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UNCOVERING REGULATOR'S IMPLICIT SOCIAL WELFARE WEIGHTS UNDER PRICE CAP REGULATION

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1. Introduction

The aim of this paper is to carry on a welfare analysis of the impact of price cap regulation by investigating the regulator's implicit preferences - expressed in terms of welfare weights - over different classes of consumer groups. The paper wishes to explore this possibility by adapting the framework suggested by Ross (1984) to detect the implicit regulator's welfare weights within a "generic" Ramsey formula[1], to infer welfare weights when the regulatory environment is characterised by price cap regulation. The intent is to supply a methodology which could be fruitfully applied to analyse price cap reforms such that undertaken in UK to regulate the tariffs of telecommunication services for residential customers.

It is clear that different types of consumers experience varying degrees of advantages from the regulators' choices over prices. On the other hand, by these choices, a full informed regulator with the right to fix the prices of the goods produced in a regulated monopoly would implicitly assign different values to the welfare of different types of

[1] The approach proposed by Ross (1984) is equivalent to the Ahmad and Stern (1984) inverse optimum problem developed to derive the implicit welfare weights underlying a commodity tax structure.

consumers. That is, under no uncertainty, if the prices are directly chosen by the regulator, they exactly reveal the regulator's preferences over consumers, and the strategy of inverting a "generic" Ramsey formula with potentially diverse welfare weights may be usefully followed.

It is well known, however, that asymmetric information characterises almost every regulatory situation and to leave some pricing discretion to the firm is often both unavoidable and desirable. Nevertheless, to consider prices chosen by the regulated firm does not rule out the possibility of investigating the regulator's welfare weights. A Laspeyres-type price cap, for instance, allows pricing discretion within borders that force the regulated firm to exploit its superior information set by making choices which lead to Ramsey prices in the long run (Vogelsang and Finsinger, 1979; Bradley and Price, 1988; Brennan, 1989; and Vogelsang, 1989). Ramsey prices ensure the highest possible welfare for the society when the welfare function is defined as a simple sum of individuals' consumer surpluses and the firm's profits. This implies that the objective of pursuing (at least in a long run perspective) the maximisation of a social welfare function which attaches equal weights to any group of consumers would underlie this regulatory choice.

Furthermore, whether the regulator's welfare function incorporated a different set of preferences over individuals, a Generalised Price Cap (GPC) - a generalisation of the conventional Laspeyres-type price cap - would still be able to guarantee the allocative efficiency in the long run. This result is formally demonstrated in Iozzi, Poritz and Valentini (2002) who show that the conventional Laspeyres-type price cap is just a special instance of the GPC. They also explain the closeness of the GPC to the regulatory reform undertaken by Oftel in 1997. We show in this paper that this link can be fruitfully used to investigate the new Oftel's preferences over different classes of customers grouped according to different socio-economic characteristics (i.e. level of income, geographic location, sex, employment status, etc.).

In some sense this problem reminds that dealt with by Ross (1984). Unlike that, we do not need to (and we do not have to) regard the observed prices as those which satisfy any Ramsey formula. What we require to derive the unknown Oftel's welfare weights will be to observe the coefficients that affect the price variation in the new price cap formula and to assume that they have been optimally chosen by Oftel in order to implement that GPC which exactly suits her social preferences.

To substantiate these arguments we first report in section 2 the Oftel's price cap reform which can be used a case-study to this analysis. In section 3 we show very briefly the theoretical background that should be used to uncover the regulator's social welfare weights within a price cap framework. Finally, section 4 provides a simple numerical example to indicate the relevance of the proposed procedure in order to detect possible adverse interactions between price cap and other regulatory instruments aimed at further social goals.

2. The Oftel's case-study

In 1997, Oftel decided to modify the price cap formula that was used since 1984 to regulate the prices set by British Telecom (BT) for domestic customers. The previous formula was basically a traditional Laspeyres-type price cap which could be formulated as a typical *RPI-X* limit on the weighted average of prices changes for the regulated firm, that is

$$\sum_m \frac{p_m^t}{p_m^{t-1}} w_m^t \leq RPI - X \qquad (1)$$

where the weighting coefficients w_m^t were equal to the firm's revenue shares at time *t*-1 for any good *m* in the regulated basket (*m*=1, …*M*).

In the new Oftel's formula the coefficients w_m^t are now the shares at time *t*-1 of the revenues accruing to the regulated firm only from those consumers who are in the first eight deciles of total expenditure in telecommunications services.

The motivation put forward by Oftel for this change was the recognition of the fact that the price reductions undertaken by British Telecom in the last 15 years have primarily advantaged the business and high-expenditure residential users, with very little gratification accruing to low-consumption residential users. For example, if we take the period from 1990/91 to 1995/96, we can see from the first row of table 1 that the price cap allowed an annual average reduction of the prices in telecommunication equal to 6.6%. In the other rows of table 1 we can see how this reduction in prices has spread among different classes of BT’s consumers. If we analyse the bills charged to residential customers and those charged to business customers, we observe that the annual average reduction of prices in telecommunication was equal to 4.2% for the former and 9.3% for the latter. Moreover, within residential customers we can see that some groups have got less benefit than others.

Indeed, the top 20% of high spending residential customers received annual price cuts equal to 5.7% on average, while the average annual cut was less than half (2.7%) for the rest of BT’s residential customers.

The main reason for that has been the different competitive pressures faced by BT in different markets. Indeed, competition has been particularly severe in the most profitable business sector and, according to Oftel (1997), nowadays the access to other providers is a so realistic alternative in this segment that the telecommunication services supplied to business customers have been totally removed from the capped basket since 1997.

On the other hand, competition is not yet sufficiently mature to guarantee an authentic option to the majority of residential customers who have therefore continued to be protected by price cap regulation. At the same time, Oftel has being aware of the necessity of implementing some correction to guarantee higher defence to those consumer groups who received less benefits in the past. To understand the reason that pushed Oftel to deal with this issue by restricting the former price cap to the only revenues earned by British Telecom from low and medium spending residential customers, it can be useful to analyse the expenditure in telecommunications among different residential consumer groups.

A synthesis of this analysis is reported in table 2 that shows the average quarterly spend per BT’s residential customer in 1994/95. The whole of residential customers splits its total expense in telecommunication assigning 65% of the bill to calls and the residual 35% to rental. These shares change if we rank customers by spend. The customers in the first 80% (low and moderate users) approximately split equally their bills in calls and rental (51% and 49% respectively) while, for the remaining 20% of high users, rental measures only 17% of total expenditure (versus the 83% of calls).

These figures allow to shed further light on the reason of the little advantage accruing to low-consumption residential users from the price reductions in telecommunications. Indeed, the reduction of prices in telecommunications has been two times greater to the top high spending customers than to the rest of customers because a much larger proportion of low and medium users' bills has been spent on those services (such as rental) which have not experienced a sharp reduction in prices[2].

The Oftel's response to this evidence was to focus its price control in a way that reflected the pattern of usage of the low-medium spending residential customers. By setting w_m^t equal to the revenue share of good *m* accruing at time *t*-1 from consumers characterised by low total expenditure in telecommunications services, a stricter control is now placed on the prices of the goods that make up a large share of the typical bill of low-consumption customers.

To have an idea of the different control over prices that can be exerted by adopting the new price cap formula instead of the traditional Laspeyres price cap, we propose here a simple example which uses the data of average spending in telecommunications reported in table 2. Suppose that the figures reported in table 2 are those referred to period *t*-1. Hence, for *m*= 1 (*rental*), 2 (*calls*), we can see that a Laspeyres type price cap at period *t* would be equal to

$$\frac{p_1^t}{p_1^{t-1}}0.35+\frac{p_2^t}{p_2^{t-1}}0.65 \le RPI - X \qquad (2)$$

[2] This is mainly due to the monopoly power that British Telecom can still exploit over the so called "last mile" of the national telecommunication network.

where 0.35 is the BT's revenue share from rental (that is, $w_1^t = (p_1^{t-1} q_1^{t-1}) / (\sum_m p_m^{t-1} q_m^{t-1}) = 0.35$), that is the average share of telecommunication spending that all BT's consumers assign to rental (see the last row of table 2). Similarly, 0.65 is the BT's revenue shares from calls which also equal to the average share of telecommunication spending that all BT's consumers assign to calls (same row of table 2).

Now, the new Oftel's price cap at period *t* would be equal to

$$\frac{p_1^t}{p_1^{t-1}} 0.49 + \frac{p_2^t}{p_2^{t-1}} 0.51 \leq RPI - X \qquad (3)$$

where 0.49 is now the BT's revenue share from rental, calculated on the quantitiy $\breve{q}_1^{t-1}$ purchased by consumers who are in the first eight deciles of total expenditure in telecommunication (that is, $w_1^t = (p_1^{t-1} \breve{q}_1^{t-1}) / (\sum_m p_m^{t-1} \breve{q}_m^{t-1}) = 0.49$) and 0.51 is the equivalent revenue share coming from calls (these figures correspond to the row of table 2 labelled as first 80% (moderate use)).

If we fix, for instance, *RPI-X*=1, it is easy to verify that, under (2), a reduction of the price of calls, say, by 10% $(p_2^t / p_2^{t-1} = -0.1)$ would imply a maximum allowed increase in the price of rental equal to 18.6% while, under (3), the same reduction of p_2 could never be coupled by an increase in p_1 higher than 6%.

In other words, for any price cap formula $\sum_m (p_m^t / p_m^{t-1}) w_m^t \leq RPI - X$, with $\sum_m w_m^t = 1$, the heavier is the coefficient w_m^t over the price change of one good, the fewer is the possibility that the regulated firm might transfer to others prices the burden of any reduction in p_m. This is indeed the essence of the 1997 Oftel's price cap reform. Thus, we can assert that the adoption of a price cap like that expressed by (3) allows to pursue those distributive objectives which were announced by Oftel itself.

However, a complete welfare analysis of this price cap reform should consider how any consumer allocates his expenditure in telecommunication services. Indeed, if Oftel does not want that price cap put other consumer groups in a comparatively disadvantaged situation, she has to think about the relative importance that rental and calls have in the bills of these consumers. In other words, if Oftel concludes to give greater importance to the welfare of low-medium spending residential customers, she has to be aware of the possible welfare effect over other customers' types.

A possible way to investigate this welfare effect is to make ad hoc assumptions on the regulator's welfare function in order to take into special account those customer types that should be characterised by a particular social concern and then to analyse the effects on this function due to the price changes induced by price cap. In fact, we are going to deal with an inverse procedure. That is, we do not formulate any assumption about the regulator's social welfare function but we uncover it and its implicit welfare weights throughout the observed regulatory choices which are actually set by Oftel.

3. Uncovering welfare weights: The theoretical background

When (RPI-X)=1, the price cap constraint given in (1) corresponds exactly to the GPC proposed by Iozzi, Poritz and Valentini (2002) provided that

$$w_m^t = (w_m^t)^* = \frac{p_m^{t-1}\dfrac{\partial W}{\partial p_m^{t-1}}}{\sum_k p_k^{t-1}\dfrac{\partial W}{\partial p_k^{t-1}}}, \qquad (m=1, \ldots M) \qquad (4)$$

where $(w_m^t)^*$ is the coefficient over the price variation of good *m* that would be optimally chosen by a regulator maximising the social welfare function $W(\boldsymbol{p}, y) = W(v^1(\boldsymbol{p}, y^1), \ldots, v^N(\boldsymbol{p}, y^N))$ defined over the indirect utility functions $v^n(\boldsymbol{p}, y^n)$ (n=1, … N) of N consumers (or groups of consumers).

Given the social welfare function $W(\boldsymbol{p}, y) = W(v^1(\boldsymbol{p}, y^1), \ldots, v^N(\boldsymbol{p}, y^N))$, we have that

$$\frac{\partial W}{\partial p_m^{t-1}} = \sum_{n=1}^{N} \frac{\partial W}{\partial v^n}\frac{\partial v^n}{\partial p_m^{t-1}} = -\sum_{n=1}^{N} \frac{\partial W}{\partial y^n} q_m^n(\boldsymbol{p}^{t-1}) \qquad (5)$$

where q_m^n represents the quantity of good *m* purchased by consumer *n*, $\boldsymbol{p}$ is vector of the prices in the regulated basket, *y* is the sum of the *N* consumers’ incomes $y^n = y^1, \ldots y^N$, and the last equality in (5) makes use of 1) the Roy’s identity, $q_m^n = -\frac{\partial v^n / \partial p_m}{\partial v^n / \partial y^n}$, and 2) the marginal change in social welfare from an infinitesimal income increase by consumer *n*, $\frac{\partial W}{\partial y^n} = \frac{\partial W}{\partial v^n}\frac{\partial v^n}{\partial y^n}$.

When (4) is satisfied, the convergence to optimal (second-best) prices is ensured in the long-run for virtually any form of $W(\boldsymbol{p}, y)$ (Iozzi, Poritz and Valentini, 2002) and we can consider $\partial W/\partial y^n$ as the regulator’s welfare weight over the *n*-th consumer (or group of consumers). $\partial W/\partial y^n$ is equivalent to the Feldstein’s definition of marginal social utility of income (Feldstein, 1972), and it can be split into two components. While $\partial W/\partial v^n$ does actually catch the regulator’s preference over customer *n*, $\partial v^n/\partial y^n$ is “*exogenous*” in some sense to the regulator as it depends on the individual utility function $v^n(\boldsymbol{p}, y^n)$. However, to interpret $\partial W/\partial y^n$ as the regulator’s welfare weight, or social preference, over individual *n* is a very standard method which is used in many papers dealing with the marginal welfare effects of price variations (for instance, Blundel and Preston, 1995; Mayshar and Yitzhaki, 1995; Newbery, 1995; Banks, Blundel and Lewbel, 1996).

Given this theoretical framework, the way we can embrace to uncover the regulator’s welfare weights is straightforward. If we assume that for any good in the regulated bundle the Oftel’s decision on w_m^t is consistent with her preferences over consumers, at any period *t* we can set the observed w_m^t (as those in (2) and (3)) equal to the optimal $(w_m^t)^*$ as defined in (4) and solve out for the welfare weights $\partial W/\partial y^n$, provided that: 1) the number of equations, *M*, is not less than the number of unknowns, *N*; and 2) we are able to observe the prices and the quantities consumed by each group of consumers at *t*-1.

4. Distributional implications: A simple numerical example

Suppose a hypothetical empirical application where the researcher is interested in evaluating the regulator's welfare weights over particular categories of consumers such as low income consumers, unemployed, or consumers with some special need. For instance, in the case of the UK telecommunication market we could imagine to investigate the welfare effect of the new Oftel's price cap formula over two specific categories of BT's customers: low-medium spending customer and customers living in rural areas. As long as protecting consumers living in rural areas were another possible regulatory task, it would be necessary to evaluate whether the new Oftel's price cap formula conflict in some measure with other regulatory instruments intended to protect that category.

To substantiate the importance of this point, we look now at a very simple example. Let us suppose a price capped firm selling two goods to one-hundred customers. At time t-1 the total revenue of the firm is equal to 2,000 pounds since

p_1^{t-1}=10 is the price of good 1

p_2^{t-1}=1 is the price of good 2

q_1^{t-1}=100 is the total quantity of good 1

q_2^{t-1}=1000 is the total quantity of good 2.

The one-hundred consumers of these two goods may be classified according to two socio-economic characteristics: expenditure and location. Let us define by A the set of those consumers belonging to the first eight deciles of the total expenditure in goods 1 and 2 and by $\overline{\mathrm{A}}$ the set of those consumers belonging to the top two deciles. Similarly let us define by B the set of consumers living in rural areas and by $\overline{\mathrm{B}}$ the set of those living in urban areas.

Of course expenditure and location may overlap in different ways. For instance, consumers belonging to the low-medium spending group (A-types) may be both B-type (living in rural areas) and $\overline{\mathrm{B}}$-type (living in urban areas). In this example we suppose that, because of this overlapping, q_1^{t-1} and q_2^{t-1} are distributed among consumers as specified in table 3.

In table 3, for any q_i^{t-1} (i=1, 2), it is possible to see how much is q_i^{Ψ}, that is the quantity of good i (i=1, 2) consumed by those consumers belonging to group Ψ (Ψ=A, $\overline{\mathrm{A}}$, B, $\overline{\mathrm{B}}$), and how much are the quantities consumed by customers belonging to each of the sets {A ∩ B}, {A ∩ $\overline{\mathrm{B}}$}, {$\overline{\mathrm{A}}$ ∩ B} and {$\overline{\mathrm{A}}$ ∩ $\overline{\mathrm{B}}$}[3].

This hypothesised disaggregation allows us to observe that, although a significant part of the expenditure accruing from low-medium spending customers goes to good 1, customers living in rural areas show to use more good 2 than customers living in urban areas do. Thus, any regulatory policy aimed at a relatively stricter control upon the price of good 1 (and at a consequently weaker control upon p_2) would have a negative impact on the welfare of those consuming a larger amount of q_2. Whether a regulator is aware of this implication, she is deliberately attaching a lower welfare weight to this group of customers.

To make this argument clearer we go now to show what are the regulator's welfare weights if different forms of price cap are implemented under the hypotheses reported in the present example.

In a two good case, the traditional price cap Laspeyres-type would be

$$\frac{p_1^t}{p_1^{t-1}}\frac{p_1^{t-1}q_1^{t-1}}{p_1^{t-1}q_1^{t-1}+p_2^{t-1}q_2^{t-1}}+\frac{p_2^t}{p_2^{t-1}}\frac{p_2^{t-1}q_2^{t-1}}{p_1^{t-1}q_1^{t-1}+p_2^{t-1}q_2^{t-1}}\le RPI-X \tag{6}$$

while, an alternative price cap - like that currently used by Oftel – could be written in this way:

$$\frac{p_1^t}{p_1^{t-1}}\frac{p_1^{t-1}q_1^{A}}{p_1^{t-1}q_1^{A}+p_2^{t-1}q_2^{A}}+\frac{p_2^t}{p_2^{t-1}}\frac{p_2^{t-1}q_2^{A}}{p_1^{t-1}q_1^{A}+p_2^{t-1}q_2^{A}}\le RPI-X \tag{7}$$

[3] To avoid a too heavy notation we do not use here the superscript t-1. In the rest of the example, however, any lack of superscripts related to period of times means that we refer to period t-1 without ambiguity.

By the inverse procedure described in section 3 we can derive the welfare weights underlying (6) and (7) by putting $\frac{\partial W}{\partial p_i^{t-1}}$ equal to q_i^{t-1} or to q_i^A respectively (i=1, 2) and then solving for $\frac{\partial W}{\partial y^{\Psi}}$, where Ψ may be set equal to A and $\overline{\mathrm{A}}$ or to B and $\overline{\mathrm{B}}$.

As we would expect, it comes out that, (6) is neutral with respect to any partition of the consumers' set. Indeed, from simple calculation we obtain that, under the regulatory regime given by (6), $\frac{\partial W}{\partial y^A}=\frac{\partial W}{\partial y^{\bar{A}}}=\frac{\partial W}{\partial y^B}=\frac{\partial W}{\partial y^{\bar{B}}}=1$.

On the contrary, by calculating the welfare weights which identify (7), we obtain that, according to the new regulatory aims, the social welfare weight over consumers A and $\overline{\mathrm{A}}$ are equal to 1 and 0 respectively. However, we also have that implementing (7) involves $\frac{\partial W}{\partial y^B}$=0.18 and $\frac{\partial W}{\partial y^{\bar{B}}}$=1.68, that is different welfare weights with lower value just on that group that would deserve a higher concern indeed.

Even if this is nothing more than a numerical example with absolutely no connection with real data, it shows a point that would probably deserve further attention in future empirical researches. Indeed, under the previous tariff basket price cap, Oftel assigned $(\partial W/\partial y)^n=1$ to any consumer unit and, then, also to any consumer group obtained by any partition of N. This implied also that the traditional price cap were "neutral" with respect to other possible policies intended to affect specific groups of TLC users. On the other hand, we can claim that, by the price cap reform undertaken in 1997, Oftel is efficiently pursuing the distributional objectives that it announced in its official documents. However, we still need empirical evidence to state whether the new Oftel's formula conflicts with other possible social objectives. In principle we cannot rule out this eventuality.

Table 1 **Average effective value of X for 1990/91 - 1995/96**	
Official Price control	6.6%
All residential customers	4.2%
First 80% of residential customers	2.7%
Top 20% high spending residential customers	5.7%
All business customers	9.3%
Source: Oftel, 1997	

Table 2			
Average quarterly spend per customer before VAT (1994/95)			
Residential customers	*calls*	*rental*	*total*
first 80% (moderate use)	£22 (51%)	£21 (49%)	£43 (100%)
remaining 20% (high use)	£106 (83%)	£21 (17%)	£127 (100%)
total	£38.8 (65%)	£21 (35%)	£59.8 (100%)
Source: Oftel, 1997			

Table 3			
	Type A	Type $\overline{A}$	
Type B	$q_1^A \cap q_1^B$ =46 $q_2^A \cap q_2^B$ =290	$q_1^{\overline{A}} \cap q_1^B$ =4 $q_2^{\overline{A}} \cap q_2^B$ =190	q_1^B =50 q_2^B =480
Type $\overline{B}$	$q_1^A \cap q_1^{\overline{B}}$ =47 $q_1^A \cap q_2^{\overline{B}}$ =480	$q_1^{\overline{A}} \cap q_1^{\overline{B}}$ =3 $q_2^{\overline{A}} \cap q_2^{\overline{B}}$ =140	$q_1^{\overline{B}}$ =50 $q_2^{\overline{B}}$ =520
	q_1^A =93 q_2^A =670	$q_1^{\overline{A}}$ =7 $q_2^{\overline{A}}$ =330	q_1^{t-1} =100 q_2^{t-1}=1000

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