REGULATION STRATEGIES FOR PUBLIC SERVICE PROVISION

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Abstract

Public service provision is more and more oriented towards the reduction of vertical integration in its supply and the introduction of market logics in this sector. The aim of these reforms is to increase efficiency of the system and ultimately to improve welfare. However, the introduction of market logics in the provision of public services is problematic because in most cases the regulator has to determine the price or to reimburse the provider for the effort it makes without observing the cost, or without having a proper market mechanism that determines the price. Another important characteristic of public service provision is related to workers' motivation. In this paper we want to compare different ways to regulate the market in order to extract such a rent from the provider. In particular, we will compare hotelling competition on price and quality with several form of dutch, first price auctions for the market.

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1 Introduction

The working of the public sector is more and more oriented towards a reduction of vertical integration in the provision of public services and the introduction of forms of competition in their provision The actual process is quite variegated. In public transport, especially railways, a separation has been created between the provider of the rail itself and the companies that exploit it; in health care quasi markets have been introduced and in education new models of competition between public and private providers is sought.

The aim of these reforms is to increase efficiency of the system and ultimately to improve welfare.

However, the introduction of market logics in the provision of public services is quite troublesome because in most cases the regulator has to determine the price or to reimburse the provider for the effort it makes without observing the cost, or without having a proper market mechanism that determines the price. This causes some important failures in the working of these internal market, especially for health care. (Levaggi, 2004; Chalckley and Malcomson, 2000)

Another important characteristic of public service provision is related to workers' motivation. The literature (Francois, 2000;2001, Glazer, 2004) has shown that most of the public sector workers are devoted, i.e. they receive utility from their salary and the output they produce. In a vertically integrated structure such devoted aspect might allow to reduce the cost of provision of the service or its quality level, but when a separation exists between purchaser and provider the advantages of employing devoted workers might become a rent to the provider (Levaggi, Moretto, Rebba, 2005)

In this environment the workings of the market is quite different from a competitive structure and it is not clear whether the objectives can be reached.

Levaggi and Levaggi (2005) show that the use of a straight agency model is not an efficient instrument to extract the information rent from the provider, unless the benefits deriving from such a private information are proportional to the effort of the agent.

In order to make competition become an instrument to reduce expenditure, the regulator should use more sophisticated tools.

In this paper we want to compare different ways to regulate public services provision in order to extract such a rent from the provider. In particular, we will compare hotelling competition on price and quality with several form of dutch, first price auctions for the market.

2 The model

In the model presented here we abstract from any risk-sharing considerations, i.e. we assume that the cost of producing the service does not depend on the state of nature and that the basic technology is available to all the competitors.

The environment In a specific community n services are produced and are used by local and external user. Each service is demanded by s_i individuals, each of them normalised to one for simplicty. The number of services used by each individual is irrelevant for our analysis which focuses on regulatory issues.

The utility derived from the use of a service depends on the quality of such a product and the cost the consumer has to incur to use it:

$$U_{s_i} = \varphi_i q_i - c_i \qquad\qquad i = 1, n \qquad\qquad (1)$$

where c_i reflects several aspect relating to cost: it can be partly determined by the price (or a user charge) the consumer has to pay and on other private costs it has to incur (transport costs for example).

The services can be produced by two multiproduct firms (A and B) that uses a specific technology. To start with, we assume that these technologies are separated and that each firm can produce all the n services.

The cost incurred by a firm to produce a specific service can be written as:

$$C_{ij} = k_i - e_i - \beta_{ij} \qquad\qquad \text{i=1,n j=A,B} \qquad\qquad (2)$$

where k_i is a fixed cost, e_i is the effort of the staff and β_{ij} is a function that captures reduction in costs due to several factors such as special contracts with the supplier and the ability of the specific provider in organising the factors of production. We define β as a productivity parameter. This element cannot be observed by the provider and characterizes the production function of each firm. It can alternatively be private information to the provider or it can be observed by its competitor. For each service i, the cost is equal to $k_i - \beta_{ij}$ and it can be lowered through the effort e_i of the provider which produces a disutility linear in the number of services produced, but increasing in the effort. We assume that

$$f(e, s_i) = s_i f(e) \quad s_i f_e(e) > 0; \quad s_i f_{ee}(e) > 0; \qquad\qquad (3)$$

Given that utility is linear in the number of services, the purchaser can set the contract for each single service.

The quality of each service produced can be observed, but it cannot be verified, to a certain extent before a court. This is a common problem to production of public services where quality cannot be measured with the outcome of the service supplied[1]. In health care, for example, the quality and the appropriateness of the treatment cannot be measured with the health gain of each single patient, in education the achievements of the students are not a precise indicator of the quality of the service supplied.

For this reason, we assume that a minimum, verifiable level of quality, set to zero for simplicity, can be contracted for while any improvement on such a level can only be obtained using indirect incentives to the provider.

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[1] For health care, see Chalckley and Malcomson (1998,2000), Bos and De Fraja (200?)

The provider

Below we identify the objectives pursued by the provider with the utility function of the staff. The provider participates in the production process only if the reward received, net of the production cost, produces a positive utility. It is interesting to note that the staff are devoted workers, i.e. they receive utility from the outcome of their effort. The utility is separate and additive in the sevices produced. For this reason, the utility function of the provider for a generic service i can be written as:

$$U(t_i + d_{ij} - C_{ij} - f(e_i)) \qquad\qquad i = 1, n; j = A, B \qquad (4)$$

where t_i is the reimbursement scheduled. The devoted quality of the effort of the medical staff is private information, i.e. d_{ij} cannot be observed by the purchaser.[2] To simplify the analysis, we assume that the utility is linear in the net reward:

$$t_i + d_{ij} - C_{ij} - f(e_i) \qquad\qquad i = 1, n; j = A, B \qquad (5)$$

This is the true utility function of the provider and it is assumed to be his private information since d_{ij} can be observed by the purchaser only if (and for the extent which) the medical staff decides to reveal such information.

The purchaser

The purchaser acts as the agent of the citizens and buys services on their behalf. The purchaser's behaviour can then be represented by the maximisation of a function defined over the consumer's surplus. Given that in this article the main focus is on the factors other than the preferences of the provider that might drive the allocation process, we assume that a process of welfare maximisation has already been carried out to allocate the resources to each service.

In this environment we want to study the best way to organise the provision of these services by a provider that is faced by (possibly) several providers of the same services. Its objective should be finding the best trade off between quality and the cost of the service, defined as the user charge the consumer has to pay and the cost the purchaser has to reimbures to meet the cost of production. In this paper, given that we compare models that alternatively increase quality or decrease price, in order to compare the results of the different models we define the purchaser's optimal strategy as the choice of the form of regulation that allows to extract the maximum rent from the provider.

The rules of the game In this game we assume that two providers, located at the extremes of a line of lenght one provide n services using two linear production function, separate in each aspect. The purchaser can imperfectly

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[2] The formulation of the cost function in equation (2) can in any case be interpreted in terms of devoted worker in a more traditional way. β_{ij} can in fact be interpreted as a lower cost that derives from the devoted characteristic of the medical staff.

observe the technology of production and the utility of the provider. These information can be private information or can be observed by the competitor.

The cost to produce each service (t_i) is higher than the price charged to the consumer (p_i) since a part of the cost is financed through general taxation (g_i). The rules for determining the initial share between price and subsidy are

determined outside the model.

The provider receive a budget for the each single service (G_i) and has to choose how to regulate the market by choosing between hotelling competition and dutch, first price auction.

Given that quality cannot be verified, for the hotelling competition the purchaser should decide if competition should be made on the quality of the service or on the price charged to the consumer (the user charges); for the auction the provider will have to decide how to split the gain in cost reduction brough about by the auction between the user charge and the tax subsidy.

2.1 Benchmark price

In this section we show how the provider set the benchmark(maximum) price. For a generic service i, the cost observed by the provider is in fact equal to $C_i = k_i - e_i$ while the true cost is equal to $C_i = k_i - e_i - \alpha_{ij}$ where $\alpha_{ij} = \beta_{ij} + d_{ij}$ and represents the combined effect on cost of the devoted aspect of the workforce (d) and the productivity parameter β.

Given that each technology is independent, we can replicate the game for each service. The problem can be written in general terms as:

$$\text{Min} \quad t_i \tag{6}$$
$$\text{s.t.}$$
$$C_i = k_i - e_i$$
$$t_i - C_i - f(e_i) \geq 0$$

where t_i is the price that should be paid to the producer of the service.

The F.O.C for the problem can be written as:

$$f'(e_i) = 1 \tag{7a}$$
$$t_i^* = C_i^* + f(e_i^*) \tag{7b}$$

The optimal effort e_i^* is determined by the equation $f'(e_i^*) = 1$, which by (7b) sets the reimbursement to $t_i^* = k_i - e_i^* + f(e_i^*)$. This represents the maximum price for the service from the observation of costs and utility by the purchaser.

The provider receives an information rent equal to α which derives from the inability of the purchaser to observe its utility and cost function. In some specific settings, this contract can be improved upon using incentive compatible scheme (Laffont and Tirole, 1993), but in a context where the price paid by user is fixed or the service is free at the point of use Levaggi and Levaggi (2005)

shows that this contract cannot be improved upon by using the rules of the traditional agency theory. For this reason, in a setting where the budget and/or the number of services to be produced is fixed, other regulatory instruments have to be used.

2.2 Hotelling competition

Levaggi (2005) shows that in the market for health care the providers use a part of the information rent to compete for patients on quality, for this reason in this section we examine quality competion as a regulatory instrument.[3]

To start with we assume that competition can be made on each service separately, i.e. each provider can supply only one service. Service users, uniformly distributed on a unit line and normalised to one, need a service that is supplied through two firms, A and B, that are located at the extremes (0 and 1) of the line. Consumers choose where to receive their service and can observe quality directly or through an agent that acts in their own interest. Each consumer is indexed by, so that x represents a patient located at point x from the origin. They have the same valuation of quality characteristics and incur the same marginal distance cost s. The utility function of a patient located at point x may be written as:

$$V_x = \begin{cases} \varphi q_A - p_A - sx & \text{if patient is admitted to hospital A} \\ \varphi q_B - p_B - s(1-x) & \text{if patient is admitted to hospital B} \end{cases} \quad (8)$$

φq_A is the monetary equivalent gain derived from the use of the service of quality q_A from provider A, p_A is the user charge it has to pay, and sx and $s(1-x)$ are travel costs. For some services, p might be equal to zero, i.e. the service might be free at the point of use and in this case competition can be made on quality only. This depends on the rules of the game. If the provider allows price competition between the suppliers, a maximum user charge $\bar{p}$ will be defined so that $p_A = \bar{p} - r_A$ where r_A is the reduction in the user charge that provider A offers to his clients.

As per quality, given that it cannot be verified in court, the provider sets a minimum verifiable level which we assume equal to zero and when suppliers compete on this element they might increase it to q_i.

Equation (8) can be written in terms of the location of the consumers as follows:

$$x = \frac{\varphi(q_A - q_B)}{2s} + \frac{(r_A - r_B)}{2s} + \frac{1}{2}$$

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[3] In general both quality and price competition can be used. Given that the function of the patient is linear, the choice depends on φ. If the price is not already set to zero (good free at the point of use) providers will compete for quality if $\varphi > 1$.

and the demand for firm i can be obtained multiplying the distance by the density which, given the unit length of the line, is equal to 1. The providers compete with patients using α, their cost reduction parameters which can be transformed in a quality increase or a price reduction. Which of the two policies can be pursued depends on the rule of the games set by the provider.

For quality competition the demand will be written as:

$$D_i^q = \left[\frac{\varphi(\alpha_j^* - \alpha_i^*)}{2s} + \frac{1}{2}\right]$$

while for price competition the demanda can be written as:

$$D_i^p = \left[\frac{\alpha_j^* - \alpha_i^*}{2s} + \frac{1}{2}\right]$$

Each provider is a competitor with the other one for the demand within the location of the two outlets and wants to maximize its total utility:

$$Max \ [t_j + \alpha_j - C_j - f(e_j)] \ * D_j$$

Given that the rules for cost reimbursement have already been defined, we can rewrite the following expression as:

$$Max \quad (\alpha_j - \alpha_j^*) * D_j \tag{9}$$

The maximisation process depends on the type of competition pursued as shown in appendix one. The optimal revelation of a will be equal to:

$$\alpha_j^* = \frac{1}{2}(\alpha_i^* + \alpha_j - \frac{s}{\varphi}) \tag{10}$$

for quality competition and to:

$$\alpha_j^* = \frac{1}{2}(\alpha_i^* + \alpha_j - s) \tag{11}$$

for price competition

The equilibrium quality depends on the assumptions on the information the two competitors have on the cost efficiency parameter of the other firms. In this context, we present three different solutions:

Simmetric Nash solution   With identical providers, it seems reasonable to assume that a symmetric Nash equilibrium exists in which firms assume that the competitors has their same α and behaves simmetrically. The quantity of α they pass onto the service user as quality will be equal to:

$$\alpha_j^* = \alpha_j - \frac{s}{\varphi}$$

If they compete on price, the solution will be instead equal to:

$$\alpha_j^* = \alpha_j - s$$

Perfect information on the other provider In this case, each provider can observe the private information of its competitor. This assumption can be justified on several grounds: given that the providers share the same technology, they might be able to have better information than the purchaser on the possible methods to improve efficiency; they use the same type of workers and they might be able to evaluate their degree of devotion.

Let us then assume that $\alpha_i = k$; the optimal revelation of α by provider j will then be equal to:

$$\alpha_j^* = \frac{1}{2}(k + \alpha_j - \frac{s}{\varphi})$$

for quality competition and to:

$$\alpha_j^* = \frac{1}{2}(k + \alpha_j - s)$$

for price competition.

An interesting solution in this context is represented by the case where one of the two providers is not devoted/efficient. In this case $\alpha_i^* = 0$ and the solution can be written as $\alpha_j^* = \frac{1}{2}(\alpha_j - \frac{s}{\varphi})$ and $\alpha_j^* = \frac{1}{2}(\alpha_j - s)$ respectively

Imperfect information Let us now assume that α is private information to each provider, i.e. in defining their reaction function, they have to guess what the other will do. In this context, each provider can have some information on the range of values of the function of the competitor and on the more probable values of a for its competitors. For the more general case, we can assume that α is distributed in the range $(0,\beta)$ with $f(\alpha) = \frac{1}{\beta}$. In this case, each providers uses α_i^*,the parameter for his competitor the expected value, i.e. $E(\alpha_i^*) = \frac{\beta}{2}$ and sets their α_j^* accordingly:

$$\alpha_j^* = \frac{1}{2}(\alpha_j + \frac{\beta}{2} - \frac{s}{\varphi})$$

for quality competition and:

$$\alpha_j^* = \frac{1}{2}(\alpha_j + \frac{\beta}{2} - s)$$

for price competition

2.3 Auction

Let us now consider a different way in which the provider can make the two producers compete. In particular we analyze a competiton for the market in which the winner has the right to produce and sell the service as a monopolist for a specific period. In this case the price is fixed or zero and the starting price is represented by equation (7b). Given that (7b) is the maximum price for service i, we implement an dutch, first price auction. In this context, each provider chooses α_j to maximise:

$$MAX \qquad x_j^*(t_j^* + \alpha_j - C_j - f(e_j)) * \pi(\alpha_J \alpha_I)$$

where $\pi(\alpha_J \alpha_I)$ is the probability of winning the auction.

As for the Hotelling model, the choice of α_j depends on the information the provider has on its competitor.

If the provider can observe the parameter of its competitor, the solution will be to offer just a little more in terms of α, provided this is compatible with his parameters. In other words, the strategy of each competitors will be:

$$\arg\max(\alpha_j^* + \epsilon; \alpha_i^*)$$

If the providers are equal, the solution will be $(\alpha_i^*; \alpha_j^*)$ and the two providers share the market. If $\alpha_j^* = 0, \alpha_i^* \simeq 0$.

Let us now see how the provider behaves if it cannot observe the parameter for its competitor.

Let us assume that α is distributed in the range $(0, \beta)$ with $f(\alpha) = \frac{1}{\beta}$. In this case the probability of winning can be written as:

$$\pi_j(\alpha_i^* < \alpha_j^*) = \int_0^{\alpha_i^*} \frac{1}{\beta} = \frac{\alpha_j^*}{\beta}$$

and the problem for the provider can be written as:

$$MAX \qquad x_j^*[(\alpha - \alpha^*)](\frac{\alpha^*}{\beta})$$

The F.O.C. for the problem can be written as:

$$\alpha - 2\alpha^* = 0$$

$$\alpha^* = \frac{1}{2}\alpha$$

In this case, the auction allows to get half of the rent of the provider in the form of cost reduction.

2.4   Comparing the results

In this section we discuss the choice of the purchaser which has to choose between making his providers compete à la Hotelling or through an auction.

The decision depends on the effectiveness of each competing model to make the provider reveal its private information and on the purchaser's objective function.

In this model, in fact, quality, although it can be observed, it cannot be verified hence it is not contractible[4]. For this reason, the revelation of α can only increase the quality level in the Hotelling model and it will reduce the price paid by the provider in the auction model.

In what follows we will compare the two regulation frameworks just on their ability to extract private information from the provider. In this analysis we only consider the effectiveness of the regulation tool in making the provider reveal its private information.

The results are summarised in table one.

	$\alpha_i = 0$	not observed	$\alpha_i = \alpha_j$
Hotelling (quality)	$\alpha_j^* = \frac{1}{2}(\alpha_j - \frac{s}{\varphi})$	$\alpha_j^* = \frac{1}{2}(\alpha_j + \frac{\beta}{2} - \frac{s}{\varphi})$	$\alpha_j^* = \alpha_j - \frac{s}{\varphi}$
Hotelling (price)	$\alpha_j^* = \frac{1}{2}(\alpha_j - s)$	$\alpha_j^* = \frac{1}{2}(\alpha_j + \frac{\beta}{2} - s)$	$\alpha_j^* = \alpha_j - \alpha_j$
Auction one good	0	$\alpha_j^* = \frac{1}{2}\alpha_j$	$\alpha_j^* = \alpha_j$

Table one: Comparing the different solutions

From a pure "effectiveness" point of view, defined as the power of the model in making the provider reveal its private information, the ranking of the two Hotelling models depends on φ,i.e. consumers' evaluation of quality. If this parameter is greater than one, quality competition is more effective.

The choice between Hotelling competition and an auction depends on the information the provider has about the game, in particular on whether he knows which information each provider possess of its competitor.

It is however interesting to note that there is not a superior model. Hotelling competition should be preferred if the providers are very different in their abilities and if they have perfect information on their provider. In this case, in fact, the use of a competition à la Hotelling allows to have some of this private information passed onto the consumers in terms of quality while in the auction such rent would stay with the provider.

If instead the two providers are quite similar and know each other well, the use of an auction mechansim should be preferred. In this case, in fact, the local monopoly rent of the Hotelling game disappear and possibly all the rent of the provider is passed onto the consumers.

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[4]A variable can be oserved when some agents can privately and subjectively observe its value; it can be verified when it can be measured in an objective way, so that its value can be written in a contract and the provider can be made liable before court of its value. See Chalckley and Malcomson (1998)

3 Extension to N goods

In this section we propose an extension to the model just presented and assume that the two providers can compete on more than one service, i.e. they are multiservice producers. We assume that the production processes are separated so that there are no scale or scope economies related to producing more than one good at the same time.

3.1 Hotelling competition

For quality and price competition, the solution is still represented by equations 10 and (11). In this case, in fact, given that the produciton of each service is separated and the consumers of both service might not necessarily be the same, the conditions for competition are set on each service separately as shown in appendix two.

3.2 Auction

For the auction case, even in the presence of separated production processess and different consumers, competition is stronger than in the previous case, especially when the providers have no prior information on the productivity parameters of their competitors. This is because by auctioning n services at the same time, the prize for winning the auction is increasing.

This is a very interesting result that, as it will be shown in this section and it does not depend on which production each supplier is more efficient in producing.

Auction for n good, no prior information Given that the price of production is linear in the competitive advantage of each provider, the auction can be made on the average price for producing the n services, i.e. n the provider that declares the minimum average cost wins the auction.

The cost for a generic service i produced by supplier j can be written as: k_i-$\alpha_{ij}^* - \frac{1}{2}$ and the average price can be written as $\frac{\sum_{i=1}^n k_i}{n}$-$\frac{\sum_{i=1}^n \alpha_{ij}^*}{n} - \frac{1}{2}$

Let us now examine the strategy for provider A. He wins if the other provider declares a sum lower than his. α_i are independently distributed according to a uniform distribution in the support $[0,\beta_i]$ $i = 1,...,n$.

The problem can be written as:[5]

$$MAX \qquad \left[\sum_{i=1}^n (\alpha_{Ai} - \alpha_i^*)\right] \left[\frac{(\sum_{i=1}^n \alpha_{Ai}^*)^n}{\prod_{i=1}^n \beta_i} \frac{1}{n!}\right]$$

Let $z = \sum_{i=1}^n \alpha_{Ai}^*$, then the maximization problem in z can be written as

$$\max_z \frac{1}{n! \prod_{i=1}^n \beta_i} \left(\sum_{i=1}^n \alpha_{Ai} - z\right) z^n$$

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[5] See appendix three for a formal derivation

The F.O.C can be written as:

$$\frac{1}{n! \prod_{i=1}^{n} \beta_i} \left[n \sum_{i=1}^{n} \alpha_{Ai} - (n+1)z \right] z^{n-1} = 0$$

so that the maximum point is

$$z_{\max} = \frac{n}{n+1} \sum_{i=1}^{n} \alpha_{Ai}.$$

which is clearly greater than the optimal result of the single auction.

This result is in fact quite interesting since it is similar to the solution of an auction with n bidders for the same service[6].

This result shows that when if the purchaser thinks that the providers have no information on the opponents, it is better to make an auction on more services at the same time. This result does not depend on the distribution of the abilities of the two providers; the only condition is that both can have access to the technology and produce both services at least at the benchmark price. In the actual implementation of this auction the regulator should avoid that the winner stipulates a sub-contract with the other provider for the supply of some of the services that he is not able to produce efficiently.

This policy would be ex post efficient from a welfare point of view, but if such a contracts are possible the two bidders would collude and the auction would not allow the purchaser to extract any rent from the providers.

If the competitors can observe some of the cost saving parameters of the other competitors, the analytical solution becomes quite complicated. In general, we can say that the rent extracted will be lower than in the previous case.

When the competitors can observe all the parameters of their competitors, the auction with n good will have the same result as the auction with one good, i.e. the competitor tha has the greatest z will be able to declare just a fraction more than the z of his competitor and it will win the action. In the case in which z for one of the two competitors is zero, all the rent deriving from efficiency will be appropriated by the provider.

4   Discussion

The model presented in the section above shows that auction and spatial competition, two of more common instruments for regulating public services have differential advantages which depends on the information structure and the preferences of the provider, i.e. its price-quality trade off.

The best way to assess the relative performances of both models is to firstly compare them on their ability to extract rent from the provider.

In this respect, we can say that in general a competition à Hotelling should be preferred in the presence of competitors that are very different from each other

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[6]See Rasmusen () for a formal proof

(maximum distance in their α) and that know their's competitors efficiency. On the other hand, in the presence of the same information structure, an auction should be preferred when the two competitors are quite similar.

The choice between a price or a quality competition depends in this case on consumers' evaluation of quality.

When the two competitors have no information on the efficiency of their competitors, an auction should be preferred and in this case it is optimal to do an auction on more than one service. In this case, in fact, the rent extracted is proportional to the number of services for which is auction is made.

The two types of auctions might however have different effects on welfare, especially if the users of the services are not the same. In the case of an auction for a single service, the price reductions will be clearly directed towards a specific good; in the case of a multiple auction, the producer can allocate the price reduction to his own discretion. If such reduction is directed towards the budget spent by the provider, which will eventually be matched by taxation, there are no problems. No matter which price is reduced, the final outcome is a reduction in the budget of the provider. If instead such price reduction affects the user charges the redistribution effects might be important and in this case the provider should also take account of this aspect in deciding which auction to implement.

The price and quality trade off is clearly even more important when Hotelling and auction are compared.

The Hotelling competition might be made work on price (the user charge) and quality while auction can be on price only, given that for the services we are modelling quality is not verifiable. In the latter case, the provider has several options on how to allocate the cost reduction derived from the auction, which can be used to reduce the user charge or the subsidy (G).

In this respect, auction are more powerful tools since through a reduction in the subsidy it might be possible to widen the number of people benefitting from the rent information extraction.

If society prefers quality to price reduction, the provider might have to choose to increase the rent of the providers in order to get a higher quality level.

5   Conclusions

The provision of publicly provided services has been radically reformed in the recent years by introducing form of competition among providers. To achieve this results the providers of public services have been privatized while a government agency has been made to act as purchaser for the citizens it represents or as market regulator.

The process of privatization leads to less information on costs and technology; as a result, the relationship between cost and the effort of the provider becomes unknown. This is a common problem in any privatization process which the literature has long recognized (Baron and Myerson, 1982) and offered solutions for specific sectors (Laffont and Tirole, 1993). The problem to be con-

sidered here is how should the regulator choose the appropriate structure for the market in terms of pricing and competition rules? In this paper, we have examined the comparative advantages of Hotelling competition vs auction in a market where the provider has some private information on its cost function that can derive from specific characteristics of the workforce it employs or from his superior ability in organising the production process.

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A   Solution to the Hotelling game

To start with let us assume that the purchaser compete for quality and max-imises the following utility function:

$$Max \quad (\alpha_j - \alpha_i^*) * D_j$$

The F.O.C. can be written as:

$$-D_j + (\alpha_j - \alpha_i^*) * \frac{\varphi}{2s}$$

Solving for α_i^* we can write:

$$\alpha_j^* = \frac{1}{2}(\alpha_j^* + \alpha_i - \frac{s}{\varphi})$$

From equation () and () one can derive the demand in the price competition case by setting $\varphi = 1$. The optimal revelation of the cost efficiency parameter for price competition will then be equal to:

$$\alpha_j^* = \frac{1}{2}(\alpha_j^* + \alpha_i - s)$$

B   Hotelling with more than one good

The purchaser maximises the following utility function:

$$Max \sum_{i=1,2} [p_{ij} + \alpha_{ij} - C_{ij} - f(ei_j)] * D_{ij}$$

Given that the rules for cost reimbursement have already been defined, we can rewrite the following expression as:

$$Max \quad \sum_{i=1,2} (\alpha_{ij} - \alpha_{ij}^*) * D_{ij}$$

The F.O.C. can be written as:

$$-D_{ij} + (\alpha_{ij} - \alpha_{ij}^*) * \frac{\varphi_i}{2s_i}$$

Solving for α_i^* we can write:

$$\alpha_{ij}^* = \frac{1}{2}(\alpha_{ij}^* + \alpha_{ij} - \frac{s_i}{\varphi_i})$$

C Derivation of the probability of winning, n services auction

The probability for A of winning the auction can be written as:

$\Pr(\sum_{i=1}^{n} \alpha_{Bi}^{*} \leq \sum_{i=1}^{n} \alpha_{Ai}^{*}) = \int_{A} f(z_1, ..., z_n) \, dz_1 \cdots dz_n$

where:

$A = \{(z_1, ..., z_n) : \sum_{i=1}^{n} z_i \leq \sum_{i=1}^{n} \alpha_{Ai}^{*}; z_i \geq 0\}$

$= \left\{ z_1 \in [0, \sum_{i=1}^{n} \alpha_{Ai}^{*}]; z_i \leq \sum_{i=1}^{n} \alpha_{Ai}^{*} - \sum_{j=1}^{i-1} z_j, i = 2, ..., n \right\}$

Therefore:

$\Pr(\sum_{i=1}^{n} \alpha_{Bi}^{*} \leq \sum_{i=1}^{n} \alpha_{Ai}^{*}) = \frac{1}{\prod_{i=1}^{n} \beta_i} \int_{0}^{\sum_{i=1}^{n} \alpha_{Ai}^{*}} dz_1 \cdots \int_{0}^{\sum_{i=1}^{n} \alpha_{Ai}^{*} - \sum_{i=1}^{n-1} z_i} dz_n$

$\qquad = \frac{1}{\prod_{i=1}^{n} \beta_i} \frac{1}{n!} (\sum_{i=1}^{n} \alpha_{Ai}^{*})^n$