the social weight makes $\hat{\mu}_2$ bigger; whether this increase in value will induce a decision to expand capacity depends on the same comparison mentioned in b2.

Case c: the overall quantity demanded by households is smaller than before. This situations are similar, but with the reverse condition, to those examined in case b, that is, capacity was sufficient and continues to be sufficient and capacity was insufficient but with the change it becomes sufficient (this is the situation that allows $\partial\hat{\mu}_2/\partial\sigma_j <0$). If the value of the shadow price for capacity decreases but it is still greater than the marginal cost of expansion, then the change in the social weight did not alter the decision in favour of the capacity expansion; if it gets smaller, then the decision is to postpone the expansion.

Rees (1984,p.91) has also derived a condition for capacity expansion. For him, the condition is:

$$\lambda^* = p(\bar{q}_0) - v \gtreqless \beta \tag{3.59}$$

where λ^* is the shadow price for capacity, $p(\bar{q}_0)$ is the that limits demand to the capacity constraint, v is the marginal cost, and β is the marginal cost of expansion. In his case, the value of the shadow price for capacity changes as result of an exogenous price change to ration the quantity demanded to the limit of production. In our case, this situation can also happen (as result of changes in households' demands as is Rees' case), but the source of this change can be changes made in the distributional weights attributed to households' utilities. In other words, the households' demands do not change (for Rees, at least one of the individual's demand has to change), but welfare weights do change, causing changes in prices, increasing the value of the shadow price for capacity for rationing the quantity demanded.

3.7 - *Conclusions*

In this chapter we have attempted to make a contribution to the public pricing discussions by examining the way in which price discrimination can be designed to make public utilities a more effective instrument of social policy. We have shown that the use of distributional objectives in the determination of the rates to be charged to different consumers enlarges the range of considerations to be taken into account by the government by requiring a prior definition concerning how public services should be financed: in addition to the amount that the government may transfer to the public utility, one should decide how prices should differ, and consequently, the amount of cross-subsidy among households the price schedule will produce.

It was also clear that the traditionally advocated rules of pricing according to marginal cost or according to the inverse of consumer's demand price elasticity have to be qualified to incorporate other elements that should help to determine the optimal rate to be charged, as well as the price differentials. These elements are not only the welfare weights used, but also the characteristics of the commodity in terms of its importance in generating household's welfare, and the shadow price of the public utility's deficit.

One important finding of this chapter is to show how households demand price elasticities and the welfare weights work together to determine optimal public prices. It was clear that the elasticities ratio has a leading role in price discrimination, determining the values the welfare weights should take to produce prescribed price differentials.

It is important to emphasize the relationship between public utilities price management and the process of economic development. This process implies, for instance, an improvement in the income distribution, which may ease the need to subsidize these public enterprises. Economic development may also bring cost reductions in the production of the public service, permitting lower prices to be charged to consumers. On the other hand, it was interesting to show how the current population growth we observe in urban centres of the developing countries may affect the the price schedules adopted by public utilities: the expansion of their services may require either a larger cross-subsidy paid by the non-poor or/and an increase in the transference of the resources provided by the government to these public enterprises.

It was also shown that currently used price schedules have implicit welfare weights being applied. We illustrated how these weights can be estimated by using the price differentials defined by these schedules. When properly made, this estimation allows the comparison of the implicit welfare weights used by similar social programmes in order to verify their consistency in distributional terms.

The sensitivity of the optimal price schedule was investigated to appraise how alternative distributional objectives affect the determination of discriminatory prices. The exercise we did found that small changes made in the aversion to inequality parameter may generate large price differentials among households.

Finally, we saw in this chapter how a fixed capacity of production affects the determination of optimal discriminatory prices. When there is a need to ration the quantity demanded by households, all prices are increased, but keeping the degree of their price differential. Since poor households spend a larger proportion of their budget with public services than the non-poor, this price increase tends to affect more the former than the latter in welfare terms. We also examined how the welfare weights attributed to households affect the decision to increase the public utility's capacity of production: it was clear that these weights may change the shadow price for capacity in such a way that makes it greater than the marginal cost of capacity expansion, allowing this expansion.

APPENDIX TO CHAPTER 3

PRIVATE PROVISION OF PUBLIC SERVICES AND PRICING

The purpose of this appendix is to report our work in deriving discriminatory prices by assuming that public services are provided by private companies instead of state-owned enterprises as we did in this chapter.[1] We examine some distributional aspects of the prices schedules set by these firms whose objective is maximization of profits, constrained or not by some regulation imposed by the government. The work done is preliminary and should be continued in the future as an important extension of our study.

The justification for removing the assumption that these enterprise are public lies in the fact that several developing countries have been implementing privatization programmes and public utilities can become candidates for future change in their ownership. Since some of these public utilities were private-owned in the past, actually they would be re-privatized.[2]

Section I of this appendix will examine the prices set by unregulated private firms and compare them to the prices we have derived in this chapter. Sections II to IV we will deal with regulation: in section II we derive the private prices that satisfy a minimum level of social welfare set by the government; in section III

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1 Roth (1987) reports examples of private provision of public services in developing countries in sectors such as education, electricity, health, telecommunications, urban transport, and water and sewerage.

2 Several reasons were used to justify their change from private to public ownership, ranging from the ideological one (imperialism exploration, since most of the them were owned by foreign companies) to the economical ones (excessive price adjustments, poor quality of the services, lack of private funds to expand the capacity of production, low level of profit and consequent private disinterest, excessive public regulation,etc.) Caves and Nelson (1959) report these problems in a study of the conditions of the electricity sector in Brazil, Chile, Colombia, Costa Rica and Mexico during the 1950s.

we address to the question of rate of return regulation, and in the final section we deal with price-cap regulation.

I - *Private Ownership and Unregulated Pricing.*

Let us assume we have the same the same K groups of households with the same characteristics mentioned in the chapter. Let us also make the following additional assumptions:

Assumption 1 : The public service is produced by a group of *n* private firms, all of them having the same cost function.[3]

Assumption 2 : The profit function of any of these firms is concave and can be expressed as

$$\Pi_i = \sum_{j=1}^{K} n_j^i \, X_{1j}^i \, P_{1j}(X_{1j}) \; - c(X_1^i) \tag{3.60}$$

where

n_j^i : number of households in the income group j (j=1,...,k) that demands commodity 1 produced by firm i (i=1,...,n);

X_{1j}^i : quantity of commodity 1 demanded from firm i by a household in the income group j;

$P_{1j}(X_{1j})$: the households in income group j's inverse demand function for commodity 1, where P_{1j} is the price charged to these households by any of these firms (the same price charged by all of them) and $X_{1j} = \sum_{i=1}^{n} n_j^i \, X_{1j}^i$, the total quantity demanded by households in income group j from all n firms;

$c(X_1^i)$: the firm's i total cost of production, where $X_1^i = \sum_{j=1}^{K} n_j^i \, X_{1j}^i$, the total quantity of commodity 1 produced by firm i and supplied to households in all income groups.

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[3] We are assuming that the public service can be provided by any number of firms; Roth(1987,pp.251-264), when reviewing cases of private provision of piped water, mentions the case of two separate suppliers in Santiago do Chile.

The objective of any of these n private firms is to maximize its profit, charging the highest prices it can charge, naturally restricted by the households demands and the firm's production conditions. The first-order condition for a maximum profit is

$$\frac{\partial \Pi_i}{\partial X^i_{1j}} = n^i_j \left[X^i_{1j} . \frac{\partial P_{1j}}{\partial X_{1j}} . \frac{\partial X_{1j}}{\partial X^i_{1j}} + P_{1j} \right] - n^i_j \frac{\partial c}{\partial X^i_{1j}} = 0 \tag{3.61}$$

or

$$n^i_j X^i_{1j} \frac{\partial P_{1j}}{\partial X_{1j}} + P_{1j} = m \tag{3.62}$$

since $\partial X_{1j}/\partial X^i_{1j} = n^i_j$ and $\partial c/\partial X^i_{1j} = m$, the marginal cost of production, for simplicity assumed to be constant.

Multiplying and dividing the left-hand side of expression (3.62) by P_{1j} and X_{1j} , we can write that

$$P_{1j} \left[\frac{n^i_j X^i_{1j}}{X_{1j}} . \frac{X_{1j}}{P_{1j}} . \frac{\partial P_{1j}}{\partial X_{1j}} + 1 \right] = m \tag{3.63}$$

or

$$P_{1j} \left[s^i_j . \left(- \frac{1}{\varepsilon_{1j}} \right) + 1 \right] = m \tag{3.64}$$

where s^i_j is the firm i's share of the market output supplied to the households in the income group j and ε_{1j} is the commodity 1 demand price elasticity of this same group of households.

Transformations made in expression (3.64) allows us to write that the firm price-cost margin is:

$$\frac{P_{1j} - m}{P_{1j}} = \frac{H}{\varepsilon_{1j}} \tag{3.65}$$

where H is the Herfindahl index of concentration.

In the particular case that all firms are of the same size, that is, H = 1/n, expression (3.65) should be written as:

$$\frac{P_{1j} - m}{P_{1j}} = \frac{1}{n\ \varepsilon_{1j}} \tag{3.66}$$

We see in expressions (3.65) and (3.66) that a variable that the firm may use to price-discriminate among its consumers is their demand price elasticities: households with more elastic demands will pay smaller prices and those with less elastic demands will pay higher prices.

Expression (3.66), however, shows an additional and important element, not a price-discriminatory one, but a parameter that plays a crucial role in determining the optimal *level* of the firm's price-cost margin: n, the number of firms in the industry; the larger is the number of firms, the smaller is the firm's price-cost margin and, consequently, smaller the prices households should pay. The highest discriminatory prices would be those charged by a private monopolist (n=1) and the lowest price (the same price for all households) would be that charged by competitive firms (n extremely large, tending to ∞), that is, their marginal cost.

In what extent does the price charged by a private firm to household j differ from that one (to be called P^W_{1j}) we derived in the chapter [expression (3.15)] when the firm is assumed to be public and its objective is maximization of welfare ?

Let us recall that P^W_{1j} is given by:

$$P^W_{1j} = \frac{m}{1 + \dfrac{\sigma_j - \mu}{\mu\, \varepsilon_{1j}}} \tag{3.67}$$

where σ_j is the household j's marginal social utility of income and μ is the shadow price for the public utility financial balance constraint, total cost minus total revenue equals the amount of deficit financed by the government. We can express the welfare price-cost margin as

$$\frac{P^W_{1j} - m}{P^W_{1j}} = \frac{\dfrac{\sigma_j}{\mu} - 1}{\varepsilon_{1j}} \tag{3.68}$$

Comparing expressions (3.65) and (3.67) we see that their ratio (let us call it M_j , for j=1,...,K) is:

$$M_j = H \,/\, [(\sigma_j/\mu) - 1] \tag{3.69}$$

It is clear from expression (3.69) that the answer to our question depends on the values taken by H, σ_j and μ. We have three possibilities:

i) if $\sigma_j < \mu(H + 1)$, $M_j > 1$, that is, for all households whose social marginal weight is smaller than $\mu(H + 1)$, the price-cost margin they will pay to the private firm that maximizes profit is higher than they would pay to a public enterprise that maximize welfare;

ii) if $\sigma_j > \mu(H + 1)$, $M_j < 1$, then, those households whose marginal weight is greater than $\mu(H + 1)$ will pay a smaller price-cost margin than they would pay under a public enterprise; and

iii) if $\sigma_j = \mu(H + 1)$, both price-cost margins are equal, that is, those households with a welfare weight equal to $\mu(H + 1)$ will pay the same price-cost margin in both situations.

II - *Price Regulation for a Minimum Required Level of Social Welfare*

Since we were interested in this chapter in deriving a price schedule that maximizes social welfare, the government may be interested in regulating the prices a private monopolist should charge its customers by setting a minimum required level of social welfare, W_0, to be reached. In other words, a regulatory agency could calculate the prices that generates the total welfare level W_0 and inform the private firms that these are the allowed prices. Let us derive the maximum price the private producer would be allowed to charge to each of the public service consumers.

The function to be maximized is:

$$L = \sum_{j=1}^{K} n_j P_{1j} X_{1j} - c(X_1) + \omega (W_o - W) \tag{3.70}$$

where

$$W = W [U_1^1, \ldots, U_1^{n_1}, U_2^1, \ldots, U_2^{n_2}, \ldots, U_K^1, \ldots, U_K^{n_K}] \tag{3.71}$$

Expression (3.70) differs from (3.60) by the addition of a term that takes care of the condition $W \geq W_o$ in the maximization of the firm's profit and by the assumption that the firm is a monopolist, for simplicity.

Using the Kuhn-Tucker first-order conditions for a maximum, we derive that

$$P_{1j} = \frac{m}{1 - 1/\varepsilon_{1j} + \omega\sigma_j} \tag{3.72}$$

Using expression (3.72) in the indirect utility function and in the first-order condition $\partial L/\partial\mu = W - W_o \geq 0$ would define the prices P_{1j} in terms of limit W_o.

Since we assume that $\omega>0$ (that is, the government is setting a limit W_o that is greater than that level of social welfare obtained in a unregulated market) and that $\sigma_j>0$, the highest prices the private firm is allowed to charge will be , as expected, smaller than those derived in a process of unregulated profit maximization; the larger the shadow price of the welfare constraint, the smaller will be price that each household should pay. It is also interesting to note that the social marginal utility of income (the social welfare weight) plays its role of making smaller the private monopolist prices: even if the households' demand price elasticities for this commodity are equal, the prices they should pay will be different for each household in case the social weights σ_j differ. In this specific case, the price schedule will show discriminatory prices following the same type of path across households as their social welfare weights differ among them.

If instead of assigning a general limit W_o to the total social welfare, the government decides to set that $W_{poor} \geq W_P^0$, that is, that the social welfare of poor should reach a given minimum level, the private monopolist will charge the following prices:

i) *To the poor*, the price level will be determined by W_P^0 and the first-order solution

$$P_{1p} = \frac{m}{1 - 1/\varepsilon_{1P} + \mu\sigma_P} \tag{3.73}$$

where

ε_{1P}: the poor household's demand price elasticity for this commodity;

μ: the shadow price for the poor's welfare constraint; and

σ_P: the poor's welfare weight.

ii) *To the rich*, the price will that one maximizes the private monopolist's profit, that is,

$$P_{1R} = \frac{m}{1 - 1/\varepsilon_{1R}} \tag{3.74}$$

where ε_{1R} is the rich's demand price elasticity for this commodity.

III - *Rate of Return Regulation and Price Discrimination*

The objective of this section is to derive the prices we should expect a private monopoly to charge its customers when the firm is under a regulation of its rate of return on capital. This regulation is justified as the instrument the government uses for lowering the monopoly's prices and consequently to improve the customers' welfare.[4]

The rate of return of a firm can be expressed as

$$s = \frac{R - C_1}{C_2} \tag{3.75}$$

where R is the firm's total revenue, C_1 is its operating costs, and C_2 is its capital. Since in this chapter we are dealing with K homogeneous groups of households in terms of income Y_j, each group consisting of n_j households, we have to express the R, C_1, and C_2 as:

$$R = \sum_{j=1}^{K} n_j \, P_{1j}(X_{1j}) \, X_{1j} \tag{3.76}$$

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[4] Averch and Johnson (1962) have shown that a rate of return regulation implies an inefficient allocation of capital by a profit maximizing firm. Then, this regulation has a cost in terms of a loss in production efficiency that should be compared with the gains in welfare generated by lower prices paid by customers.

where $P_{1j}(X_{1j})$ is the inverse demand function for commodity 1 (the public service to be produced by a private firm) and X_{1j} is the quantity of this commodity demanded by household type j;

$$C_1 = \sum_{j=1}^{K} n_j \, w \, L_j \tag{3.77}$$

where w is the wage rate and L_j is the quantity of labour (the only assumed variable input) required to produce the quantity X_{1j}; and

$$C_2 = \sum_{j=1}^{K} n_j \, C_{2j} \tag{3.78}$$

where C_{2j} is the quantity of capital required to produce X_{1j}. The total cost of production is

$$C = \sum_{j=1}^{K} n_j (wL_j + rC_{2j}) \tag{3.79}$$

where r is the interest rate, the unitary cost of capital.

The private monopolist's objective, under the government's regulation of its rate of return, is to maximize its profit Π subject to $s \leq \bar{s}$, where $\bar{s}$ is the regulated rate of return. Then, it should maximize

$$\Pi = \sum_{j=1}^{K} n_j \, P_{1j}(X_{1j}) \, X_{1j} \; - \; \sum_{j=1}^{K} n_j \, (wL_j + rC_{2j}) \tag{3.80}$$

subject to

$$\frac{\sum_{j=1}^{K} n_j P_{1j}(X_{1j}) X_{1j} - \sum_{j=1}^{K} n_j (wL_j + rC_{2j})}{\sum_{j=1}^{K} n_j C_{2j}} \leq \bar{s} \tag{3.81}$$

We assume that $r<\bar{s}<s$, that is, the regulated rate of return should be greater than the remuneration of capital,(otherwise the monopolist would have no interest in producing this commodity), and smaller than the unconstrained rate of return.

The maximand function is expressed as

$$Z = \sum_{j=1}^{K} n_j \, P_{1j}(X_{1j}) \, X_{1j} \; - \; \sum_{j=1}^{K} n_j \, (wL_j + rC_{2j}) \; -$$

$$- \lambda \left[\sum_{j=1}^{K} n_j \, P_{1j}(X_{1j}) \, X_{1j} \; - \; \sum_{j=1}^{K} n_j \, wL_j \; - \bar{s} \sum_{j=1}^{K} n_j C_{2j} \right] \tag{3.82}$$

where λ is the Lagrange parameter.

Assuming that Z is a concave function, the Kuhn-Tucker conditions for a maximum are

$$\partial Z/\partial L_j \leq 0 \quad \text{for } L_j \geq 0 \tag{3.83}$$

$$L_j.\partial Z/\partial L_j = 0 \tag{3.84}$$

$$\partial Z/\partial C_{2j} \leq 0 \quad \text{for } C_{2j} \geq 0 \tag{3.85}$$

$$C_{2j}.\partial Z/\partial C_{2j} = 0 \tag{3.86}$$

$$\partial Z/\partial \lambda \geq 0 \quad \text{for } \lambda \geq 0 \tag{3.87}$$

$$\lambda.\partial Z/\partial \lambda = 0 \tag{3.88}$$

Since we have that

$$\partial \Pi/\partial L_j = n_j\left[P_{1j}\ \partial X_{1j}/\partial L_j + X_{1j}\ \partial P_{1j}/\partial X_{1j}\ .\ \partial X_{1j}/\partial L_j\right] - n_j w \tag{3.89}$$

$$\partial \Pi/\partial C_{2j} = n_j\left[P_{1j}\ \partial X_{1j}/\partial C_{2j} + X_{1j}\ \partial P_{1j}/\partial X_{1j}\ .\ \partial X_{1j}/\partial C_{2j}\right] - n_j r \tag{3.90}$$

we can write

$$\partial Z/\partial L_j = (1-\lambda)\left[(P_{1j} + X_{1j}.\partial P_{1j}/\partial X_{1j}).\partial X_{1j}/\partial L_j\right] \leq (1-\lambda)w \tag{3.91}$$

$$\partial Z/\partial C_{2j} = (1-\lambda)\left[(P_{1j} + X_{1j}.\partial P_{1j}/\partial X_{1j}).\partial X_{1j}/\partial C_{2j}\right] \leq (r-\lambda\bar{s}) \tag{3.92}$$

Let us assume that the equilibrium values for L_j, C_{2j} and λ are positive, that is, $L^*_j>0$, $C^*_{2j}>0$ and $\lambda^*>0$; actually, the assumption that $\bar{s}<s$ implies $\lambda^*>0$.[5] Then, the above expressions allow us to write

$$(P_{1j} + X_{1j}\ \partial P_{1j}/\partial X_{1j}).\partial X_{1j}/\partial L_j = w \tag{3.93}$$

$$(P_{1j} + X_{1j}\ \partial P_{1j}/\partial X_{1j}).\ \partial X_{1j}/\partial C_{2j} = \frac{r - \lambda^*\bar{s}}{1 - \lambda^*} \tag{3.94}$$

The left-hand side of expressions (3.93) and (3.94) are, respectively, the marginal revenue product of inputs L_j and C_{2j} ; in the case of expression (3.93), it is equated to the labour wage rate

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[5] The derivative $\partial\lambda/\partial\bar{s}$ is negative; it is also clear that as $\bar{s}$ tends to s, the value taken by λ tends to zero.

w, and in the expression (3.94), it is equate to something that is smaller than the interest rate r since

$$\frac{r - \lambda^* \bar{s}}{1 - \lambda^*} = r - \frac{(\bar{s} - r)\ \lambda^*}{1 - \lambda^*} \tag{3.95}$$

since $\bar{s}>r$ and expression (3.71) shows that $\lambda^*<1$.[6]

Combining expressions (3.73) and (3.74) and expressing the marginal revenue in terms of the j's demand price elasticity for this commodity, we derive the price P_{1j} as

$$P_{1j} = \frac{w + r - \dfrac{(\bar{s} - r)\lambda^*}{1 - \lambda^*}}{1 - 1/\varepsilon_{1j}} \tag{3.96}$$

The above expression allows us to see that in the case of an unregulated rate of return (profit maximization without constraint) or of a not biding regulation (that is, $\bar{s}>s$), cases in which λ^* is zero, the private monopolist will charge the Ramsey's price, or the inverse elasticity rule, since w+r is the marginal cost of production. When $0<\lambda^*<1$, that is, when the rate of return regulation is biding, the numerator of expression (3.96) becomes smaller, lowering prices for all households.

Since there is a relationship between $\bar{s}$ and λ^*, a simple examination of expression (3.96) is not sufficient to show us the final effect of a tightening of the rate of return regulation, that is a decrease in $\bar{s}$, but still keeping $\bar{s}>r$. To show this effect we need to derive expression (3.96) in respect to $\bar{s}$:

$$\frac{\partial P_{1j}}{\partial \bar{s}} = - (\bar{s} - r).\frac{\partial}{\partial \bar{s}}[\lambda^*/(1 - \lambda^*)] + \frac{\lambda^*}{\lambda^* - 1} \tag{3.97}$$

But,we have that

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[6] This means that the quantity of C_{2j} being employed is larger than the required in an efficient use of this input, as pointed out by Averch-Johnson (1962).

$$\frac{\partial}{\partial \bar{s}}\left[\lambda^*/(1-\lambda^*)\right] = \frac{(1-\lambda^*)\partial\lambda^*/\partial\bar{s} + \lambda^*\ \partial\lambda^*/\partial\bar{s}}{(1-\lambda^*)^2} = \frac{\partial\lambda^*/\partial\bar{s}}{(1-\lambda^*)^2} \qquad (3.98)$$

Then,

$$\frac{\partial P_{1j}}{\partial \bar{s}} = -\frac{\bar{s}-r}{(1-\lambda^*)^2} \cdot \frac{\partial\lambda^*}{\partial\bar{s}} - \frac{\lambda^*}{\lambda^*-1} > 0 \qquad (3.99)$$

since $\partial\lambda^*/\partial\bar{s} < 0$ and $0<\lambda^*<1$.

Thus, expression (3.99) shows that if the government decides to tighten the level of the regulation, that is, to decrease the maximum level of the allowed rate of return $\bar{s}$, the private monopolist will be forced to adjust its prices by lowering them for all consumers. This has a positive effect upon social welfare by allowing households to consume a larger quantity of all commodities. As long as the outlay of the poor with this particular commodity corresponds to a larger proportion of their incomes, this tightening of the allowed rate of return will benefit them in a larger scale. In should noted, however, that the condition $\bar{s}>r$ is a limit that should be observed, otherwise the private monopolist would not be interested in producing this commodity.

IV - *Price-Cap Regulation and Discriminatory Prices*

Privatized utilities in the United Kingdom, such as British Telecom and British Gas, have been price-regulated according to a rule or formula known as "price-cap regulation": the price-index of the monopolistically supplied services of the firm (PI) is constrained by RPI - X, that is, the retail price index minus a constant which intends to measure the firm's productivity increase. This formula was proposed by Littlechild (1983) and is considered a better way of regulating these firms in comparison to a rate of return regulation.

Bös (1991,pp.124-134) discusses the effects of this type of regulation upon the efficient use of the inputs when

i) PI is either a price-index whose weights are quantities exogenously given, or these weights are endogenously determined by the proportion of the total revenue each service sold by the utility generates [7];

ii) The level of productivity X is either endogenously defined (as the firm's increase in productivity) or exogenously, politically determined.

Bös proves that among the four possible combinations of PI and X, three of them produce distorted results and that the only one (he calls it "political regulation") that produces an efficient allocation of inputs is that for which the quantity weights and the level of productivity are exogenously defined.[8] For this reason, in this chapter we are going to assume that the price-cap regulation being considered is the political one.

Since we assume that the privatized utility should charge discriminatory prices among its costumers; that these costumers are n households homogeneously grouped in k groups according to their incomes Y_j; that there are two commodities produced in the economy, commodity 1 produced by the privatized utility and commodity 2, a composite good; we are going to define the utility price index (PI) and the retail price index (RPI) in the following way:

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[7] This means that the price-index is

i) either calculated as $PI = \frac{\Sigma P_m^t x_m^0}{\Sigma P_m^0 x_m^0}$, where x_m^0 is the quantity of the good m produced by the monopoly and is the quantity of that good that enters in the commodity basket of the retail price index and P_m^t and P_m^0 are its price in year t and in the base year 0; this means that the changes in prices are weighted by the exogenously defined quantities x_m^0,

ii) or calculated as $PI = \sum_m \left\{ \left[\frac{P_m^t x_m^t}{\sum_K P_k^t x_k^t} \right] . \frac{P_m^t}{P_m^0} \right\}$; the term in brackets being the proportion of the total revenue generated by good m; this proportion is endogenously determined.

[8] British utilities use the endogenously determined revenue proportions as weights to calculate PI and the government regulatory body defines X exogenously.

$$PI = \frac{\sum_{j=1}^{K} n_j \, P^t_{1j} \, X^0_{1j}}{\sum_{j=1}^{K} n_j \, P^0_{1j} \, X^0_{1j}} \tag{3.100}$$

$$RPI = \frac{\sum_{j=1}^{K} n_j \, P^t_{1j} \, X^0_{1j} + n \, P^t_2 \, X^0_2}{\sum_{j=1}^{K} n_j \, P^0_{1j} \, X^0_{1j} + n \, P^0_2 \, X^0_2} \tag{3.101}$$

The objective of the privatized utility is to maximize its profit subject to the regulation PI≤RPI-X. Then, we can write the following Lagrangian equation:

$$L= \sum_{j=1}^{k} n_j \, P^t_{1j} X^t_{1j}(P^t_{1j}) - c(X^t_1) - \phi \left[RPI - X - PI\right] \tag{3.102}$$

Assuming the concavity of these economic functions, the necessary first-order condition for a maximum conditioned profit for this utility is:

$$\frac{\partial L}{\partial P^t_{1j}} = n_j \left[P^t_{1j} - m^t\right] . \frac{\partial X^t_{1j}}{\partial P^t_{1j}} + n_j \, X^t_{1j} -$$

$$-n_j \, \phi \, X^0_{1j}\left[\frac{1}{I^0} - \frac{1}{M^0}\right]=0 \tag{3.103}$$

where $m^t=\partial c/\partial X^t_{1j}$ (marginal cost in year t), I^0 is the denominator of RPI and M^0 is the denominator of PI.

Using expression (3.103) we can write that

$$\left[P^t_{1j} - m^t\right] . \partial X^t_{1j}/\partial P^t_{1j} = - X^t_{1j} \left[1 - \phi . (X^0_{1j}/X^t_{1j}) . \frac{M^0 - I^0}{I^0 M^0}\right] \tag{3.104}$$

or

$$\left[P^t_{1j} - m^t\right] . \partial X^t_{1j}/\partial P^t_{1j} = - X^t_{1j} \left[1 - R_j\right] \tag{3.105}$$

where

$$R_j = \phi.(X^0_{1j}/X^t_{1j}).\ (M^0 - I^0)/(I^0M^0) \tag{3.106}$$

We have that R>0 because $\phi \leq 0$ (Kuhn-Tucker condition) and $M^0<I^0$ (since M^0 has less terms than I^0).

Using the definition of demand price elasticity for household j in expression (3.105), we can write this utility's price-cost margin as

$$\frac{P^t_{1j} - m^t}{P^t_{1j}} = \frac{1}{\varepsilon_{1j}}\left[1 - R_j\right] \tag{3.107}$$

As we know, $1/\varepsilon_{1j}$ is the price-cost margin of a unregulated private monopolist; expression (3.107) is consistent with this price-cost margin since in the absence of a price-cap regulation we have $\phi=0$ and, consequently, $R_j = 0$.

As we see in expression (3.107), the use of the formula PI≤RPI - X to regulate a privatized utility produces a reduction in the price-cost margin imposed upon household j measured by the ratio R_j/ε_{1j}. Then, we can say that:

i) for a given R_j (that is, for a given politically chosen level of productivity-what affects the value of ϕ), the larger the demand price elasticity of household j, the closer this household will be to paying the price that an unregulated monopolist would charge its consumers; and

ii) the larger the required reduction in PI (that is, the larger the politically chosen value for X), the larger will be R_j and, consequently, the greater the reduction in the price-cost margin of the monopoly, reducing the prices for all households.

Expression (3.107) also allows to see that, by choosing a convenient value for X, it is possible to increase the value of R_j to make $P^t_{1j} = m^t$, that is, to make the privatized monopolist charge the competitive price to all its consumers. We should remember that the same result could be obtained in a unregulated privatized utility if the number of firms is large enough, that is , when n tends to infinity, assuming the cost function is the same for all n firms. Since this assumption is hardly verified and it is not realistic to expect the public service being provided by a large number of firms, a pricing rule such as the political price-cap regulation is the best way to achieve a price-competitive tariff. It should be noted, however, any of the two procedures (increasing X or increasing n) would result in the same price being charged to all households, an undesirable result from a redistribution of real income point of view. Since we are interested in deriving discriminatory prices among consumers, we assume that the value of the chosen X will be one high enough to produce them.

Another aspect that deserves attention is the fact that the price-cap regulation actually, as shown in expression (3.87), is a profit regulation or rate of return regulation since the choice of level of productivity X to be subtracted from the retail price index implicitly produces a level of profit equal or above what is considered a normal profit.

We already know that the price-cap "political regulation" may produce discriminatory prices if $R_j \neq 0$ and R_j and ε_{1j} differ among the K groups of households. But what we can say about its possible redistributive role ?[9] We already know [from expression (3.72)] that in the case of a regulation of the type $W \geq W_0$, the redistributive objective is reached since the price-cost margin of the privatized monopolist firm is equal to $(P^R_{1j} - m)/P^R_{1j} = (1/\varepsilon_{1j}) + \omega\, \sigma_j$, where $\omega > 0$ and σ_j has a positive and declining value for higher households'

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[9] This question was brought to our mind by the comparison made by Bös (1991,p.127-131) of the redistributive effect of the prices derived from a price-cap regulation applied to a firm that produces several goods and the price structure derived for the same firm in the analyses made by Felstein (1972a,b,c) ; Bös concludes that the price-cap "political regulation" has the same redistributive effect the Feldstein's price structures have, that is, necessities will make the price-cost margin smaller and luxuries will produce a higher price-cost margin. This conclusion, however, cannot be extended to our case since we are interested in discriminatory prices among households for the same commodity and not in discriminatory prices for different commodities.

incomes. For the price-cap regulation, its redistributive role cannot be guaranteed: it depends how R_j varies across households' groups; the price-schedule derived from it will be redistributive of real income only if R_j is also a declining function of households' incomes, but there is no reason to believe that this is the case. We know that R_j will differ from one group to other group of households if the ratio X^0_{ij} / X^t_{ij} differs between them. Since we cannot make any guess concerning the way this ratio varies, we cannot reach any conclusion as to its redistributive effect.

CHAPTER 4

PUBLIC UTILITY PRICES AND POVERTY

4.1 - *Introduction*

In this chapter we will be interested in deriving public utility's prices which satisfy some objectives set by a social policy that is concerned with poverty and its consequences upon the level of welfare of the population.

Using poverty as an analytical subject in the definition of governmental policies in developing countries is justified not only by the large number of those that are in deprivation, but also by the fact that the intensity of the phenomenon requires a wider attack against it, including the use of public prices as one of the instruments to tackle the problems of poverty in these countries.[1] Poverty is a very important problem in the Brazilian context: according to Psacharopoulos et al. (1992), 44 percent of the poor in Latin America live in Brazil.[2]

Although related phenomena, poverty and income inequality are different characteristics of the income distribution: we can have income inequalities without poverty (there are no poor and individual incomes differ) and no income inequalities and poverty (all individuals earn the same low level income). It should be noted that for this reason neither minimization of poverty necessarily means

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[1] See World Bank (1990) for a whole set of suggested policies for improving the conditions of the poor, one s related to the need of promoting the use of the labour force, and others related to the provision of basic social services to the poor.

[2] We report recent measurements of absolute poverty for Brazil in the following section.

minimization of income inequalities, nor the reverse is necessarily true.[3]

In this chapter we are going to examine two basically different pricing policies, both of them focusing the problem of poverty: the first one is an extension of what was examined in chapter 3, that is, we continue with the idea of choosing prices that maximize social welfare but we introduce the additional constraint that a minimum entitlement objective should be taken into account in the maximization exercise to allow the poor to consume a minimum quantity of the service; the second pricing policy concentrates in the idea of setting prices that minimize poverty. Such an approach my be justified by the fact that poverty is a severe problem in less developed countries such as Brazil and that politicians and policy-makers advocate the use of the scarce resources to alleviate the social problems of the segment of the population below the poverty line. The objective of this chapter is then to derive and to examine the price schedules that should be set under these two different pricing policies and to discuss the limits public utility pricing may have to obey when we want to favour the poor.

Taking into account the issue of poverty necessarily introduces us to the additional set of complex problems related to its definition and measurement. Both problems have been scrutinized abundantly in the economic literature in order to refine the concept of being poor and to improve the quantification of this social condition. Section 4.2 that follows makes a summary of the main points covered by this literature. In section 4.3 we derive prices that at the same time maximizes social welfare and allow the poorest households to consume at least a minimum quantity of the service provided by the public utility; this is a minimum entitlement pricing policy. In section 4.4 we discuss a pricing policy for public

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[3] Beath, Lewis and Ulph (1988) call the attention to the fact that although the goals of reducing poverty and reducing inequality can be complementary in some cases, in others they can clash. For the latter cases, they give the following example: a poverty policy of transferring income to just below the poverty line would be effective, but inequality would increase.

utilities focused on a minimization of poverty objective. In the following sub-section 4.4.1 we show how a policy of charging a lower price to the poor is constraint by the limits imposed by the maximum price that be charged to the non-poor. In sub-section 4.4.2 we return to the idea of a minimum entitlement, but in the context of prices that minimizes poverty and favour the poor. Finally, the following section 4.5 calls the attention to the problem of the growing number of poor in urban centres of developing countries and how this affects the analyses made in former sections of this chapter.

4.2 - *Poverty concepts and measurements*

Poverty can de defined in several different ways, some of them taking into account a more restricted view of the problem, others focusing a wider spectrum of characteristics, including not only economic dimensions, but also social and political aspects. However, these different definitions have in common the idea that poverty is related to the lack of access to some standard of living considered essential or minimal for an adequate life in society. Departing from this common understanding, the differences in conceptualizing poverty arise from dissimilar views of what a "minimal adequate standard of living" actually means.

One strand of the different forms of specifying the characteristics of such a standard of living is connected with the idea that poverty has both an absolute and a relative dimension. In the absolute case, the definition of poverty makes no reference to other standards of living that exist in that or other societies; its definition is related to what is considered essential for life. This is the common view of poverty that prevails in developing countries, where the concern with this problem is more weightily linked with the idea of individual survival.

We can recognize three different lines of thought of how that standard of living should be defined:

1) *the poverty line approach*: according to this approach, the poverty line is that amount of total income or expenditure required for an individual or household to survive, by

consuming the commodities in the quantities deemed to be essential to this purpose.[4] Implicit in this approach is the idea of a minimum of welfare that can be derived from the consumption of those commodities. This concept of the poverty line can be modified and expanded to measure relative poverty by utilizing the definition of a basket of goods and services that is considered as the normal or minimum in a given society, hence unrelated to individual survival.

2) *the basic needs approach*: in this approach, being poor is the condition of those individuals whose consumption falls short of those consumption targets specified in a development strategy aimed at the abolition of absolute poverty. This approach does not necessarily leads to the determination of a minimum level of income or expenditure as in the poverty line case; the failure of satisfying those targets or needs naturally classifies the individual to be among those for which specific social programmes are designed for solving it.[5]

3) *the participation approach*: this approach is due to Townsend (1979); it differs from the two previous ones by relying neither on commodities nor needs to define poverty. The problem of poverty is viewed in terms of the individual lack of resources required for his social participation or interaction, understood in quite a wide sense: that is , access to a level of consumption of goods and enjoyment of activities that conforms to a customary pattern in that individuals' society.[6] In this sense, the participation approach is directly connected with the idea of *right*

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[4] Atkinson (1989,pp.11-12) calls the attention for the fact that income and expenditure are distinct ways of measuring poverty, leading to different results.

[5] Streeten and Burki (1978) discuss this approach and suggest six areas covering the essential basic needs: nutrition, basic education, health, sanitation, water supply and housing, and related infrastructure.

[6] In Lewis and Ulph (1988) this idea of participation enters in the individual utility function, which allows them to define the poverty line as the level of disposable income at which the indirect utility function shows a discontinuity, jumps to a upper level.

to a minimum level of resources, as suggested by Atkinson (1989,p.12), meaning the minimum level of income required for individual participation in a given society.

A more wider approach for poverty is being developed by Desai (1990) building on ideas advanced by Sen (1985). This approach deals with the idea of *capability*, that is, owning or not owning the resources that allow an individual to have access to a set of capabilities, such as to survive and have good health, to ensure biological reproduction, to interact socially, to have knowledge and freedom of expression and thought, amongst others. As we can, this approach incorporates all the others cited before. From the operational point of view, we can anticipate several difficulties in quantifying all the multiple dimensions this approach requires for selecting those poor in a society. It is true that the set of capabilities may have several highly correlated attributes, which may make less difficult the task of separating the poor from the non-poor.

Once the poor in a society is identified the next step is to measure the intensity of the problem. Several indices have been used or suggested by the poverty analysis literature. One of the most commonly used index is the *headcount ratio*; it measures the percentage of poor in a population and it is expressed either as

$$H = \frac{q}{n} \qquad (4.1)$$

where q: number of poor,

n: number of individuals (households) in the population.

or as

$$H = \int_0^z f(Y)dY \qquad (4.2)$$

where Y: individual income,

f(Y): frequency density function of income Y,

z: income level that identifies poor and non-poor (for instance, the poverty line).[7]

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[7] From now on z must be understood as this income level; for sake of simplicity, we assume that all those already mentioned ways of defining poverty can be summarized by defining an income level that

The headcount ratio is not a good poverty index; it is a weak indicator of the intensity of the problem since it only measures the percentage of individuals in a population that lack the resources to be considered as non-poor; it is also important to know how the incomes of the poor are dispersed and how far they are from the poverty line.

To eliminate this above weakness, some authors use the poverty gap to indicate the difference between the individual income and the z income level and aggregate these differences to calculate a poverty index called the *income gap ratio*:[8]

$$I = \sum_{i} \frac{g_i}{q.z} \qquad \text{for } i \in S(z) \tag{4.3}$$

where $g_i = z - Y_i$

Y_i: income of individual i, for $Y_i \leq z$

(z): set of poor individuals.

Atkinson (1989,p.29) has a list of potential poverty indices:

i) *the normalized deficit*:

$$D = \int_0^z \left(1 - \frac{Y}{z}\right) f(Y)dY \tag{4.4}$$

ii) *the Watts measure* [Watts(1968)]:

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has the role of identifying the poor and the non-poor. In this sense, z can be named as the poverty line, although it can have more dimensions than the survival characteristic attached to the poverty line itself.

8 Sen (1976) shows that the headcount and the income gap ratios violate either the monotonicity or the transfer axioms; the monotonicity axiom states that, all other things being equal, a decrease in the income of an individual considered as poor must increase the poverty index (this does not happen with the headcount ratio); the transfer axiom states that a transfer of income from a person below the poverty line to a less poor one must increase the poverty index (this does not happen for the headcount and for the income gap ratios).

$$W = - \int_0^z \log_e(Y/z)\ f(Y)dY \qquad (4.5)$$

iii) *the Clark et al. second measure* [Clark, Hemming and Ulph (1981)]:

$$C = \frac{1}{c} \int_0^z \left[1 - (Y/z)^c \right] f(Y)dY \qquad (4.6)$$

where $c \leq 1$

iv) *the Foster et al. measure* [Foster, Greer and Thorbecke (1984)]:

$$P_\alpha = \int_0^z \left[1 - Y/z \right]^\alpha f(Y)dY \qquad (4.7)$$

where $\alpha \geq 0$, α is the aversion to poverty parameter.

The poverty index derived by Sen(1976) also uses the income gap, but he weights the differences in incomes by the position of the individual in the poverty rank:

$$P = H \left[1 - (1 - I) \{ 1 - G (q/q+1) \} \right] \qquad (4.8)$$

where H: the headcount ratio,

I: the income gap ratio,

G: the Gini coefficient of the income distribution of the poor.

In a recent report on poverty and income distribution in Latin America, Psacharopoulos et al.(1992) calculated some of the above poverty indices for the Latin American countries in the 1980s in order to assess how the phenomenon evolved in that decade. Their measurements are based on two different poverty lines: one measures poverty in itself, referred to a poverty line of $60 per person per month purchasing power parity (PPP) dollars; the other, measures extreme poverty, and the poverty line is $30 per person per month

PPP.[9] Table 4.1 collects their measurements for Brazil.

The three indices in Table 4.1 show increases in the already high levels of poverty in the 1980s for Brazil, not only in terms of the $60 poverty line, but also for the $30 one. As we see, poverty has reached about 41 percent of the Brazilian population in 1989, what means a total of about 57 million inhabitants living below the $60 poverty line, of which 26 million were in extreme poverty. As to the poverty gap, an index that measures the amount necessary to raise the income of the poor to the level of the poverty line as a percentage of this line, the measurement for the period 1979-89 shows that poverty in Brazil has deepened, changing from about 14 to about 19 percent in terms of the $60 line and from about 4 to 7 percent for extreme poverty. Further, the Foster, Greer and Thorbecke measure shows that the inequalities also increased in the income distribution within the poor population in that decade.

Several authors discuss specific characteristics that the poverty indices should have and most of the time they make suggestions of improvements in this measurement of poverty.[10] Since our objective is not to make contributions in this field, we will

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[9] Several authors use different ways of defining the poverty line in Brazil: to Hicks and Vetter (1983) and Rocha (1988) this line is a basic basket of goods evaluated at local regional prices; Fishlow (1972), among others, adopts multiples of the legal monthly minimum wage (MW); Tolosa (1991) uses as index the value of one fourth of the highest MW in 1980 annually adjusted according to the inflationary rate, and reports its use by other studies.

[10] See, for instance, Subramanian (1990) criticizing the Sen and Foster et al. indices and deriving another index; Thon(1979), contrary to Sen's views, thinks that the weighting of the income gap should take in to account not the individual income position in the poverty rank, but in relation to the income distribution of the whole population; Vaughan (1987) and Lewis and Ulph (1988) are interested in the welfare aspects of the poverty indices.

Table 4.1: *Measurements of the Absolute Poverty in Brazil, 1979 and 1989.*

POVERTY INDICES	YEAR	
	1979	1989
Headcount Index:		
Poverty (*)	34.1	40.9
Extreme Poverty (**)	12.2	18.7
Poverty Gap:		
Poverty (*)	13.7	18.8
Extreme Poverty (**)	3.9	7.1
Foster, Greer and Thorbecke Measure: (***)		
Poverty (*)	7.4	11.2
Extreme Poverty (**)	1.8	3.8

Source: Psacharopoulos,G., Morley,S., Fiszbein,A., Lee,H., and Wood,B. (1992).*Poverty and Income Distribution in Latin America: The Story of the 1980s*. Washington,D.C.: World Bank, Latin America and the Caribbean Technical Department, Regional Studies Program, Report no. 27.
(*) poverty line of $60 per person per month purchasing power parity (PPP) dollars.
(**) poverty line of $30 per person per month PPP.
(***) for $\alpha=2$

not go into the discussion of the advantages or the disadvantages of those indices.

A desirable property for a poverty index is that one that states that its first partial derivative in terms of the poverty line should be positive, that is, that the measurement of the poverty should change in the same direction of the change of the poverty line. This means that for smaller values of z, the poverty index should measure lower levels of poverty. All the above indices share this property. For this reason, instead of choosing one specific poverty index, in the next section we will be trying to derive a public utility price so as to minimize z, the poverty line, and thus poverty, as defined by any of the above indices, is also minimized.

4.3 - *Prices and Minimum Entitlement for the Poorest*

Prices derived in chapter 3 were found by maximizing a social welfare function subjected to a deficit constraint. No restriction was put upon the quantity consumed of commodity 1 (the publicly produced commodity) by any household, that is, for no household was a minimum consumption required in that maximization exercise. The quantity of commodity 1 consumed by a household would be determined by its demand function taking into account the commodity price and other demand determinants, such as its income and the prices of other goods; there is no guarantee that this quantity will fulfill any socially desirable quantity goal.

A public utility's pricing policy constrained by a minimum entitlement objective for the poorest households may come out of a regulatory safety net implemented by the government to protect consumers against the effects of changes in social spending and deregulation or regulation of economic activities such as those made by the American government in the case of the divestiture of local telephone companies by AT & T in 1984, as reported by Brown and Sibley (1986,p.183). It also may be part of a group of measures taken by governments of developing countries to protect the poor against the adverse effects caused by stabilization programmes.[11]

In this section we are going to assume that the possibility of some poor households not consuming a given socially desirable quantity is caused by the inadequacy between prices and their incomes. Assuming that their incomes cannot be increased by the use of any transferring mechanism, what is left and what is going to be examined in this section is how to determine prices that allow that

[11] See World Bank (1990) for a list of several projects implemented in developing countries with the idea of establishing a safety net for the poor.

minimum entitlement to be observed.[12] There are other examples of this type of discordance, such as the case of merit goods, for which the state intervention is justified in other paternalistic grounds, that is, individuals may be incompetent to fully appreciate the utility of a given consumption, allocate too little resources to that end, and the society decides to impose a minimum level of consumption on individuals, independent of their tastes. The kind of government intervention assumed here (change in the cross-subsidy structure by lowering the price paid by the poor) may have both a paternalistic and a non-paternalistic justifications: the idea is not only to increase the poor's welfare level (this is the paternalistic objective), but also the other households' welfare (the non-paternalistic objective).[13] Examples of a minimum entitlement policy with these two characteristics are setting low prices for water/sewage services with the possible objectives of not only allowing a more hygienic way of life to the poor, but also to minimize the financial costs imposed on non-poor to cure their diseases; in the electricity sector, charging a lower rate would not only allow the poor access to a more efficient use of energy, but also expand the electric appliances market.

In modern societies, this kind of paternalistic intervention is considered permissible and even a duty of the State. Even the most liberal political philosophies, although condemning the interference of the State, admit that in the case of destitution and incompetence this intervention is appropriate.

It should be noted that the idea of a minimum entitlement as

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[12] This minimum entitlement, besides being related to a social policy strategy, may also be related to the idea of a "regulatory safety net" applied by regulatory agencies to protect consumers against undesirable business practices and the effects of governmental changes in social spending; see Brown and Sibley (1986,p.183-192) for the case of telecommunication service in the United States.

[13] This classification is taken from VanDeVeer (1986), where he discusses the principles of paternalism. A paternalistic intervention aims the protection or promotion of the welfare of the object of interference; a non-paternalistic intervention aims the welfare of others than the subject of interference.

used in this section does not conflict with the postulate of non-paternalism used in Welfare Theory: the government's interference is made through the price system, lowering the price for the poor and allowing them to consume the minimum entitlement quantity, that is, the social welfare will continue respecting the households' preferences.

Finally, the objective of lowering the price to be paid by the poor could be obtained by increasing the level of subsidy $\bar{D}$ given to the public utility. However, this would lower all the prices P_{1j}, wasting resources and benefiting the non-poor.

The required minimum quantity is exogenously determined. It can be taken from either, for instance, recommended quantities by the World Health Organization, or planning goals.[14] This thesis does not try to define it. Our interest is only to examine how this additional constraint changes the optimal solution found in chapter 3.

Section 4.3 1 illustrates how the interest with a minimum entitlement policy may come about in the context of the analysis we developed in chapter 3.

4.3.1 - *The Nature of the Problem*

To illustrate how a minimum entitlement policy may be considered in pricing we are going to use the price and quantity formulas we derived in section 3.2.1 for the special case of a Cobb-Douglas utility function be used to represent households preferences.

We can write, with constant returns to scale, that:

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[14] As reported by Julius and Alicbusan (1989,p.25), in the projects examined by the World Bank the minimum water requirement for the poor is 25 liters per capita per day.

$$P_{1i} = \kappa \, Y_i^{\vartheta} \qquad \text{for } i=1,\dots,K \tag{4.9}$$

$$\text{where} \quad \kappa = \frac{m\alpha \left[\sum_{j=1}^{K} n_j Y_j^{\frac{(1-\alpha)(1-\rho)}{(1-\alpha)+\alpha\rho}} \right]}{\bar{D} - F + \alpha \sum_{j=1}^{K} n_j Y_j}$$

$$\text{and} \quad \vartheta = \frac{\rho}{(1-\alpha)+\alpha\rho}$$

$$X_{1i} = \xi \, Y_i^{\varphi} \qquad \text{for } i=1,\dots,K \tag{4.10}$$

$$\text{where} \quad \xi = \left[\frac{\bar{D} - F + \alpha \sum_{j=1}^{K} n_j Y_j}{m \sum_{j=1}^{K} n_j Y_j^{\frac{(1-\alpha)(1-\rho)}{(1-\alpha)+\alpha\rho}}} \right]$$

$$\text{and} \quad \varphi = \frac{(1-\alpha)(1-\rho)}{(1-\alpha)+\alpha\rho}$$

Note that the price and quantity formulas are exponential functions that depend, among other factors, on the degree of aversion of inequality ρ. In figure 4.1a we plot the curves for the quantity formula when $\rho>1$, $\rho=1$, and $0<\rho<1$. From expression (4.10) we can see that when $\rho=1$ (that is, $\varphi=0$) the quantity consumed will be the same for all Y_j since $\varphi=0$ and then $X_{1j}=\xi$, as shown by curve ODD. It is easy to see that when $\rho>1$, the quantity formula generates decreasing quantities for larger incomes (curve OEE), and that, when $\rho<1$, it generates increasing quantities for larger incomes (curve OABC).[15]

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[15] For $\rho=0$, the quantity formula is the linear equation $X_{1j}=\xi Y_j$, that generates higher quantities for higher incomes, where $\xi>0$. This curves is not shown in figure 4.1a because the analysis that follows

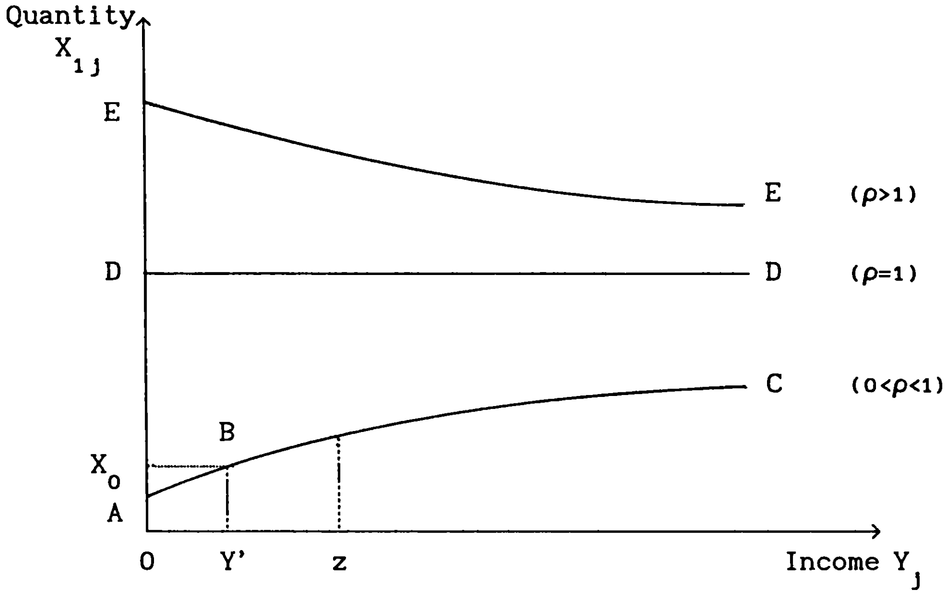

Figure 4.1a: Quantity consumed at different degrees of aversion to inequality.

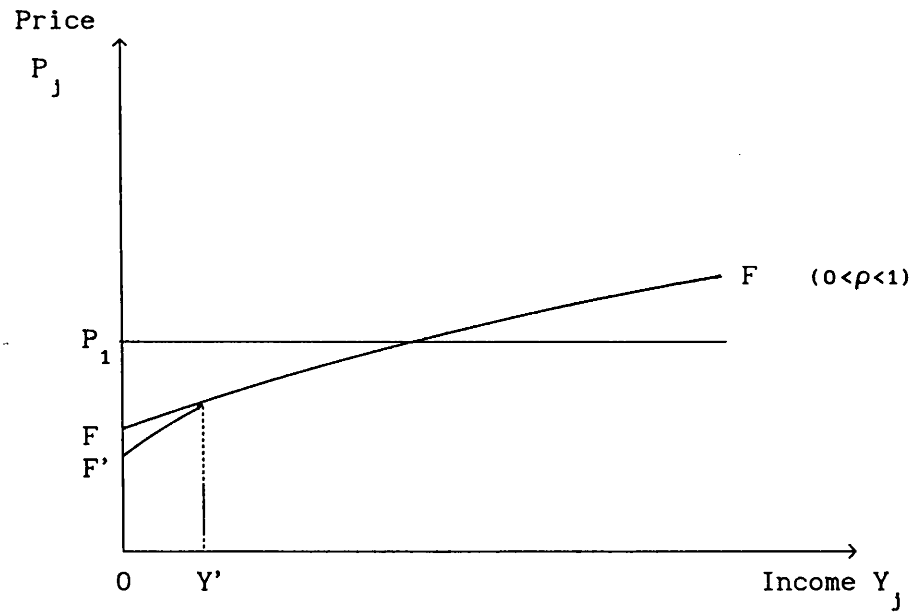

Figure 4.1b: Optimal prices for different levels of income when $0<\rho<1$.

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applies to all exponentials for which $\rho<1$.

It is clear from figure 4.1a that the poorest households are most likely to consume least is the case of curve OABC when the quantity formula shows increasing quantities for larger incomes. It is in this case that the concern with the quantities consumed by the poor is relevant. In that figure we are illustrating the minimum entitlement as the quantity X_0. Thus, the positive differences X_0-X_{1j} up to income Y' identify the poor households (z is the poverty line discussed in the former section)for whom a minimum entitlement pricing policy should apply; households whose incomes are equal or greater than Y', including the poor between Y' and z, are not benéficiaries from this pricing policy. Note that the problem is characterized for a situation in which the government may be showing less concern with inequality (what justifies $\rho<1$), but is concerned about poverty and its consequence in terms of underconsumption.

Figure 4.1b shows the price curve OFF which relates the optimal price to be charged to households for each level of income when $0\leq\rho<1$.[16] The curve OF'F (for which the optimal prices are lower than those given by curve OFF for incomes up to Y') is a price formula which allows the poorest households (those earning incomes up to Y') to consume X_0. Then, the corresponding quantity curve would be OX_0BC.[17] In the following section we examine the prices that should be charged to households whose incomes are smaller than Y' to allow them to consume X_0.

4.3.2 - *Determination of Prices with a Minimum Entitlement*

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[16] When $\rho=0$, the price is equal to all Y_j; for $\rho\neq0$, prices are increasing with incomes.

[17] We are assuming that the non-poor are capable of subsidizing the consumption of those who benefit from the minimum entitlement pricing policy, that is, despite the smaller quantities consumed, the extra revenue generated by the non-poor is sufficient to cover the extended price subsidy given to those in need.

Formally, we can derive prices which maximize social welfare and allow the consumption of a minimum quantity of commodity 1 to all households in the same way we did in chapter 3 by introducing the additional constraints that $X_{1j} \geq X_0$ for j=1,...,K. This means that the maximand function would contain K (one for each group of households) constraints $\mu_j\left[X_{1j}-X_0\right]$, where μ_j are the Lagrange multipliers for these constraints. We know that when these constraints are binding, all μ_j are equal to zero and the prices the public utility should charge are equal to those already derived in chapter 3, expression (3.15). However, it may happen that some of these constraints are binding, that is, there would be prices that would not allow some households to consume X_0; this is the case illustrated in figure 4.1a, the poor whose incomes are smaller than Y'. For households in this situation we would have $\mu_j \neq 0$.

It should be clear that:

i) as mentioned above, for those households whose prices allow them to consume X_0 , the optimal prices are exactly the same we calculate with expression (3.15); and

ii) for those households illustrated in figure 4.1a whose consumption would be smaller than X_0 at prices given by expression (3.15), the prices that allow them to consume this quantity can be derived directly from their demand functions; for instance, in the case of a Cobb-Douglas utility function we used in chapter 3, these prices would be $P_{1j}=\alpha Y_j/X_0$, for j=1,...,K. Thus, actually we do not need to undertake the maximization exercise to know these prices once we know their demand functions and their incomes.

It can be shown that if we use the maximand function

$$L= W + \mu\left[\bar{D} - C(X_1) + R(X_1,P_{1j})\right] + \sum_{j=1}^{K}\mu_j \left[X_{1j}- X_0\right] \tag{4.11}$$

we would derive the following optimal prices:[18]

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[18] We are assuming the same set of assumptions we used in chapter 3

$$P_{1j} = \frac{m - \dfrac{\mu_j}{\mu}}{1 + \dfrac{\sigma_j - \mu}{\mu\, \varepsilon_{1j}}} \qquad \text{for } j=1,\ldots,K \tag{4.12}$$

As we can see, expression (4.12) shows that the numerator contains an additional factor $-\mu_j/\mu$, a factor that does not appear in expression (3.15). We have already commented that when the minimum entitlement is binding, P_{1j} of expression (4.12) are the same given by expression (3.15). For those households whose consumption would be below the minimum entitlement quantity X_0 at the prices given by expression (3.15), the prices calculated with expression (4.12) [with $\mu_j \neq 0$] are equal to those we would derive from their demand function for this commodity, as mentioned before.

The price reduction necessary to allow some households to consume at least H_0 is determined, inter alia, by the value taken by the shadow price of the minimum entitlement constraint μ_j. From expression (4.12) we can write that this value, for each household j, is

$$\mu_j = \mu \left[m - \left(1 + \frac{\sigma_j - \mu}{\mu\, \varepsilon_{1j}} \right) . P_{1j} \right] \tag{4.13}$$

for j=1,...,K. Since we know that $\mu_j \geq 0$ is a condition for the maximization of welfare and that $\mu > 0$, we have the necessary condition that

$$\frac{m}{1 + \dfrac{\sigma_j - \mu}{\mu\, \varepsilon_{1j}}} \geq P_{1j} \tag{4.14}$$

But the left-hand side of expression (4.14) is the optimal price households type-j should be charged when there is no minimum entitlement constraint [prices given by expression (3.15)] and the right-hand side is the price which allows them to consume at least

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plus the minimum entitlement constraint.

the minimum quantity X_o. In figure 4.1b these two prices are seen as points on the curves FF and F'F', respectively: up to income Y', the former price is higher than the latter and shadow price of the minimum entitlement is positive to lower the price as needed to make the constraint to be satisfied. When both prices are identical, the constraint is redundant, and consequently, its shadow price is null.

It is clear that the higher is the level of the minimum entitlement X_o, the higher will be the value taken by μ_j and consequently the larger the fall in P_{1j} to allow households to consume that larger quantity, as shown by expression (4.12) and by figures (4.1a) and (4.1b). It is also clear that this expansion in the level of X_0 will tend to increase the number of households to be benefited from this pricing policy and to decrease the number of those who will be called to finance this subsidy.

One may misled by the idea that we can solve any problem of under-consumption by adopting a minimum entitlement pricing policy since the only thing that it requires is lowering the price for those in need of a higher level of consumption and compensating this subsidy by charging higher rates to the other households. This is not what is meant in this section. For reasons we are about to expose, this kind of policy can be implemented in a limited way, without intending to be the final solution for the problems of poverty in developing countries like Brazil.

The implicit assumption in the minimum entitlement policy is that someone will be able to fill the revenue gap that the subsidy given to the poor will generate, either the government (by expanding the subsidy already given to these public utilities), or the public utility itself (by resorting to resources taken out from its investment fund), or the other households (by being charged a higher price). Let us examine these alternatives:

Increase in $\bar{D}$:

Being poor generally means to be deprived of the basic necessities of life. Then, their under-consumption manifests not on only one good, but in several commodities, some of them produced by public enterprises like the public utilities. It seems unreasonable to think that the government of a developing country can fill all the needs of extra funding in all sectors to allow the lower prices required by a minimum entitlement pricing policy. Actually, for a large segment of the poor, there would be a need to provide the commodities free of charge.[19] Naturally, the limited government resources (very scarce in the present moment of depression in Brazil) may be applied on a very limited scale, in some selected few commodities.

Use of the public utilities' investment funds:

It is clearly improper to use these funds to this end since these financial resources have a specific function of providing for the need of expanding the public utility's capacity of production; it is a short-sighted policy that does not take into account the ultimate consequences of under-investing upon the poor itself and upon the other households, such as rationing, impossibility of extending the networks and unreliability of the services provided. It is also clear that, given their limited availably (when they exist), these funds cannot solve a permanent, structural, situation of poverty as observed in developing countries.

Cross-subsidization by other households.

The assumption that the process of cross-subsidization by the other households will work according with what is expected, that is, that it can generate enough revenue to cover (or to complement, if other sources are also used) the subsidy given to the poor begs proof, mainly when we consider the following points:

i) the number of poor to have its consumption subsidized

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[19] Sometimes the free provision of the basic needs goods and services are advocated to allow a minimum entitlement to all consumers. Julius and Alicbusan (1989,page 4) report that in a number of countries some services are provided free for all consumers, with the following consequences: excess demand has overwhelmed available supplies, deterioration of the quality of service, funds have been insufficient for maintenance and operating costs, morale decline in the professional staff, inefficient investment allocations, little managerial incentive for cost control, and frustration of distributional objectives.

may be excessively large in relation to the capacity of funding this policy: according to data on income distribution in Brazil, around 41 percent of its total population are poor, of which almost half live in extreme poverty.[20] This means that we are talking about the needs of about 12 million poor households, with around 5.5 million in extreme poverty. And also means that their consumption up to the minimum entitlement level should be subsidized by the other about non-poor 18 million households, including a large very low medium income class segment of the population;

ii) the higher prices required to be charged to the other households may be so high that possibly this would cause the following consequences:[21]

a) some of those supposed to pay part of the subsidy will actually be a beneficiary of it since their quantity demanded at the new prices will be below the stated minimum entitlement quantity level. This means that instead of regarding only the original 12 million households, we should also consider this additional contingent;

b) the revenue obtained by the higher prices charged to the other other households may not be enough to cover the total need of subsidizing the minimum entitlement quantity: the amount of additional revenue generated by this pricing policy depends on the households' demand price elasticities for the commodities; it may work for some of the commodities that are essential services, without close substitutes, but it may induce substitution, such as, for example, households resorting to private wells and street disposal of used water in case of water/sewage services, and gas replacing electricity for household uses.

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[20] See section 4.3 for the definition of poverty and for the measurements of poverty in Brazil.

[21] Consequences *a* and *b* are similar to those that may occur on income taxation when the exemption level is raised and the marginal tax is increased to compensate for the revenue loss: the substitution effect may cause a reduction in total revenue.

iii) the need of resources required from the cross-subsidy scheme would goes beyond the amount demanded by the subsidy given to consumption: since the total quantity demanded would be higher and the supply may be insufficient to produce the quantity required, the capacity of production must be expanded to allow the policy to be effective and avoid rationing; this policy would advance the need of funding for capacity expansion.

iv) the marginal cost of production may increase (requiring higher prices) by the need of extending the service networks not only to more disperse locations (such as suburban areas of the medium and large urban centres), but also to concentrations of households living uphill and central locations in shanty towns as is the case of Brazil.

All these elements indicate limitations, but not the impossibility of implementing such a policy in countries like Brazil and other developing ones; they should be considered as constraints to the general scope of letting all households to have access to at least a minimum quantity of the basic services provided by public utilities.

4.4 - *Pricing and Minimization of Poverty*

In this section we examine a different pricing policy: instead of deriving a price schedule that maximizes social welfare, we want to use a different approach, that is, we will be interested in discussing the prices that can be charged to the poor. The purpose of the present section is then to derive a price schedule compatible with a government objective of pricing public utilities' services in such a way that poverty is minimized. As mentioned before, this type of pricing policy has been advocated by politicians and policy-makers in developing countries to fight the severe problem of poverty we observe in these countries. Thus, our task in the present section is to examine how the objective of minimimization of poverty can be reached and to discuss the constraints to this ppricing policies.

To separate poor from non-poor we are going to use the concept of poverty line. In the context of the analysis to be developed in this section, the poverty line is defined as

$$z = \text{MIN}\ \{Y|X_1(P_1,P_2,Y)\geq X_1^z, X_2(P_1,P_2,Y)\geq X_2^z\} \tag{4.15}$$

where $X_i(P_1,P_2,Y)$ is the demand function for commodity i, for i=1,2, and X_1^z and X_2^z are exogenously defined quantities of commodities 1 and 2, respectively; these quantities may be defined as those compatible with the normal or standard basket of goods and services in a given community. Then, the poverty line z is the minimum income level that allows households the consumption of at least these quantities.

Let us assume that from the above demand functions for commodities 1 and 2 we can derive Engel curves that shows increasing quantities demanded for higher incomes, as is the case examined in section 4.3 for the Cobb-Douglas utility function.[22] Examination of these Engel curves will show us the value of z.

In figure 4.2 we show a household income distribution and a possible position for the poverty line. All households earning incomes below z are considered as poor, and all the others non-poor. Then, income z defines the level of poverty or poverty index(PI) in the population, as discussed in section 4.2. The poverty index is defined as

$$PI = \int_0^z f(Y)dY \tag{4.16}$$

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[22] The demand functions for commodities 1 and 2 in the Cobb-Douglas utility function are $X_{1j}=\alpha Y_j P_{1j}^{-1}$ and $X_{2j}=(1-\alpha)Y_j P_2^{-1}$, that is, the demand depends only on the household's income and on its respective price.

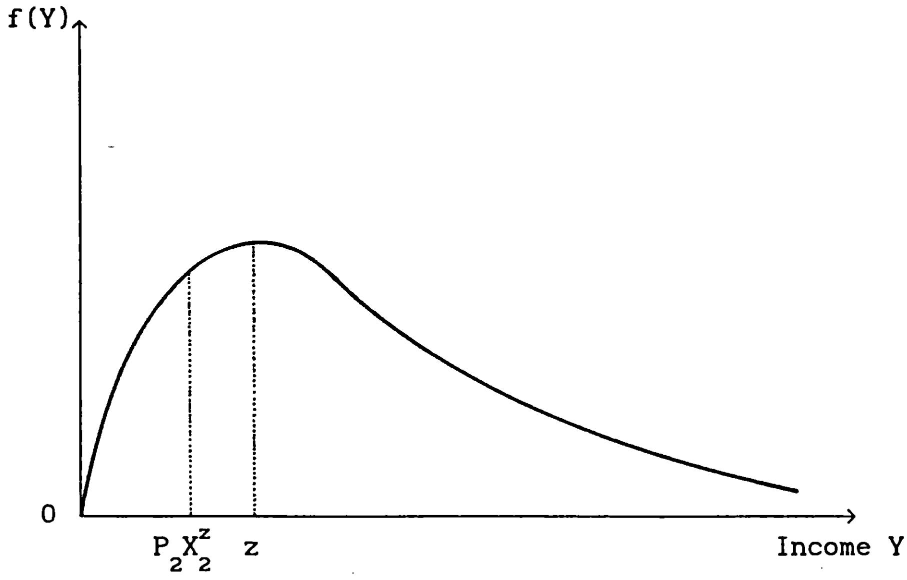

Figure 4.2: Income distribution and the poverty line.

Figure 4.2 shows that we can write that

$$\int_0^z f(Y)dY = \int_0^{P_2X_2^z} f(Y)dY + \int_{P_2X_2^z}^{z} f(Y)dY \qquad (4.17)$$

where $P_2X_2^z = z - P_1X_1^z$.

The minimum the poverty index PI can reach is $\int_0^{P_2X_2^z} f(Y)dY$ when we lower P_1 down to zero,as shown in figure 4.3.

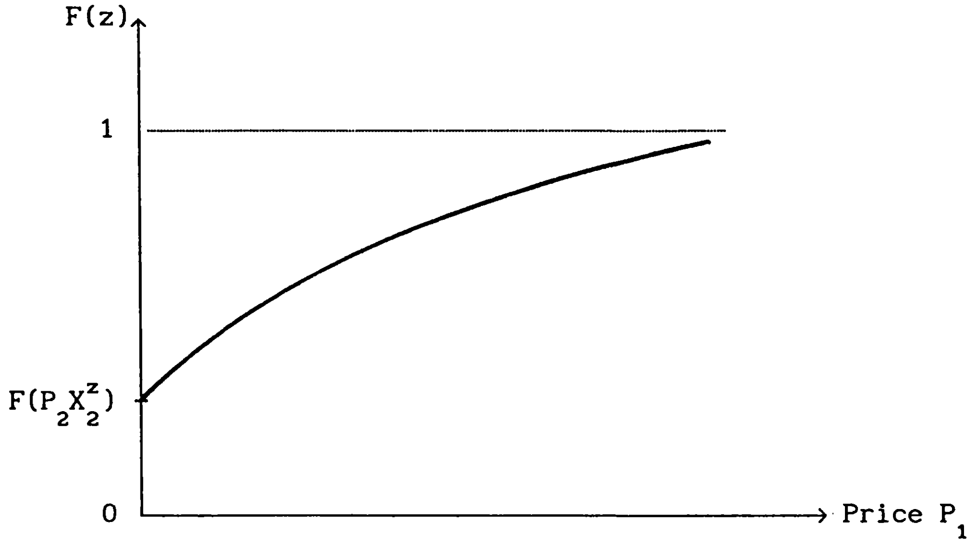

Figure 4.3: Interval for the value of the poverty index.

To minimize PI we must $\int_{P_2X_2^z}^{z} f(Y)dY$, that is , to minimize F(z).

The price of commodity 1 that minimizes F(z) is clearly the minimum price the public utility can charge its consumers. It depends on its budgetary constraints, that is, on its total cost, on the revenue collected by the sales of its commodity, and on the amount of deficit the government is prepared to finance; in other words, the public utility has to satisfy the constraint total cost minus total revenue should be at least equal to its allowable deficit. The lowest price is that one that satisfies the equality in this constraint, that is,

$$C\left[\sum_{j=1}^{n} X_{1j}\right] - \sum_{j=1}^{n} P_1 X_{1j} = \bar{D} \tag{4.18}$$

The above expression cannot be solved unless both the demand and the cost functions are specified. For simplicity, let us assume that the demand function (derived from a Cobb-Douglas utility function) is

$$X_{1j} = \alpha Y_j P_1^{-1} \tag{4.19}$$

where Y_j is the income of the jth household.

Let us also assume that the total cost function is

$$C\left(\sum_{j=1}^{n} X_{1j}\right) = F + k \left(\sum_{j=1}^{n} X_{1j}\right)^{\theta} \tag{4.20}$$

where F is the public utility fixed cost of production, k is a positive (k > 0) constant and θ is a returns to scale parameter, with $\theta \leq 1$.

Using these functions in expression (4.18) , we can write

$$P_1 = \left[\frac{k}{\dfrac{\bar{D} - F}{\left[\alpha \sum_{j=1}^{n} Y_j\right]^{\theta}} + \dfrac{1}{\left[\alpha \sum_{j=1}^{n} Y_j\right]^{\theta-1}}} \right]^{1/\theta} \tag{4.21}$$

This price is the lowest that the public utility can charge, subject to condition (4.18). As such, this is the price that minimizes poverty in this society since it is the public utility tariff that makes z reach its smaller possible value. As expected, this price is inversely related to the amount of deficit financed by the government, the only instrument it has, in the present case, to make this price smaller and, consequently, decrease the level of poverty.[23]

An alternative way of reaching the same result is to induce the implementation of programmes that increase productivity in the public utility, thereby reducing the cost component contribution in the minimum price determination.

Inspection of expression (4.21) shows that the public utility price in the present case cannot be zero: it tends to zero (without being equal to zero) when $\bar{D}$ tends to ∞ . This means that the lowest level of poverty that could be reached using this tariff would be

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[23] Since this deficit ($\bar{D}$) is financed by transferences of resources out of government revenues, care should be taken that the increased amount required to lower the public utility tariff will not be raised by additional taxation or other ways that have a perverse net effect upon poverty.

higher than the area below the income distribution curve calculated between incomes 0 and $P_2X_2^z$. The impossibility of charging a zero price, however, derives from the particular case of demand and cost functions used in the analysis; it is obvious that without these functions, one can imagine a situation by which the public utility could distribute its production without charge, as long as the government covers the total cost of implementing such a policy.

It should be noted that this pricing policy of minimizing poverty by charging the lowest price the public utility is in condition to charge has its cost in comparison with that that maximizes social welfare: although poverty is minimized, the poorest households will in worst condition in welfare terms and the non-poor in better condition. It is easy to see why. Figure 4.1b can be used to illustrate the problem. The lowest price given by expression (4.21), the same for all Y_j, is necessarily higher than those that would be charged to the poorest and lower than those charged to the non-poor; price P_1 is a parallel to the horizontal axis, cutting the curve FF from above for the lowest incomes. At this higher prices, the poor demand smaller quantities, and at lower prices, the non-poor demands higher quantities. This differential distributional impact, however, may be irrelevant since the curve FF depicted in figure 4.1b is related to $0<\rho<1$, that is, low degree of aversion to inequality, which makes the concern with poverty more important than with inequality.

4.4.1 *Minimization of Poverty and Discriminatory Prices.*

In the preceding section we were interested in deriving a public utility price that minimizes the poverty level in a society. This price would be unique, indifferently charged to all households, irrespective of their social condition. As we saw, this price would be as low as the deficit financing by the government allows.

One could discuss how adequate such a policy would be from a social point of view: in reality, the government, trying to minimizing poverty by charging a low tariff to consumers, would be extending this benefit to households that do not need such a protection. In other words, this type of pricing policy suffers from the same problem of targeting diagnosed in poverty-alleviation programmes, in which part of the financial transfers applied in implementation leak to the non-poor, thus checking their efficacy.[24]

Instead of charging the same low price to all customers, we can now think in the public utility charging two different prices, the lower one, P_P, to be paid by the poor households (as we are interested in decreasing the level of poverty), and the other, P_R, by the non-poor.[25]

The quantities demanded by the poor and the non-poor at prices P_{1P} and P_{1R}, respectively, are determined by their demand functions:

$$X^i_{1j} = X_1(P_{1i} , P_2, Y^i_j) \tag{4.22}$$

for i= P(poor), R (non-poor).

where X^i_{1j} : quantity demanded of commodity 1 by household j earning an income Y^i_j ,

P_{1i}: price to be paid by household with social condition i for a unit of commodity 1 ,

P_2 : price of the composite commodity 2.

The total quantity demanded of commodity 1 (X_1) can be written as:

$$X_1 = X^P_1 + X^R_1 \tag{4.23}$$

where $X^i_1 = \sum_{j=1}^{K_i} n^i_j \; X^i_{1j}$ for i=P,R, respectively, the total quantity demanded of commodity 1 by the poor and the non-poor.

The public utility total revenue (TR) is:

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24 Kambur (1987) discussed the issue of targeting in relation to the transfers made by the social security programmes in the United Kingdom and their impact on poverty.

25 We shall use "rich" and "non-poor" interchangeably in the context.

$$TR = P_{1P}.X_1^P + P_{1R}.X_1^R \tag{4.24}$$

and its total cost of production (TC) is:

$$TC = F + k\, X_1^{\theta} \tag{4.25}$$

where F is its fixed cost, k is a constant and θ is a returns to scale parameter.

Since the public utility must balance its revenue with its cost, that is , $TC - TR = \bar{D}$, we can write that

$$[\ F + k\ (X_1)^{\theta}\ ] - [\ P_{1P}\ X_1^P + P_{1R}\ X_1^R\ ] = \bar{D} \tag{4.26}$$

or

$$P_{1P}\ X_1^P = F - \bar{D} + k\ (X_1)^{\theta} - P_{1R}\ X_1^R \tag{4.27}$$

Expression (4.27) shows the interrelationship between prices P_{1P} and P_{1R}. In the appendix to this chapter we calculate the derivative $\partial P_{1P}/\partial P_{1R}$ and we show the values it can take. This derivative is the expression

$$\frac{\partial P_{1P}}{\partial P_{1R}} = - \frac{X_1^R\ (\ 1 - \varepsilon_{1R}\ ) - k\ \theta\ X_1^{\theta-1}\ \partial X_1^R/\partial P_{1R}}{X_1^P\ (\ 1 - \varepsilon_{1P}\ ) - k\ \theta\ X_1^{\theta-1}\ \partial X_1^P/\partial P_{1P}} \tag{4.28}$$

Expression (4.28) indicates that the sign of that derivative is dependent upon the relative net effect of changes that simultaneously occur both in the cost of production and in the total revenue. In other words, a decrease in the price P_{1P} can be allowed if the changes in the revenues and in total cost of production is sanctioned by a increase in P_{1R} ; however, it may be the case that an increase in P_{1R} will require an increase in P_{1P} to cover the gap in costs and revenues.[26] Then, as shown in the appendix, assuming that the demand price elasticities are constant, the form of association between these two prices is a trade-off curve with the following graphs:

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[26] This problem is equivalent to that examined in income taxation about the trade-off between the exemption level and the marginal tax, given some required level of tax revenue.

i) monotonically decreasing, that is, a lower P_{1P} is always possible as long as it can be financed by a higher P_{1R} in order to balance total revenue with total cost. Of course, this depends on the non-poor's demand price elasticity for this commodity at higher prices: the substitution effect should produce a fall in the quantity demanded in a lower proportion than the rise in price. Cases of a decreasing curve are illustrated by cells 1,2,3,8,9,11,13,14 and 15 in table 4.2 in the appendix;

ii) monotonically increasing, when the negative net effect of the decrease in the revenue predominates over the cost of production and requires a rise in P_{1P} when P_{1R} is increased; this is the case of cells 4, 5, 6, 7, 12, and 16 in table 4.2 in the appendix. For these cases, a public utility pricing policy for poverty alleviation would require a lowering of the price paid by the rich household, that is, a decrease in the price they pay would generate a net revenue that would allow a lower price to be charged to the poor.

Let us adopt a more realistic view , that is , let us assume that the household's demand for commodity 1 has a variable price elasticity and that $\partial\varepsilon_{11}/\partial P_{11} \geq 0$, being inelastic at a lower price and very elastic at a higher prices. In this case, the (P_{1P},P_{1R}) trade-off curve show an U form, P_{1P} decreasing in value for an increasing value of P_{1R}, reaching a minimum and ,after this point, increasing as P_{1R} continues to increase; this case can be identified in table 4.2 in the appendix by cells 1, 10 and 16, when P_{1R} increases from a lower to an upper value.

Figure 4.4 illustrates the trade-off between prices P_{1P} and P_{1R} when the curve has a U-form .

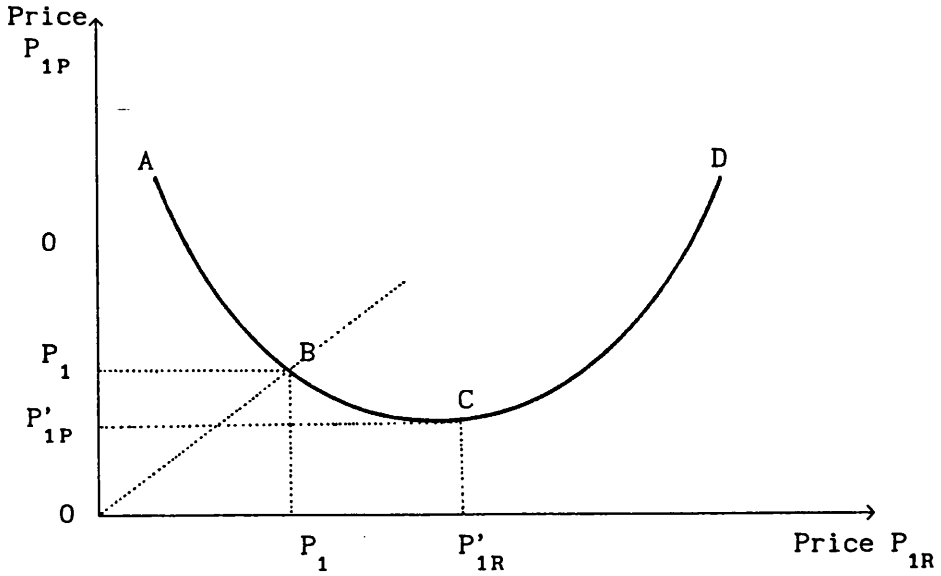

Figure 4.4: Trade-off curve between P_{1P} and P_{1R}.

The descending section of that curve (section AC) is, as mentioned before, explained by the fact that the increased revenue generated by a higher price charged to the rich household (since its demand is assumed to be inelastic at those prices) exceeds the additional cost of producing an increased quantity of commodity 1 sold at a lower price to the poor (whose demand is elastic at that prices). Section CD of that curve shows the reverse: higher P_{1R} prices are not sufficient to generate enough revenue (the rich's demand elasticity is now price elastic and the poor's is inelastic) to overcome a higher cost of production and the price P_{1P} must increase to balance the public utility's accounts.

The 45° line in Figure 4.4 shows the points of identical prices P_{1P} and P_{1R}. Let us assume that point B on the price trade-off curve marks the lowest price the public utility can charge in a system of non-discriminatory pricing, i.e, the price P_1 we derived earlier, as given by expression (4.21). Let us also assume that point C on the same curve shows the combination of the minimum price that can be charged to the poor (P'_{1P}) and the respective price to be paid by the rich (P'_{1R}) in a discriminatory price system that subsidizes the consumption of the poor, since $P'_{1P} < P_1$. We can see in that figure that the arc BC is the relevant section of that trade-off curve for a discriminatory pricing policy in favour of the poor; the choice of the prices the poor and the rich should pay is constrained by the intervals ($P_1 > P_{1P} \geq P'_{1P}$) and ($P_1 < P_{1R} \leq P'_{1R}$).

The lowest price P'_{1P} is the one for which the derivative $\partial P_{1P}/\partial P_{1R}$ [expression (4.28)] is equal to zero; this minimum P_{1P} is reached when

$$X_1^R (1 - \varepsilon_{1R}) = k \, \theta \, X_1^{\theta-1} \, \partial X_1^R/\partial P_{1R} \tag{4.29}$$

The derivation of the minimum price P_{1P} and the compatible price P'_{1R} , and the respective quantities demanded at these prices (four unknowns) requires the solution of a system of four simultaneous equations comprising expressions (4.27) and (4.29) and the two demand equations for commodity 1. Those four unknowns will be function of the exogenous variables F, D, Y^i_{1j}, P_2, h and n and the parameters k, θ and ε_{1i}.

It should be noted that the use of a discriminatory price in which the poor is charged the lowest feasible price a public utility can set is not a guarantee that the level of poverty will decrease: it may or may not. The only thing which is certain is that the welfare of the poor will improve and the welfare of the non-poor will be worst in comparison with a situation of a unique minimum price since the poor will be paying a lower price and the non-poor a higher. The reason for this conclusion is easy to understand: the determination of the poverty line [as defined by expression (4.15)] may be dominated by the condition $X_2(P_1,P_2,Y) \geq X_2^z$ and it may be the case that $\partial X_2/\partial P_1=0$ (as in the case of Cobb-Douglas utility function; the demand function for commodity 2 does not depend on the price P_1, only on P_2 and on the household income). However, we think that in most cases, when the public utility charges a lower price to the poor, some poor will improve their condition by being allowed to consume the quantities X_1^z and X_2^z, that is, they will not longer be poor, and the poverty level will decrease.

Having a discriminatory price system as outlined above is not a sufficient condition for solving the targeting problem: the deficit financed by the government may still be used to subsidize the price paid by the non-poor.[27] One way of avoiding this problem is to restrict the choice of P_{1R} among those prices equal to or greater than the marginal cost. Doing this will spare the subsidy given by the government only to those that are considered to deserve it, making the price they pay as low as possible and minimizing the number of households in poverty. Another solution would be to charge the same price [derived from expression (4.21), assuming that $\bar{D} = 0$] to both poor and non-poor households and to give vouchers to the poor (totaling the real amount of $\bar{D}$) so they can use them to pay their public utility bills.[28] The discriminatory price system would be revealed by the existence of two prices, the one derived from expression (4.21) paid by the non-poor and the smaller effective price paid by the poor.[29]

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[27] Actually, the use of a discriminatory price introduces a new type of problem, the poverty trap, a problem frequently examined in studies related to income tax and social benefits systems; see, for instance, Dilnot and Star (1986) and Kanbur (1987). The poverty trap occurs for those households whose income are close to the limit at which the price increases: for those, their income is "levied" at a very tax rate, leaving the household with a net income (net of the price paid) smaller than the incomes of some of those who pay a lower price.

[28] A system of non-marketable vouchers could be used to achieve both a price reduction for commodity 1 for the poor and the attainment of a target level of consumption of the subsidized commodity; in Section 5.6 we discuss the question of setting a price that is compatible with a minimum consumption requirement.

[29] The entitlement to vouchers could be guaranteed to those households that fulfill a means-tested benefit regulation as done in the United Kingdom for social security benefits and in the United States for welfare assistance. The correct targeting in this case would be assured by the assessment of the household's income and resources. This system, however, presents some problems: i) it has an administrative cost that should be considered and ii) not all eligible poor households would claim the benefit because of the social stigmatization that means-tested programmes produce. For the importance of the welfare stigma in US and UK in this context, see the references cited by Kanbur (1987,p.133).

4.4.2 - *Poverty, Pricing and Minimum Entitlement*

It may happen that some of the poor could not afford to consume the quantity X_1^z even at the lowest prices we just discussed in the former section and the government thinks that it is justifiable to implement a pricing policy for commodity 1 that allows all households to consume at least that socially desirable quantity, that is, to set prices which satisfy a minimum entitlement condition for the poor.

Since the minimum prices we examined in the former section are those allowed by the $\bar{D}$ constraint and the possibility of cross-subsidization among households, the implementation of such a minimum entitlement policy would require additional resources transferred by the government to finance it. The reason for this is the fact that for those poor to benefit from this policy prices should be lowered to the level that is required to allow them to consume that quantity. Of course, these prices are lower than the price the public utility is able to set given the current deficit $\bar{D}$.[30]

These lower prices that should be charged to the poor to allow them to consume at least X_1^z are determined by their demand functions,as we have already seen in section 4.3. For instance, in the case of a Cobb-Douglas utility function these prices are given by

$$P_{1j} = \frac{a\, Y_j}{X_1^z} \tag{4.30}$$

As mentioned above, the feasibility of such policy is dependent on the amount of additional subsidy the government is

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[30] Actually, besides an additional $\bar{D}$, we should also consider all other sources of funds that could be used to finance this policy, as we did in section 4.3.

prepared to transfer to the public utility. It may be the case that this total additional cost cannot be financed out of government resources and the minimum entitlement pricing policy for the poor should consider a smaller quantity than the desirable X_1^z.

It should be noted that even if the minimum entitlement pricing policy for commodity 1 is financially feasible with the quantity X_1^z , the implementation of this policy would not eliminate poverty. The reason for this is that, although all households would be allowed to consume the minimum quantity of commodity 1, there would be poor households whose incomes would not allow them to consume the quantity X_2^z, the socially desirable minimum quantity of the composite commodity 2. This policy may help to diminish the poverty level if the reduction of commodity 1's price for some poor now allows them to consume X_2^z , changing them from being poor to non-poor.

4.5 - *Effects of the Population* Growth *on Prices.*

It is important to note that the U curve depicted in Figure 4.3 refers to the given numbers of poor and rich households implicit in expression (4.27). Since a growing number of poor households is a common phenomenon observed in large urban centres in countries of the Third World, it is important to examine the consequences it brings to a pricing policy that intends to lower the level of poverty in these countries.

Assuming the poor are paying the subsidized price P'_{1P} shown in Figure 4.4, an increased number of poor households means that someone should be called to finance the required additional sum of total subsidy. It can be financed either by cuts made in other government expenditures or by the taxpayer, through additional taxation. It can also be financed by the households themselves, paying higher prices. It should be noted that both groups of households, the poor and the rich, will be affected in this case: charging a higher price only to the rich is not sufficient since P'_{1R} is the highest price it can pay without generating a smaller total revenue; then, the poor will also be called to contribute, paying also a higher price to complement the required public utility's total revenue.

In the case of the subsidized price P_1^* to allow the consumption of a minimum quantity of the commodity, the situation is similar to that just seen. The growing number of poor households will certainly be paying this lower price and the deficit constraint will be affected. The solutions in the short-run are either expanding $\bar{D}$ or increasing the prices to consumers or both. In this last case, it is possible that even the poor will be affected since, as we mentioned before, the additional revenue obtained from the rich could not be enough to cover costs.

The accelerated population growth seen in urban centres of Third World countries causes another type of problem to public utilities, with consequences on its prices: capacity of production is reached more rapidly and funds are required to expand this capacity. This may mean that the discriminatory prices examined in this chapter should be reexamined to allow the additional constraint of generating enough financial resources to pay for the costs of the expansion. Additional analysis is required to examine how these funds should be generated by poor and non-poor households through higher tariffs in case the government decides users should bear the full costs of the capacity expansion. This analysis is made in the next chapter of this thesis.

4.6 - *Conclusions*

The objective of this chapter was to discuss prices to be charged by a public utility when the adopted pricing policy intends to focus on poverty. Then, the approach followed in this chapter was different from that used in chapter 3 by assuming that the government is more interested in facing poverty rather than inequality when setting public prices.

In section 4.3 we derived prices that maximizes welfare subject to a minimum entitlement constraint. We saw that when the minimum entitlement X_o is a positive quantity greater than zero, the prices we derive in that section differ from those derived in chapter 3 in the following aspects:

a) when the minimum entitlement constraint is binding, the price should be lowered to a given level that depends directly on the shadow price for that constraint. This means that the higher the level of minimum entitlement, the larger should be the cut in the price to allow the household to buy that minimum quantity of the commodity.

b) as long as the amount of subsidy given by the government does not change, any reduction in price to allow households the minimum entitlement will require increase in the prices paid by those households that are not beneficiaries of the the minimum entitlement pricing policy. This increase is required to compensate the loss of revenue that such policy entails; thus, this policy is actually a way of introducing or reinforcing a system of cross-subsidization among households.

In the same section we discussed several problems that may hinder the implementation of a minimum entitlement pricing policy by public utilities:

i) in the case that this policy should be financed out of government's resources, that is, by additional resources provided by the government to the public utilities, its implementation may be not possible if the amount of resources needed is larger than the amount the government is ready to transfer, as is the case in most developing countries;

ii) to finance this policy out of possible profits made by these public utilities is a way of postponing additional capacity expansions, with adverse social and economic effects;

iii) to use a cross-subsidization scheme to finance such policy may not be viable if the non-poor's demand price elasticity for the commodities is elastic at these higher prices or if these prices induce substitution, resulting in a smaller public utility's total revenue than that required.

All this does not mean that a minimum entitlement policy cannot be implemented by public utilities. A combination of sources of subsidization plus a less ambitious goal in terms of the minimum consumption allowed may make viable such policy .

In section 4.4 we examine the objective of minimization of poverty through pricing. We saw that when the public utility's pricing policy preference is that of charging the same price to all households, reaching that objective depends on the lowest price made possible by the financial balance constraint. In other words, the minimization of poverty depends on the level of subsidy that the government is prepared to transfer to the public utility to allow the least price to charged to households. In the short-run, this is the only instrument that the government can manipulate to induce the attainment of the objective it set to the public utility. In the long-run, one should expect that improvements made in the cost management of the public utility and the reap of economies of scale may allow lower prices to be charged, with favourable impacts upon the objective of minimization of poverty.

In the case of a discriminatory pricing policy being used by a public utility, besides those elements cited above as the influence and constraint the price level that can be charged to the poor, it is possible to finance a lower price offered to these consumers by using a cross-subsidization scheme with the purpose of minimizing the poverty. However, the analysis made in this chapter shows that there is a trade-off curve between the price to be paid by the poor and the price to be paid by the non-poor and that this trade-off curve may set limits to the lowest level the public utility can choose to favour the poor; the important element that restricts the price choice is basically the non-poor's demand price elasticity for the commodity at higher prices, which may check the possibility of additional revenues being raised with those higher prices.

In this chapter we also examined the compatibility of pricing for the minimization of the poverty with an additional constraint of a minimum consumption requirement for the poor. We saw that this policy would require additional funds being transferred to the public utility to finance the lower prices the poor will charged to allow them a minimum entitlement.

Another finding of the analysis made in this chapter was to show how the growth of the number of poor may restrain the possibility of reaching a higher level of minimization of the poverty, as defined here, through the pricing policies adopted by public utilities: we saw that the additional need of consumption subsidization for the newcomers may require price increases not only for the non-poor, but also for the poor. Since the phenomenon of immigration of poor households to urban centres is a common fact in several countries of the Third World, we should expect that the effectiveness of such policy of pricing to attain minimization of the poverty in these countries to be smaller than needed.

APPENDIX TO CHAPTER 4

ANALYSIS OF THE FUNCTION THAT RELATES P_{1P} TO P_{1R}

We saw that prices P_{1P} and P_{1R} are interrelated and that, according to the expression (4.27), this relationship is :

$$P_{1P}\, X_1^P = F - \bar{D} + k\,(X_1)^{\theta} - P_{1R}\, X_1^R$$

We can study the form of this relationship by analyzing the sign of $\partial P_{1P}/\partial P_{1R}$.

Before calculating that derivative, let us calculate $\partial(P_{1P}X_1^P)/\partial P_{1R}$, $\partial X_1/\partial P_{1R}$ and $\partial(P_{1R}X_1^R)/\partial P_{1R}$ as intermediary steps.

$$\frac{\partial(P_{1P}X_1^P)}{\partial P_{1R}} = P_{1P}\,\frac{\partial X_1^P}{\partial P_{1P}} \cdot \frac{\partial P_{1P}}{\partial P_{1R}} + X_1^P\,\frac{\partial P_{1P}}{\partial P_{1R}} \tag{4.31}$$

or, dividing and multiplying it by X_1^P

$$\frac{\partial(P_{1P}X_1^P)}{\partial P_{1R}} = X_1^P\,\frac{\partial P_{1P}}{\partial P_{1R}}\left[\,1 - \varepsilon_{1P}\,\right] \tag{4.32}$$

where $\varepsilon_{1P} = -\,P_{1P}/X_1^P \,.\, \partial X_1^P/\partial P_{1P}$, the poor household's demand price elasticity for commodity 1.

By definition, $X_1 = X_1^P + X_1^R$; then,

$$\frac{\partial X_1}{\partial P_{1R}} = \frac{\partial(\,X_1^P + X_1^R\,)}{\partial P_{1R}} = \frac{\partial X_1^P}{\partial P_{1P}} \cdot \frac{\partial P_{1P}}{\partial P_{1R}} + \frac{\partial X_1^R}{\partial P_{1R}} \tag{4.33}$$

and

$$\frac{\partial(P_{1R}\,X_1^R)}{\partial P_{1R}} = X_1^R + P_{1R}\cdot\frac{\partial X_1^R}{\partial P_{1R}} = X_1^R\,(\,1 - \varepsilon_{1R}\,) \tag{4.34}$$

where ε_{1R} is the rich household's demand price elasticity for commodity 1.

Since

$$\partial(X_1)^{\theta}/\partial P_{1R} = \theta(X_1)^{\theta-1}\ \partial X_1/\partial P_{1R} \tag{4.35}$$

we can now use the above intermediary results to express $\partial P_{1P}/\partial P_{1R}$ as:

$$\frac{\partial P_{1P}}{\partial P_{1R}} = -\ \frac{X_1^R\ (1 - \varepsilon_{1R})\ - k\ \theta\ X_1^{\theta-1}\ \partial X_1^R/\partial P_{1R}}{X_1^P\ (1 - \varepsilon_{1P})\ - k\ \theta\ X_1^{\theta-1}\ \partial X_1^P/\partial P_{1P}} \tag{4.36}$$

The derivatives that appear in the numerator and in the denominator of expression (4.36) are negative since commodity 1 is assumed to be a normal good for both the poor and the rich households. To simplify the analysis of the sign of that expression, let us write it as

$$\partial P_{1P}/\ \partial P_{1R} = -\ \frac{a + b}{c + d} \qquad b>0 \text{ and } d>0$$

Table 4.2 lists the signs this derivative can take for selected values for the price elasticities.

TABLE 4.2: SIGN OF THE DERIVATIVE $\partial P_{1P}/\partial P_{1R}$ (*)

VALUES FOR ε_{1P} AND ε_{1R}		$a > 0$ $(0<\varepsilon_{1R}<1)$	$a = 0$ $(\epsilon_{1R}=1)$	$a < 0$ $(\epsilon_{1R} > 1)$ positive numerator	$a < 0$ $(\epsilon_{1R} > 1)$ negative numerator
$c<0$ $(\varepsilon_{1P}>1)$	positive denominator	1 −	2 −	3 −	4 +
	negative denominator	5 +	6 +	7 +	8 −
$c = 0$ $(\varepsilon_{1P} = 1)$		9 −	10 −	11 −	12 +
$c > 0$ $(0 < \varepsilon_{1P} < 1)$		13 −	14 −	15 −	16 +

(*) for expression (4.36) or its equivalent $\dfrac{\partial P_{1P}}{\partial P_{1R}} = -\ \dfrac{a + b}{c + d}$

CHAPTER 5

FROM THIRD-DEGREE TO SECOND-DEGREE PRICE DISCRIMINATION IN PUBLIC UTILITY PRICING.

5.1 - *Introduction*

In the first chapter it was shown how public utilities in Brazil use their price schedules to cross-subsidize the households' consumption; they do that in obedience to regulatory norms that establishes that the tariffs applied to lower levels of consumption (presumedly the poor) should be smaller than those assigned to higher levels of consumption. Thus, their price schedules are set in terms of the quantity households consume of their services instead of its socio-economic condition. The implicit assumption is that there is a positive relationship between household consumption of these public services and household income.

Price schedules derived in previous chapters of this dissertation are income-related and not referred directly in terms of household consumption. The purpose of this chapter is to examine several problems that may appear when we use a price-quantity schedule with a distributive objective to replace a price-income schedule. First, in section 5.2, we show that a price-income schedule defines a set of pairs of quantities and prices that can be used for pricing the households' consumption; this price-quantity schedule will have the same distributional characterist of the original price-income schedule as long as the relationship we observe in this schedule between the quantity consumed by the household and its income is not broken. However, since households may select a different quantity they were expected to choose on the basis of their incomes, this change affects the price schedule's distributive characteristics; in section 5.3 we examine the self-selection problem and illustrate how adverse selection may appear with the use of block-quantity pricing. In section 5.4 we use the household's individual rationality and incentive compatibility constraints to derive the prices the poor and non-poor should be charged for their consumption; we also show how the adverse selection problem affects both prices. Since household is an non-observable variable and is a costly one to be obtained, in section 5.5 we examined the possibility of using a proxy, other than the quantity consumed, to price consumers.s In section 5.6 we discuss how the choice between a price-quantity and a price-income schedule is affected by errors of classification of the households' social condition and by the degree of aversion to inequality being used to derive the price schedule. This chapter also contains an appendix to show how the indifference curves used in section 5.3 are derived.

5.2 - *Translating a Price-Income Schedule into a Price-Quantity Schedule.*

We have been deriving optimal public utility discriminatory prices in terms of households' incomes. The implementation of these price schedules would require the knowledge of the consumers' earnings to define the tariff each one of them should pay for the service provided. In other words, a public utility with such a price schedule needs to have access to the signal (income) that allows household discrimination; the signal here has the same role exerted by age, family composition, occupation, location, and other variables in cases of third degree price discrimination.

Household income or any other income-related variable is an information that may be expensive to obtain and subject to a degree of measurement error. Individuals tend to under or over report their earnings if the incentives play in one direction or the other. In the case of a progressive price schedule (as in the case of income tax), the incentive would work towards households reporting lower income levels. Besides that, the administrative costs of collecting, recording and updating this information cannot be overlooked. Thus, it is not surprising that public utilities prefer adopting price schedules defined in terms of the quantity consumed of their services, even if they are interested in the distributional impact of their tariffs, as in the Brazilian case.

It is possible to translate a price schedule defined in terms of household income into a one that is consumption related. This translation is made via the household's demand function for that service: once it is known the price P_{1J} that a household with income Y_j should pay, the quantity consumed X_{1j} by this household is defined by its demand function. Thus, we have a pair of P_{1J} and X_{1j} for each Y_j. The complete set of pairs for price and quantity consumed is the price schedule in consumption terms. That is, if

$$P_{1j}=f(Y_j) \tag{5.1}$$

for j=1,...,K , and

$$X_{1j}=g(P_{1j},\ P_{2j},\ Y_j) \tag{5.2}$$

where P_{2j} is the price of the composite commodity (all other commodities), then we can define the function

$$P_{1j}=h(X_{1j},P_{2j}) \tag{5.3}$$

by using the inverse

$$Y_j=g^{-1}(P_{1j},\ P_2,\ X_{1j}). \tag{5.4}$$

In section 3.2.1 we derived a set ofprice and quantity formulas that came out of the maximization of a social welfare function (constrained by the public utility's financial balance constraint) when the households had their behaviour represented by a Cobb-Douglas utility function. These formulas when $\theta=1$ are:

$$P_{1i} = \frac{m.\ \alpha\left[\sum_{j=1}^{K} n_j Y_j^{\frac{(1-\alpha)(1-\rho)}{(1-\alpha)+\alpha\rho}}\right].Y_i^{\frac{\rho}{(1-\alpha)+\alpha\rho}}}{\bar{D}-F + \alpha\sum_{j=1}^{K} n_j Y_j} \qquad i=1,...,K \tag{5.5}$$

$$X_{ii} = \left[\frac{\bar{D} - F + \alpha\sum_{j=1}^{K} n_j Y_j}{m \sum_{j=1}^{K} n_j Y_j^{\frac{(1-\alpha)(1-\rho)}{(1-\alpha)+\alpha\rho}}}\right] . Y_i^{\frac{(1-\alpha)(1-\rho)}{(1-\alpha)+\alpha\rho}} \qquad i=1,\dots,K \qquad (5.6)$$

The pair $[P_{ii},X_{ii}]$ for Y_i, when $i=1,\dots,K$, defines a price-quantity schedule.[1] If households with income Y_i examines this price quantity schedule and choose to consume the quantity defined by expression (5.6) for which they are charged the corresponding price defined by expression (5.5), the implementation of this price-quantity schedule will produce the same distributional effect envisaged in the price-income schedulefrom which it originated. However, the assumption that households will choose the "correct" quantity, that is, the quantity they are supposed to choose given their income level [expression (5.5)] may not be true; they may feel it worthwhile (in utility terms) to select a different pair $[P_{ii},X_{ii}]$, which affects the distributional effect that the price-quantity schedule is supposed to have. In the following sections we will examine how an such adverse selection can occur in the pricing context we are studying in this thesis and how prices should be reformulated in the presence of this problem.

5.3 - *The Self-Selection Mechanism.*

Any producer, including our public (or private) monopolist faces two kinds of demand constraints: the *individual rationality* and

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1 Note that depending on the value taken by the aversion to inequality parameter ρ this price-quantity schedule may define identical prices for different quantities consumed and different prices for identical quantities; the former occurs for ρ=0 and the latter for ρ=1. For ρ>1 there will be a one-to-link between prices and quantities.

the *incentive compatibility* constraints. The first has to do with the fact that the consumer must be willing to purchase a non-zero quantity at a given price and the latter kind of constraint states that each consumer must prefer its bundle of consumption to the other consumer's bundle. Let us assume two types of consumers, the poor and the rich: the monopolist wants to sell the quantities X_{1P} and X_{1R} to the poor and rich consumers at the prices P_{1P} and P_{1R}, respectively.

The *individual rationality* constraint for these consumers can be expressed as

$$U_P(X_{1P}, Y_P - P_{1P}X_{1P}) \geq U_P(0, Y_P) \tag{5.7}$$

and

$$U_R(X_{1R}, Y_R - P_{1R}X_{1R}) \geq U_R(0, Y_R) \tag{5.8}$$

and the *incentive-compatibility* (or *self-selection*) constraint as

$$U_P(X_{1P}, Y_P - P_{1P}X_{1P}) \geq U_P(X_{1R}, Y_P - P_{1R}X_{1R}) \tag{5.9}$$

$$U_R(X_{1R}, Y_R - P_{1R}X_{1R}) \geq U_R(X_{1P}, Y_R - P_{1P}X_{1P}) \tag{5.10}$$

Arbitrage may affect a price discrimination scheme, frustrating its objective; one type of arbitrage is exactly the transferability of demand between different bundles offered to consumers, that is, consumers choosing to consume quantities that are not in accordance to the quantities they were expected to consume and, consequently, paying different prices they were expected to pay.[2]

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[2] The transferability of demand will generally induce the producer to increase the discrimination by increasing the differences in the quality of the services provided. In the case of the price discrimination adopted by airlines, these companies reinforce the self-selection devices by exaggerating the differences in quality towards the first-class services to affect the possible rich's preference for the tourist-class seats; Phlips(1983,p.5) gives a testimony that the difference in service is greater than that justified by the fares. In the case of public utilities supplying services such as water/sewage, electricity and piped gas, it is hard to find a way of introducing differences in quality to avoid

To illustrate the circumstances in which households may transfer their demand from higher quantity at higher price to a lower quantity at a lower price, let us examine four types of pricing schedules to be applied to two groups of households, the poor and the rich:

Type A: Households are classified according to their social condition in groups and to each group is assigned a price their members will be charged, irrespective of the quantity consumed of commodity 1.[3] Prices P_{1P} and P_{1R}, for $P_{1P}<P_{1R}$, are respectively the prices the poor and the rich should pay for each unit consumed;

Type B: Households' consumption of commodity 1 is charged according to the following two-block price-quantity schedule: for a consumption up to a given quantity (let us say, X_o) each unit consumed is charged at a price P'_1; for any consumption higher than X_o, each of <u>all</u> units consumed is charged at P''_1, for $P''_1>P'_1$.

Type C: The same two-block price-quantity schedule as type B, with the difference that the price P''_1 is charged to the consumption units that <u>exceeds</u> X_o This type is similar to the price schedules used by public utilities in Brazil, as described in section 1.3;

Type D: A price-quantity schedule in which the price increases with the quantity consumed; thus, each consumption unit has a different price, that is to say, the marginal price varies (increases) with the quantity consumed, with this marginal price

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transferability of demand. The other type of arbitrage is the transferability of the commodity, that is, the consumers that buys at a lower price transfers the commodity to a consumer that was supposed to pay a higher price; its existence destroy any discriminatory price scheme.

[3] In section 5.6 we examine how errors of classification affect the choice between a price-income and price-quantity pricing regimes.

applied to each marginal quantity.[4]

Figures 5.1 to 5.4 illustrates these four types of pricing schedules. In the horizontal axis are represented the quantities consumed X_{1i} and in the vertical axis we have the households' total bill $(TB)_i$ for i= P(poor),R(rich). The curves of total bill are different according to the type of pricing schedule being used:

i) in the case of type A, the total bill for the poor and for the rich are the straight lines O-POOR and O-RICH respectively, with constant marginal prices P_{1P} and P_{1R};

ii) in the case of type B, the total bill is the curve OABC, with a constant marginal price P'_1 up to X_o (in the segment OA) and a constant, higher, marginal price P''_1 for quantities superior to X_o (in the segment BC). The curve OABC shows a discontinuity in the segment AB explained by the upward movement ot the total bill curve when <u>all</u> units are charged at P''_1 instead of at P'_1;

iii) in the case of type C, the total bill OAB shows in thesegments OA and AB the same marginal prices P'_1 and P''_1 shown by type B; however, instead of having a discontinuity in A, the total bill curve shows a kink at this point since the higher price P''_1 applies only to the marginal quantities;

iv) in the case of type D, the total bill curve $(TB)_i$ is a continuous curve with tangents that increase with the quantity consumed since higher prices are used for charging each marginal quantity.

Let us examine now some possible consumer equilibria when these types of pricing schedules are used to charge households for

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[4] Type D can be thought as an approximation of type C, for an infinite number of blocks, each block comprising one unit consumed.

their consumption of commodity 1. In figure 5.1 to 5.4 we will be using indifference curves relating quantities consumed of commodity 1 to the total bill these consumptions entail. In the appendix to this chapter we discuss the transformation of the original households' indifference curves defined in terms of the quantities consumed of commodities 1 and 2 to ones defined in terms of the quantity consumed of commodity 1 and the respective household's expenditure made to buy this quantity. This change is convenient since it is important to show how the equilibrium will be reached for different expenditure levels.[5] Figure 5.1 shows two indifference curves, C^P and C^R. These curves are related to two utility functions $U_i\left[(TB)_i, X_{1i}\right]$ for i=P(poor household), R(rich household), where X_{1i} is the quantity consumed of commodity 1 by household i , and $(TB)_i$ is its respective total bill for consuming that quantity, that is, $(TB)_i = P_{1i}X_{1i}$; we are assuming that $\partial U_i/\partial(TB)_i < 0$ and $\partial U_i/\partial X_{1i} > 0$. We are also assuming they are concave, that is, the disutility of an increase in the total bill requires a larger increase in the quantity consumed to generate the same level of utility to household i. The most preferred indifference curves are the lowest ones: for a given X_{1i} , the largest level of utility is given by the lowest level of $(TB)_i$.[6] Curve C^R is steeper than C^P, what means that $U'_R > U'_P$ for all X_1, that is, the marginal utility of consuming an additional quantity of X_1 is greater for the rich than for the poor. In other words, the rich's marginal willingness-to-pay is always greater than the poor's.[7]

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5 Note that Sharkey and Sibley (1993,pp.202-205) also found it necessary to use expenditure-quantity indifference curves to discuss the self-selection problem.

6 For figures 5.1 to 5.4, the depicted curves C^P and C^R will be assumed to be lowest ones that can be reached when a given pricing schedule is used.

7 This means that the rich is a high-demand and the poor is a low-demand consumer; they have non-crossing demands for commodity 1 and the rich's demand is above the poor's.

Figure 5.1 exhibits a *full information equilibrium*, that is, a quantity equilibrium that is produced when a type A pricing schedule is used, that is, when the households' social conditions are known to the public utility and the discriminatory prices P_{1P} and P_{1R} are accordingly applied.[8] At these prices (constant for any quantity consumed) the chosen quantities demanded by the poor and the rich are X_{1P} and X_{1R}, respectively. Note that when this type of pricing schedule is used, there is not possibility of arbitrage, that is, for instance, the rich consuming the same quantity consumed by the poor in order to pay the lower price.

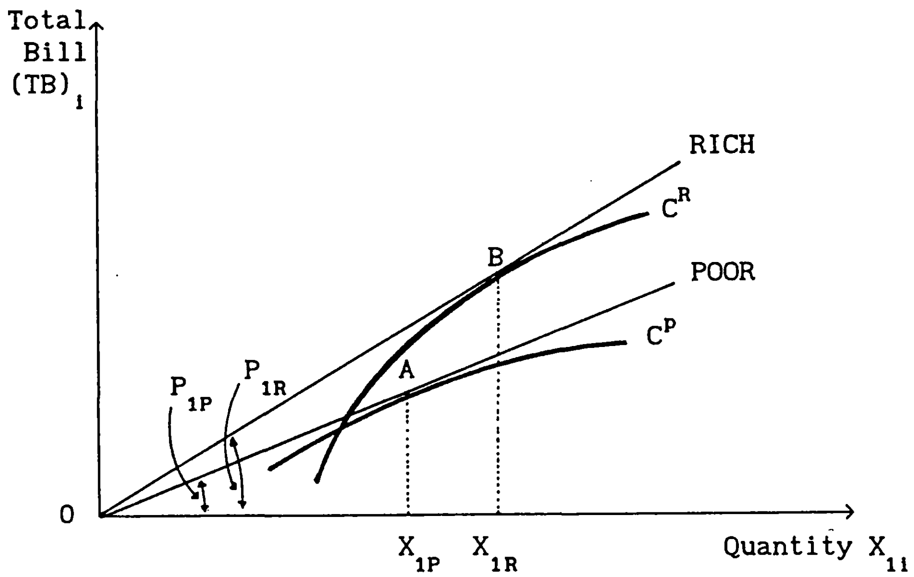

Figure 5.1: Discriminatory prices and full information equilibrium.

Figures 5.2 and 5.3 show a possible quantity pooling equilibrium when a block-price schedule type B or C is used, respectively. In both figures we illustrated a situation in which the

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[8] We are employing Spence's (1974) terminology used in his analysis of the job market signaling.

rich's self-selection constraint induce them to select the same quantity consumed by the poor, paying the same lower price. Of course, their choice frustrates the distributional objective the price schedule may have whem it was assumed that the rich would select a higher quantity, paying consequently a higher price. It should be noted that the pooling quantity equilibrium is allowed by the discontinuity or the kink at point A of the total bill curve: the indifference curve C^R is steeper than C^P; then they could not touch the total bill curve in the same point if this point had not that special condition.

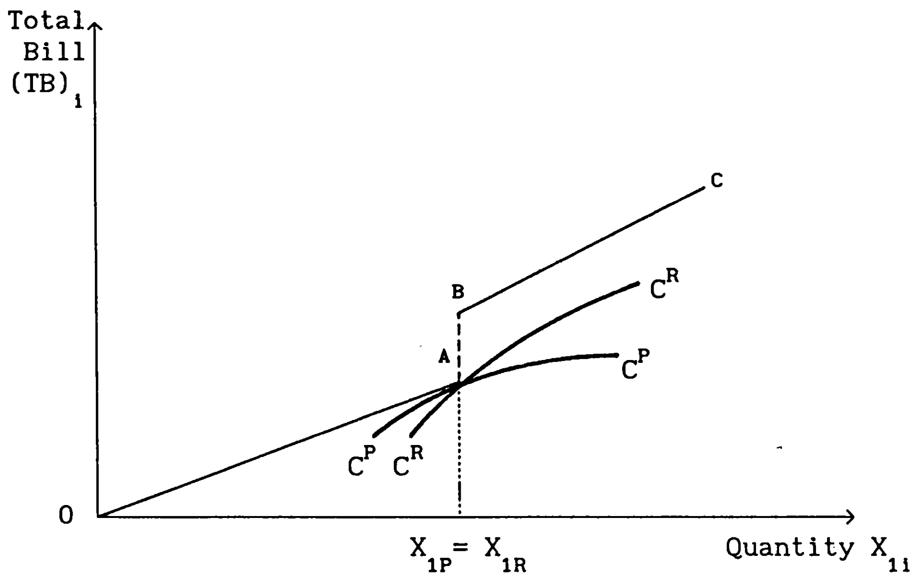

Figure 5.2: Type B block-quantity pricing schedule and a quantity pooling equilibrium.

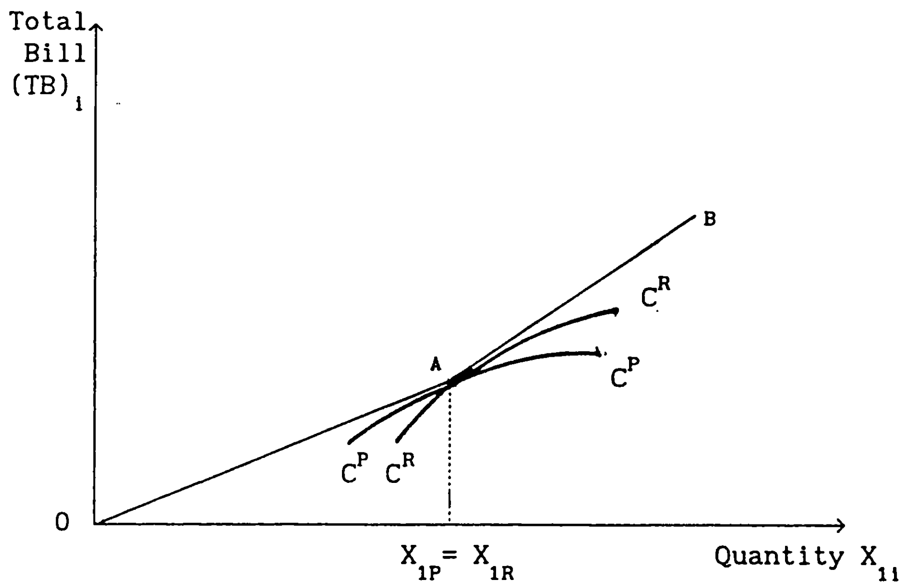

Figure 5.3: Type C block-quantity pricing schedule and a quantity pooling equilibrium.

Figure 5.4 illustrates a quantity separating equilibrium which occurs when the the pricing schedules is of type D, that is, when the total bill curve is a continuous smooth curve as depicted in the figure. The equilibrium quantities chosen by the poor and by the rich will be necessarily different since their indifference curves show different degrees of steepness.

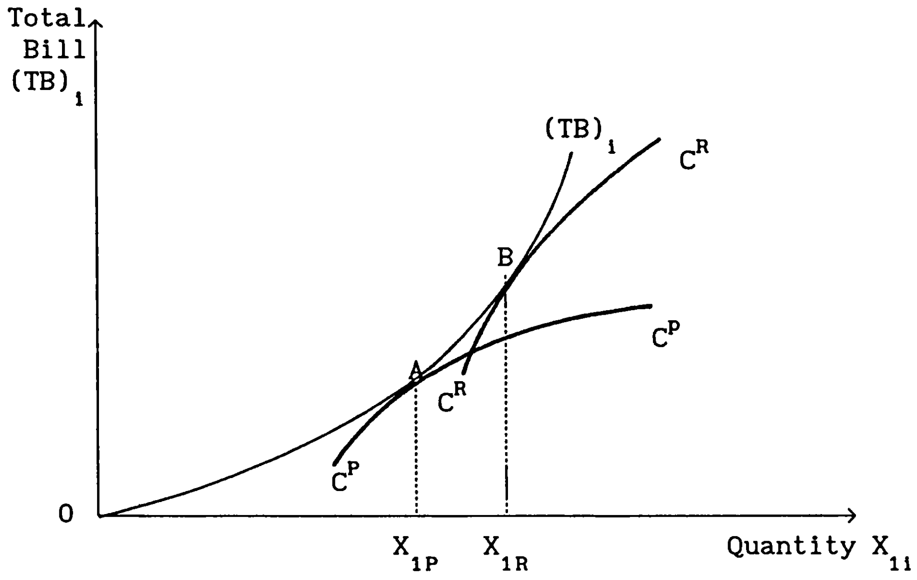

Figure 5.4: Type D price schedule and a quantity separating equilibrium.

In the event of a generalized personal arbitrage as that one illustrated in figures 5.2 and 5.3, then instead of observing a set of strictly progressive discriminatory prices being practiced (assuming a continuous income distribution), some households with different incomes could bunch together in terms of the quantities consumed, bringing about price constancy for them, although their incomes differ. As a consequence, the conceived social policy built in the public utility's price schedule (that is, price growing with income, as in the Brazilian case) would be frustrated.

It seems clear that a possible failure of a block quantity price schedule in generating an effective progressive pricing in terms of households incomes is not due to the fact that households are cheating their socio-economic conditions (actually, when the price schedule is defined in terms of the quantity consumed, consumers are not supposed to reveal their incomes), but because there may be no compatibility between the higher quantities they are assumed to consume and the corresponding higher prices they should pay, given their consumption preferences. In other words, the *signal* (in the Spence's (1974) sense) they are required to give, the quantity consumed, is attached to such a high price that this makes them prefer transferring their demands to a lower level of consumption and, consequently, paying a lower price. The next section will deal with this problem, deriving a price for which the problem of adverse selection is eliminated.

5.4 - *Derivation of* an *Adverse Selection-Free Optimal Price.*

The nature of the problem is that, although consuming a larger quantity of X_1 would make the rich household enjoy a higher level of welfare, this expanded quantity would mean a higher total bill and in their comparison of the additional welfare with the additional costs of obtaining it, these households come to the conclusion that it is not worth.

The higher total bill the households should pay results from the larger quantity of consumption by the fact that the price schedule sets a progressive tariff in terms of the quantity consumed.

It is important to clarify the nature of the problem we are going to examine in this section. These are the main, simplified, features of the problem:

i) We assume two groups of households, the poor and the rich or non-poor; there are n_P households in the poor group and n_R in the rich group. The poor are low-demand consumers and the rich are high-demand consumers.

ii) The public utility uses a price schedule that offers two bundles: (X_{1P}, P_{1P}), respectively the quantity the poor is supposed to consume and the unit price they should pay for this quantity; (X_{1R}, P_{1R}), directed to the rich, where X_{1R} and P_{1R} are the quantity the are supposed to consume and the price for each unit they consume, respectively.

iii) The choice of the prices P_{1P} and P_{1R} by the public utility has to take into account the individual rationality constraints and the incentive compatibility constraints of each of those two types of households, in addition to the objective of maximization of social welfare and the financial balance constraint.

Let us derive the prices P_{1P} and P_{1P} that satisfy constraints (5.7) to (5.10) in addition to the financial balance constraint; let W be the social welfare function and $TC - R \le \bar{D}$ be the public utility's financial balance constraint, where C is its total cost function, R is its total revenue and $\bar{D}$ is the level of deficit financed by the government.

To derive P_{1i} for i= P (poor), R (rich) we need to maximize W subject to those conditions. The maximand function is

$$L = W + \mu_1[\bar{D} - C + R] + \mu_2\Big[U_P(X_{1P}, Y_P - P_{1P}X_{1P}) - U_P(0, Y_P)\Big] +$$

$$+ \mu_3\Big[U_R(X_{1R}, Y_R - P_{1R}X_{1R}) - U_R(0, Y_R)\Big] +$$

$$\mu_4\Big[U_P(X_{1p}, Y_P - P_{1P}X_{1P}) - U_P(X_{1R}, Y_P - P_{1R}X_{1R})\Big] +$$

$$\mu_5\Big[U_R(X_{1R}, Y_R - P_{1R}X_{1R}) - U_R(X_{1P}, Y_R - P_{1P}X_{1P})\Big] \qquad (5.11)$$

where μ_i for i=1,...,5 is, respectively, the Lagrange parameter for the financial balance constraint, for the poor's individual rationality and the incentive-compatibility constraints, and for the rich's individual rationality and incentive compatibility constraints.

The Kuhn-Tucker necessary conditions for a maximum of L are:

$$\partial L/\partial X_{1R} \le 0 \quad , \; X_{1R} \ge 0 \qquad \text{and } X_{1R}.\partial L/\partial X_{1R} = 0$$
$$\partial L/\partial \mu_i \ge 0 \quad , \; \mu_i \ge 0 \qquad \text{and } \mu_i.\partial L/\partial \mu_i = 0 \; , \text{ for } i=1,\ldots,5.$$

We have that

$$\partial W/\partial X_{1i} = - n_i \; \sigma_i \; X_{1i} \; \partial P'_{1i}/\partial X_{1i} \qquad \text{for } i=P,R \qquad (5.12)$$

where σ_i is the marginal social utility for household i;

$$\partial C/\partial X_{1i} = n_i \; m \qquad (5.13)$$

where m is the marginal cost of production;

$$\partial R/\partial X_{1i} = n_i\ P_{1i}(1 - 1/\varepsilon_{1i}) \quad \text{for } i=P,R \tag{5.14}$$

where ε_{1i} is the household i's demand price elasticity for commodity 1;

$$\partial\Big[U_P(X_{1P}, Y_P - P_{1P}X_{1P})\Big]/\partial X_{1P} = n_P\ U'_P(X_{1P}, Y_P - P_{1p}X_{1P}) \tag{5.15}$$

$$\partial\Big[U_R(X_{1P}, Y_R - P_{1P}X_{1P})\Big]/\partial X_{1P} = n_P\ U'_R(X_{1P}, Y_R - P_{1P}X_{1P}) \tag{5.16}$$

$$\partial\Big[U_R(X_{1R}, Y_R - P_{1R}X_{1R})\Big]/\partial X_{1R} = n_R\ U'_R(X_{1R}, Y_R - P_{1R}X_{1R}) \tag{5.17}$$

$$\partial\Big[U_P(X_{1R}, Y_P - P_{1R}X_{1R})\Big]/\partial X_{1R} = n_R\ U'_P(X_{1R}, Y_P - P_{1R}X_{1R}) \tag{5.18}$$

For short, let us call the derivatives that appear in the right-hand side of expressions (5.15) to (5.18), respectively, $U'_P(X_{1P})$, $U'_R(X_{1P})$, $U'_R(X_{1R})$ and $U'_P(X_{1R})$.

We have that the first-order conditions $\partial L/\partial X_{1P}=0$ and $\partial L/\partial X_{1R}=0$ are:

$$\partial L/\partial X_{1P} = n_P \Bigg\{ -\sigma_P\ X_{1P}\ \partial P_{1P}/\partial X_{1P} + \mu_1 \Big[-m + P_{1P}(1 - 1/\varepsilon_{1P})\Big] + $$

$$+ \mu_2\ U'_P(X_{1P}) + \mu_4\ U'_P(X_{1P}) - \mu_5\ U'_R(X_{1P}) \Bigg\} = 0 \tag{5.19}$$

$$\partial L/\partial X_{1R} = n_R \Bigg\{ -\sigma_R\ X_{1R}\ \partial P_{1R}/\partial X_{1R} + \mu_1 \Big[-m + P_{1R}(1 - 1/\varepsilon_{1R})\Big] + $$

$$+ \mu_3\ U'_R(X_{1R}) - \mu_4\ U'_P(X_{1R}) + \mu_5\ U'_R(X_{1R}) \Bigg\} = 0 \tag{5.20}$$

Solving the conditions (5.19) and (5.20) in terms of the prices the poor and the rich should be charged, we have:

$$P_{1P} = \frac{m - \left[\frac{\mu_2+\mu_4}{\mu_1}\right]U'_P(X_{1P}) + \frac{\mu_5}{\mu_1}U'_R(X_{1P})}{1 + \frac{\sigma_P - \mu_1}{\mu_1 \varepsilon_{1P}}} \tag{5.21}$$

$$P_{1R} = \frac{m - \left[\frac{\mu_3+\mu_5}{\mu_1}\right]U'_R(X_{1R}) + \frac{\mu_4}{\mu_1}U'_P(X_{1R})}{1 + \frac{\sigma_R - \mu_1}{\mu_1 \varepsilon_{1R}}} \tag{5.22}$$

Expressions (5.21) and (5.22) show that when the individual rationality and incentive compatibility constraints are satisfied, the Lagrange parameters μ_2 to μ_5 are zero and prices P_{1P} and P_{1R} are equal to those derived in section 3.2. Note the role played by parameters μ_2 and μ_3: when the individual rationality of any one of the two groups of households is not satisfied, these parameters act to reduce the respective price to induce the household to purchase the commodity; the level of reduction is influenced not only by μ_1 but also by the household's marginal utility at the critical quantity. As to parameters μ_4 and μ_5, the self-selection parameters, note that they are in the both price formulas, for P_{1P} and P_{1R}, with reverse signs. For instance, the rich's self-selection parameter μ_5 appears with a negative sign in P_{1R} and a positive sign in P_{1P}. This mean that in order to avoid a possible adverse selection by the rich, price P_{1R} would be reduced by the action of μ_5, while the price P_{1P} would be increased. These two changes would make the rich prefer choosing to purchase the quantity X_{1R} at price P_{1R} rather than the quantity X_{1P} at price P_{1P}. The same conclusion can be reached in case of adverse selection by the poor:if their utility level is greater consuming X_{1R} at price P_{1R}, the parameter μ_4 will make P_{1P} cheaper and P_{1R} more expensively relatively, inducing them to choose X_{1P} at P_{1P}.

It is also important to remember that prices also need to satisfy the other necessary condition for a maximum society's welfare, that is, the public utility's financial balance constraint; their absolute levels depend on the satisfaction of this constraint.

We cannot end this section without calling the attention to the fact that the solution of the adverse selection problem may have a very important consequence in distributional terms: as we just saw, when the price schedule induces the rich to make an adverse selection and price adjustments are required to to induce them to select the quantity they are expected to choose, paying the price planned for that quantity, these price adjustments mean a higher P_{1P} and a lower P_{1R}. This means that these adjustments will improve the welfare situation of the rich, but will decrease the welfare enjoyed by the poor. Hence, in a real situation it should be considered whether is better in welfare terms to let the rich adversely select the poor's price and quantity as set in the price schedule or to lower the rich's price to induce them to select the higher planned price they should pay and increase the poor's price. Given the fact that the number of poor is generally larger than the number of rich and that the decrease in the quantity consumed by the poor will affect more heavily the total welfare since the social weight attributed to their consumption is higher than that attributed to the rich's, the alternative of letting the rich to make the adverse selection is preferable.

5.5 - *The Use of a Proxy for Household Income*

Since a price schedule's progressiveness may be affected by the adverse selection problem when household income, which is unknown, is replaced by the quantity consumed of the commodity, one may think that this can be avoided by the use of a proxy for either income or consumption, such as housing values.[9] This section shows

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[9] Note that the quantity consumed of a commodity can be considered as a proxy for income as long as a higher individual household income implies is associated with a higher household consumption. Empirical data in chapter 1 has shown us that this association is not perfect.

that this substitution may not, and in most cases it does not, produce the desired effect since the consequence of rich and poor households paying the same price, as we examined in section 5.3, tends to be also present when we use a proxy. This is the reason that justifies this section.

The use of proxies for households' incomes or ability to pay is not uncommon: municipalities in developing countries use the market valuation of the houses as an indicator of the resident's ability to finance local services; in the United Kingdom, water services are priced according to the rateable value of the houses concerned.[10] Physical characteristics of the house, such as its area and number of rooms, and even its location, have been used by urban planning boards in several countries as income indicators of its residents.

The basic problem of using these and other indicators or proxies for household income rests upon how they correlate with income. A perfect substitute for income would be an easily observable proxy that is perfectly (variance zero) and positively associated with household income. However, a proxy with such characteristics does not exist; even those positively associated with income do not have a zero variance. In this case, we cannot have an unique relationship between an individual household income level and the proxy level. This can be shown by assuming that:

Assumption 5.1: The public utility uses a proxy Z_j for the household-j's income Y_j $(j=1,...,n)$ and defines its price schedule as $P_j = f(Z_j)$ such that $\partial P_j/\partial Z_j > 0$ (since it is required that $\partial P_j/\partial Y_j$);

Assumption 5.2: The relationship between Z_j and Y_j is not perfect, being disturbed by a random composite factor u_j with $E(u_j) = 0$ and $\text{var } u_j = \sigma_j \neq 0$.

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[10] Physical characteristics of the house are also used in Brazil to estimate household consumption of water when the quantity consumed is not gauged by a meter.

Assumption 5.2 means that $Y_j=g(Z_j,u_j)$ and $E(Y_j)=h(Z_j)$, that is, for a given Z_j we have a conditional distribution of several possible values for Y_j . Then, when the public utility uses the price schedule $P_j=f(Z_j)$, it will be charging all those Y_j with the same price and, consequently, the pricing policy $\partial P_j/\partial Y_j>0$ does not hold, although $\partial[E(P_j)]/\partial Y_j>0$.

Figure 5.5 is an illustration for this situation. The second quadrant shows the price schedule defined in terms of a proxy for income. Lines OM and ON in the third quadrant show the most probable income levels for a given proxy level (we are assuming a growing dispersion for these conditional levels, a possible situation, although not a necessary one for our argument). In the first quadrant we see the effective result of this public utility pricing policy in distributional terms: all those households with

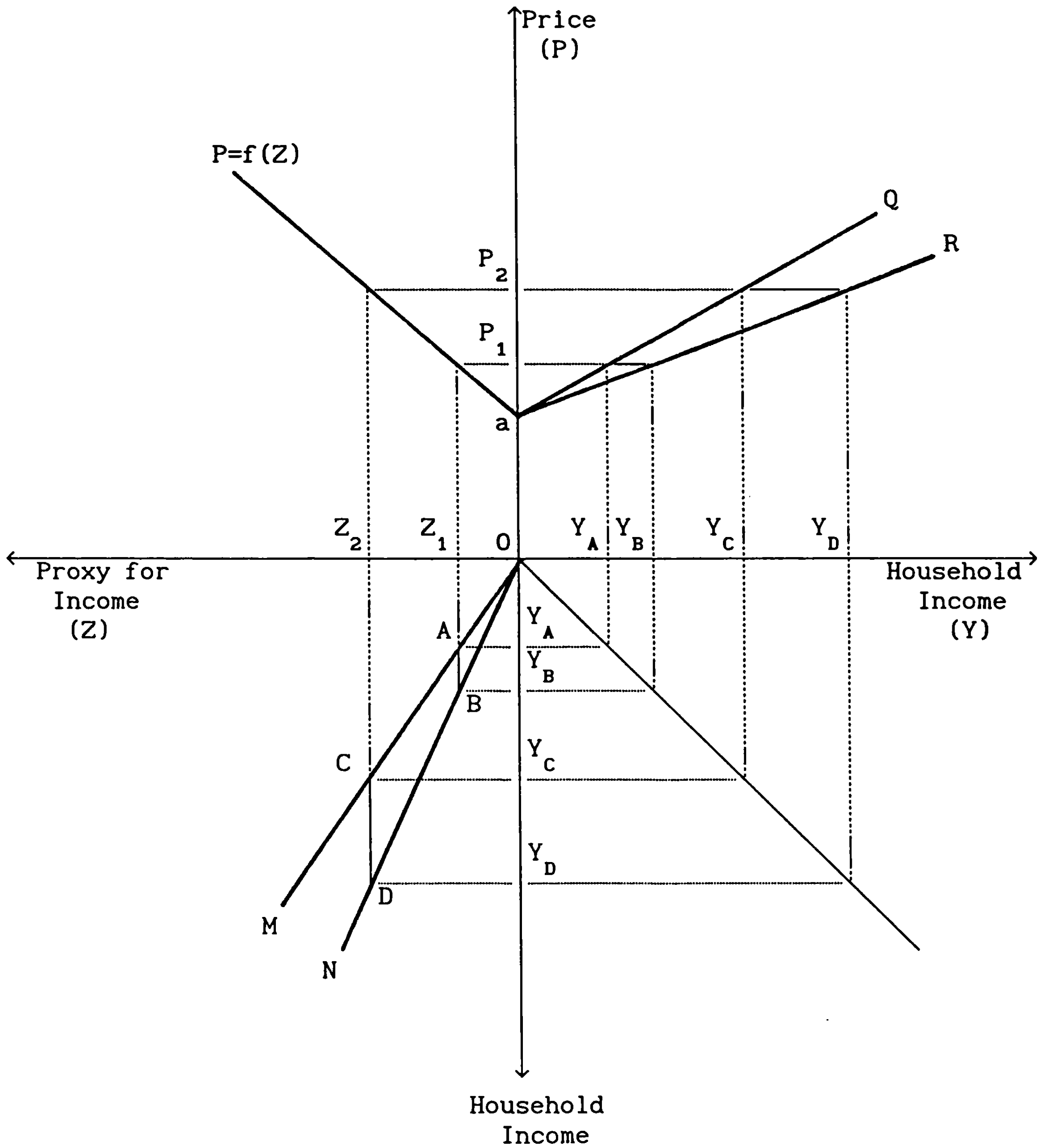

Figure 5.5: Proxy for household income and the relationship between price and household income.

incomes in the interval $[Y_A - Y_B]$ pay the same price P_1 since they share the proxy level Z_1; all those with the proxy level Z_2 , that is, most probably those in the income interval $[Y_C - Y_D]$, are charged the same P_2. Lines aQ and aR are the limits for the most probable income levels being charged the same given price. Since we made the assumption of a increasing variance (assumption 5.2) for the income levels (represented in Figure 5.5 by the segments AB and CD) the range of household incomes that pay the same price enlarges for larger incomes; for instance, households with income within the interval [Y_A - Y_B] pay the same price P_1 and households with incomes within the wider interval [Y_C - Y_D] pay the price P_2.

Since proxies for household income seem not be perfect, the lesson to be extracted from this analysis is that using them to replace this variable in the public utility price schedule cannot avoid the problem of this schedule not being progressive as required.

5.6 - *Errors of Classification and Welfare Losses in Pricing Regimes*

In former chapters we derived price schedules under the assumption that households would be charged by their use of public services according to their incomes, that is, household income is an observed variable that could be used by a public utility to charge differential prices to its customers in order to attain a given distributional objective. In section 5.2 we have noted that the implementation of a price-income schedule may not be feasible; households would have an incentive to under report their incomes and the costs involved in obtaining this information could be large, and we discussed problems related to the alternative solution of implementing a price-quantity schedule. In this section we intend to examine what is involved in the choice of one of these two pricing regimes. This means that the possibility of implementing a price-income schedule in favour of a price-quantity one will be reconsidered under specific circumstances. Our discussion benefits from the analyses made in the optimal taxation literature in discussing a similar question; in particular we will be using extensively the results obtaining by Stern (1982). It should be mentioned that our analysis, following Stern, will not take into account the important question of the different administrative costs involved in implementing one or the other pricing regimes. Although we are going to assume that this cost is identical for both regimes, we are aware that this assumption need not be true; we want to focus our attention on the exam of how classification errors affect our choice of pricing regimes.

We know that there is an important difference between the price-income and a price-quantity regimes in terms of requisites for implementation: the former requires the classification of the households by income in order to set the price they will be charged, while in the latter regime, the pricing system is anonymous, i.e., the household faces a price schedule and then makes its choice. The household classification required by a price-income schedule can be made either with household income itself or with a suitable proxy such as the physical characteristics of the house,its location, or any characteristic to set the the rateable charge as done in the United Kingdom. When household income is used, it does not mean that classificatory task will be done without errors: in addition to the problems of adequately measuring income, we would have to deal with the possibility of incorrect reporting made by households. Thus, the possibility of making errors of classification appears in both cases. Let us assume for simplicity that we have in our society two types of households, the poor and the non-poor and we want to classify them in two groups according to their social condition. Let us call δ the probability of misclassifying a household, where $0\le\delta\le1$. We know that when $\delta=0.5$ the classificatory system will be completely random since the chance of a classified poor to be a poor or a rich will be equal. Let us also call δ_p and δ_R the average proportion of poor and non-poor misclassified, respectively..

The price schedules derived in former chapters have not taken into account the possibility of the public utility being informed incorrectly about the number of households in each of the K groups. For instance, when we derived in section 3.2.1 the optimal prices in case households have their preferences represented by a Cobb-Douglas utility function, the implicit assumption was that there were no errors of classification. We know that when this assumption is satisfied, these prices are in the case of two groups of households (poor and non poor):

$$P_{1i} = \frac{m^{1/\theta}\left[\sum_{i=P}^{R} n_i Y_i^{\frac{(1-\alpha)(1-\rho)}{(1-\alpha)+\alpha\rho}}\right] . Y_i^{\frac{\rho}{(1-\alpha)+\alpha\rho}}}{\left[\bar{D} - F + \alpha \sum_{i=P}^{R} n_i Y_i\right]^{1/\theta}} \qquad i=P,R \qquad (5.23)$$

where P_{1P} and P_{1R} are found when we maximize

$$W = \sum_{i=P}^{R} n_i . \frac{U_i^{1-\rho}}{1-\rho} \qquad \text{where } U_i = X_{1i}^{\alpha} . X_{1i}^{1-\alpha} \quad \text{for } i=P,R \qquad (5.24)$$

subject to the public utility's financial balance constraint

$$F + m.\left[\sum_{i=P}^{R} n_i . X_{1i}\right]^{\theta} - \sum_{i=P}^{R} n_i . X_{1i} . P_{1i} \leq \bar{D} \qquad (5.25)$$

The number of households n_i that appears in expressions (5.24) and (5.25) are the correct ones. If we use different, incorrect numbers, of course the optimal prices we derive are not the same we have in expression (5.23). Let us examine the welfare consequences of using a classificatory system that makes errors of classification, that is, we do not have a perfect information about households' social condition.

Figure 5.6a illustrates in the utility space the equilibrium position A, point of tangency between the utility possibility frontier SS and the highest attainable social indifference curve W_1 when δ=0. Curve SS is the locus of all combinations of $n_i U_i^{1-\rho}/1-\rho$, for i=P,R, allowed by the constraint (8.12), given the sets of households' preferences.[11] For each pair of group utility in curve SS

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[11] The vertical axis of figure 5.6a measures the level of $W^P = n_P . U_P^{1-\rho}/1-\rho$, that is, the total welfare of the poor, while the horizontal axis measures the level of total welfare of the non-poor, $W^R = n_R . U_R^{1-\rho}/1-\rho$.

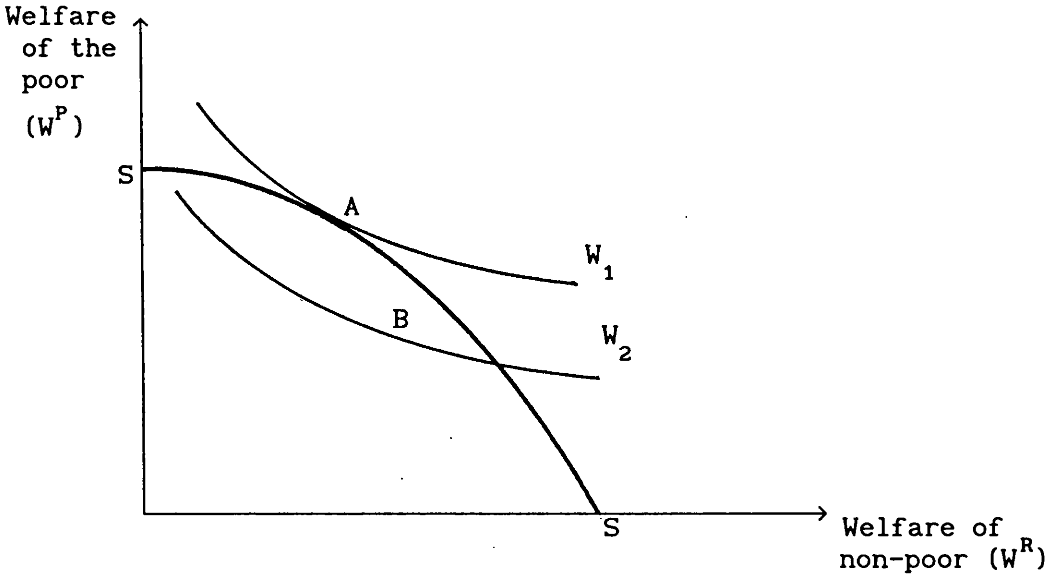

Figure 5.6a: Welfare Loss with Errors of Classification

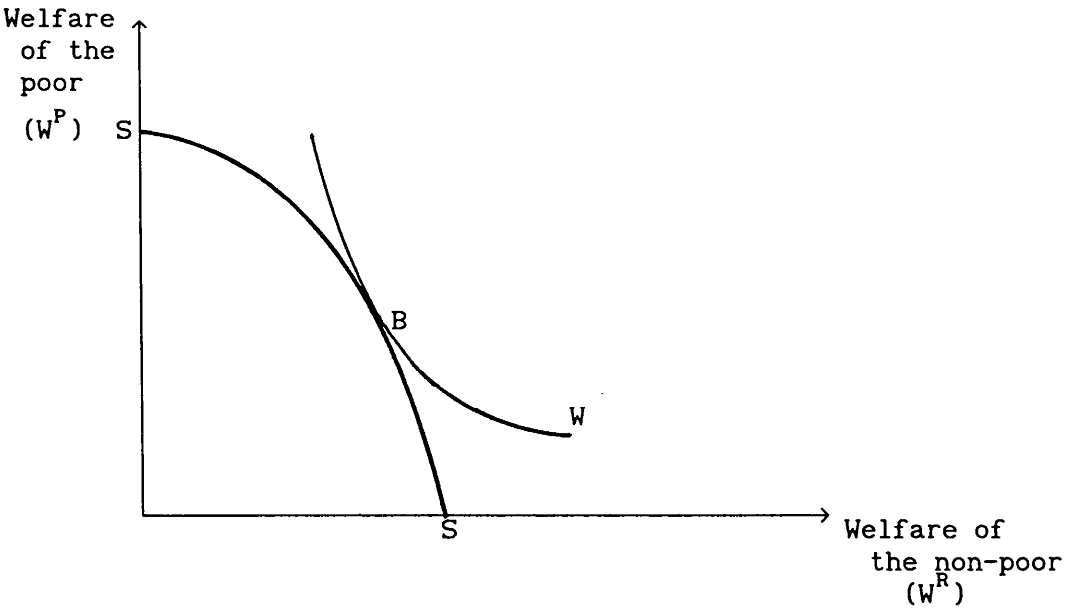

Figure 5.6b: Optimum Equilibrium with Errors of Classification.

is defined an efficient pair of prices $\left[P_{1P}, P_{1R}\right]$; the pair of prices in A is the one that maximizes social welfare. Expression (5.23) defines these prices. Note that both the utility possibility frontier and the social welfare function are dependent on the numbers of households we have in each group.

Figure 5.6b illustrates the optimal equilibrium when there are errors of classification, that is, when the numbers of poor and non-poor households are n'_P and n'_R respectively instead of the correct ones n_p and n_R; the numbers n'_p and n'_R are those we use to define the equilibrium point B when the utility possibility frontier is S'S' and the social indifference curve W. To point B corresponds a pair of prices different from that pair we have derived in expression (5.23) and that is related to point A in figure 5.6a; let us call these different prices as P'_{1P} and P'_{1R}; these prices, when used by the public utility, will either satisfy the financial balance constraint in expression (5.25) or not. If they satisfy, they generate a combination of poor and non-poor utilities on the curve SS, a combination different from that given by the point A since the prices are different; if they do not satisfy, these combination of utilities is inside the frontier SS, point C for instance. In both cases, the total level welfare will smaller (for instance, that given by W_2) than that obtained in A, since $W_1 > W_2$. Then, there is a welfare loss associated with the use of a pair of prices that is derived with incorrect information about the number of households in each social group.

Let us examine now the possibility of welfare loss associated with a price-quantity schedule. This pricing regime is not subject to classificatory errors since there is no need to personalize the households for pricing purposes. Its welfare loss is related to the deadweight loss it entails, similar to that we observe with income and commodity taxation when the consumer makes adjustments in his or her economic behaviour, in comparison with a situation in which the consumer cannot react or change the amount he is supposed to pay, as is the case of lump-sum taxes. The price-income pricing system is equivalent to a differential lump-sum tax system: the household's income is identified (without or with errors in classification, as we just discussed) and a price is determined; the household cannot choose another price and there is no reason to adjust the quantity consumed. These changes are allowed in a price-quantity pricing system, and the amount of deadweight loss is dependent on the households' demand price elasticities.

Figure 5.7a shows the same utility possibility frontier shown in figure 5.6a: point A on the social indifference curve W_1 is the same equilibrium point given by the maximization of welfare when there are no classification errors in the price-income regime. Let us considers now the price-quantity regime. This regime is defined by a price-quantity schedule, that is, a rule that determines the price per unit unit consumed to be charged according to the quantity consumed, for instance, $P = \omega + \tau X$, where ω and τ are constants and P and X are the price and quantity consumed, respectively. Let us assume for the moment that $\tau = 0$ and every household is charged the same price ω; the optimal point on the social indifference frontier that represents the pair of utilities enjoyed by the poor and the non-poor is assumed to be point M. This point is on the frontier because the price being charged does not vary with the quantity consumed, thus there is no substitution effect involved, being equivalent to a lump-sum tax. It should also noted that point M cannot be point A because in A we have a set of two different prices, that is, in A the prices are $[P_p, P_R]$ and in M the set of prices is $[\omega, \omega]$. In figure 5.7b we illustrate how a poor and a non-poor household have chosen the quantities consumed of commodity 1. In that figure we have the maps of indifference of the poor and the non-poor that we derived in the appendix to this chapter and that we used in section x.x; we should remember that the most preferred indifference curves are the lowest ones. Let us assume that C^P_o and C^R_o are the lowest indifference curves that the poor and the non-poor can reach when $\tau = \tau_o = 0$, respectively; the quantities they consume are respectively X_{1P} and X_{1R}. Let us assume now that price change according to the quantity consumed, that is, $\tau > 0$. When $\tau > 0$, unitary price varies with the quantity consumed and larger quantities consumed entail higher prices that smaller quantities. This rule introduces distortionary effects since households will adjust their

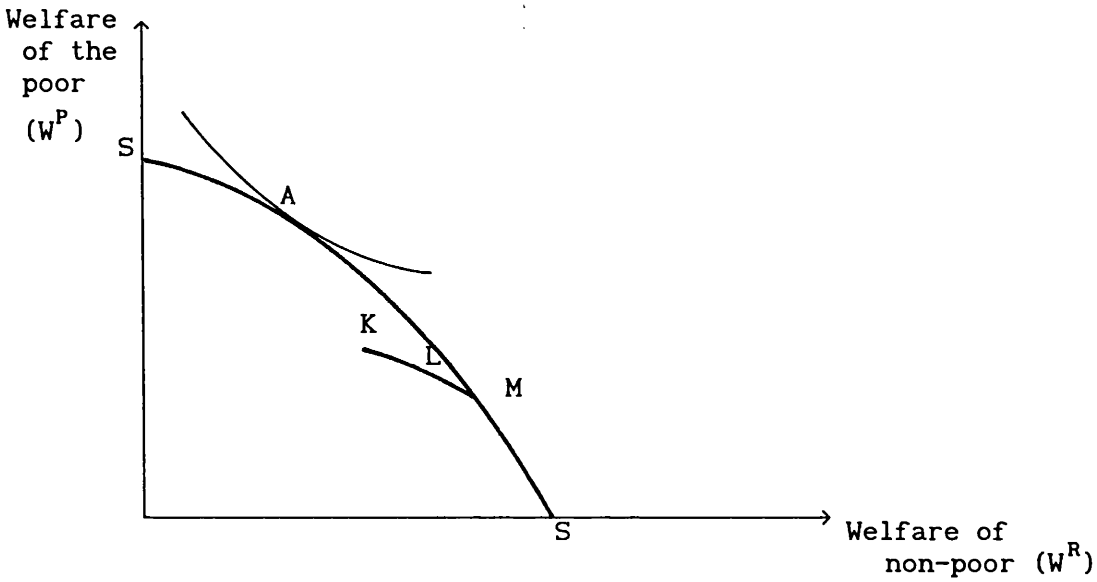

Figure 5.7a: Welfare loss in a price-quantity regime

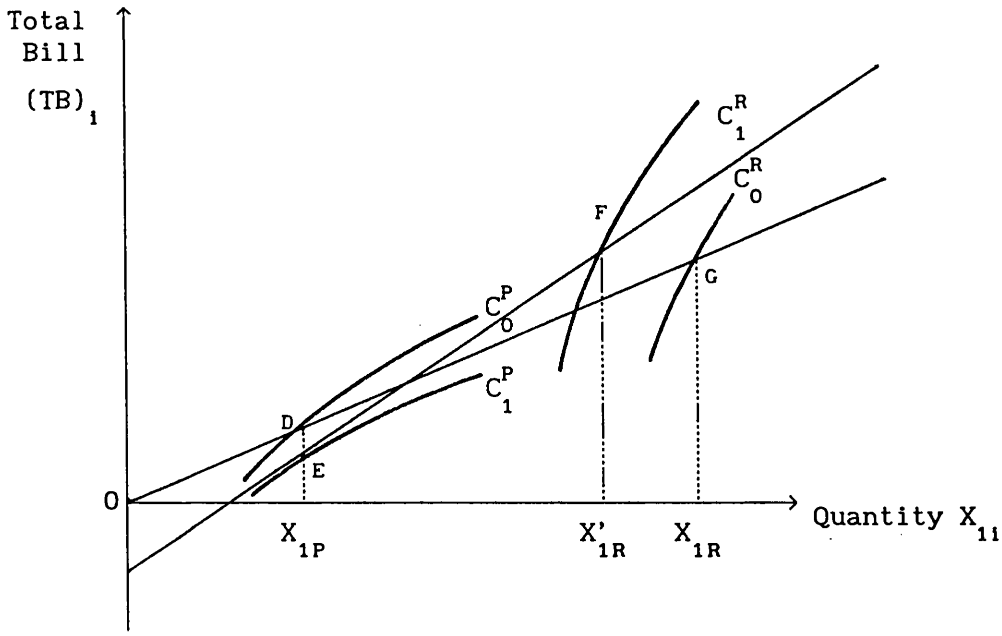

Figure 5.7b: Quantity equilibrium for the poor and non-poor at different τ's.

behaviour. The idea of making $\tau > 0$ is to move in the utility set to the left of point M (in figure 5.7a), increasing the utility level of the poor, U_P, towards more equality. To have this result, however, in addition to increase the value of τ from zero to a positive one, we must change ω in such a way that more than compensate the poor for the change in τ.[12] This is shown in figure 5.7b by the curve τ_1 of total bill, with a higher inclination than curve τ_o, allowing the poor to reach a lower indifference curve C_1^P (allowing them to enjoy a higher utility level) at the cost of a lower utility level enjoyed by the non-poor, since now the lowest indifference they reach is C_1^R, where $C_1^R < C_o^R$. This move has a cost in terms of efficiency, a trade-off equity vs. efficiency, illustrated in figure 5.7a by a new utility possibility frontier KLM, in the interior of the former frontier. Point L represents the maximum value U_P can reach for a given U_R when $\tau=\tau'$, and point K is the maximum for U_P for a given U_R when $\tau= \tau''$ for $\tau''> \tau'$. We are assuming that K marks the upper limit for U_P since a higher τ, that is, a higher price for the quantities the non-poor are considering to consume would make them to modify their consumption in such a way that the revenue they would generate would be smaller than before and the public utility's financial balance constraint would require an increase in the price paid by the poor, with a resulting decrease in U_P; this means that it is impossible to go beyond K in terms of the level of utility that the poor can reach.[13] It is clear in figure 5.7a that the social indifference curve that maximizes social welfare when the pricing regime is of price-quantity type will generate a level of social

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[12] This is equivalent in income taxation to a increase in the marginal tax compensated with a increase in the lump-sum payment. Note, however, that in our case we are assuming a change in ω that more than compensate the poor, increasing their utility.

[13] This is equivalent to the situation described by a Laffer curve in income taxation studies. In our analysis this curve would describe the maximum amount of revenue the public utility could obtain from the non-poor by charging them a higher price to subsidize the price paid by the poor; that maximum revenue is that obtained when $P_{1R}= \omega + \tau''X_{1R}$.

welfare below W_1. In other words, the welfare level obtained with a optimal price-income schedule when there are no errors of classification is higher than an optimal price-quantity schedule.

We saw in figure 5.6a that an optimal price-income schedule without errors of classification is better than one with errors in welfare terms. Since an optimal price-income schedule without errors is an ideal regime of pricing but with low possibility of implementation, we should compare the welfare losses of a price-income schedule with errors and of a price-quantity schedule in order to decide which one entails smaller loss in efficiency terms. We are going to concentrated our attention on the welfare losses caused by different levels and types of errors of classification and by different degrees of aversion to inequality.

Let assume that $\delta_P=\delta_R=0.5$, that is, that misclassification is random for both groups of households and that 50 percent of poor and of the non-poor are misclassified. This means that half of the poor will incorrectly pay the higher price the rich is charged and half of the rich will incorrectly pay the lower price the poor is charged in the price-income regime. The result of this situation is that the average price effectively paid by the members of each group of households will be the same for poor and non-poor, an weighted average of the optimal prices P_{1P} and P_{1R} (the optimal prices when there are no errors). When $\delta_P=\delta_R=0.1$, those average prices are distinct and close to P_{1p} and P_{1R}. We can say that when the proportions of misclassifications are equal for each group of households and this error approaches zero, the effective average prices tend to P_{1P} and P_{1R}, and as this error increases to 0.5 (random classification), the average effective prices converge to a value between P_{1P} and P_{1R}, which means that the welfare loss will vary from zero to a maximum value when all households are classified in an random way. Figure 5.8 shows the relationship between the level of social welfare that can be reached by a price-income regime and different proportions of errors of classification, with a maximum value for the social welfare when there are no errors and declining values for increasing levels of misclassification.

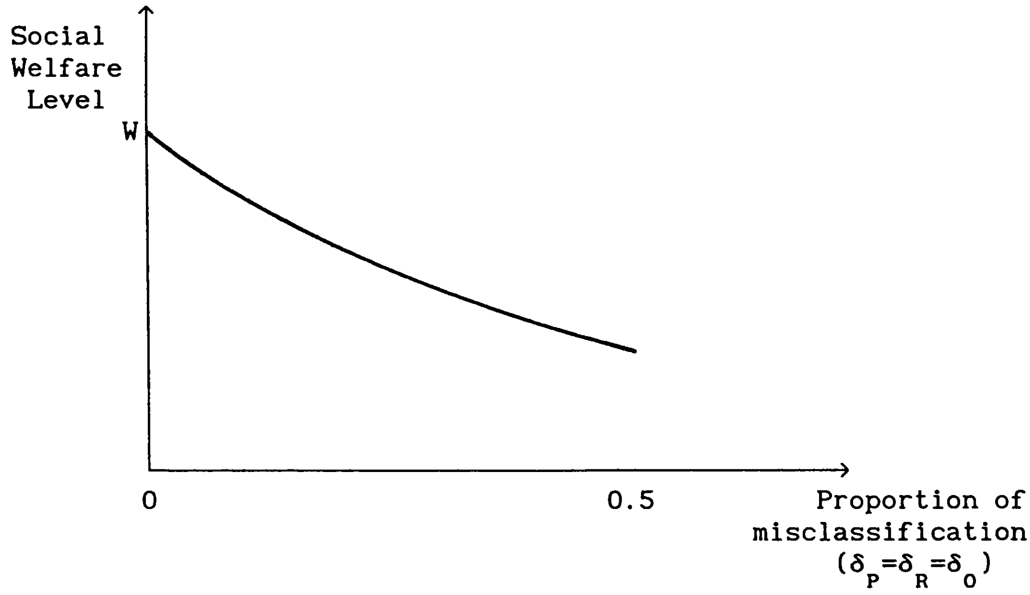

Figure 5.8: Welfare Loss at Different Levels of Errors of Classification

In the analysis just made we assumed the same probability of making errors of classification of the poor and the non-poor. However, this is not a reasonable assumption. If the public utility adopts a discriminatory price system with increasing prices for higher household incomes, there will be no incentive for the poor either to cheat the public utility by presenting themselves as non-poor or for not reacting to an error of classification since those of them misclassified would have to pay a higher price than that they are supposed to pay. For the non-poor, on the contrary, it is good for them to be misclassified and not react to these errors. Then, it is reasonable to assume that the proportion of poor misclassified is smaller than of non-poor and the analysis of the welfare loss in this case should take into account different combinations for these proportions. To simplify the analysis, we are going to assume a special case, that is, we are going to assume that the poor can successfully contest any error of classification made.

In this case, the proportion of poor misclassified is zero and the proportion of non-poor varies from zero to 0.5. The proportion combination [0,0], meaning no errors for both groups, is the ideal case and there is no welfare loss. Let us examine the proportion combinations [0,0.1] and [0,0.5]. When the classification system correctly classifies the poor and classifies the non-poor in an random way (δ_R=0.5), the average effective price for the poor would be P_{1P} and for the non-poor a value between P_{1P} and P_{1R}, as seen before. When δ_R=0.1, the average effective price for the non-poor will be between P_{1P} and P_{1R} but closer to P_{1R} than in the case δ_R=0.1. However, in both situations, those effective average prices are not consistent with the public utility's financial balance constraint and corrections in prices should be made, with the consequent increase in the price paid by the poor P_{1p}. Since the correction required in P_{1P} in the case δ_R=0.5 is higher than that required in the case δ_R=0.1, the welfare loss will be larger in the first case relative to that in the latter case. This means that, for a constant δ_P=0, the welfare loss increases with larger errors of classification made with the non-poor and a figure depicting this is similar to that shown in figure 5.8, but having δ_R in the horizontal axis.

Another parameter that affects the level of welfare is ρ, the aversion to inequality parameter, as we saw in expression (8.11). We used this parameter in the definition of an isoelastic social welfare function $W = \sum_{i=P}^{R} n_i \frac{U_j^{1-\rho}}{1-\rho}$ and we saw that when ρ=0 the SWF is of the utilitarian form, and for ρ>0, the SWF is of the egalitarian form; when $\rho\to\infty$, the SWF is of the Rawlsian or maximin form. To have an idea of the influence of ρ on the level of welfare, let us continue to use, for simplicity, a Cobb-Douglas utility function to express the consumption behaviour of the two groups of households. Using the price formula defined by expression (5.23), the optimal price ratio between the two groups is given by the expression

$$\frac{P_{1P}}{P_{1R}} = \left[\frac{Y_P}{Y_R}\right]^{\left[\frac{1}{\alpha + (1 - \alpha)/\rho}\right]} \qquad (5.26)$$

We see in expression (5.26) that when $\rho=0$, the maximization of welfare requires $P_{1P}=P_{1R}$, equal prices for all households. Since every household is charged the same price, there is no need to classify them and then the level of welfare is W, independent on the level of misclassification, if we insist in classifying the households. This is shown in figure 5.9 as a parallel line in relation to the horizontal axis. As the value of ρ increases, the optimal prices differ and their difference increases for larger ρ's. This means that making an error $\delta_R=0.5$ when ρ is close to zero and making the same level of error when $\rho=3$, for instance, will produce different welfare losses: the welfare loss for $\rho=3$ is greater. This conclusion is based upon the same reasoning we used before: if $\delta_R=0.5$, the correction (increase) in the price paid by the poor to satisfy the public utility's financial balance constraint will decrease the level of welfare enjoyed by the poor in a larger amount when $\rho=3$ in comparison with the welfare loss generated when $\rho=0.1$, for instance. In figure 5.9 we draw some curves relating the level of welfare that can obtained at different levels of errors of classification, for different degrees of aversion to inequality.

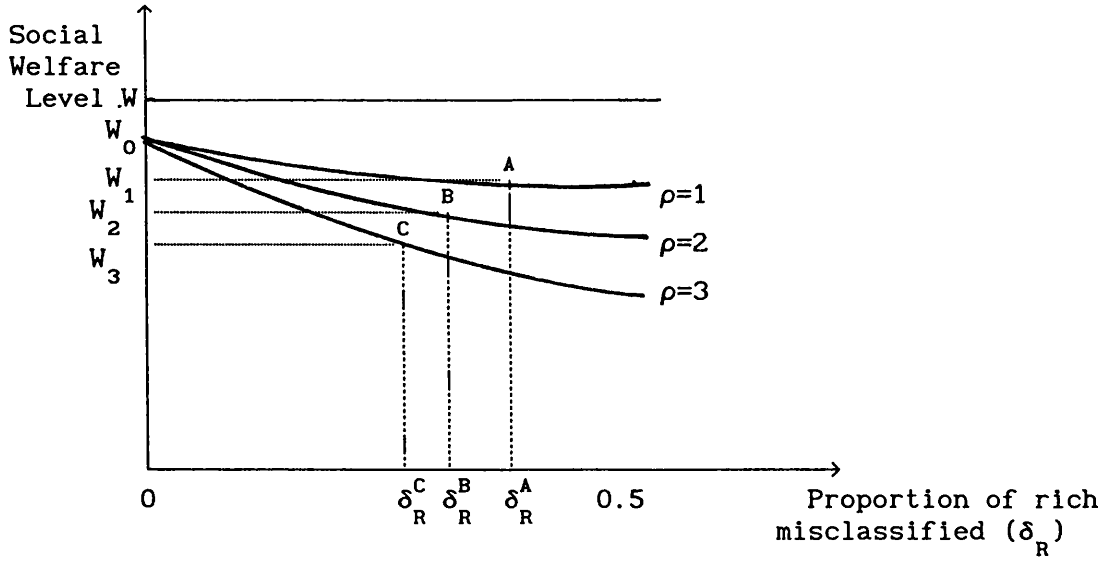

Figure 5.9: Welfare Loss at Different Levels of Errors of Classification and Different Levels of Aversion to Inequality.

We have already seen in figure 5.7a that for different degrees of aversion to inequality in a price-quantity regime the optimal equilibrium point will be located on the segment KLM of the utility possibility frontier, with different levels of social welfare. What we should do now is to compare the different levels of welfare that can be obtained in each price regime to see which one is superior to the other. Naturally, an actual comparison would require us to have information about the economic functions we should consider and about the values of the parameters involved, including the proportions of errors of classification made and the degree of aversion to inequality we should work with. Here we are going to illustrate the kind of analysis that could be done as a step to decide which regime is desirable. The analysis is similar to that made by Stern (1982) who has studied the results obtained in a numerical exercise assuming different values for the relevant parameters.

Let W_0 be the social welfare level obtained with a price-quantity regime when $\rho=0$; we put W_0 below W in figure 5.9 because we already know of the distortionary effect this regime has. The difference W - W_0 is the welfare loss in case of the implementation of a price-quantity regime when $\rho=0$, in the case of a Cobb-Douglas utility function. For a degree of aversion to inequality $\rho=1$, let us assume that the price-quantity generates a social welfare W_1; then, for misclassification of the non-poor just below δ_R^A, the implementation of a price-quantity regime would produce a welfare loss in terms of the welfare that could be obtained with a price-income regime. This means that we cannot discard the implementation of a price-income regime because of its errors of classification; the decision to discard it in favour of a price-quantity regime has to be based on the analysis of the welfare loss or gain of each regime. If $\delta_R>\delta_R^A$, the price-quantity regime would be superior, for $\rho=1$. It should be noted that δ_R^A is the level of error that makes indifferent the implementation of one or the other regime. The decision to choose one of them in this case had to be based on other aspects, including the possibility of the costs of administration of each regime be different. For $\rho=2$ and for $\rho=3$, δ_R^B and δ_R^C are respectively the levels of errors for which the choice of the regime cannot be solved in term of welfare loss, but we know that if $\delta_R<\delta_R^B$ for $\rho=2$ and if $\delta_R<\delta_R^C$ for $\rho=3$, the choice should be the price-income regime since the price-quantity regime would produce a welfare loss.

It is worth noticing that we draw the curves in figure 5.9 in such a way that $\delta_R^C<\delta_R^B<\delta_R^A$.[14] This means that as the aversion to inequality gets stronger, the smaller are the levels of errors required to justify the choice of the price-quantity regime. In other words, the price-quantity regime will be desirable at a low level of misclassification of the non-poor when the aversion to inequality is strong. The explanation for this lies in the fact that a misclassification of the non-poor becomes more serious in welfare terms the larger is the value of ρ since, as ρ gets larger, the price differential gets larger as well; then, the adjustments in the price paid by the poor to satisfy the financial balance constraint would result in larger losses of welfare in the price-income regime, with

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[14] The curves drawn by Stern have this same characteristic.

resulting advantages appearing for the price-income regime.

It is clear that if there are no errors of classification, the price-income regime is superior in welfare terms. With errors, the convenience of choosing one or the other regime depends on the level of error and on the degree of aversion to inequality. The preference for one of the regimes will be dependent on the possibility of implementing a classificatory regime with a minimum level of errors and on how the inequality in welfare should be treated.

5.7 - *Conclusions.*

The analyses made in this chapter show that:

1) The implementation of a price-quantity schedule derived from a price-income schedule with a given distributional objective may produce results that do no conform with this objective because households may make an adverse selection: their self-selection constraint may induce them to select the quantity and the price that was originally thought to be chosen by other households.

2) The occurrence of an adverse selection is caused by the fact that the price the households are charged when they select a given quantity is so high that it is better for them, in utility terms, to choose a lower quantity and pay the respective lower price that that quantity entails. It was shown that when we derive a price that is void of an adverse selection problem, the self-selection constraint makes the original price to be lower and, at same time, increases that lower price the households had originally selected. These changes in prices corrects the problem that could be caused by an adverse selection. However, this correction has a cost in welfare terms: since the lower price (that paid by the poor) is increased and the higher price (that paid by the non-poor) is lowered, this correction will decrease the welfare of the poor and increase the welfare of the non-poor. One has to judge whether this outcome is

better or not than the outcome of letting the non-poor to consume the quantity assumed to be select by the poor and pay its corresponding lower price; given the fact that the poor are in larger number than rich and that their welfare is generally valued more in social terms, the latter alternative is better.

3) Since household income is not an observable variable and is a costly one to be obtained, we may think that we can use a proxy, other than the quantity consumed, to price consumers. However, as we saw in this chapter, the use an observable proxy is not a guarantee that we will not have an adverse selection problem since the self-selection mechanism may still produce the same bunching of choices we examined in the case of the use of the quantity consumed by the household as the sign for differential pricing.

4) Isolating the possible differences in administrative costs for its implementation, the choice between a price-income and a price-quantity schedules is dependent on the welfare losses that each of these pricing regimes produce. In case of a price-income schedule without errors of classification, there is no doubt that this pricing regime would be better in welfare terms than a price-quantity regime because of the distortionary effects of the latter regime. With errors of classification, that is, with a price-income regime that misclassifies households' social condition and then generates a welfare loss, the choice depends on how large this loss is compared with the loss produced by a price-quantity schedule. Since the larger is the probability of making an error of classification, the larger is the welfare loss, the choice of a price-income schedule instead of a price-quantity may be warranted for smaller errors. Another factor that affects this choice is the aversion to inequality parameter: as this aversion gets stronger, the smaller are the levels of errors required to justify the choice of a price-quantity schedule.

APPENDIX TO CHAPTER 5

RELATIONSHIP BETWEEN A CONSUMER INDIFFERENCE MAP INVOLVING QUANTITIES AND THE ONE INVOLVING THE QUANTITIES AND THE CORRESPONDING OUTLAYS WITH A GIVEN COMMODITY.

Since the individual rationality and the self selection constraints require us to deal with utilities and expenditures in consuming commodities 1 and 2 at several different prices, the illustration of the problem of arbitrage examined in the text demands the use of consumers' indifference maps related not directly to the quantities, but to the total bill for each choice made of the quantity bought of commodity 1.

Before showing how both indifference maps are related, it is important to remember that the household type i's income Y_i is spent buying commodities 1 (the commodity the public utility produces) and 2 (the composite good) at prices P_{1i} and P_2, that is,

$$Y_i = P_{1i}X_{1i} + P_2X_{2i} \quad \text{for } i=1,\dots,K \tag{5.27}$$

where X_{1i} and X_{2i} are the quantities bought of those commodities. Then, the household i's total bill (TB_i) for buying commodity 1 is

$$TB_i = P_{1i}X_{1i} = Y_i - P_2X_{2i} \quad \text{for } i=1,\dots,K \tag{5.28}$$

Let us assume that U^A, U^B and U^C in figure 5.10a are three indifference curves in the household i's indifference map. Let us assume that A is its equilibrium position, given Y_i, P_{1i} and P_2. Since point A (for quantities X^A_{1i} and X^A_{2i}) is on the indifference curve U^A, let represent in figure 5.10b the combination X^A_{1i} and the corresponding total bill TB_A as point U^A. Let us now assume that the price P_{1i} has increased; this means that buying the same quantity X^A_{1i} of commodity 1 requires from household a larger expenditure with this commodity, equal to TB_B. In terms of figure 5.6a, this means that its budget equation line changes, setting the equilibrium at point B in curve U^B, where $U^B<U^A$, since $X^B_{2i}<X^A_{2i}$. In figure 5.10b the combination

TB_B and X^A_i is point U^B. In the same manner, a lower price produces

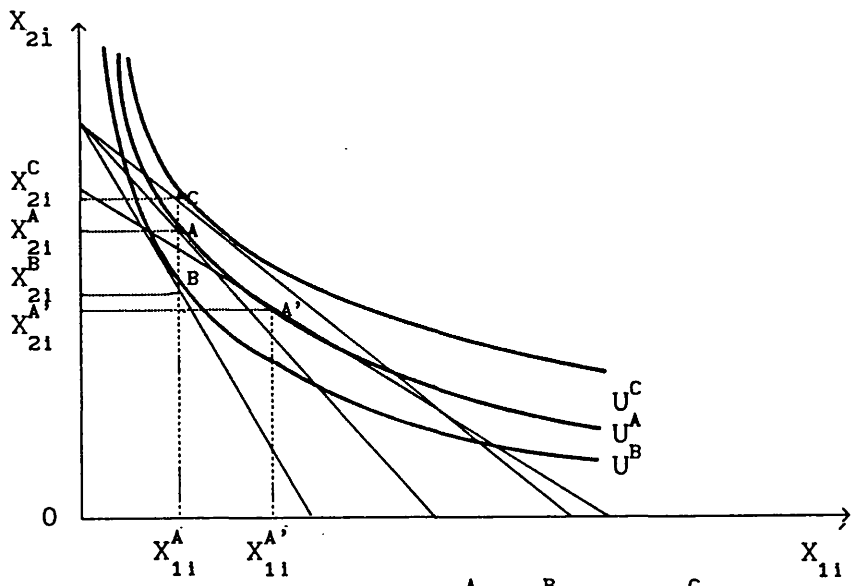

Figure 5.10a: Curves U^A, U^B and U^C in the household i's indifference map for quantities of the commodities 1 and 2.

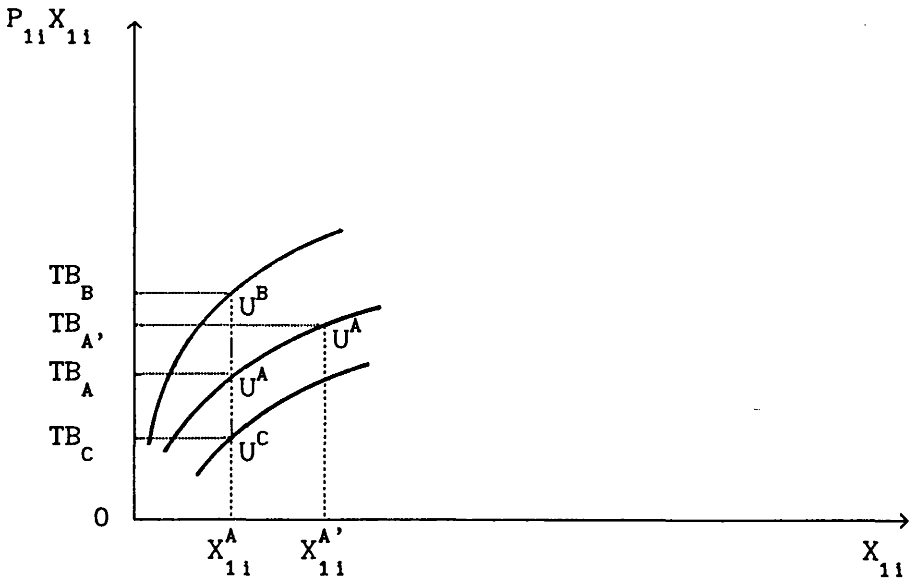

Figure 5.10b: Curves U^A, U^B and U^C in the household i's indifference map for quantities of commodity 1 and their required outlays.

point U^C in figure 5.10b related to point C in figure 5.10a; of course, $U^C>U^A>U^B$. This means that for a given quantity of commodity 1, a higher expenditure or total bill in paying for this quantity produces a smaller level of utility for household i since the quantity of commodity 2 must be reduced to satisfy the budget equation.

Let us now examine how combinations of different quantities of commodities 1 and 2 producing the same level of utility in figure 5.10a relate to points in figure 5.10b. For instance, point A' produces the same level of utility as point A. Point A' will be an equilibrium point for household i if its marginal rate of substitution at $X^{A'}_{1i}$ equals a price ratio P_{1i}/P_2 different from that at X^A_{1i} in which both prices have changed, as shown by the new budget line that is tangent to U^A at $X^{A'}_{1i}$. Then, to point A' in figure 5.10a corresponds point U^A in figure 5.10b. This means that a higher level of utility generated by the consumption of a larger quantity of commodity 1 is exactly offset by the effect of the increase in this commodity total bill, that is , a smaller quantity consumed of commodity 2. Repetition of the same procedure would allows to draw the complete indifference curve U^A for different combinations of total bill and quantity of commodity 1, and for U^B, U^C and any other utility level,as well. As we have already mentioned, since the total bill with commodity 1, that is, $P_{1i}X_{1i}$, is inversely related to the quantity that can be spent with commodity 2, that is, X_{2i}, the indifference curves in figure 5.10b are concave and show an order of utility levels in reverse to that shown in figure 5.10a: in the former, the higher is the indifference curve, the larger is the level of utility; in the former, the lowest indifference curves are the highest in utility.

The analysis made in this chapter also requires us to examine the adverse selection problem by comparing the the behaviour of two households, a poor and a rich household, that is, we have to examine how choices are made given their indifference maps. Actually, their indifference maps are assumed to be the same; their difference lies in the rich's having a higher budget line because of its larger income. We also should remember that the analysis made in chapter required us to assume that the rich is a high-demand consumer and the poor is a low-demand consumer; this means that their demands for commodity 1 are non-crossing, that is $U_R(X_1)>U_P(X_1)$ and $U'_R(X_1)>U'_P(X_1)$.

Figure 5.11a shows two indifference curves, U^A and U^B; the former is the highest curve within the reach of the poor's income given the set of prices, and the latter is the corresponding one for the rich. At point A, the poor demands the quantities X^A_{11} and X^A_{21} of commodities 1 and 2; this combination is shown in figure 5.11b as point U^A for the combination TB_A and X^A_{11}. The equilibrium point B for the rich is in the same manner represented in figure 5.11b as the point U^B for the combination TB_B and X^B_{11}. Let us assume now that prices have changed just enough to produce new equilibrium points A' and B' that share the same characteristic: both points imply the same quantity reduction in the consumption of commodity 2 for the poor and the rich households. Since the rich's marginal utility is higher, these new equilibrium points will show a larger quantity of commodity 1 required by the poor to compensate its loss in utility by the reduction in commodity 2; for the rich, the same reduction in commodity 2 requires a smaller additional quantity. In figure 5.11b, the new equilibrium points are also labelled as U^A and U^B since they are in the same indifference curves, but they related to different combinations of expenditures or total bill and quantities of commodity 1, respectively, $TB_{A'}$ and $X^{A'}_{11}$ for the poor and $TB_{B'}$ and $X^{B'}_{11}$. It should be noted that, since in the vertical axis the additional total bill for commodity 1 is the same for both households (they refer to the same reduction in the quantity of commodity 2 at new different prices for this commodity) and in the horizontal axis the additional quantity of commodity 1 consumed by the rich is smaller, the rich's indifference curve in figure 5.11b is steeper than the poor's.

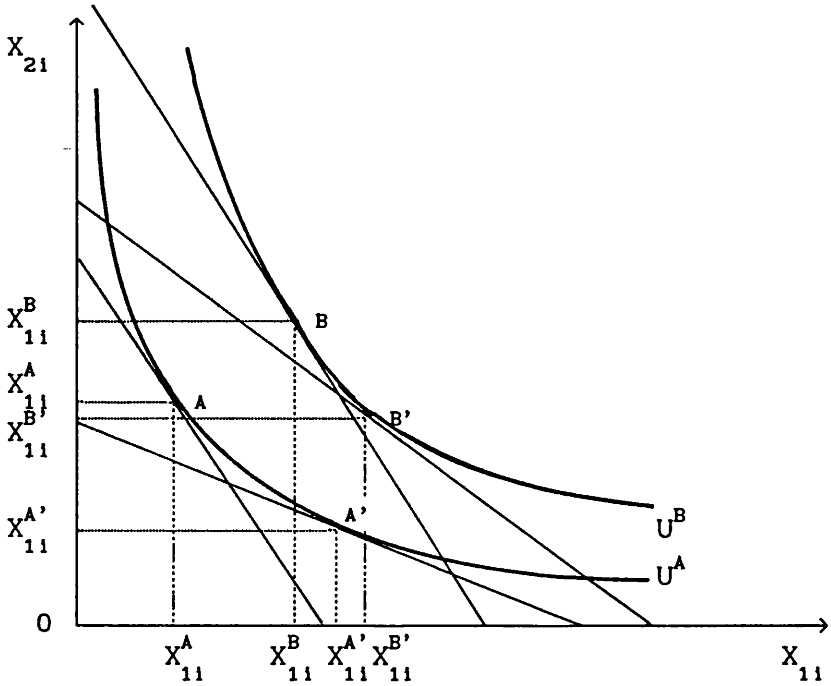

Figure 5.11a: Curves U^A and U^B in the indifference maps of the poor and the rich, respectively, for quantities of the commodities 1 and 2.

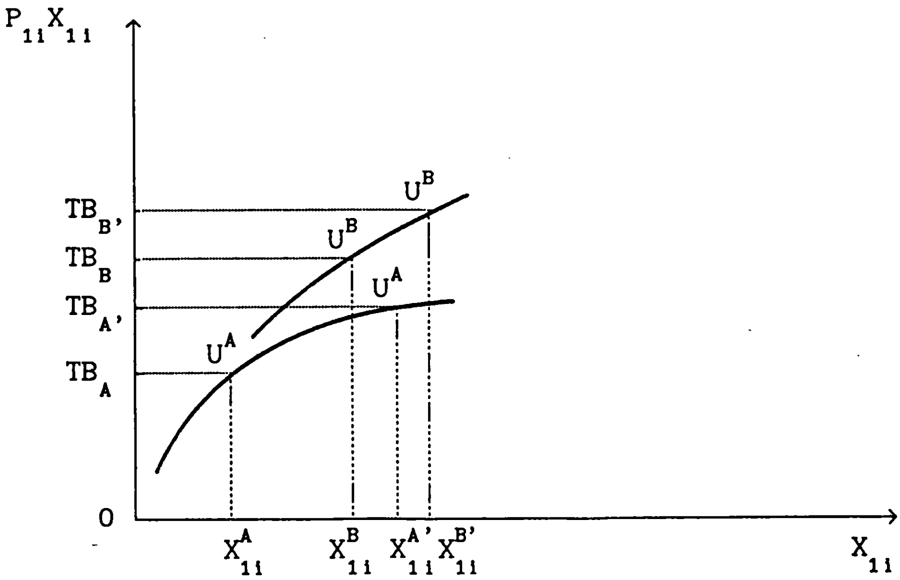

Figure 5.11b: Curves U^A and U^B in the indifference maps of the poor and the rich, respectively, for quantities of commodity 1 and their required outlays.

CHAPTER 6

CONCLUSIONS AND POLICY IMPLICATIONS

The objectives of this thesis were, firstly, to show that the second-degree price discrimination used by public utilities in Brazil as an instrument of income redistribution may be producing undesirable results: there are indications that this pricing policy objective has not been performing in the way it was supposed to do, that is, the poor households have been paying higher average prices for their consumption than the non-poor; and secondly, to examine how public utility prices could be charged to enhance the distributive role the government in Brazil wishes for the prices charged by these state-owned enterprises.

Before revising the findings of each chapter of this thesis, we would like to stress two standpoints under which the subject of this thesis and its findings should be evaluated:

1) Under certain circumstances it may be the case that income taxation will be the most efficient instrument for income redistribution and that differential commodity taxation and, by extension, discriminatory public utility pricing, may add little to the objective, if any, of redistributing income. However, since we know that the case against differentiated commodity taxation and discriminatory public pricing is dependent upon assumptions that are not necessarily satisfied in practice (particularly the economical and political possibilities of putting in operation an income tax structure with the proper characteristics to deal with the degree of absolute and relative poverty and its causes, as currently seen in Brazil and other less developed countries), we think that using public utility prices as a complementary distributive instrument is justified;

2) Administrative costs are a severe obstacle to the implementation of a third-degree price discrimination pricing policy

by public utilities, particularly a price-income pricing system; besides the costs of obtaining and updating the data required by this pricing system, one should be aware of the possibility of large errors of classification this system may have since consumers have incentives to understate their incomes under it. Thus, we accept that a price-income pricing system is not a feasible one in terms of implementation. However, public utilities may still adopt a third-degree price discrimination pricing policy by resorting to proxies to income, such as the quantity consumed of the service (we are going to comment about this possibility later in this chapter), the market value of the houses, and the physical characteristics of the houses, for instance; in Brazil, public utilities may use the existing data on market values of the houses, used by municipalities to charge local taxes.[1]

Let us review the main conclusions of this thesis:

Chapter 1 was devoted to the description of the institutional characteristics of the Brazilian experience on public utility pricing and to the analysis of the distributional impact of the prices charged to households. We saw that the current pricing practice used by public utilities is the adoption of a second-degree price discrimination scheme expressed by block-tariff price schedules. These schedules are set with increasing marginal prices for higher quantities consumed; the declared purpose of such a pricing policy is to cross-subsidize the consumption of the poor households. Thus, the basic assumption of this pricing policy is that there is a positive association between household consumption of these public services and households' incomes. The analysis of data from a sample survey allowed us to investigate the distributional impact of the price schedule used by one of these public utilities. Empirical data showed us:

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[1] Errors of classification should also be considered when proxies for income are used since they may be not perfectly correlated to household income.

Firstly, that there is an association between household income and average household consumption of the service, but that there is a large dispersion for individual household consumptions, mainly in the case of low-income households. Thus, this means that individual household consumption is not a perfect proxy for household income, as assumed by that pricing policy;

Secondly, the average price paid by consumers of water has an inverted J-form: the highest average prices are paid by the households with the lowest incomes, which means that instead of being progressive, the price schedule is effectively income regressive for the poorest households. This fact is reinforced by the finding that the relative share of the lowest income classes in the total SANEPAR's revenue is slightly higher than their share in total consumption.

However, we cannot generalize our findings of regressiveness concerning the water/sewage sector (here represented by SANEPAR's price schedule), by extending them to the electricity and piped gas services, for instance, without the necessary empirical data.However, we have shown empirically in this chapter that the idea that setting a nonlinear progressive price schedule defined in terms of blocks of the quantity consumed by the household is not a guarantee that effective average prices will be necessarily progressive in household income terms. Our point of view is that the distributional aspect of the pricing policy should be explicitly embodied in the derivation of these prices, either in a third-degree or a second-degree price discrimination pricing schedule.

Chapter 2 was dedicated to the survey of literature on price discrimination and public utility pricing. In addition to reviewing the most relevant studies on public utility pricing (particularly those concerned with the distributive role this pricing policy may have) we had the opportunity to list several arguments that can be used to justify the use of this policy as a complementary distributive device to taxation in less developed countries. We also saw the Brazilian literature on the subject is very scarce and that the present thesis may induce new studies on public pricing to be published in the country.

In chapter 3 we started our task of deriving prices schedules for a third-degree price discrimination by public utilities. Firstly, we derived optimal prices in the context of social welfare maximization; we also illustrated how implicit welfare weights can be estimated from currently used price schedules; and later we examined how optimal discriminatory prices are sensitive to different welfare weights used by the government. In this chapter we have attempted to make a contribution to the public pricing discussions by examining the way in which price discrimination can be designed to make public utilities a more effective instrument of social policy. We have shown that the use of distributional objectives in the determination of the rates to be charged to different consumers enlarges the range of considerations to be taken into account by the government by requiring a prior definition concerning how public services should be financed: in addition to the amount that the government may transfer to the public utility, one should decide how prices should differ across households , and consequently, the amount of cross-subsidy the price schedule will produce. It was also clear that the traditionally advocated rules of pricing according to marginal cost or according to the inverse of consumer's demand price elasticity have to be qualified to incorporate other elements that should help to determine the optimal rate to be charged, as well as the price differentials. These elements are not only the welfare weights used, but also the characteristics of the commodity in terms of its importance in generating household's welfare, and the shadow price of the public utility's deficit.

One important finding of chapter 3 was to show how households demand price elasticities and the welfare weights work together to determine optimal public prices. It was clear that the elasticities ratio has a leading role in price discrimination, determining the values the welfare weights should take to produce prescribed price differentials.

On the other hand, it was interesting to show in chapter 3 how the current population growth we observe in urban centres of the developing countries may affect the the price schedules adopted by public utilities: the expansion of their services may require either a larger cross-subsidy paid by the non-poor or/and an increase in the transference of the resources provided by the government to these public enterprises.

The sensitivity of the optimal price schedule was investigated to appraise how alternative distributional objectives affect the determination of discriminatory prices. The exercise we did found that small changes made in the aversion to inequality parameter may generate large price differentials among households. The message of this exercise is that it may not be political feasible to use the welfare weights the government would judge adequate to significantly alleviate the inequalities in income distribution.

We also examined in chapter 3 how the fixed capacity of production may affect the determination of optimal discriminatory prices. When there is a need to ration the quantity demanded by households, all prices are increased, but keeping the degree of their price differential. Since poor households spend a larger proportion of their budget with public services than the non-poor, this price increase tends to affect more the former than the latter in welfare terms. We also examined how the welfare weights attributed to households affect the decision to increase the public utility's capacity of production: it was clear that these weights may change the shadow price for capacity in such a way that makes it greater than the marginal cost of capacity expansion, allowing this expansion.

Poverty was the central focus of attention of chapter 4; the approach followed in this chapter was different from that used in chapter 3 by assuming that the government is more interested in alleviating poverty rather than inequality when setting public prices. In this chapter we examined two types of pricing policies: In the first, the assumption was made that the government adopts a paternalistic approach towards public utility pricing by setting a minimum entitlement constraint to be satisfied in the derivation of discriminatory prices. In the second, we assumed that the social objective is the minimization of poverty, justified not only by the degree of poverty in Brazil, but also by the need of the government to concentrate some part of its scarce resources into alleviating this problem. As to the minimum entitlement pricing policy, we saw that, as expected, when that constraint is binding, prices should be lowered to the level determined by the demand functions of the households who need this kind of protection. Since this will affect the public utility's financial balance, we discussed in this chapter the problems that may hinder the implementation of a minimum entitlement pricing policy by public utilities:

i) in the case that this policy should be financed out of government's resources, that is, by additional resources provided by the government to the public utilities, its implementation may be not possible if the amount of resources needed is larger than the amount the government is ready to transfer, as is the case in most developing countries;

ii) to finance this policy out of possible profits made by these public utilities may be a way of postponing additional capacity expansions, with adverse social and economic effects;

iii) to use a cross-subsidization scheme to finance such policy may not be viable if the non-poor's demand price elasticity for the commodities is elastic at these higher prices or if these prices induce substitution, resulting in a smaller public utility's total revenue than that required.

All this does not mean that a minimum entitlement policy cannot be implemented by public utilities. A combination of sources of subsidization plus a less ambitious goal in terms of the minimum consumption allowed may make viable such policy .

As to the pricing policy directed to minimization of poverty, we saw that reaching a lower or a higher goal in this policy when there is no price discrimination depends on the level of subsidy the government is prepared to transfer to the public utility to allow the least price to be charged to households. In the short-run, this is the only instrument that the government can manipulate to induce the attainment of the objective it set to the public utility. In the long-run, one should expect that improvements made in the cost management of the public utility and the possibility of reaping economies of scale may allow lower prices to be charged, with favourable impacts upon the objective of minimization of poverty. In the case of a discriminatory pricing policy being used by a public utility, besides those elements cited above as the influence and constraint the price level that can be charged to the poor, it is possible to finance a lower price offered to these consumers by using a cross-subsidization scheme with the purpose of minimizing the poverty. However, the analysis made in this chapter shows that there is a trade-off curve between the price to be paid by the poor and the price to be paid by the non-poor and that this trade-off curve (a type of Laffer curve) may set limits to the lowest price the public utility can choose to favour the poor; the important element that restricts the price choice is basically the non-poor's demand price elasticity for the commodity at higher prices, which may check the possibility of additional revenues being raised with those higher prices.

In chapter 4 we also examined the possibility of pricing for the minimization of the poverty with an additional constraint of a minimum consumption requirement for the poor. We saw that the demand functions of the poor to be benefited from this pricing policy are the determinants of the prices they should be charged; since these prices are lower than those they should normally pay, the problem of how to finance this pricing policy has to be considered again.

It should be noted that the growth of the number of poor may limit the possibility of poverty minimization,as defined here, through the pricing policies adopted by public utilities. We saw that the additional need of consumption subsidization for the newcomers may require price increases not only for the non-poor, but also for the poor. Since the phenomenon of immigration of poor households to urban centres is a common fact in several countries of the Third World, we should expect that the effectiveness of such a policy of pricing to attain minimization of the poverty in these countries to be much reduced.

In chapter 5 we considered the possibility of the price schedules derived for a third-degree price discrimination not being implementable. We first showed that it is possible to translate the price-income schedules derived in chapter 3 and 4 into price-quantity ones. However, we saw that the implementation of a price-quantity schedule derived from a price-income schedule with a given distributional objective may produce results that do no conform with this objective because households may make an adverse selection: their self-selection constraint may induce them to select the quantity and the price that was originally thought to be chosen by other households. The occurrence of an adverse selection is caused by the fact that the price the households are charged when they select a given quantity is so high that it is better for them, in utility terms, to choose a lower quantity and pay the respective lower price that that quantity entails. It was shown that when we derive a price that is void of an adverse selection problem, the self-selection constraint makes the original price to be lower and, at same time, increases that lower price the households had originally selected. These changes in prices corrects the problem that could be caused by an adverse selection. However, this correction has a cost in welfare terms: since the lower price (that paid by the poor) is increased and the higher price (that paid by the non-poor) is lowered, this correction will decrease the welfare of the poor and increase the welfare of the non-poor. One has to judge whether this outcome is better or not than the outcome of letting the non-poor to consume the quantity assumed to be select by the poor and pay its corresponding lower price.

We also showed in chapter 5 that the use of proxies for income, other than the quantity consumed, may also have the perverse effect upon the distributive characteristics we would like the pricing system to have, that is, the occurrence of an adverse selection problem is also a possibility.

In chapter 5 we also saw that, isolating the possible differences in administrative costs for its implementation, the choice between a price-income and a price-quantity schedules is dependent on the welfare losses that each of these pricing regimes produce. In case of a price-income schedule without errors of classification, there is no doubt that this pricing regime would be better in welfare terms than a price-quantity regime because of the distortionary effects of the latter regime. With errors of classification, that is, with a price-income regime that misclassifies households' social condition and then generates a welfare loss, the choice depends on how large this loss is compared with the loss produced by a price-quantity schedule. Since the larger is the probability of making an error of classification, the larger is the welfare loss, the choice of a price-income schedule instead of a price-quantity may be warranted for smaller errors. Another factor that affects this choice is the aversion to inequality parameter: as this aversion gets stronger, the smaller are the levels of errors required to justify the choice of a price-quantity schedule.

There are at least two lines of research open as continuation of the work developed in this thesis:

1) Since public utilities sell their services not only to households, but also to producers, one could consider how the distributive role attributed to the pricing policy adopted by these public enterprises should be taken into account in an integrated approach of final consumers (households) and intermediate consumers (producers); the idea is to examine the possibility and the rationale for not only cross-subsidization among households and among producers, but also between these two sectors of consumers, for distributive reasons. The current Brazilian practice of charging producers is the use of a block-quantity price schedule with increasing marginal prices for higher quantities. However, it is known the existence of special contracts signed by public utilities with high-consumption producers that lower the average price paid by these firms, either lowering the subsidy the producer sector may be giving to the household sector, or demanding a higher subsidy from this sector and impairing a more effective use of a price system that favours the consumption of the poor households;

2) To examine how the currently state-owned public

utilities in Brazil should be regulated in distributive terms in case they are privatized. In the appendix to chapter 3 we started this study, but the subject deserves further exploration. Privatization in Brazil has been circumscribed to the manufacturing sector up to now; however, since the government, in its (federal, state and municipal) levels, may be interested in extending the privatization process to some public services, it is important to analyze how the objective of redistribution of income could be introduced into this regulation. Prices of public services tend to be a very sensitive political issue, particularly in countries of the Third World, and for this reason it would be interesting to study how prices for different consumers would be affected, and in which degree, when the service is provided by regulated private producers. This kind of study would contribute towards an informed choice between the continuation of the use of state-owned enterprises or their replacement by private enterprises.

Let us now examine some policy implications this study allows to consider:

i) We have mentioned before that we do not consider feasible the implementation of a price-income schedule by public utilities. We admitted, however, that it would possible to use a proxy for income, such as the market value of the house, the same basis used by municipalities in Brazil to charge local taxes. Public utilities could, then, use the same data bank to establish the rate each household would be charged for its consumption of the service. Of course, we are assuming that this variable is a good proxy for household income; this assumption, however, should be tested empirically. In principle, we can accept that it should be a high correlation between the income of the household and the value of its house. However, care should be taken to avoid the possible market distortions in housing values or short-term fluctuations in the values of the houses that would make this variable unreliable as a proxy for the household's social condition. Another proxy that has been suggested is the location of the house; location can be a good proxy for income in some Brazilian cities since we can observe a distinct spatial distribution of the population according to its income. However, there are cities, such as Rio de Janeiro or Sao Paulo, where it is hard to find a significant homogeneity in household incomes in sections of the city to allow location to be an appropriate discriminatory variable for differential pricing. In this case, the probability of making errors of classification of the households' social conditions would be high and, consequently, the use of a price-quantity schedule may be more likely to be a better pricing regime in welfare terms, as examined in chapter 5.

ii) In chapter 3 we illustrated the sensitivity of the price differentials in relation to the value taken by the aversion to inequality parameter. We saw that this sensitivity may be very high, that is, the rate of progression in prices may make the price schedule politically unfeasible. Although households may accept discriminatory prices as a redistributive device, they may not be prepared to agree with the large price differentials derived for strong degrees of aversion to inequality. And we also should remember that high marginal prices for higher incomes or higher values taken by proxies of income may fail to generate the required revenue to subsidize the consumption of the poor; this may happen because either the non-poor's demands become highly elastic at this high price and/or because the non-poor prefer to make an adverse-selection, in order to avoid paying this high price.

iii) Assuming that

(a)a price-income regime is considered unfeasible,

(b)that the use of the market value of the house, its location, or its physical characteristics are not adequate proxies for household income, and

(c)that it is preferable to continue using the quantity consumed as the variable to discriminate prices among consumers,

we think the following considerations are helpful to improve the redistributive effect these prices related to consumption are expected to have:

A) We saw in chapter 1 that the poor's average consumption of water is much lower than the quantity they are charged monthly: the mandatory minimum bill entitles them to consume a quantity that is about twice that they effectively consume. Although one cannot eliminate the regressive effect such an entrance fee has, it would be important to minimize it by lowering the value of the monthly minimum mandatory bill and by adjusting the quantity the new lower entrance fee will entitle. Of course, this change in the prices has to be compensated for by an increase in the subsidy paid by other consumers or financed by the government;

B) To avoid the problem of adverse selection which may be occurring in the Brazilian case, one should consider introducing a continuous in quantity total bill, that is, a price schedule in which the marginal price changes (increases) for each additional quantity, as illustrated as type D and figure 5.4 in chapter 5. We saw that with this type of pricing, consumers are separated in terms of their consumption and the non-poor will always select to consume a higher quantity than the poor, paying the higher price they are expected to pay. This may not happen in the currently used block-quantity pricing system;

C) It is important to link the definition of the entrance fee and the quantity of consumption it allows, as mentioned in A), with the idea of minimum entitlement discussed in chapter 4. It seems unclear whether the quantity these public utilities in Brazil are allowing the poorest to consume when they pay the entrance fee has anything to do with the socially desirable minimum quantity to be consumed: we saw that some water companies allow the consumption of 10 cubic meters, others 15 cubic meters, and others 20 cubic meters; although these differences could be explained by regional climatic differences, it does not seem to be the case. The policy of a minimum entitlement should be implemented by redefining the entrance fee by charging different entrance fees that would allow the poorest households to consume a minimum socially desirable quantity. Of course, in the definition of this minimum should be considered not only the quantity recommended by institutions such as the World Health Organization, but also what is feasible to fund via cross-subsidization and via government funds transferred to these public utilities;

D) It is necessary to make sure that the price these public utilities are charging the poorest households is the lowest price they could charge given their financial balance constraints defined by the cross-subsidization scheme and the possibility of governmental subsidization. An effort in the direction of charging the lowest price to the poorest will allow not only the public utility to minimize the regressive effect the entrance fee has, but also to help alleviate the problem of poverty;

E) It may also be necessary to make a revision in the rate of progression of the price schedules being used by public utilities. We know that it is necessary to conjugate several aspects in the definition of this rate: firstly, this rate is necessary to discriminate between consumers, allowing that the cross-subsidization operates with a given objective; secondly, this rate must generate price differentials which are politically acceptable; and finally, the rate should not induce an adverse selection by the non-poor.

We saw in chapter 2 that the Brazilian economic literature on public utility pricing is very scarce. We hope that the discussion of the findings of this thesis will open the way to additional studies on this subject in Brazil and that the contribution we intended to make with the present work will help public utilities to better define and evaluate their pricing policies.

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