# Pricing and Price Regulation in a Customer-Owned Monopoly *

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**Abstract**

In the first part of the paper we study the pricing policies of a customer-owned firm in the absence of external regulation. The profit-sharing rule turns out to be a key element of the price choice. The analysis focuses on the uniform and the proportional rules, and the main result is that the self-discipline effect generally ensures the dominance of customer-ownership over investor-ownership in welfare terms, though in neither case it is enough to attain the first-best in equilibrium. Therefore price regulation is needed for customer-owned firms too. In the second part we address this topic and the basic finding is that price regulation is affected by the ownership mode and the optimal regulatory policies for investor-owned service providers are not optimal for customer-owned ones. Moreover, regulation outcomes depend on the sharing rule too. The paper closes with a few results on the optimal regulatory design for customer-owned firms.

**Key words**: Customer ownership, public utilities, regulation, sharing rules
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# 1 Introduction

In many western countries most public utilities–and in some countries public services at large–were government-owned for a large part of the 20th century, while the rest were generally operated by investor-owned firms, usually tied to governments through a variety of arrangements (cf. e.g. Millward, 2005, on the historical evolution of a few public utilities in Europe). In the interstices of this bi-partite framework there stood cooperative providers of public utilities as an exception to the rule. By far the largest number of them were, and are still active in the electricity and water sectors, but a few are found in others too, from telecommunications to natural gas supply and community heating (see Mori, 2013, for an overview). Some operate in monopoly markets, like water cooperatives and the historical electric cooperatives e.g. in the USA and Italy, others in oligopoly markets, like e.g. the newest electric cooperatives which produce power from renewable sources (solar, wind, etc.). Most of them are customer-owned (again the historical electric cooperatives in the USA and Italy are relevant examples).

Utility cooperatives have a long history, the first of them appearing in the electricity sector at the end of the 19th century (cf. Mori, 2013). After a promising start, they have lagged behind the two alternative organizational forms and today their weight, though growing, is modest all over the world (with the conspicuous exception of the USA, where electric cooperatives are the major providers in rural areas with several million customers, NRECA, 2005). In spite of this, the current difficulties of privatization make customer-ownership's perspectives more favourable now than in the past. In few words, on the one hand, government investments in public utilities are hindered in many countries–notably European ones–by a severe public finance crisis (cf. Abrardi et al., 2014). On the other, the option of contracting out services or selling public enterprises to investors bringing fresh capital into the sector is meeting with a growing opposition by citizens worldwide. The reasons for this are various but rate rises, which followed privatization in many cases, have certainly played a prominent role (Hall et al., 2005, Checchi et al., 2009, Bonnet et al., 2011). In some countries the crisis of privatization policies has turned into a deadlock. Italy is an emblematic example in this regard. An overwhelming poll against the privatization of water services in a 2011 referendum has stopped investments in the sector and virtually blocked reforms of local public utilities in the country.

In this overall picture new interest is growing in the option of customer-ownership as a means to bring fresh capital to the public services sector without arousing citizen opposition. In the early 2000's, following the failed privatization of Welsh wa-

ter services, a policy debate developed in the UK about alternatives to the classical privatization centred on the delegation of provision to investor-owned operators, among which a prominent place is held by customer-ownership. Its advocates argue that this would be capable of overcoming the flaws of for-profit firms in the operation of public utilities on several planes, especially rates. The assumption is that price-fixing by the very people who pay for the service would make for satisfactory outcomes for themselves, thereby reducing the scope of price regulation (Kay, 1996; Birchall, 2002). Some even contend that customer-ownership would make price regulation altogether unnecessary (Morse, 2000, Maltby, 2004). These claims, however, though appealing on the intuitive plane, lack firm theoretical or empirical foundations. Bennet, et al. (2003) and Bennet and Jossa (2010) discuss the same issues more formally but their focus is on idiosyncratic investments and the allocation of residual control rights. Hansmann (1996) addresses the efficiency comparison between customer-ownership and investor-ownership of public utilities in an extensive way. His main conclusion is that in natural monopoly customer-ownership may dominate the for-profit solution since it would avoid the exploitation of consumers and the costs of regulation typical of the latter. Again, these suggestions have no clear theoretical or empirical basis and, intuitively appealing though they appear, are actually no more than working hypotheses to be probed. New theoretical work is then needed to assess if and in which conditions the customer-ownership of public utilities indeed leads to better pricing policies than the alternatives, and hence can be a real candidate for future privatization projects.

In this paper we make a first move in this direction. The object is the comparison between customer-ownership and investor-ownership of a monopoly public service/utility with a special focus on pricing and price regulation. The first problem we encounter is how to model the former. A customer-owned cooperative is a particular form of enterprise where customer-members hold equal decision-making power, i.e. decisions are taken by the majority rule, and moreover are the ultimate recipients of profits. Our model of customer-owned cooperative builds on Hart and Moore (1996) and is also related to the earlier literature on consumer cooperatives (we refer to the "Historical note" at the end of section 3 for a detailed review). As in Hart and Moore (1996) we include pricing policies among the decisions that the cooperative's members take directly. An alternative way of modelling collective action in a cooperative is to assume that members appoint a board of directors and leave strategic decisions to them under appropriate incentives (a sort of "managerial cooperative"). If in certain circumstances this model may be appropriate (see e.g. Bubb and Kaufmann, 2013), here it is not, since pric-

ing is one of the most important decisions to the customers of a public utility and their attention is likely to be highest on this issue. In our model we follow Hart and Moore in assuming that the cooperative's pricing policy is chosen by members through direct voting. As a matter of fact, even if actual ballots were not held on this issue and the decision were left to managers, a sensible management would probably try to conform to the median voter's will, since this member shall in due course decide on their confirmation (a similar argument is used by Peltzman, 1971, in modelling the managers of a government firm). Another feature that is common with Hart and Moore's model is that we limit the analysis to the case where all customers are members too.

Our focus, however, is different. The first aim we pursue is to establish the basic conditions for the adoption of price regulation by external authorities. To this end, in section 3 we make a direct comparison between the pricing policies under the two alternative ownership modes–for-profit and cooperative– *without* regulation. As it turns out, a crucial role in pricing is played by profit sharing rules. Differently from the standard case, if the service operator is a customer-owned cooperative, consumption choices, the voting process (on pricing policies), and external regulation are all affected by the way profits are distributed among customers themselves. In line with the early literature on consumer cooperatives (see the "Historical note" quoted above), here we allow for two of the most common sharing rules–the uniform and the proportional rule–that, as we will see, also have a special meaning for regulatory policy.

The main economic difference between investor- and customer-ownership is that customers obtain a surplus from trade with the cooperative, while investors take advantage from profits only. This fact has a positive impact on the cooperative's prices, which turn out generally lower than standard monopoly prices, thanks to a *self-discipline effect*. However, without regulation even a cooperative will generally not choose the first-best price, essentially owing to the democratic process in the presence preference heterogeneity. Under the uniform sharing rule the democratic process will generally not lead to the first best and the distance from it will be larger, the larger the asymmetry among customer preferences. By contrast, under the proportional rule, the distortion does not depend on asymmetries in member preferences but on the amount of fixed costs. Under this rule fixed costs are shared in proportion to individual consumption. Then the larger fixed costs are, the stronger the incentive for members to reduce consumption in order to reduce their share of fixed costs, and the larger the welfare loss. To sum up, it is true, as is claimed by its advocates, that in the absence of regulation customer-ownership allows to attain a higher social welfare than investor-ownership. How-

ever, the self-discipline effect typical of the former is usually not strong enough to bring about the first best, whereby the claim that external price regulation can be satisfactorily replaced by so-called "self-regulation"–that is, unfettered price setting by the community of customers–turns out not true. The conclusion is that a price regulation of customer-owned cooperatives is generally desirable, even in the best of all worlds for "self-regulation", that is in the absence of non-member patrons.

If there is a need for regulation, the baseline question is of what kind it must be. So far customer-owned monopolies have been ignored by the theoretical literature on price regulation and by regulatory practice too. As a matter of fact, regulators/legislators around the world have generally failed to recognize them as a category apart for regulatory purposes and tend to assimilate them either to government firms, as is the case with electric cooperatives in most US states, or to for-profit providers, as occurs in Italy for the same category of cooperatives. In the former case they are in fact treated like municipally-owned firms and are exempted from third-party price regulation; in the latter, they are instead subject to it and in the same way as for-profit providers. Ad-hoc policies are instead altogether missing from regulatory practice. In light of this, an interesting research objective is to understand how firm ownership affects the price regulation of monopoly.

This task is eminently comparative. Is a regulated customer-owned cooperative capable of attaining better outcomes in social welfare terms than a regulated traditional for- profit operator? In other words, can price regulation be more effective in the presence of a cooperative firm than a for-profit one? This topic is novel and here we take the first steps starting from a virtually virgin soil. In consideration of this, we do not address the main question directly but we limit ourselves to a few narrower questions with a view to preparing the ground for future research. The first question to ask is, of course, if rules designed for the profit-maximizing monopolist can be applied satisfactorily to customer-owned cooperatives operating in the same circumstances. A few insights into this are obtained in section 4 by a simple exercise within a regulatory environment inspired by the seminal work of Baron and Myerson (1982). By applying the optimal two-part tariff for the classic monopolist to a customer-owned cooperative we discover that the outcome is strictly dependent on the profit sharing rule, which affects the price choice and in turn the regulatory process as well. The uniform and the proportional rules are not only the most common such rules but are also especially interesting from the viewpoint of regulatory theory, since they are the limit cases in which two-part tariffs reduce to a single dimension. As a matter of fact, under the uniform rule any two-part tariff reduces to a linear tariff and the outcome is the same as in the

absence of regulation, whereby the for-profit optimal tariff is wholly ineffective if applied to the cooperative. A first conclusion is then that ownership does matter and that ad-hoc rules are generally needed for cooperatives. A further point is that the regulator can exploit the special nature of the cooperative to implement simple mechanisms that would not be effective with a for-profit operator. In particular, we show that the combination of the proportional sharing rule and a suitable choice of the fixed part of the tariff is capable to approximate the first best and in some relevant cases even to implement it exactly. The cooperative's decision-making process is typically political, since conflicting interests arising from heterogeneous preferences are to be composed through collective choice mechanisms like the majority rule. If we allow for this fact in analyzing the cooperative, we must be prepared to allow for similar considerations with regard to the regulator. In the economics literature on the optimal design of regulation the regulator is generally represented as benevolent, i.e. as a public agency that furthers the social welfare. At a closer look, however, this is a political subject too and, as such, is affected by special interests, which she is to compose in some way. Appropriate consideration of this aspect cannot then be avoided in the comparison of ownership modes. This perspective opens a further research direction that is discussed in the last part of the section.

The paper is organized as follows. After setting out the model in section 2, in section 3 we make a welfare comparison of the pricing policies by an investor-owned and a customer-owned firm under the uniform (sec. 3.1) and the proportional rules (sec. 3.2). Section 4 is devoted to discussing the main issues and working out a few preliminary results about the price regulation of customer-owned cooperatives.

# 2 The model

We study a natural monopoly market for a public service where just one firm is present on the supply side at any time (e.g. because of legal barriers to entry). The production technology is characterized by a constant marginal costs $c$,[1] whereby

[1]This hypothesis is common in the literature on the regulation of monopoly (see e.g. Baron and Myerson, 1982, and the ensuing literature on optimal regulatory design) and is usually an innocuous simplification. Some of the results we will obtain, however, do not extend to variable marginal costs and in these cases the assumption becomes restrictive. We shall signal where this occurs.

the total cost is given by

$$C(x) = F + cx, \tag{1}$$

where $x$ it the total output and $F$ the fixed cost. Let $p, p \geq 0$, be the unit price charged by the monopolistic firm. The firm's profits are then equal to

$$\pi = (p - c)x - F. \tag{2}$$

On the demand side, there are $n$ individuals who consume the service and a composite bundle of other goods, whose consumptions are denoted respectively $x_i$, $y_i$, $i = 1, \ldots, n$. Their utility function is given by

$$u_i(x_i, y_i) = ax_i - \frac{x_i^2}{2\theta_i} + y_i, \tag{3}$$

$a > c \geq 0$, $\theta_i \in [\underline{\theta}, \overline{\theta}], \underline{\theta} > 0$. Parameters $\theta_i$, which differentiate the willingness to pay for the service across consumers, are distributed according to the function $G(\theta)$. We define $\Theta = \sum_{i=1}^{n} \theta_i$.

The budget constraint of each individual requires that his total expenditure be not larger than his income level, i.e.

$$px_i + y_i \leq M_i, \tag{4}$$

where $M_i$ is the income of individual $i$ (the price of the composite good $y$ is normalized to 1). By taking account of (4) as an equality (since preferences are strictly increasing), it is expedient to rewrite the individual utility function as follows

$$u_i(x_i) = ax_i - \frac{x_i^2}{2\theta_i} - px_i + M_i. \tag{5}$$

In this paper we study two modes of firm ownership, ownership by shareholders external to the community of consumers, i.e. *investor-ownership*, and ownership by its customers, i.e. *customer-ownership*. To simplify, we restrict the analysis to the case where all customers are members of the cooperative (non-member patronage is ruled out). The ultimate difference between a for-profit firm and a cooperative is that in the latter customers share in the profits/losses of the firm according to some sharing rule. Formally, in the former case customer income is equal to an exogenous amount, $M_i{}^{\circ}$, which also represents the customer status quo. In the latter, instead, the customer income $M_i$ is endogenous since it includes the individual share of the firm's profits–positive or negative–too. The individual income is then generally defined as

$$M_i = M_i{}^{\circ} + \gamma f_i(\pi), \tag{6}$$

where $\gamma$ is a dummy variable with values $0$, if the firm is investor-owned, and $1$, if the firm is a customer-owned cooperative, and $f_i(\pi)$, $\sum_i f_i(\pi) = \pi$, is the share of profits[2] $\pi$ to member $i$. Sharing rules $(f_1(\pi), \ldots, f_n(\pi))$ can take the most diverse forms but here we focus on two of the most common specifications, the uniform, $f_i(\pi) = \pi/n$, and the proportional rule, $f_i(\pi) = \pi x_i/x$ (we refer to section 3 for a discussion).

Two words on the institutional nature of the customer-owned cooperative we deal with here. There are many types of cooperatives and many meanings attached to the term. Here we simply mean a firm that is owned and controlled in a democratic way by its members. By the principle of open membership–which is almost universally applied, though in many different ways from a practical standpoint– everyone who wishes to join or leave a cooperative is free to do so. We assume this too, which, together with the assumption that non-member patronage is not allowed (see above), implies that to enjoy the service the prospective customer must join the cooperative. Conversely, if she decides not to consume, she may quit the cooperative without cost. In fact, by the previous assumptions the choice not to become a member here amounts to the choice of not consuming the service at all. As we will see in due course, this may indeed be the case when the cooperative's pricing policy generates losses whose individual shares are larger than the maximum surplus customer-members can obtain from consumption.[3] These sparse remarks are already enough to realize that individual demands $x_i(p)$ are influenced by the ownership mode and, in the case of a cooperative service provider, by the profit-sharing rule as well.

# 3 The pricing policies of unregulated customer-owned cooperatives in monopoly

A claim put forth by some advocates of the customer-ownership of public utilities is that it would allow to replace price regulation by public authorities with "self-regulation", thus avoiding the well-known pitfalls and costs of third-party regulation (cf. the Introduction). Is this true? To answer the question, we first need

[2]Note that this term here includes losses as well.

[3]As a matter of fact, a basic difference between government enterprises and a cooperative firms is voluntary participation to losses. The former are backed by government's taxing power and citizens cannot ultimately escape taking part in the operating losses when they materialize. This is not true of a cooperative where membership is voluntary.

to know the pricing behaviour of unregulated customer-owned cooperatives running a public utility and how this compares with an investor-owned firm's. Some research was made in the past on the price policies of consumer cooperatives but that referred to markets rather distant from public utilities (we will come back to this later, see the "Historical note" at the end of this section) and in fact very little is presently known on the topic of direct interest to us, namely the pricing policies of large cooperatives operating in monopoly markets and what differentiates them from ordinary monopolists. To fill the gap, this section is devoted to the analysis of this problem.

The textbook for-profit monopolist is the benchmark with which we compare the customer-owned monopolist. In order to make reading easier, we start by recalling a few basic results about the standard undifferentiated monopoly, appropriately translated to fit our context. An individual consumer's demand is derived in the usual way from (5) and is given by

$$x_i^I(p) = \theta_i(a - p). \tag{7}$$

Accordingly, the aggregate demand function is

$$x^I(p) = \Theta(a - p). \tag{8}$$

In the usual way we can also derive the optimal (undifferentiated) price for an investor-owned monopolist

$$p^I = \frac{a + c}{2} \tag{9}$$

and the corresponding profits

$$\pi^I = \Theta \left( \frac{a - c}{2} \right)^2 - F. \tag{10}$$

To stay in the market, of course, the for-profit firm must earn positive profits in equilibrium (monopoly price larger than average cost), i.e.

$$\Theta \left( \frac{a - c}{2} \right)^2 > F.$$

and this is the meaningful case, on which we focus. In these conditions the budget-balancing supply $x^{Av}$ is such that $x^I < x^{Av}$.

The comparison between customer and investor-ownership is here made on the basis of a utilitarian social welfare function, i.e. the unweighted sum of consumer and producer surpluses,[4] i.e.

$$W = \sum_{i=1}^{n} u_i = \sum_{i=1}^{n} \left( ax_i - \frac{x_i^2}{2\theta_i} + M_i^{\circ} \right) - cx(p) - F. \tag{11}$$

Under this formulation any dollar accruing to firms has the same social value as a dollar accruing to consumers. Note that within the class of consumer-minded social welfare functions this is a specification especially favourable to producers as opposed to consumers, and hence to investor-ownership. Its advantage is that it simplifies the analysis without spoiling the conclusions, since the cooperative firm's dominance results that hold under it would not cease to hold and would be even reinforced, were the social planner to assign more weight to consumers. In this context the first best is simply characterized as follows:[5]

$$p^{FB} = c, x^{FB} = \Theta(a - c).$$

In a cooperative the individual choice problem is not the same as in the classic monopoly analysis, since consumers are also members of the cooperative and in that role they participate in the distribution of the profits generated from trade with themselves. This means that members' individual income now includes a profit share.[6] As we will see, individual choices depend on the sharing rule that is adopted. In a cooperative there are two collective choices to be made, the first concerning the sharing rule–which bears on the "constitutional" plane–and the other concerning the price to be charged. In the following analysis we eskew the former and focus on the latter. More precisely, we analyze the price choice under the uniform and the proportional rule taken as given institutional features. In this scenario consumers first vote on a price and then each of them decides how much to consume given the previous decision. With both rules the analysis follows the standard backward induction methodology: for any sharing rule we first derive the individual optimal choice at the consumption stage for each price, then we identify his preferred price at the voting stage. The equilibrium price is determined under

[4]Note that, if producers are customer-owned, customers and producers coincide, profits are already included in consumer utility.

[5]In case of an investor-owned firm the monopolist must receive a fixed fee set in order to guarantee the nonnegative profit constraint: $T = F$. Formal proofs are straightforward.

[6]The legal form it takes–whether patronage dividend or stock dividend, or other–is immaterial in the present context.

the majority rule by the median voter's choice (a similar application of the median voter theorem is made by Hart and Moore, 1996).[7]

## 3.1 Uniform sharing rule

Under the uniform profit-sharing rule the individual consumer's income includes the profit share $\pi/n$. By replacing this term into equation (6) and taking account of equation (5) the consumer maximization objective at the consumption stage can be rewritten as follows

$$U_i(x_i) = ax_i - \frac{x_i^2}{2\theta_i} - px_i + M_i^\circ + \frac{(p-c)(x_i + x_{-i}) - F}{n}. \tag{12}$$

From the first order condition we obtain the individual demand at an internal optimum

$$x_i(p) = \theta_i \left[ a - p + \frac{p-c}{n} \right]. \tag{13}$$

Corner equilibria, however, are possible too, if members can withdraw at will and costlessly from the cooperative–as is usually the case under the "open membership" rule (see section 2)–and zero consumption is a feasible choice for individuals (i.e. the good is not vital), as we assume here. Indeed, in these circumstances consumption will be zero whenever profits are negative and the individual share of losses higher than the consumer surplus. All this is summarized in the following lemma.

**Lemma 1.** *Under the uniform sharing rule individual demand functions are given by*

$$x_i^{CU}(p) = \begin{cases} \theta_i \left[ a - p + \dfrac{p-c}{n} \right] & \text{if} \quad U_i(x_i(p)) \geq M_i^\circ \\ 0 & \text{if} \quad U_i(x_i(p)) < M_i^\circ \end{cases} \tag{14}$$

In the following analysis we take into account only tangency equilibria. That is, we focus on equilibrium prices such that the consumption identified by (13) meets the individual participation constraint for all $i$. Given the increasing monotonicity of individual utility in $\theta_i$, this requires that the equilibrium price satisfy the following inequality

[7] As a matter of fact, a cooperative has much in common with political entities like governments and legislatures with regard to the collective decision-making process. The implications of this are discussed in the last part of section 4.

$$\underline{\theta}_i \frac{\left(a - p + \frac{p-c}{n}\right)^2}{2} + \frac{(p-c)(\Theta - \underline{\theta}_i)\left(a - p + \frac{p-c}{n}\right) - F}{n} \geq 0, \qquad (15)$$

which follows from equation (12), appropriately re-arranged.

Note that, when the price charged by the firm is higher (lower) than the marginal costs, individual demands are larger (smaller) than in the case where they are not members (cf. equations (7) and (14)) and this distortion is inversely related to the number of members. This effect occurs because customer $i$ pays the gross price $p$ but, being a member of the cooperative, also gets back $(p-c)/n$ for the marginal unit of the good. Therefore the net marginal price to member $i$ is equal to $p - (p-c)/n$.

The aggregate demand function follows straightaway from equation (14) and is given by

$$x^{CU}(p) = \Theta \left[ a - p + \frac{p-c}{n} \right]. \qquad (16)$$

Every customer-member will have an own preferred price for any set of parameters that can be derived from the maximization of the indirect utility function

$$\max_p \left[ a x_i(p) - \frac{[x_i(p)]^2}{2\theta_i} - p x_i(p) + M_i{}^{\circ} + \frac{(p-c)x(p) - F}{n} \right], \qquad (17)$$

subject to $p \geq 0$.

By taking account of (14) and (16), we get the first-order condition of the unconstrained problem

$$\left[ a - p + \frac{p-c}{n} \right] \left( \bar{\theta} - \theta_i \right) - \frac{p-c}{n} \frac{n-1}{n} (\Theta - \theta_i) = 0. \qquad (18)$$

where $\bar{\theta} = \Theta/n$ is the average consumers' preference.

**Lemma 2.** *Under the uniform sharing rule:*

1. *each member's indirect utility is single-peaked in the price;*
2. *each member has a preferred $p_i^*$ that depends on $\theta_i$ in the following way:*

$$p_i^*(\theta_i) = \begin{cases} \dfrac{na(\Theta - n\theta_i) + c[(n-2)\Theta + \theta_i]}{(n-1)[2\Theta - (n+1)\theta_i]} & \text{if} \quad \theta_i \leq \Theta \dfrac{na + (n-2)c}{n^2 a - c} \\ 0 & \text{if} \quad \theta_i \geq \Theta \dfrac{na + (n-2)c}{n^2 a - c} \end{cases} \qquad (19)$$

3. *$p_i^*(\theta_i)$ is monotonically decreasing in $\theta_i$;*

4. *if $\theta_i \gtreqless \bar{\theta}$ then $p_i^*(\theta_i) \lesseqgtr c$.*

**Proof.** See the Appendix.

The first property states that members' preferences have a global maximum in $p$ and the second one identifies each member's preferred price. The third property says that consumers with a higher demand prefer lower prices. Finally, the last property states that if a consumer's demand is weakly higher (lower) than the average demand, then his preferred price is weakly lower (higher) than the marginal cost. Therefore, the "average" consumer prefers, and votes for, the first-best price.

**Proposition 1.** *Let $\hat{\theta}$ be the median value of $G(\theta)$. Then under the uniform sharing rule a customer-owned firm sets a price equal to:*

$$p^{CU} = \begin{cases} \dfrac{na(\Theta - n\hat{\theta}) + c[(n-2)\Theta + \hat{\theta}]}{(n-1)[2\Theta - (n+1)\hat{\theta}]} & \text{if} \quad \hat{\theta} \leq \Theta\dfrac{na + (n-2)c}{n^2a - c} \\ 0 & \text{if} \quad \hat{\theta} \geq \Theta\dfrac{na + (n-2)c}{n^2a - c} \end{cases} \tag{20}$$

The proof of the Proposition is straightforward. The first property of the Lemma 2 ensures that the median voter theorem (Black, 1948) is applicable to our context. By the third property–monotonicity of the preferred price in $\theta_i$–the median voter coincides with the "median" consumer. As a result, the implemented price coincides with the median consumer's preferred price, which is obtained by replacing $\theta_i$ with $\hat{\theta}_i$ in equation (19).

**Corollary 1.** *Under the uniform sharing rule a customer-owned firm implements the first best price if and only if preferences of the median and the average consumer coincide.*[8]

The Corollary follows immediately from Proposition 1 and property 4 of Lemma 2. It says that the equality between the implemented price and the marginal cost occurs only in one specific case. This is essentially a negative result, since the ideal allocation which ensures the highest global consumer satisfaction is generally not attained, and it is enough to confute the naive equation–sometimes vented in the policy and advocacy literature–"price control by customers equal to zero

[8] Note that this property holds with variable marginal costs too. Bowen (1943) finds that under the uniform rule with symmetric voter preferences the allocation of a public good under the uniform cost-sharing rule is efficient (see the historical note at the end of this section).

distortions". It is true that under customer-ownership the implemented price conforms to consumer preferences and is set in their interest, but exactly whose preferences and in whose interest?

The reason why a consumer-controlled firm does not generally implement the policy that would most benefit them collectively is to be sought in *preference heterogeneity*. When consumers are all equal, there is obviously no point in realizing profits to be subsequently paid back to themselves and they all will agree on the price that maximizes their consumer surplus, i.e. equal to the marginal cost. In other words, their only benefit consists in consumption. By contrast, when the willingness to pay varies across member-customers, their interests diverge too and a new phenomenon may arise–the exploitation of the minority by the majority. This phenomenon has been previously noted in the literature (Ben-Ner, 1986) but so far it has not been analyzed formally.

Customers who consume less have a preference for profit-making prices with a view to sharing in the profits realized at the expense of those who consume more; conversely, those who consume more prefer loss-making prices with a view to making low-consumption members to pay for part of their service use. If the majority is of the former type the cooperative will make profits; if it is of the latter type, it will incur losses. We stress again that the exploitation phenomenon arises only when there are differences among member demands, i.e. individual preferences are asymmetric (no asymmetry in individual preferences, no exploitation; the weaker the asymmetry is, the closer the price adopted by the customer-owned firm is to the first best one). Apart from the loss-making strategy, which is never adopted by investor-owned firms, we see unexpected similarities between the two ownership modes here, since the exploitation of the minority by the majority much resembles the opportunism of for-profit monopolists that is contrasted by regulatory authorities (even strategic loss-making is just another way to exploit customers, much as standard monopoly rent-seeking is). As a matter of fact, opportunism is inherent to both. What differentiates them is the *self-discipline effect*.

To illustrate the point, consider the cooperative's members interested in implementing high prices, in order to reap profits from other members. These do act like the for-profit monopolist but not to the same degree and the reason is simple. Differently from investors, they are customers too and have to buy at the same prices as the members they exploit. Then, the negative impact of high prices on their consumer surplus counteracts the positive effect on profits, thus deterring them from pushing prices to the standard monopoly level. Of course, the lower the surplus effect, the closer the cooperative price will be to the monopoly level, but this can be reached only in the presence of zero demand by the median voter,

which is precluded in the conditions assumed here. The conclusion is that the customer-owned cooperative supports a strictly larger welfare than the for-profit one, as is stated in the following proposition (for the proof see the Appendix).

**Proposition 2.** *Under the uniform sharing rule there holds* $W^{CU} \geq W^{I}$ *for any* $G(\theta)$.

## 3.2 Proportional sharing rule

A popular way of distributing profits/losses is by the proportional sharing rule, which determines individual surplus shares in proportion to individual trade, i.e. $\pi x_i/x$.[9] Rules belonging to the class of "patronage dividend" schemes are in practice quite often specified like this or are variants of it. By replacing the above term into equation (5), the utility function becomes

$$U_i(x_i) = ax_i - \frac{x_i^2}{2\theta_i} + M_i^\circ - \left(c + \frac{F}{x}\right) x_i. \tag{21}$$

The most basic implication of the proportional sharing rule is the irrelevance of the nominal price $p$ for consumer choices. Indeed, under it the net price is always equal to the average production cost, independently of the nominal unit price (note that, differently from the uniform rule, the average price is equal for all members).[10] Therefore the choice of the nominal unit price by the cooperative is irrelevant (the voting outcome is actually indeterminate), since the net price is just determined by the traded quantities. The first order condition is[11]

$$a - \frac{x_i}{\theta_i} - c - \frac{F}{x}\left(1 - \frac{x_i}{x}\right) = 0, \quad \forall i = 1, \ldots, n. \tag{22}$$

The equilibrium at the consumption stage can be found by solving simultaneously the FOCs for all individuals. From equations (22) there follows the following Lemma (proof in the Appendix).

[9] Also known as the Rochdale rule, since the distribution of profits in proportion to trade was one of the main principles set by the Rochdale Pioneers, cf. Holyoake (1983).

[10] This fact was first noted by Enke (1945) and holds in the presence of variable marginal costs too.

[11] Note that we keep assuming that any individual finds it convenient to consume the good. This requires a vector $(\theta_1, \theta_2, \ldots, \theta_n)$ such that the average cost in equilibrium is below $a$, otherwise nobody will consume.

**Lemma 3.** *Under the proportional sharing rule individual and aggregate consumer demands are characterized by the following properties:*

1. *if* $F = 0$ *then:*
$$x_i^{CP} = \theta_i(a - c) = x_i^{FB}; \tag{23}$$
2. *if* $\theta_i > \theta_j \quad \Leftrightarrow \quad x_i^{CP} > x_j^{CP}$*;*
3. $x^{Av} \leq x^{CP} \leq x^{FB}$.

When $F = 0$, by property 1 each member's consumption is at the first best level, since equation (23) is just equation (7) for $p = c$ (when the fixed cost is $0$, members pay a net price equal to the marginal cost, whatever their level of consumption).[12] Property 2 states that in equilibrium individual consumption is higher, the higher their willingness to pay. Finally, the third property states that the aggregate consumption is comprised between the first and the second best consumptions, from which we get the following proposition (proof in the Appendix).

**Proposition 3.** *If the cooperative adopts the proportional sharing rule, then* $W^{CP} \geq W^I, \forall\, G(\theta)$.

We stress that, in a customer-owned firm, individual consumption choices depend on fixed costs under the proportional sharing rule. If they are zero, the first best is implemented in equilibrium. Instead, if they are positive, the first best is generally not attained but the aggregate consumption is comprised between the first and the second best. An implication of this fact is that under the proportional sharing rule a customer-owned firm always supports a higher social welfare than its unregulated investor-owned twin.

A couple of final remarks are in order. First, we have shown that customer-ownership is not sufficient for the attainment of the socially preferred or even customers' preferred outcome. As we have seen, neither sharing rule generally implements the first best, which is attained only in particular circumstances, specific to each of the two cases. Then, contrary to some naive claims circulating in policy debates (see Introduction), it is not true that the customer-ownership of a

[12] Bergstrom (1979) obtains an analogous implementation result for the first-best allocation of a public good with constant marginal costs, cf. the historical note at the end of this section (note that this result ceases to hold if marginal costs are variable, see the next section for a discussion of this case in a regulatory context).

monopoly makes external regulation redundant or less costly. Second, as it turns out, neither rule is dominant over the other, that is, neither is absolutely preferable in all circumstances. A natural question to ask is how dominance relations between them are characterized. We do not attempt to give an answer here but we note that under the uniform rule the first best is attained if member preferences are symmetric, independently of costs, whereas under the proportional rule it is attained if fixed costs are zero, irrespective of member preferences. Then, the intuition is that the socially preferred rule depends on the amount of fixed costs and the degree of asymmetry in member preferences.

A further issue, distinct from that of ordering sharing rules according to some welfare criterion, is the choice of the sharing rule by members. The constitutional process of a cooperative is a complex one, as is shown by the few contributions that have addressed it formally (for one see Zusman, 1992). One fact, however, is clear enough, that the cooperative's democratic process does not guarantee the adoption of the socially best rule. This can easily be seen by a simple argument. Consider the case $F = 0$, in which the proportional rule supports the first best. Then, if members choose the proportional rule, in this case they in fact choose the first-best outcome. However, the same outcome can be implemented in this special case by voting for the uniform rule and a price $p = c$. Since by Lemma 2-(4) the median voter generally prefers a different price, this implies a preference for the uniform rule over the proportional one. Therefore, in this case the median voter would vote for the uniform rule even though the proportional rule would allow to maximize the social welfare.

**Historical note** – Customer-owned utilities are just a special kind of consumer cooperatives and antecedents of our results are found in the theoretical literature on them. Though consumer cooperatives had been debated from different angles since the early 19$^{\text{th}}$ century, the first microeconomic analyses of them made their appearance much later. Perhaps the first to analyze their pricing policies and to contrast them to for-profit firms' were Enke (1945) and Yamey (1950). Both address the impact of the sharing rule on individual budget constraints and their analysis focuses on the proportional rule. Extensions of these models, addressing specific aspects such as membership size, non-member patronage, etc. were later made by Anderson et al. (1979), Sandler and Tschirhart (1981). Ireland and Law (1983) are the first to make a formal investigation of the uniform rule's impact on the behaviour of a consumer cooperative and to compare it with the proportional rule. The main differences between this literature and our paper regard the nature of the market and members' preferences. The previous papers refer implicitly

or explicitly to retail markets, where the single cooperative usually finds itself in competition with other firms, whether cooperative or for-profit. Here, instead, we deal with a public service provided in monopoly conditions. Then price regulation by public authorities becomes a relevant aspect of the comparison between customer-ownership and investor-ownership. The analysis of regulation in turn requires an appropriate comparative analysis of pricing policies under the different ownership modes. In this regard our paper differs from the old ones in that it allows explicitly for heterogeneous member preferences. All the previously quoted contributions touch, more or less superficially, on the theme of member heterogeneity and its impact on the consumer cooperative but none of them delves into the collective choice process within it. Here we have explicitly analyzed it by the majority rule model as e.g. in Hart and Moore (1996) (previous applications of the majority rule model to the cooperative context mostly concerned producer cooperatives, cf. Putterman, 1980; Putterman and DiGiorgio, 1985).
To complete the picture, we quote two contributions that, though applying the majority model rule to an apparently distant problem, in fact deal with issues that are substantially very close to ours: the sharing of costs instead of profits among voters. Bowen (1943) is the first to study the provision of a public good whose cost is to be distributed among citizens through taxes on an egalitarian basis–essentially by the uniform sharing rule applied to production costs–and whose quantity is decided by the majority rule. Bergstrom (1979) makes a more formal analysis of this problem and also extends it to the proportional rule (applied to wealth) too. The cost-sharing rule plays in these models the same role as the profit-sharing rule in ours, in that it affects each voter's preferred level of the public good and ultimately the final consumption and cost allocation, much as in a customer-owned cooperative. Results are similar too (see footnotes 8 and 12 above for more details). The main difference to our paper, apart from the nature of the good (private vs. public), is that our main concern is with the institutional nature of the business that produces the service, in particular we are interested in the comparison of the investor vs. customer-owned firm's performance–a problem that is absent in the public goods literature.

# 4 Price regulation and customer-ownership

In the previous section we compared the pricing policies of a monopolistic firm under two alternative ownership modes and found that in the absence of price regulation customer-ownership leads to less distorted prices than investor-ownership.

Public utilities run by unregulated for-profit firms, however, are uncommon in advanced economies and regulation usually improves social welfare. These improvements will rarely be maximal, since regulators are affected by information asymmetries about the production process that prevent the attainment of the first best. Nonetheless, the welfare gains brought about by regulation may be such that the regulated for-profit firm outperforms its twin unregulated customer-owned cooperative in welfare terms. The condition for this is that the cost of collective decision-making in the cooperative be larger than the cost of regulation under asymmetric information, which is more likely, the more heterogeneous member preferences and the lighter information asymmetries are.[13] This in itself, however, does not mean that customer ownership ceases to be dominant when regulation is brought into the picture. Indeed, cooperatives can be regulated too and may turn out to be the most efficient organization form under appropriate regulatory rules.

The idea that regulating cooperatives may be more effective than regulating for-profit firms finds support in what we have seen in the previous sections. As a matter of fact, there are two potential advantages of cooperatives over for-profits in this regard. First, in a non-discriminatory regime prices imposed on the minority are paid by the majority too and hence, on deciding them, they take account of their surplus and this generally has an alleviating effect on the exploitation of their monopoly power by the majority, as we have seen in section 3.1. Thus, as in the absence of regulation the self-discipline effect lets cooperatives perform better in social terms than their for-profit counterparts, it is likely that it enhances the effectiveness of the regulation of cooperatives too and allows a regulated cooperative to attain a larger social welfare than a regulated for-profit operator. Moreover, there is a customer information effect. A cooperative's member-customers have access to internal information, particularly about production costs, which is crucial for the regulatory process. As classic regulation theory emphasizes, a central issue for third-party price regulation is the information asymmetries that typically affect an external regulator. This information held by customers can be used to improve the regulatory process in favour of themselves and thus enhance their welfare even further. In conclusion, the correct comparison is not between regulated for-profit firms and unregulated cooperatives but between regulated firms of the two types and the assumption is that the advantages it enjoys may enable a cooperative to perform better than its for-profit twin even in a regulatory context. The task of theory is to establish the intensity of these advantages and in which conditions they are enough to make the cooperative dominate the for-profit firm. In a word,

[13] A numerical example can be obtained from the authors upon request.

what is needed is a comparative analysis of regulation under the two alternative ownership modes.

The existing literature is of little help in this regard. On the one hand, the large literature on the regulation of monopoly deals exclusively with for-profit firms and has nothing to say about cooperatives.[14] On the other, the economics of the cooperative firm mostly ignores the issue either. Hansmann (1996) for instance offers one of the most extensive theoretical treatments available but, apart from a few cursory remarks, essentially ignores the issue of price regulation.[15] Advocates of the cooperative solution usually hold either of two positions. Some of them, as we have already noted, claim that third-party regulation is unnecessary thanks to customer self-regulation replacing government regulation.[16] Others instead, though recognizing that some external regulation is needed, claim that it is less costly and more effective than with for-profit firms. For instance Birchall (2002, p. 167) insists that the cost of external regulation would be lower than for an investor-owned firm because customer ownership makes the regulatory process less adversarial.[17] These claims, however, do not rest on analytical foundations and are either false, like the former (we have already noted that an unregulated customer-owned firm may actually perform worse than a regulated investor-owned one), or require important qualifications, like the latter. For this there is needed a formal analysis of the regulation of customer-owned cooperatives.

There are two preliminary questions to address before setting to work. The first is under which conditions the price regulation of customer-owned cooperatives is actually useful. If there are no externalities and all customers are served by one customer-owned cooperative of which they are members, the social welfare coincides with the aggregate customer welfare. Moreover, if all customers

[14] A possible explanation of this fact is that worldwide the most relevant class of cooperatives operating public utilities has historically been that of US electric cooperatives, which are by and large exempt from price regulation (cf. Hansmann, 1996, p. 170).

[15] As a matter of fact, the cooperative organization of public utilities was discussed earlier too by authors like Vilfredo Pareto, Sydney and Beatrice Webb and others, but these contributions were sparse and unsystematic.

[16] See for example Maltby (2003), p. 49: "In the case of a Consumer Service Corporation, the users of the service operate effective control over the organization, eliminating the conflict between owners and users. In such circumstances there is no longer a role for traditional price regulation" (Consumer Service Corporation denotes here an organization similar to a customer-owned cooperative from the governance standpoint). A similar view is held by Morse (2000), p. 476: "Problems of asymmetric information do not occur when utilities are consumer cooperatives for they do not require price regulation".

[17] See also Kay (1996), p. 45.

are members of a monopolistic cooperative that provides a service to themselves and they are equal in tastes and income, it is pretty clear that they will vote unanimously for the price which maximizes the social welfare, if the sharing rule is the uniform one. Then, when they are to choose the sharing rule, by anticipating the final outcome, they will unanimously decide for the uniform one (no rule other than this is in fact needed). In these circumstances, price fixing by an external regulator can only do worse and therefore third-party's price regulation is not only unnecessary but even to be avoided. Outside this special case, however, it is not generally true that a regulated customer-owned provider of a public utility will attain the first best. To be more precise, when customer preferences are differentiated or some customers are not members, monopoly power is reduced relative to the investor-ownership case but not fully annihilated, and the members' majority will use it against the minority or non-member customers, to the effect that the first best will generally not be attained (cf. section 3). In these circumstances there opens up a space for the regulation of customer-owned cooperatives too. The second question is whether the optimal pricing rules for profit-maximizing firms are appropriate for customer-owned cooperatives too. Of course, if this is not the case, one must look for ad-hoc rules.

**Specific regulatory rules for customer-owned cooperatives**

Customer-owned cooperatives differ from for-profit firms in a number of respects. One of the most important for regulation is that the customers of a cooperative are also the ultimate recipients of the profits produced by it. The consequence of this is that the way cooperatives respond to regulation depends on how profits are distributed among them, i.e. on the profit-sharing rule.

To illustrate the point, let us try to transfer the regulatory rules optimal for the for-profit monopolist to a customer-owned cooperative in the conditions of what is perhaps the best-known model of price regulation in monopoly, that is Baron and Myerson (1982). In that environment the marginal cost $c$ is the (profit-maximizing) firm's private information and the regulator only knows the fixed costs $F$, which are assumed to be common knowledge. Information asymmetries about $c$ generally prevent the attainment of the social optimum, whenever there is a concern for welfare distribution and particularly the social planner has a bias in favour of consumers, as when the social welfare function is of the class

$$W = (CS - T) + \alpha\Pi, \alpha < 1,$$

($CS$ is the aggregate consumer surplus, $T$ is the sum of transfers from consumers

to producers, $\Pi$ is the producer surplus).[18] Note that that under this formulation the first best allocation remains that of the previous section (see equations (23)), though information asymmetries now prevent its attainment through regulation. However, as Baron and Myerson show, the second best–i.e. the optimal welfare subject to the incentive-compatibility constraints relative to the privately known variable–is attainable by adopting an appropriate two-part price $(p, T)$, where $\hat{c} \mapsto p$ is a unit-price function and $\hat{c} \mapsto T$ a fixed part function ($\hat{c}$ denotes a report on the marginal cost).

A simple practical procedure for the implementation of the mechanism, much used for analytical purposes, is the following. The regulator asks the firm to make a report $\hat{c}$ on its marginal cost and then she irrevocably sets the unit price and the fixed fee corresponding to that report, $(p(\hat{c}), T(\hat{c}))$. Now we apply this procedure to a customer-owned cooperative under a given profit-sharing rule. Apart from being the most common sharing rules, the uniform and the proportional ones are especially interesting from a theoretical standpoint since they represent two polar cases, under which, as we will see in a moment, two-part tariffs in fact reduce to a single-dimension tariff, more precisely to a linear pricing rule under the uniform and to a fixed fee rule under the proportional one. Let us focus now on the uniform rule. Given cooperatives' democratic governance, members are to vote by the majority rule on the cost level to be reported to the regulator. Once the report reaches the regulator, she proceeds in the same way as in the previous case. The individual member's utility under the uniform sharing rule is then

$$U_i\left(\theta_i, c, \hat{c}\right) = a\tilde{x}_i\left(\hat{c}\right) - \frac{\tilde{x}_i^2\left(\hat{c}\right)}{2\theta_i} - p\left(\hat{c}\right)\tilde{x}_i\left(\hat{c}\right) - \frac{T\left(\hat{c}\right)}{n} + \frac{\left(p\left(\hat{c}\right) - c\right)\tilde{x}\left(\hat{c}\right) + T\left(\hat{c}\right)}{n} \tag{24}$$

where $\tilde{x}_i\left(\hat{c}\right) = x_i(p\left(\hat{c}\right))$. The term $T(\hat{c})$ disappears from the equation, which means that under the uniform sharing rule members are actually indifferent to the fixed fee level. In other words, under this rule any mechanism $(p(\hat{c}), T(\hat{c}))$ reduces in fact to a linear tariff, $p(\hat{c})$ (cf. section 3.1). As a consequence, all members will vote for the cost report $\hat{c}$ associated to their own preferred unit price and under the majority rule this will lead to the adoption of the unit price preferred by the median member. In conclusion, the cooperative's behaviour will be just the same as in the complete absence of regulation. Note that the regulation ineffectiveness is here essentially due to the intrinsic linearity of the pricing rule under the uni-

[18] If $\alpha = 1$ as in the previous section, the Loeb-Magat solution of information asymmetry problem would be applicable and the maximum social surplus would be attained. We refer to Baron and Myerson (1982) and Baron (1989) for a full discussion of this point.

form sharing scheme, which is actually the cause of regulatory ineffectiveness in a broad class of environments and a variety of organizational forms, including for-profit firms.

The exercise makes it clear that ownership is generally not neutral for price regulation. As we have seen, it may occur that the (constrained) optimal mechanism for a for-profit firm, like the Baron-Myerson one, is wholly ineffective when applied to a cooperative. In other words, a regulatory mechanism that is optimal for a profit-maximizing firm is not generally so for a customer-owned cooperative and the rich array of regulatory instruments that can be successfully applied to the former are not applicable, as they stand, to the latter. Then, there are required ad-hoc designed rules.

The previous exercise provides further suggestions too. Whereas with profit-maximizing firms it is in most cases enough for the regulator to act only on prices, as e.g. in the Baron-Myerson environment (where, we recall, two-part prices are sufficient for constrained optimality), in the case of customer-owned cooperatives the regulator will have to meddle with the internal rules governing the relations among members, in particular the profit-sharing rule. Moreover, as is clearly shown by the previous argument, in order for price regulation to be effective it is necessary that the sharing rule differ from the uniform one (actually this is not the only tricky one and there are others unusable too).

**Simple mechanisms**

It is not the aim of this paper to develop a full-fledged analysis of the regulation of cooperatives but a further step can be made to illustrate a point of great interest: the relevance of *simple mechanisms* for the regulation of cooperatives. The theory of optimal regulation focuses on high-powered regulatory mechanisms capable to extract the highest possible social surplus in situations where constraints of various nature–especially informational–are at work. A drawback of sophisticated (Bayesian) price-fixing is that it requires a number of activities, such as collecting information, monitoring, etc., to be performed by a bureau that is costly (it requires an administrative apparatus) and potentially fallible (like any agent it is prone to pursue objectives other the community's welfare). Interest in simple mechanisms like e.g. price cap schemes has thus grown over time, though they are usually suboptimal. Simple mechanisms are especially interesting when customer-owned cooperatives are concerned, essentially for two reasons: customer-ownership may enhance the effectiveness of those used for for-profit firms, when applicable to cooperatives, and also enlarge the array of light

regulatory instruments available, since its nature–in particular the fact that owners are users as well–allows to employ some that are of no use at all with for-profit firms.[19] The next result illustrates the point.

Let us get back again to the Baron-Myerson environment, where the regulator is uncertain about the marginal cost but fully informed on the level of fixed costs. In the previous section we saw that, if the cooperative adopts the proportional sharing rule, the outcome coincides with the second best, i.e. the total consumption where the aggregate demand crosses the average cost curve. Then, if the marginal cost is constant, as assumed in the previous section, the regulator can implement the first best outcome just by forcing the cooperative firm to charge an individual fixed fee equal to $F/n$ and leaving it free to set the unit price (knowing that under the proportional sharing rule whatever nominal price reduces to a net actual price equal to average cost, see above section 3.2, whereby the only regulatory tool available is in this case the fixed fee). In such a case the fixed costs are covered by the fixed fee and each member demands exactly the quantity he would buy at the first-best price (see equation (23)). Note that the policy of forcing the cooperative to adopt the proportional sharing rule and to charge an aggregate fixed fee equal to the fixed costs is perfectly feasible within the Baron-Myerson environment, since it requires just the knowledge of fixed costs, whereas the optimal mechanism identified by Baron and Myerson (1982) for for-profit firms requires the regulator's knowledge of the aggregate demand function as well. Then, in addition to being less demanding on the informational plane, it is also more effective than the optimal regulation of a for-profit firm, in that it supports the first best.

To be sure, this strong dominance result is due to the particular conditions we have assumed here–in particular constancy of marginal costs– and does not carry over as such to other situations. However, weaker results may hold in more general environments. For instance, in the case of decreasing marginal costs[20] it is easy to check that the previous policy leads to outcomes strictly comprised between

[19]The idea that customer-owned cooperatives allow a light-handed regulation, differently from their for-profit counterparts, has been been put forth before in the literature (see e.g. Kay, 1996, p. 46: "The result would be a much more light-handed system of regulation than we currently have") but it is never said what this sort of regulation should consist in.

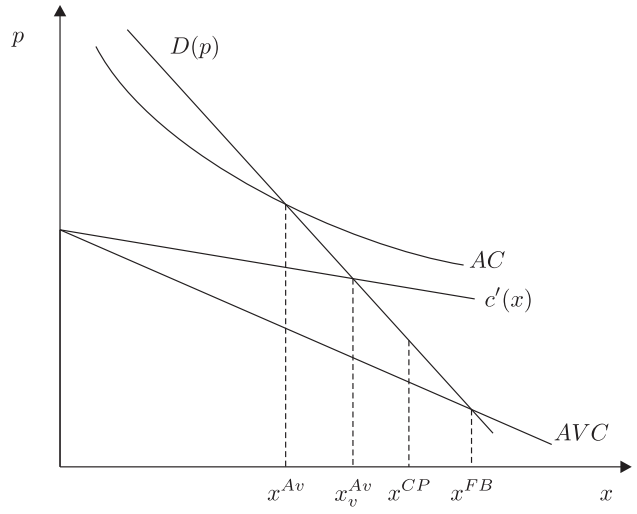
[20]Decreasing marginal costs are sufficient to ensure that the average costs are everywhere higher than marginal costs, that is one of the conditions of natural monopoly. However, it is possible to have a natural monopoly also with increasing marginal costs. In that case the regulatory rule $T = F$ continues to guarantee that the aggregate consumption is comprised between the quantity in which the demand function crosses the marginal cost function and the quantity at which it crosses the average variable cost, the only difference being that in this case the latter is at the right of the former.

the first best (where the aggregate demand function crosses the marginal cost) and the second best (where the aggregate demand function crosses the average cost function), as stated in the following proposition.

**Proposition 4.** *In the presence of a customer-owned firm with cost function* $C(x) = F + c(x)x$ *and adopting the proportional sharing rule, if* $c'(x) < 0$ *and* $T = F$ *then* $x^{Av} < x_v^{Av} < x^{CP} < x^{FB}$.

In other words, there exists a simple–"unsophisticated"–rule that, though generally not supporting the first best, allows to approximate it by a difference that depends on the variability of marginal costs and the distance between marginal and average variable costs (the less variable and the closer to average variable costs is marginal cost, the closer the final outcome will be to the first best).

Figure 1: Approximate implementation of the first best by a simple regulatory rule




A general conclusion that can be drawn from the previous discussion is that there do exist light forms of regulation effective with customer-owned cooperatives but of no avail at all with for-profit ones. The expectation is that, thanks to their participatory nature, the simple rules available for customer-owned cooperatives are more numerous and presumably more effective than those for investor-owned firms. Nonetheless, since the first best is generally not attained by them, there is no a priori presumption of global dominance–i.e. always and in all conditions–of regulated cooperatives over regulated profit-seeking firms, differently from

what is claimed by some of the most naive advocates of the customer-ownership of public utilities. Comparisons in terms of social welfare will then have to be made between regulatory schemes appropriate to the two ownership modes.

To be meaningful, these comparisons must be made on a level ground, i.e. in the same conditions. This principle has important implications. The first and most basic one is that, as we have noted, it is not meaningful to allow for regulation when for-profit firms are concerned and instead discard it a priori for cooperatives. Accordingly, it is not meaningful to compare a regulated operator of the first type and an unregulated one of the latter (unless institutional constraints make it impossible to have regulated firms of both types), since, as we have seen above, regulation is potentially welfare-improving for cooperatives as well. There is a further and more fundamental reason why that sort of comparison is not correct.

**The benevolent regulator and the politics of cooperatives**

Let us go back again to the Baron-Myerson mechanism for the price regulation of for-profit firms. Basic to that model–and the literature on mechanism design spawned by it–is the assumption of a benevolent regulator, as in the public interest theory of regulation/political action, of which it is actually part.[21] That theory is founded on assumptions analogous to the Coase theorem's, in particular the absence of transaction costs (cf. e.g. Noll, 1989). More precisely, assuming a welfare-maximizing regulator amounts to viewing the political negotiations leading to the definition of the regulator's objectives as perfectly frictionless, that is free of transaction costs among society's members. As a consequence, any deadweight welfare losses would be due only to the irreducible advantages enjoyed by producers thanks to information asymmetries.

Consider an unregulated customer-owned cooperative in such conditions. If the Coase theorem holds for the regulator's constituency (whereby the profit-maximizing objective is furthered), it must be assumed to hold for the body of the cooperatives' members too, which is just a subset of the former. The implications of this are straightforward. If the Coase theorem held, *both* the cooperative and the regulator would act in such a way as to maximize the social welfare. The two situations in fact would differ just in the amount of information held by the decision-maker. As owners, customer-members have direct access to the internal

[21] Baron and Myerson (1982) and the ensuing literature on the optimal regulation design under information asymmetries of various kinds belong to this theoretical approach and can indeed be viewed as an extension of the public interest theory allowing in a rigorous way for informational constraints to the pursuance of the social welfare objective by a benevolent regulator.

information, particularly on production costs, while the regulator does not and is uncertain about relevant aspects of it. For instance in Baron and Myerson's (1982) model the regulator is uncertain about marginal costs (fixed costs and market demand are instead assumed to be common knowledge in that model). Therefore, the shift from investor-ownership to customer-ownership essentially implies that variables that were private information to the producer–e.g. marginal costs–become private information to customers. Under complete information about production costs and in the absence of transaction costs members are then able to renegotiate prices and profit-sharing rules so as to maximize the social surplus and reach the first best (we are still assuming as before that all customers are members too, and therefore the only potential problem for efficiency is preference heterogeneity).

It is to be noted that cooperatives' internal rules are not an obstacle to this. If for instance the cooperative's by-laws provide for the distribution of profits according to the uniform rule, we know that the first best is generally not attained through the democratic process (cf. Lemma 2). That means that there exist a different price and different distribution of the surplus which would make *all* members better off, whereby in the absence of transaction costs they can adopt them just by unanimously vote a change in the initial contract (by-laws). Then, if there are no transaction costs, appropriate adjustments can and will be made so that a unanimous and efficient agreement is actually reached. In conclusion, under Coase's ideal conditions and customers' complete information about production cost, self-regulation would be enough for attaining the first best.[22]

By contrast, in the real world cooperatives are governed through the democratic process, which, as we have seen, normally entails inefficient outcomes. Then, there must be transaction costs that prevent the Coasian outcome. Transaction costs among citizen-customers have deep implications. The most obvious is, as we have already noted, that they call for government regulation of the cooperative. Moreover, the principle of level playing ground requires that, if we allow for transaction costs in modelling the customer-owned cooperative, we cannot ig-

[22]The conclusion would not change if customers' information about production costs were incomplete: there would just change the definition of first best. Democratic governance places all members in the same position before the cooperative and lets them have equal access to internal information. This means that, even if for whatever reason members do not have perfect information about the cooperative's operations, no information asymmetries are likely to arise among them. In these circumstances the first best output and distribution are those corresponding to the largest expected social surplus and members are still in a position to make all arrangements necessary to achieve them. By contrast, such an outcome is unattainable by a regulator under asymmetric information (at most he will be able to enforce the optimal regulatory scheme subject to the incentive constraints, as e.g. in Baron and Myerson, 1982).

nore them when dealing with the regulator of its for-profit counterpart. In other words, if we admit that the cooperative's political decision-making is imperfect due to transaction costs, and hence the Coasian solution is unattainable, we are bound to make a similar move on the side of the for-profit firm, i.e. to allow for the transaction costs affecting government regulation and the ensuing politics of the regulatory process.

As a matter of fact, it is now widely recognized both in the economics and the political science literature[23] that governments are imperfect in their action not only because of external constraints–informational and other–but also because they are subject to the pressure of special-interest groups and hence their aims do not generally coincide with the social welfare, which is a sign of transaction costs too. In light of this, models of regulated for-profit firms can no longer be based on the benevolent-regulator assumption.

In conclusion, when we allow for the regulation of profit-maximizing firms, we have to make a double move in order to meet the principle of level playing ground. On the one hand, we have to waive the benevolent-regulator framework and allow the political process (and relevant transaction costs) into the analysis both on the side of the regulator and on the side of the cooperative; on the other, we must introduce some sort of regulation for the cooperative. The real challenge from an analytical standpoint is to shift from the naïve view of the normative-as-positive theory (and the Coase theorem's assumptions underlying it) to more realistic models of regulation that make room for politics. The analysis of political decision-making thus becomes crucial for a proper assessment of the for-profit firm's and the cooperative's performance in social welfare terms. Ultimately, the question is: is the cooperative's internal politics better or worse than government politics? This topic is fundamental but cannot be further pursued here and is left to future research.

# 5 Conclusions

In this paper we make the first steps towards a theory of monopoly public utilities run by customer-owned firms. This organizational solution has been debated from a policy viewpoint but so far economic theory has essentially ignored it. We have shown that some of the claims that circulate in the policy debate are not warranted from a theoretical standpoint. In particular, it is not true that the

[23] As in the wide literature on the political economy of economic policy, see e.g. Acemoglu and Robinson (2013).

customer-ownership of a public utility is capable to solve at one touch all the flaws that typically affect the price regulation of for-profit firms. The main point is that "self-regulation" is generally not enough for an optimal outcome and hence must be buttressed by appropriate government regulation. It is nonetheless true that, once we extend price regulation to the customer-owned cooperative, this appears to have advantages over the for-profit firm and better outcomes may generally be attained through it. A few preliminary results we have presented in this paper support this view but further work is needed along the lines we have traced.

# Appendix

**Proof of Lemma 2**

1. The first-order condition for internal optima of the maximization problem (17) is

$$(a-p)\frac{dx_i}{dp} - x_i\left(1+\frac{dx_i}{dp}\frac{1}{\theta_i}\right) + \frac{x(p)}{n} + \frac{p-c}{n}\frac{dx}{dp} = 0.$$

From equation (14) we know that

$$\frac{dx_i}{dp} = -\theta_i\frac{(n-1)}{n}$$

that is

$$1+\frac{dx_i}{dp}\frac{1}{\theta_i} = 1/n.$$

Therefore, the second-order derivative of the utility function is equal to

$$\theta_i\frac{n-1}{n} + \frac{\theta_i}{n}\frac{n-1}{n} - \frac{\Theta}{n}\frac{n-1}{n} - \frac{\Theta}{n}\frac{n-1}{n}.$$

After straightforward simplifications we get

$$-\left[2\Theta - \theta_i(n+1)\right]\frac{n-1}{n^2}.$$

Therefore, the utility function of member $i$ is concave if

$$\frac{\theta_i}{\Theta} < \frac{2}{n+1},$$

and convex in the opposite case. However, when

$$\frac{\theta_i}{\Theta} > \frac{2}{n+1}$$

we can prove that the utility function has a minimum at $p_i^* > a$. Given that the utility of every member is $0$ at $p = a$, we can conclude that when the utility function is convex, it is also monotone decreasing in the interval $[0, a]$. Consequently, whatever the value of $\theta_i$, the utility function is single-peaked in $p$ in the interval $[0, a]$.

2. By solving equation (18) for $p$ we obtain the preferred price

$$p_i^* = \frac{na(\Theta - n\theta_i) + c[(n-2)\Theta + \theta_i]}{(n-1)[2\Theta - (n+1)\theta_i]}.$$

If

$$\theta_i \geq \Theta \frac{na + (n-2)c}{n^2 a - c}$$

the preferred price would be negative. This means that for such values of $\theta_i$ the first derivative is negative for any positive price and consequently such members would vote for a null price.

3. By deriving equation (19) with respect to $\theta_i$ we get (recalling $a > c$, cf. section 2)

$$\frac{\partial p_i^*}{\partial \theta_i} = -\frac{n(a-c)(\Theta - \theta_i)}{(2\Theta - (n+1)\theta_i)^2} < 0$$

4. In equation (18) the first and the second term have the same sign. Therefore, if $\theta_i \geq \bar{\theta}$, the first term is weakly negative and consequently $p$ must be weakly lower than $c$. The reverse is true whenever $\theta_i \leq \bar{\theta}$.

□

**Proof of Proposition 2**

In our simplified environment characterized by quadratic utility functions and linear marginal costs the social welfare is decreasing in the distance between the aggregate consumption in equilibrium and the aggregate consumption at the first-best price. With an investor-owned firm the aggregate consumption can be calculated from equation (9) and equation (8), whence we obtain

$$x^I(p^I) = \Theta \frac{a-c}{2}.$$

On the other hand, under a customer-owned firm adopting the uniform sharing rule, the aggregate consumption in equilibrium can be found by including equation[24] (1) in equation (16). By developing calculations and rearranging we obtain

$$x^{CU}(p^{CU}) = \Theta \frac{(\Theta - \hat{\theta})(a-c)}{2\Theta - (n+1)\hat{\theta}}. \tag{25}$$

[24] We neglect the case in which the median consumer has a value of $\theta$ such that its preferred price would be negative, i.e. the case in which $p^{CU} = 0$. Indeed, in such case the welfare loss would be reduced and so this case would favor the customer-owned firm with respect to the investor-owned firm.

It is easy to check that $x^{CU}(p^{CU})$ is monotone increasing in $\hat{\theta}$. We have two cases. When the median $\theta$ is lower than the average level, the welfare loss in the cooperative solution increases as $\hat{\theta}$ ($\hat{\theta} > 0$) approaches 0. Then the upper least bound on the social welfare is located at the limit point $\hat{\theta} = 0$ (which is never reached in our context, since $\theta_i > 0, \forall i$, see section 2). By replacing this value into equation (25) we obtain $x^{CU}(p^{CU}) = \Theta\frac{a-c}{2} = x^I(p^I)$. In practice, if the majority of members did not consume the good, then the pricing policy of such a cooperative would be the same as the for an investor-owned firm and the social welfare loss is identical in the two cases.

The other case is when the median consumer is higher than the average consumer, in which the social welfare loss is increasing in the value of $\hat{\theta}$. However, we prove below that if such value is constrained to respect condition (15), then the welfare loss cannot be higher under the customer-owned firm than under the investor-owned firm.

The social welfare loss is higher under a customer-owned firm if there holds $x^{CU} - x^{FB} \geq x^{FB} - x^I$. By

$$x^I = \Theta\frac{a-c}{2} \tag{26}$$

and $x^{FB} = \Theta(a-c)$ the previous condition can be rewritten as

$$x^{CU} \geq \Theta\frac{3(a-c)}{2}. \tag{27}$$

Moreover, by replacing $x^{CU}$ with the expression in equation (25) and then rearranging, we obtain the following condition

$$\hat{\theta} \geq \Theta\frac{4}{3n+1}. \tag{28}$$

This, however, cannot be satisfied without violating condition (15). Indeed, by replacing (20) into condition (15) and setting $F = 0$ (if the condition (15) does not hold in this case, it does not in the others as well) we obtain

$$2\Theta^2 + (n-3)\Theta\underline{\theta} - 2n\Theta\hat{\theta} + (n-1)\hat{\theta}\underline{\theta} > 0. \tag{29}$$

Moreover, for any $G(\theta)$, the value of $\underline{\theta}, \hat{\theta}$ and $\Theta$ must necessarily satisfy the following inequality

$$\Theta - \frac{(n-1)\underline{\theta}}{2} - \frac{(n+1)\hat{\theta}}{2} \geq 0. \tag{30}$$

Both inequalities (29) and (30) are monotone decreasing in $\hat{\theta}$ and consequently are both more easily satisfied for its lowest value. Then we can substitute to $\hat{\theta}$ the minimum value that satisfies inequality (28) in both inequalities (29) and (30). By developing and rearranging the first inequality we obtain

$$\underline{\theta} > \frac{2\Theta}{3n-1}, \tag{31}$$

while the second becomes

$$\underline{\theta} \leq \frac{2\Theta}{3n-1}. \tag{32}$$

Therefore we have shown that for any distribution $G(\theta)$ the constraint of condition (15) ensures that the welfare loss is always lower under a customer-owned firm than under an investor-owned firm.

□

**Proof of Lemma 3**

1. The first property follows directly from equation (22).

2. a) We first prove $\theta_i > \theta_j \quad \Rightarrow \quad x_i > x_j$. Assume to the contrary that $x_j > x_i$. Then there follows

$$x_j - x_i = (\theta_j - \theta_i)(a-c) + \frac{F}{x^2}[\theta_j(x-x_j) - \theta_i(x-x_i)] > 0.$$

Given that the first term is negative the above inequality implies $\theta_j(x-x_j) > \theta_i(x-x_i)$ but, if $\theta_i > \theta_j$ and $x_j > x_i$, the last inequality is false. Then there must be $x_i > x_j$.

2. b) ($x_i > x_j \quad \Rightarrow \quad \theta_i > \theta_j$) From $x_i > x_j$ there follows

$$x_i - x_j = (\theta_i - \theta_j)(a-c) + \frac{F}{x^2}[\theta_i(x-x_i) - \theta_j(x-x_j)] > 0.$$

Again, assume to the contrary $\theta_j > \theta_i$. The first term of the inequality would be negative and hence the second term should be positive. This requires $\theta_i(x-x_i) > \theta_j(x-x_j)$ but, if $\theta_j > \theta_i$ and $x_i > x_j$, this is impossible. Then, there must be $\theta_i > \theta_j$.

3. From equation (22) we get

$$x_i = \theta_i \left[ a - c - \frac{F}{x}\left(1 - \frac{x_i}{x}\right)\right], \quad \forall i = 1, \ldots, n. \tag{33}$$

By summing all (33) over $i$ we obtain

$$\sum_{i=1}^{n} x_i = x^{CP} = \Theta(a-c) - \frac{F}{x^2}\left(\Theta x - \sum_{i=1}^{n} \theta_i x_i\right).$$

Note that $x^{FB} = \Theta(a-c)$ and consequently $x^{CP} \leq x^{FB}$ because $\Theta x > \sum_{i=1}^{n} \theta_i x_i$. At the same time, by rearranging the previous equation we obtain

$$x^{CP} = \Theta\left(a - c - \frac{F}{x}\right) + \frac{F}{x^2}\left(\sum_{i=1}^{n} \theta_i x_i\right).$$

Given that $x^{Av} = \Theta\left(a - c - \frac{F}{x}\right)$ it follows that $x^{CP} \geq x^{Av}$.

□

**Proof of Proposition 3**

An investor-owned monopoly is sustainable only if the optimal monopolistic price is higher than the average cost, i.e. $x^I \leq x^{Av}$. By the third property of Lemma 3 there holds $x^{FB} \geq x^{CP} \geq x^{Av}$, and hence $x^{CP} \geq x^I$. Since the social welfare increases in the level of aggregate consumption when $x \leq x^{FB}$, this implies $W^{CP} \geq W^I$.

□

**Proof of Proposition 4**

Given the constraint $T = F$, with a cost function $C(x) = F + c(x)x$ the profit is $(p - c(x))x$. Therefore, under the proportional sharing rule each consumer chooses a consumption $x_i$ that maximizes the utility function written as follows

$$U_i(x_i) = ax_i - \frac{x_i^2}{2\theta_i} + M_i{}^{\circ} - c(x)x_i.$$

Internal optima must satisfy

$$\theta_i[a - c(x) - c'(x)x_i] - x_i = 0.$$

By summing these conditions over all consumers we obtain the aggregate demand function implicitly defined by

$$x^{CP} = \Theta[a - c(x)] - c'(x)\sum_{i=1}^{n} \theta_i x_i.$$

It is worth noting that in this context the first best allocation is defined implicitly by $x^{FB} = \Theta[a - c(x) - c'(x)x]$. Therefore

$$x^{FB} - x^{CP} = -c'(x) \left( \Theta x - \sum_{i=1}^{n} \theta_i x_i \right).$$

Given that $\Theta x > \sum_{i=1}^{n} \theta_i x_i$, if $c'(x) < 0$, the previous equation is positive, i.e. $x^{CP} < x^{FB}$, as stated in the proposition. At the same time, the aggregate consumption at the crossing between the average variable cost and the standard demand function is characterized by the condition $x_v^{Av} = \Theta[a - c(x)]$. Thus,

$$x^{CP} - x_v^{Av} = -c'(x) \sum_{i=1}^{n} \theta_i x_i.$$

If $c'(x) < 0$, the right-hand member of the equation is positive, i.e. $x_v^{Av} < x^{CP}$, as stated in the proposition. Finally, the second best, i.e. the aggregate consumption where the standard demand function crosses the average cost function is characterized by the condition $x^{Av} = \Theta\left(a - c(x) - F/x\right)$ , which implies $x_v^{Av} - x^{Av} = \Theta F/x > 0$ $x^{Av} < x_v^{Av}$, whatever the sign of $c'(x)$.

□

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