Società italiana di economia pubblica

WORKING PAPERS

The deregulatory process in the taxi industry: a critical appraisal

Angela S. Bergantino
Università di Parma
abergan@tin.it

Ernesto Longobardi
Università di Bari
e.longobardi@dse.uniba.it

- provisional draft -
(please do not quote)

October 2000

Abstract

A simple model is presented in order to analyse the main failures in the taxi market, mainly due to search costs, externalities, asymmetries in information. Also regulation, however, has been generally unsatisfactory: it has resulted in shortage of supply, high waiting time, high value of medallions, bad distribution of the service, little innovation. From the beginning of the eighties, a number of countries has experienced some forms of deregulation: even within a variety of situations, the outcomes have been quite disappointing. Instead of relying on deregulation, probably a new scheme of regulation, innovative with respect to the past, should be drawn.

JEL Classification: L43, L51, L92
Keywords: taxi, regulation, deregulation

Contents

Angela S. Bergantino is the author of sections 2.1, 3, 4

1 Introduction

In the literature a number of studies have considered the peculiarities of the taxi market, stressing the pervasive failures which characterise it.

The central point is that competition in the taxi market is necessarily imperfect. On the one hand, the spatial character of the market and the intrinsic mis-match between demand and supply lead to high search costs that, in turn, allow each taxi operator to fix prices over marginal costs. Although it might be that, at social optimum, price should be higher than marginal cost, due to the possible presence of reciprocal externalities in consumption, there is no guarantee at all that efficient pricing would result from a free entry situation. The latter, instead, would probably bring about too high monetary prices and excessive capacity. Although to a lesser extent, a similar outcome would emerge in a monopolistic situation.

An additional source of market failure is the existence of pervasive asymmetry of information in both the moral hazard and the adverse selection types.

The above explains why the taxi industry has been traditionally strictly regulated. Disregarding the first regulatory experiences that took place in the 17th century, modern forms of regulation originated in the United States during the thirties and, subsequently, spread to other countries.

Also regulation, however, has been generally unsatisfactory: it has resulted in shortage of supply, high waiting time, high value of medallions, bad distribution of the service, little innovation. In fact, the taxi sector has become a paradigmatic case of bad regulation, as such amply referred to in the economics textbooks.

From the beginning of the eighties, starting again in the United States, in a number of countries the taxi sector has undergone a new phase characterised by a general tendency to deregulation, supported by an optimistic view on the possibility to rely more heavily on market forces.

These expectations, however, had no valid theoretical foundations and could be justified merely as a reaction to the generally bad results of the previous systems of regulation. Even within a variety of situations, in fact, deregulatory experiences have been quite disappointing. The most general result of the reforms has been a significant increase in supply, which however has not been accompanied neither by a decrease in fares nor in waiting time, while the quality of the service has shown a definite tendency to deteriorate.

Recently a growing consciousness of the need to rethink the criteria of the regulatory schemes, instead of relying on deregulation, is gaining momentum.

This paper wants to be a first contribution in this direction. It starts with the presentation of a simple model of the taxi market, with results

which, for some aspects, contradict outcomes that have become standard in the literature (§ 2). It then focusses on the analysis of the main failures emerging from the experiences of both regulation (§ 3) and deregulation (§ 4). The essential elements of a new possible model of regulation of the service are sketched in the conclusion (§ 5).

2 Some economics of taxis

The economic literature on taxis originated from the pioneering studies of Orr (1969); Douglas (1972); Shreiber (1975) and De Vany (1975). They all move from the recognition of a pervasive market failure in this sector and analyse the effect of regulation of fares and entry under different assumptions on the market structure and on the organisation of the service (the main reference is to a cruising system). More recently, in an unpublished paper, Brunstad (1991) sheds some light on the different outcomes of monopoly and free entry, in comparison with social optimum, under the hypothesis of constant return to scale; Cairns and Liston-Heyes (1996) reconsider the rational for regulation in a cruising taxi market; H*ä*ckner and Nyberg (1995) extend the analysis to an oligopoly Bertrand equilibrium; Arnott (1996) provides a structural model of radio dispatch system, analysing the difficulties of the decentralization of social optimum and giving an interesting insight on the possibility to regulate the sector through an incentive compatible mechanism.

2.1 A model of the taxi market

In the following we present a simple model which re-examines the conditions for social optimum and the failure of the market in both monopoly and free entry situations. In some respect the model incorporates a number of semplifying hypotheses, which are standard in the literature. On the other hand, it allows a greater generality as it does not include any particular assumption neither on the returns to scale nor on the technical mode of provision of the service.

The following notation will be employed.
D = demand for taxi trips;
P = price for a trip;
T = average waiting time;
w = time value to the consumers;
M = matchings between customers waiting for a taxi and vacant taxis;
Q = customers searching for a taxi;
V = number of vacant taxis;

$N = V + D$ = total number of taxis;
$U = \frac{V}{N}$ = unoccupancy rate;
c = cost per idle taxi;
γ = additional operating cost for an engaged taxi;
ϵ_y^x = elasticity of the variable X with respect to Y;
X_y partial derivative of the variable X with respect to Y;
opt, m, c = superscripts indicating the value of variables in equilibrium in the case of social optimum, monopoly and free entry, respectively.

2.1.1 The demand

The demand for taxi trips is considered as a function of their *full price*, given by the fare (P) and the value (w) of the average waiting time (T) for the *representative* consumer:

$$D = f(P + wT) \tag{1}$$

with $D_p < 0$ and $D_t < 0$ and where D (a flow) represents the *new* demand for taxi trips, i.e. people deciding to use a taxi; while, in the following, Q (a stock) represents the *pool* of people who, having decided to use a taxi, are already searching for one.

In writing equation (1), we assume the length and the speed of each taxi trip to be constant. In this way, on the one hand, demand may be expressed in terms of number of trips (D); on the other, we can have a unique monetary price (P) for each trip. This assumption is not very restrictive, since a restatement of the model in terms of units of taxi time would lead to the same results.

A more limiting simplification is, instead, that of homogeneity of consumers with respect to the value of waiting time. With heterogeneity, as it will be discussed later on, the welfare implications of the model could be significantly different.

2.1.2 Waiting time

In the literature, a number of different approaches have been used in modelling waiting time. While some authors consider waiting time as a function of a variable representing the supply side, others express it as a function of some variable of demand, and others still, as a function of both[1].

[1]De Vany (1975) belongs to the first category since, in defining full price, he places waiting time as a function solely of the taxi-hours supplied. Häckner and Nyberg (1995), instead, consider, within the utility function of the representative consumer, the role of

The latter formalisation seems more appropriate, since it takes into account the two types of interdependence which characterize the taxi market: an interdependence between demand and supply and an interdependence between demand and itself (reciprocal consumption externality).

A correct formalisation of waiting time, in fact, should pass through the definition of the technical characteristics of the "production function" of the service, which consists of the *matching function* between customers searching for a taxi and taxis searching for a customer (Schroeter (1983); Brunstad (1991)).

In formulating the matching function we do not make any specific hypothesis about the nature of the returns to scale as, instead, it is usually done, either implicitly or explicitly, with the important exception of Schroeter (1983). As it will be clear soon, the technological properties of the matching function play an essential role in determining the conditions of social optimum. Specific assumptions about them are, in fact, at the basis of some of the more widely accepted results: in particular, the necessity of subsidising the sector as a first best solution, is dependent on the hypothesis of increasing returns to scale.

The number of meetings between waiting customers and vacant taxis depends on the size of the two "pools" (Q and V):

$$M = m(Q, V) \tag{2}$$

with:

$$M_q = \frac{\partial M}{\partial Q} > 0; \quad M_v = \frac{\partial M}{\partial V} > 0$$

Given the elasticities of the matching function with respect to the number of people searching for a taxi (α_q) and to the number of vacant taxis (α_v):

$$\alpha_q = \frac{\partial M}{\partial Q}\frac{Q}{M} = M_q\frac{Q}{M}; \quad \alpha_v = \frac{\partial M}{\partial V}\frac{V}{M} = M_v\frac{V}{M}$$

the matching function will be characterized by increasing, constant or decreasing return to scale if, respectively:

$$\alpha_q + \alpha_v \begin{matrix} > \\ = \\ < \end{matrix} 1$$

reciprocal consumption externalities, composed of two elements: the consumption of all other users and a parameter (β) that condenses both consumers' aversion to waiting time (index of impatience) and the technical relationship between capacity and waiting time. For interpretative purposes, however, the first definition seems to prevail. Finally, Cairns and Liston-Heyes (1996) consider the effects of demand and supply jointly.

A number of studies assume increasing returns[2]. This property - according to which an equi-proportional increase in the number of customers and of servers would produce a more than proportional increase in the rate of service - is often assumed as implicit in the technology of the taxi service. In reality it has been borrowed from the literature on scheduled transit systems. In this latter case it is obvious that, in absence of congestion, an equal percentage increase in the number of people waiting to be served at a boarding point and in the frequency of runs would decrease average waiting time by the same proportion. In the case of taxis, this result does not hold if we refer to a stand system, because of the one-to-one nature of the matching between customers and servers: in a traditional taxi service, the "full capacity" of a single vector is automatically reached when a single unit of demand is satisfied[3]. Those who evocate these increasing returns in the taxi service, in fact, refer, generally, to either a cruising or a radio dispatch system and justify them in term of economies of density (with an increase in both demand and supply, agents would be not only more numerous but also closer together on average). However, in these instances, economies of density may be hampered by counteracting decreasing returns in the dispatch system (Schroeter (1983)), as a bad distribution of servers on the territory[4] or the congestion of telephone lines in the case of a traditional radio dispatch system. In fact the very limited empirical evidence existing does not support the hypothesis of increasing returns to scale in the taxi industry[5].

The average waiting time (T) is given by the product of the amount of people searching for a taxi (Q) and the intermeeting time (M^{-1}).

$$T = \frac{Q}{m(Q,V)} \tag{3}$$

[2]Increasing returns to scale are assumed, among the others, by Douglas (1972); De Vany (1975); Beesley and Glaister (1983); Cairns and Liston-Heyes (1996); Arnott (1996). Brunstad (1991) maintains that increasing returns have been overemphasised in the literature and adopts a model with constant returns.

[3]Considering, as common in the literature, a unit of demand either a single passenger, or a group of passengers travelling together.

[4]Actually, as we shall see further on (§ 4), one of the problems of deregulation as been the bad distribution on the territory of operators.

[5]The only estimate of the return to scale in the taxi industry, as we know, is provided by Schroeter (1983) with reference to the Minneapolis radio dispatch taxi market, with 1979 data. He finds no conclusive support to the hypothesis of increasing returns. Using a Cobb-Douglas he obtains the following estimates: $\alpha_q = 0.8395$ (*s.d.* 0.0649), $\alpha_v = 0.2933$ (*s.d.* 0.0875). Both α_q and α_v are significantly less than one at conventional significance level and the hypothesis $\alpha_q + \alpha_v = 1$ against the alternative $\alpha_q + \alpha_v > 1$ cannot be rejected even at the 10% level of significance.

A steady state assumption, prescribing that Q will be constant over time, is imposed:

$$D = M \tag{4}$$

Partial differentiation of equation (3) with respect to D and V, taking into account that, from (3) and (4), $Q = DT$, leads to the following:

$$T_d = \frac{\partial T}{\partial D} = \frac{T(1-\alpha_q)}{M} \tag{5}$$

$$T_v = \frac{\partial T}{\partial V} = -\alpha_v \frac{T}{V} \tag{6}$$

Looking at equation (5), we see that the effect of D on T will be positive, null, or negative according to the magnitude of α_q. D, in fact, has a twofold effect on waiting time. A direct one, with positive sign: a new person searching for a taxi would impose an extra waiting time to the other customers. An indirect one, of opposite sign, which is a scale effect through the matching function.

With $\alpha_q = 1$, $T_d = 0$, i.e the two effects counterbalance and, therefore, demand has no effect on waiting time, which becomes a function of V alone.

Incidentally, it can be noticed that this very special case is the assumption implicitly used by all the authors that have made waiting time a function solely of the density of vacant taxis (for instance, Douglas (1972); De Vany (1975) and Beesley and Glaister (1983)).

With $\alpha_q < 1$, $T_d > 0$ which indicates the existence of a negative reciprocal externality in consumption (of the "fishery" type): at the margin an increase in demand would impose an extra cost, in terms of waiting time, to the consumers as a whole. It noteworthy that this latter case is the relevant one in practice, as values of $\alpha_q >= 1$ would imply returns to scale of an unrealistic magnitude. Also the available empirical evidence indicates that α_q is significantly lower than one[6].

Instead, from equation (6) it can be seen that the the sign of the effect of V on T is unambiguously negative.

[6]See above note 5.

2.1.3 Costs

In the literature there are two main approaches to costs. The first, referred to a cruising system, assumes costs as independent from the state of the vehicle, engaged or empty. The second, more general, expresses total costs distinguishing between vacant and occupied taxis. The latter approach is adopted here,thus:

$$C = (c + \gamma)D + cV \tag{7}$$

where c is the cost of an idle taxi and γ is the additional cost of an engaged taxi, both assumed to be constant. While this assumption is realistic for an idle taxi, for an occupied taxi operating costs would probably increase over a certain utilisation rate. However, no empirical work is available on the real cost structure. The few authors who do not make this assumption adopt a traditional U-shaped cost curve. As for us, given the lack of evidence, we prefer to privilege simplicity and stick with the hypothesis of constant cost.

2.2 Social optimum: the taxi industry should not necessarily be subsidised

The model is made up by equations:

$$D = f(P + T) \tag{8}$$

$$T = g(D, V) \tag{9}$$

$$C = (c + \gamma)D + cV \tag{7}$$

In equation (8) we have dropped w, since, as far as it depends on the monetary unit, it can be normalised to one.

Social welfare is the sum of consumer and producers' surpluses:

$$SW = \int_0^D f^{-1}(z)dz - TD - [c(D + V) + \gamma D] \tag{10}$$

Maximising SW with respect to D and V yields the following first order conditions:

$$D: \quad P = (c + \gamma) + DT_d = (c + \gamma) + T\epsilon_d^t \tag{11}$$

$$V: \quad c = -DT_v \tag{12}$$

Equation (11) states that the optimal fare would cover the marginal cost of the trip corrected for the total value of the externality produced by an increase in demand at the margin ($DT_d = T\epsilon_d^t$).

Equation (12) states that "excess" capacity must be added up to a point where its cost equals its social value in terms of a reduction in waiting time.

The second order conditions are:

$$D: \quad \frac{\partial[p - DT_d - (c+\gamma)]}{\partial D} = -T_d < 0 \tag{13}$$

$$V: \quad \frac{\partial(-DT_v - c)}{\partial V} = -T_{vv}D - D_t T_v^2 < 0 \tag{14}$$

Condition (13) is fulfilled if $T_d > 0$, i.e. if the externality in consumption is negative. In the following, in the light of what it has been pointed out about the reasonable values of α_q (§ 2.1.2), we assume it to hold.

Condition (14) will be fulfilled when:

$$T_{vv} > 0 \quad and \quad |D_t T_v^2| < |DT_{vv}| \tag{15}$$

Profits (Π) are given by:

$$\Pi = PD - (c+\gamma)D - cV \tag{16}$$

Substituting from equations (11) and (12) we have that, at the optimum:

$$\Pi \begin{matrix} > \\ = \\ < \end{matrix} 0 \quad \Leftrightarrow \quad DT_d + VT_v \begin{matrix} > \\ = \\ < \end{matrix} 0 \tag{17}$$

that is to say, profits will be positive, null or negative according to the strength of the externality in consumption (DT_d) with respect to the effect of excess capacity on average waiting time (VT_v).

In the presence of a *negative* externality, the excess of the optimal price over private marginal cost would provide resources *to finance* the excess capacity. If the externality is strong enough, the standard result of negative profits at the optimum may be reversed.

This result, in turn, corresponds to the one, well known in the literature, which links the sign and the extent of profits at the social optimum to the nature of scale returns in the matching function. In fact, substituting in (17) equations (5) and (6), we get:

$$\begin{array}{c} > \\ \Pi = 0 \\ < \end{array} \quad \Leftrightarrow \quad \begin{array}{c} < \\ \alpha_q + \alpha_v = 1 \\ > \end{array}$$

Furthermore it can be easily shown[7]that:

$$\begin{array}{c} < \\ \alpha_q + \alpha_v = 1 \\ > \end{array} \quad \Leftrightarrow \quad \begin{array}{c} < \\ |\epsilon_v^t| = |\epsilon_d^t| \\ > \end{array}$$

We can thus conclude with the following proposition:

Proposition 1. *At the social optimum the taxi industry should be subsidised if and only if the reciprocal externality in consumption is weaker than the effect of excess capacity on waiting time, i.e if waiting time is more elastic with respect to vacancies than with respect to demand.*

2.3 Market's failures

At this stage it is necessary to clarify the interrelation between changes in the monetary price and in the level of demand implicit in the model.

Totally differentiating (8), considering $dV = 0$, dividing both sides by dP and solving for $\frac{dD}{dP}$, gives:

$$\frac{dD}{dP} = \frac{\frac{\partial D}{\partial P}}{1 - D_t T_d} \tag{18}$$

Equation (18) represents the total impact on D of a change in price, V being held constant. This is composed by a direct effect ($\frac{\partial D}{\partial P}$, T being held constant) and an indirect one ($\frac{1}{1-D_t T_d}$): the initial change in demand induced by a price variation reflects on waiting time and hence again on demand.

In order to distinguish them, we denote $\frac{dD}{dP}$ in bold $\mathbf{D_p}$[8]. In bold we'll denote also the elasticity of demand with respect to the full effect of the change in price: $\epsilon_{\mathbf{p}}^{\mathbf{d}} = \frac{\mathbf{D_p}}{D} P$.

[7]In fact, $\epsilon_d^t = 1 - \alpha_q$ and $\epsilon_v^t = -\alpha_v$.

[8]Chiang (1974) (p. 214) refers to it as *partial total derivative* and denotes it by $\frac{\S y}{\S x}$.

2.3.1 Unregulated monopoly

Let us assume that an unregulated monopoly would choose P and V as to maximize profits given by equation (16).

The f.o.c. are:

$$P: \quad P^m = (c+\gamma) - \frac{D^m}{\mathbf{D_p^m}} = \frac{c+\gamma}{1+\frac{1}{\epsilon_{\mathbf{p}}^{\mathbf{d}}}} \tag{19}$$

$$V: \quad c = -\frac{D^m}{\mathbf{D_p^m}} \; D_t^m T_v^m \tag{20}$$

Equation (19) is the monopolist's mark-up, with the latter being greater than the standard case, because of the higher rigidity of demand: the monopolist *exploits* the "impatience" of consumers setting higher monetary prices.

Equation (20) states that excess capacity will be added up to a point where marginal profits from occupied taxis equal the cost of an additional vacant taxi.

Comparing equation (19) with equation (11), we see that the monopoly's price will not necessarily be inefficient. In fact we have:

$$P^m \begin{matrix} > \\ = \\ < \end{matrix} P^{opt} \quad \Leftrightarrow \quad -\frac{D^m}{\mathbf{D_p^m}} \begin{matrix} > \\ = \\ < \end{matrix} D^{opt} T_d^{opt} \tag{21}$$

We can restate relation (21) with the following proposition:

Proposition 2. *The welfare effects of a profit maximising monopoly, in terms of equilibrium price, relatively to the first best, depend on the magnitude of the mark up compared with the reciprocal externality in consumption.*

It is noteworthy that also with respect to capacity and to the level of demand, on a pure theoretical ground, the welfare implications of monopoly are not clear-cut.

This result can be ascertained by investigating the properties of the monopoly's equilibrium at the optimal price.

As we have just seen (21), the monopolist will maximise profits at the optimal price when:

$$-\frac{D^m}{\mathbf{D_p^m}} = D^{opt} T_d^{opt} \tag{22}$$

Substituting in (20):

$$D^{opt} D_t^m T_v^m T_d^{opt} = c \tag{23}$$

hence:

$$T_v^m = \frac{c}{D^{opt} D_t^m T_d^{opt}} \tag{24}$$

while from (12):

$$T_v^{opt} = -\frac{c}{D^{opt}} \tag{25}$$

Consider now that, given $T_{vv} > 0$, i.e. the marginal reduction in waiting time due to vacancies ($|T_v|$) is decreasing, that is required by the s.o.c. for the optimum (15), we'll have that:

$$\begin{matrix} > \\ T_v^m = T_v^{opt} \\ < \end{matrix} \quad or \quad \begin{matrix} < \\ |T_v^m| = |T_v^{opt}| \\ > \end{matrix} \quad \Leftrightarrow \quad \begin{matrix} > \\ V^m = V^{opt} \\ < \end{matrix} \tag{26}$$

Comparing equation (24) with (25) and considering (26), we see that:

$$|D_t^m T_d^{opt}| \begin{matrix} > \\ = 1 \\ < \end{matrix} \quad \Leftrightarrow \quad \begin{matrix} > \\ V^m = V^{opt} \\ < \end{matrix} \tag{27}$$

The greater the sensitivity of demand with respect to waiting time, which determines the convenience for the monopolist to install additional capacity, and the greater the value of the reciprocal externality at the optimum, the greater will be the excess capacity in the monopoly case compared with the optimal one.

On empirical grounds, however, we can exclude values of D_t and T_d for which the installed capacity in monopoly would be equal to or greater than at the optimum.

In fact, consider that:

$$|D_t T_d| >= 1 \quad \Leftrightarrow \quad |\epsilon_t^d \epsilon_d^t| >= 1 \quad \Leftrightarrow \quad |\epsilon_t^d| >= \frac{1}{|\epsilon_d^t|} \tag{28}$$

Given reasonable values of α_q, and hence of ϵ_d^t, we should assume totally unrealistic values of the elasticity of demand with respect to time (ϵ_t^d) in order for (28) to hold[9].

If, for the same monetary price, the monopolist installs less capacity, its demand curve will lie to the left of the one corresponding to the social optimum.

We can thus conclude with the following proposition:

Proposition 3. *In an unregulated monopoly, given realistic values of the parameters, capacity and output will be lower than at the optimum.*

2.3.2 Free entry

In a decentralized economy, we can assume that a single firm will perceive that its decision regarding the amount to supply will affect neither the average occupancy rate nor the market price, i.e. the single firm is both *price taker* and *occupancy rate taker*. In this case, it will maximise profits by equating the marginal (=average) revenue to marginal cost.

However, while the assumption of perfect competitive behaviour with respect to the occupancy rate may hold, the informational structure of the taxi market prevents us to assume the same with respect to price.

As it has been widely stressed in the literature since the pioneering work on the subject (Douglas (1972); Shreiber (1975)), up to a recent contribution (Cairns and Liston-Heyes (1996)), at any prevailing price P_0, the acceptance, by a customer, of a taxi trip offer will signal a willingness to pay greater than P_0, given the search cost of finding a different taxi[10].

Thus, within a certain range of possible price values, charging a price $P_0 + \delta$, with δ not greater than the additional search cost to the consumer, will increase individual profits. With free entrance, this will induce new

[9]If we consider the estimate of α_q given in note 5, we have $\epsilon_d^t = 0.16$: in order to have more installed capacity in the monopoly than in optimum the value ϵ_t^d should be equal to 6.25!

[10]Search costs in the taxi market would include the cost of waiting to find a second taxi, the psychic costs of refusing a ride with the risk of loosing a relatively good offer (Fingleton et al. (1998)). The size of any search cost depends on the number of taxis available - if there is excess demand, price comparison will be more difficult to make - and on the location of the customer. They are likely to be high for someone hiring a taxi at a random point on the street, while lower for a customer at a taxi rank where price comparison might be easier. In the latter case, however, the imposition of extra charges might be an obstacle to a correct evaluation and the social convention that the customer should hire the first taxi at the rank (FIFO rule) excludes the possibility of choosing. Finally, search costs are obviously significantly reduced in the market for telephone ordered taxis where price comparisons have a much lower cost.

operators to enter the market, thus eroding extra profits. The result will be an upward pressure on prices and on the number of taxis.

Is there a limit to this process?

It has been stressed that the individual incentive to increase the fare over the existing equilibrium level will vanish, at a price (P^c), when further increases would cause profits per cab to diminish (Douglas (1972); Brunstad (1991)).

Prices above P^c can not be ruled out. An additional major source of imperfection in information, undermines the effectiveness of price competition: a reduction of price, given the spatial nature of the market and the random characteristics of the interaction between demand and supply, will not attract new clients, resulting just in a loss of revenue for the single operator[11]. However, while P^c may not be considered in any sense an equilibrium price, it is often referred to in the literature as a useful point of reference for comparing the result of a free entrance solution with other market forms and with social optimum (Douglas (1972); Brunstad (1991)).

Given that profits per cab ($\bar{\pi}$) are:

$$\bar{\pi} = \frac{PD}{N} - (c+\gamma)\frac{D}{N} - c\frac{V}{N} \tag{29}$$

differentiating equation (29) with respect to P, and solving, yields P^c:

$$P^c = \gamma - \frac{1}{U}\frac{D^c}{\mathbf{D_p^c}} \tag{30}$$

It can be shown (Douglas (1972); Brunstad (1991)) that the demand-monetary price schedule passing through P^c would lie to the right both of the demand passing through the point of social optimum (P^{opt}) and of that passing through the monopolist's price (P^m).

2.4 Concluding remarks

Our analysis suggests that the result, widely accepted in the literature, according to which, at first best, the taxi sector should be subsidised, cannot be taken for granted. The issue is essentially empirical, since, on theoretical grounds the possibility of positive or null profits at social optimum cannot be ruled out.

[11]This applies especially to a cruising market: large companies operating through a telephone/radio dispatch system, might, instead, have an incentive to acquire a reputation for setting low fares as their location is well identifiable and price competition can work as a mean to attract more customers.

The analysis, instead, supports the finding, widely accepted in the literature, that monopoly will imply a less capacity and output than the optimal ones.

As far as free entry is concerned, we have made reference to the existing literature that - although generally lacking a complete and convincing formalization, due to the difficulties to depict free entry with an equilibrium analysis - concords in retaining that free entry would lead to excessively high monetary prices and capacity.

There are, therefore, strong reasons in favour of regulation. Additionally, other factors, which would support it, should be taken into account: the diffuse problem of asymmetric information - both in the form of moral hazard and adverse selection -, and the connected need for consumers protection that has been, traditionally, one of the main justification for public intervention.

The most limiting aspect of the model we have presented, although common to the majority of other studies, is the assumption of homogeneity of consumers with respect to the value of time. The welfare conclusions presented are, as a matter of fact, heavily conditioned by this assumption: in a world of heterogeneous consumers, a system of single-price regulation would be, in any case, inefficient. We return briefly to this aspect in the last section.

3 The experiences of regulation

3.1 Origin and modes of regulation

Regulation of the taxi industry had its origin in North American cities[12], where, following the onset of the Great Depression, massive entry in this market - a natural outlet for unskilled unemployed - led to forms of cut-throat competition The regulatory process spread quite rapidly and by the thirties most North American cities had introduced price, entry and quality regulation[13], followed, shortly after, by most other countries in the world.

Price regulation concerned both the level of tariffs and their structure. The former was, in some cases, rigidly established; in other ones, allowed to vary within a predetermined range. The fare structure was differentiated according to time of day, combination between travelled time and distance,

[12]Actually, the first example of taxi regulation can be dated back to 1635 when, under the reign of Charles I, the London and Westminster hackney carriages were regulated. A further example of seventeenth century's regulation is that concerning the introduction, in 1674, of a licensing system for the "sedan chairs" in Japan (Kang (1998)).

[13]According to an estimate released by the US Federal Trade Commission (1984), 43 out of 93 US cities with a population of more than 100,000 had restricted entry into the taxi industry by 1934.

additional charges for multiple occupancy, luggage, holidays, and so on. In any case, the regulatory framework did not leave any significant margin for price competition.

Entry regulation was introduced, in general, through the adoption of a licensing system, on the basis of which the number of operators was determined administratively. A number of different methods were used: arbitrary ceiling, set by freezing the number of licences; use of a ratio, generally based on the population of the area served; requirement for the applicant to prove the need for additional supply; franchise system, whereby the authority awards the right to operate a certain number of vehicles on a contract basis and subject to charges; "compliance" criteria, whereby access to the market is conditional upon the operator's capability to satisfy a number of standards.

Regulation of service quality involved, generally, monitoring the vehicle's suitability and the drivers' quality in terms of area knowledge and behaviour. Additionally, operators were often obliged to provide service at all times and in all areas or to belong to a radio booking centre, in order to ensure a high availability of the service. Finally, monopoly rights - which consist in both the exclusive franchise to organise taxi services in a geographically limited market area and the exclusive right to ply for hire - have been also important elements of taxi regulation.

3.2 The drawbacks of regulation

The overall results of regulation have been highly unsatisfactory, especially on efficiency grounds. The evidence is incontestable.

In general, entry regulation has resulted in the outright prohibition for newcomers to access the market, creating insuperable entry barriers[14]. This, in turn, has brought about unjustified rents for the incumbents, excessively high value of medallions and, in most cases, a chronic underprovision of service with excessive waiting times.

On the tariffs' side, there is some evidence that fares were generally settled at a higher level than optimal (Taylor (1989); Boroski and Mildner (1998)). The regulated tariffs' structure, moreover, lacked any provisions of adjustment to account for changes in market's conditions, in the cost structure and in the quality of the service provided: at most, the annual increase in the number of licences was rigidly predetermined and kept fixed over time. Regulation has generally failed to guarantee appropriate quality standards

[14]Among the most recent contributions, Kang (1998), Fingleton et al. (1998), Holle (1997) and Radbone (1998) report striking evidence of the immobility of the licencing system.

in the market[15] and, in many cases, measures seemingly related to quality requirements, were transformed in effective barriers to entry[16]. Innovations in the market and development of new services have been frustrated: on the one hand, by the barriers adopted against potential competitors; on the other hand, by the rigidity of the tariffs' structure and the impossibility to apply tariffs differentiated on the basis of the characteristics of the service; and, further, by specific norms as the prohibition of advertising and of multiple hiring [17].

The causes of the bad results of regulation are manifold.

A major shortcoming has been undoubtedly, the lack, in the regulatory framework, of any sort of incentive, for the operators, to reveal correct information concerning the fundamental variables related to the actual use of the vehicle and to the demand effectively satisfied.

The poorness of the regulatory schemes together with the well known capability, apparently in every country, of the taxi operators' organisations to lobby public institutions, have been the two main ingredients of a failure of regulation that has become a school case for textbooks and treaties (Viscusi et al. (1996); Carlton and Perloff (1994); Kahn (1975); Walters (1993)).

As Viscusi et al. (1996) put it, taxi regulation "appears to be a classic example of Economic Theory of Regulation" (p. 342) since, while each taxicab company would gain a lot from regulation, each consumer would be harmed only a little. In other words, given that there are many fewer taxicab companies than consumers, the cost of organising political support is much lower

[15]Fingleton et al. (1998) report that a 1990/1 survey carried out in Dublin found that the quality of the vehicles was generally good, but that there was a significant minority of poor quality cars, and that in many cases passenger were refused short haul trips and received discourteous treatment. Similar conclusions are reported by Teal and Berglund (1987) for most American cities. In particular, according to Goldsmith (1997) in Indianapolis there were "rampant complaints" from customers and the universal judgement was that the service was poor, expensive and highly selective.

[16]In Tokyo, for instance, the applicant for a new company licence was required to have a minimum of 60 taxis, while single taxi licences applicants must have matured more than 10 years experience without being punished for offending relevant laws Kang (1998). The economic literature has devoted limited attention to the question of quality regulation. It should be considered that any qualitative regulation has, in general, inherent quantitative implications since, higher quality standards, increase costs and, to keep supply at given levels, prices would have to rise.

[17]In a number of countries, among which New Zealand, Japan, the UK and Italy, advertising on the vehicle and multiple hiring were prohibited or strongly restricted (in New Zealand shared rides were limited to two people at specific pick up points). In Ireland, until 1983, taxis could not use telephonic or radio communications, while in Indianapolis, until 1994, it was illegal for a taxi driver to cruise the streets or for customers to hail a taxi, resulting in waits of up to 90 minutes for telephone orders (Consumer Policy Institute (1997)).

for the former, while, for the politicians, it is easier to quantify the industry' gains than the larger, but more diffuse and less identifiable, consumers' ones[18].

Another focal point in the regulatory experiences in the taxi sector is the attribution of responsibility, on the one hand to the different levels of government, on the other hand to political or technical bodies. Evidence shows that in countries where the tariffs were decided by central bodies[19] they failed to take into account possible relevant local differences in the structure of the market; while, in countries[20] where the determinations of fares was left to local authorities, the problems of regulator's capture seemed to be particularly accentuated. In this latter case, the result has been, generally a strong differentiation of tariffs among municipalities, often not justifiable on economic grounds[21]. In any case, at both central and local government level, the implementation of regulatory schemes were mainly left to political bodies, whereas specialised agencies could probably have provided greater guarantees of independence and specific technical competence.

4 Lessons from deregulation

Deregulation of the taxi industry started, once again, in the United States, where, between the end of the senventies and the beginning of the eighties, twenty two cities had totally or partially deregulated the sector[22]. The main measures introduced concerned the access to the market and the determination of tariffs[23]. In some cases, also the institutional framework changed

[18]Shreiber (1975) states that "the changes in rates that have taken place from 1937 to the present [1975] were made not for regulating cab occupancy and availability, but rather for the purpose of raising cab drivers' earnings or the profitability of cab ownership" (p.278). For instance, in Arizona, already in 1933, a constitutional amendment was introduced with the stated objective of protecting existing operators from further competition. In New Zealand, more recently (1983), successful lobbying by the operators lead to the deletion of most of the recommended changes towards deregulation from the 1983 review of the transport industry, slowing down the whole process, Kang (1998).

[19]For instance, this was the case of Sweden and South Korea, where taxi fares were centrally decided by the Ministry of Transport and applied uniformly throughout the country.

[20]Such as New Zealand, Japan and Ireland.

[21]In New Zealand and Japan, in 1987, there were 78 and 77 different fare levels, respectively Kang (1998).

[22]Among these: San Diego, Seattle, Phoenix, Atlanta, Sacramento, Kansas City, Milwaukee, Tucson (Arizona), Oakland and Fresno (California), Washington D.C. and Raleigh (South Corolina).

[23]In most of these cities entry barriers have been removed or loosened (the latter by maintaining either some financial/economic obligations, or some limited qualitative con-

with a shift of regulatory and monitoring powers from local authority offices to *ad hoc* agencies with specific responsibilities and expertise.

One of the main drawbacks of these pioneering experiences of deregulation was the failure to introduce effective provisions to tackle the deterioration in quality standards which could have been expected as a consequence of the reforms.

The countries that, between the end of the eighties and the nineties, followed the American experience on deregulation (i.e. New Zealand, Australia, Canada, Japan, South Korea, Sweden and United Kingdom[24]) learned the lesson and, together with measures directed at favouring a greater flexibility and a better correspondence between demand and supply, implemented policies aimed at considering the potential market failures stemming from quality and safety aspects of the service. Indicative of the attention reserved to these issues is the principle that has inspired the changes in Japan: "gradual easing of the economic controls and enrichment of the social regulation".

In most of these countries, the reforms were, therefore, twofold. On the one side, they introduced measures directed at totally or partially relaxing the restrictions on the number of operators or on the levels of the tariffs; on the other one, they were aimed at reinforcing quality standards. Among the first category, the main measures have concerned: the removal of the licence granting power from local authorities, the unification of operating areas[25], the abrogation of uniform and administratively determined tariffs, the abolition of obligations hampering competition both within the sector and with "neighbouring sectors" (other forms of urban transport)[26]. Among

trols concerning drivers' capabilities and vehicles' standards) and administrative tariffs have been abandoned (in some instances, this has occurred by imposing maximum or minimum ceilings, in others, by enabling operators to freely determine the fare schedule with the sole obligation of preventive communication to the authority).

[24]In Ireland and in the Netherlands the deregulatory process has just begun while in Italy, the local authority of Rome is still attempting to fully implement the reforms. For greater details the reader is referred to the work of Bergantino and Longobardi (2000).

[25]This has had a particular relevance for Japan, Sweden, the UK and the Netherlands where one of the main objectives of the reform has been to reduce the high fragmentation of the territory. In Japan, for instance, following the reform, the operating areas were more than halved: less than 1000 were left in 1997 of the 2317 of the pre-deregulation period (Kang (1998).)

[26]Among these measures we can include the removal of the distinction, for regulatory purposes, between similar services (taxis, hire cars, limousines, public urban transport); the creation of fair conditions for competition among the various transit services (privatisation of public transport companies, reduction of public subsidies for some categories, introduction of competitive bidding for specific transport services, and so on), the possibility to offer "shared rides" (New Zealand, Japan and the UK), the standardisation of procedures for assigning licences among different Local Authorities; the abrogation of

the second category, we can mention the introduction of greater controls on the capabilities of the drivers and the reliability of the companies[27], specific requirements relating to the vehicle[28], limits to the working hours (or to the distance covered[29]), promotion of innovative services, more stringent obligations and controls for those who fail to comply with the rules[30], constitution of *ad hoc* organisations for monitoring the activity on the market[31].

The main outcomes of deregulation in various countries are summarised in Table 1. As we can see, deregulation has lead to a significant increase in supply. This has taken place in the form of both new entries or an expansion of existing firms. In the former case, often, the new entrants have been single, mono-vehicular, operators and thus the market structure has not varied significantly: the main result has been an increase in the turn over rate, which, has made the market more volatile, reducing the specialisation in the industry[32]. Furthermore, it is noteworthy that the increase in capacity has not, in general, spread uniformly, but has concentrated mainly in larger

rules granting a specific radio dispatch companies the exclusive right to operate in one area and, finally, the provision of publicly owned radio dispatch companies in competition with private ones. The latter, has had a particular relevance for Sweden, where, in the pre-regulation period, taxi operators were compulsorily required to connected to the radio dispatch company present in the operating area and in which it operated as a monopolist.

[27]These measures have generally concerned more stringent requirements on language and topographical knowledge, psycho-physical health, criminal records, trade skills, economic and financial guarantees. In Japan, for instance, the reform required taxi companies to employ a qualified vehicle manager responsible for the safety and the management of the fleet.

[28]This is particularly relevant for London, where, the specificity of the investment in a special purpose vehicle (black cab), constitutes, for the regulator, an indirect guarantee the respect of the rules by the taxi operators. Their breaching, in fact, would be very costly for the driver, as it would imply the withdrawal or the suspension of the licence.

[29]In Tokyo, for instance, the limitations on the hours of service have been reinforced with a prescription on the maximum distance an operators can cover in a day (365 km per day, Kang (1998)).

[30]In New Zealand the reform introduced a system of demerit points to which both companies and drivers are subject: if the operators reach 200 points within a two year period, their licence is withdrawn for five years.

[31]In general, these Agencies have the role of limiting the margins of discretion of local authorities in implementing the rules, responsible, in the past, for territorial dissimilarities in the procedures for assigning licences and monitoring quality. Their function, often, is also that of representing a counterpart to the taxi associations. In some instances these authorities are part of the Ministry of Transport or of the pre-existing Authorities for local mobility, in others, they have been created as totally independent bodies.

[32]Dempsey (1996) reports that one of the principal drawbacks of deregulation in the American cities has been the high turnover rates of small independent companies. The problem has been registered also in Sweden, where, according to Kang (1998), in the first years following deregulation there have been more than 1000 bankruptcies.

cities and in the already overcrowded airport taxi stands[33].

Regarding tariffs, there is not clear-cut evidence on the effects of deregulation. A tendency to increase, however, seems to prevail. This is certainly the case for USA, Japan and Sweden[34]. In the latter, however, after an immediate increase, tariffs started decreasing, following the exit from the market of a high proportion of newcomers[35]. In Australia tariffs have remained constant in real terms; in New Zealand they have decreased in larger cities[36].

As far as waiting time is concerned, in general deregulation has failed in reducing it significantly[37]. Other aspects of the quality of the service, besides waiting time, have undoubtedly deteriorated[38], while, no significant

[33]In New Zealand and Sweden, for instance, the increase in capacity has concentrated mainly in the larger cities (Morrison (1997) and G*ä*rling et al. (1995)). Also Kang (1998), Boroski and Mildner (1998) and Fingleton et al. (1998) report concordant evidence for the USA. Furthermore, according to a number of studies, in general, in the American cities most new entry concentrated on taxi ranks which were already well served, such as airports and hotels (Frankena and Pautler (1986); Teal and Berglund (1987); Price Waterhouse (1993); Fingleton et al. (1998); Boroski and Mildner (1998)). Toner (1996) refers that, also in the U.K. experience, one of the main causes of failure of deregulation has been the overcrowding at ranks, due to their insufficient number and bad distribution.

[34]Empirical evidence gathered for the United States shows that deregulation has lead to a great volatility of tariffs, which, except for some cities, has been generally translated in an upward tendency (Dempsey (1996), Price Waterhouse (1993) and Kang (1998)). Also Frankena and Pautler (1986) report that the reduction in tariffs expected as a result of deregulation has not occurred and that, instead, they have increased. Further evidence is contained in Teal and Berglund (1987) who show that in six of the seven cities analysed tariffs have increased.

[35]See above note 32.

[36]For New Zealand there is a uniformity of judgements on the downward pressures that deregulation has exerted on tariffs (Ministry of Transport (1991) and Morrison (1997)). In particular, according to a detailed study conduced by Morrison (1997) in Wellington, the users pay less, in real terms, in 1994 than they did in 1989. He also reports that the reduction, however, has not been homogeneous among companies, in fact, he finds that for a service with equal characteristics, there is a 34% variation in the fares of the six companies analysed (similar results hold also for some American cities: in Seattle and San Diego, the second biggest company offered tariffs 15% lower respect to the leader in the market).

[37]Waiting times have reduced where the increase in the numbers of operators has been accompanies by the promotion of the radio dispatch systems (New Zealand, Australia, Sweden). In the American taxi market, according to the study of Price Waterhouse (1993), waiting times have not changed significantly if compared to pre-deregulation figures.

[38]There is a unanimous judgement concerning the deterioration of the level of quality of the service in the post deregulation era, even in countries where more care has been devoted in maintaining high quality standards (Kang (1998); Boroski and Mildner (1998); Dempsey (1996); Gaunt (1996); Toner (1996); Price Waterhouse (1993); G*ä*rling et al. (1995); Teal and Berglund (1987)). The motivations adduced are various: in Sweden, in some cities of the United Kingdom, in USA, in New Zealand and in Australia, these

innovation has taken place in the industry, with a few exceptions[39].

The increase in fares, together with stable or worsened quality and waiting time conditions, are probably at the basis of the most striking results of deregulation: demand, in general, has not expanded[40].

In conclusion, the scenario just depicted seems in line with the core of the theoretical predictions about a free entry situation as compared with a regulated setting: higher unoccupancy rate financed by higher prices.

The puzzling aspect is the ineffectiveness of the increase in the unoccupancy rate in reducing waiting times. In fact, the simple relation usually adopted to explain waiting time is unable to account for significant elements connected with the modes of functioning of the service. The effect of increases in supply may be weakened by its inappropriate distribution on the territory (e.g. concentration in airport taxi stands), the lack of adhesion of the new operators to radio dispatch systems[41] and the inefficiency of the system of FIFO queuing at stands[42].

---

results are imputed mainly to the entrance in the market of non local drivers with little language and geographical knowledge of the areas, the increase in part time workers, a low rank provisions in relation to the increased supply, poor enforcement of the rules. In particular, a number of studies point out the increased occurrence - after deregulation - of rate gouging, short trips refusal, refusal to serve suburban areas, discourteous treatment of passengers and fights at the taxi ranks.

[39] Although some innovative services have been introduced after deregulation, both the quantitative and qualitative level of these additional or modified services has been limited, and, in most cases, well below the expectations (Kang (1998); Gaunt (1996); Teal and Berglund (1987) and G*ä*rling et al. (1995)). The innovations have consisted, mainly, in new transport services via taxis - minicabs, forms of collaborations between taxi and public bus services, specialised taxis for company services, exclusive taxis (VIP services), specialised services (night rides, "women only" taxis) - and in the use of taxis for non customary service - distribution of mail and marketing (New Zealand, Japan, and, in part, Sweden). No significant innovations have been introduced, instead, in the UK, USA or Australia (Kang (1998); Boroski and Mildner (1998); Dempsey (1996); Gaunt (1996); Frankena and Pautler (1986)).

[40] The great majority of studies concord that demand has not varied significantly after deregulation. For instance, G*ä*rling et al. (1995) - comparing the demand for taxi services in the different sized municipalities in Sweden in the pre and post deregulation periods - found that demand, generally decreased in larger towns, while, in small and medium size towns, where it showed slight increases, these did not appear to be statistically significant.

[41] Many mono-vehicular operators, in fact, have entered the business without using radio dispatching services, that, have instead a determinant role in coordinating supply and demand.

[42] Many authors emphasise how the FIFO discipline hampers the development of the potential competition that should naturally stem from the presence of a higher number of suppliers at stands (Frankena and Pautler (1986); Teal and Berglund (1987); Price Waterhouse (1993); Boroski and Mildner (1998)).

Table 1: Some results of deregulation

Country-City	Supply	Tariff level	Quality and waiting time	Industrial structure	Innovation	Drivers' conditions
AUSTRALIA	no significant increase	no significant increase	limited reduction in waiting times	increase in leasing practices	no new services	reduction in drivers salaries
Adelaide	no significant increase in taxis, sharp increase of hire cars (from 50 to 900 between 1991-1997)	increases in line with inflation	slightly reduced waiting times	significant increase of leasing (from 70 (1989) to 527 (1998)), appearance of lease management companies	no new services	reduction of 13% in salaries between 1983 and 1996
JAPAN	increase	generally increased but differently in the country	no significant changes	significant reduction in the number of operating areas	new services	no evidence of significant changes
Tokyo	increase (1,500 new taxis between 1993-1996)	differentiated increase, introduction of tariff zones	no significant changes	prevalence of large companies	blue line service (night service), collective taxis, shared rides	no significant changes
NEW ZEALAND	increase (+68%) especially in larger cities	reduced in larger cities, slight increases in smaller municipalities	lower quality of drivers, reduced waiting times	reduced concentration	new services	sharp increase in hours worked
Wellington	46% increase in taxis and 48% increase in hire cars (1989-1994)	reduced	lower quality of drivers, reduced waiting times	reduced concentration, taxi companies increased from 5 to 21 (1989-94)	new services (taxi-vans and executive taxis, mail delivery, advertising)	sharp increase in hours worked
SOUTH KOREA	Increase in hire cars					
UK	Increase of 48% in taxis and of 56% in hire cars (1986-1991)	No relevant changes; in restricted areas they have steadily risen		The composition of taxis and hire cars has not changed	No new services	
IRELAND						
Dublin	Non significant increase in the number of taxis, hire cars increase from 800 to 3,000 (1992-1997)					

Country-City	Supply	Tariff level	Quality and waiting time	Industrial structure	Innovation	Drivers' conditions
USA	Significant increases in larger cities and at airport taxi stands	Significant increases	No significant reduction in waiting times, strong deterioration in service standards	High turnover	No new services	Reduction in income
Phoenix	83% increase	12% increase	No evidence of quality competition, waiting times slightly reduced	Increase in operators' turnover, lower concentration in initial period, 40% of independent taxi left the industry within 15 months	No new services	Reduction in income
San Diego	127% increase	12% increase	No evidence of quality competition, waiting times slightly reduced	Increase in operators' turnover, lower concentration in initial period	No new services	Reduction in drivers' income
Seattle	33% increase	12% increase	No evidence of quality competition, waiting times slightly reduced	Increase in operators' turnover, more than 60% of independent taxi left the industry within 18 months	No new services	Reduction in income
SWEDEN	75% increase within the first two years of the reform	Increase in the first years after deregulation, reduction in the following years	Lower quality of service and of drivers, increased waiting times	Fragmentation of supply, high turnover rates	Some new services	deteriorated conditions
Stockholm	Almost doubled	Increase in the first years after deregulation, reduction in the following years	Increase in complaints, quality of drivers has deteriorated, no relevant reduction in waiting times	Small and often monovehicular companies dominate the market, high mortality-natality rate, productivity has increased	Substantial increase in the number of vehicles of greater size 6-8 seats) and growth in the specialised businesses	Introduction of "commission wages", increase in the working hours

—**Sources**: Boroski and Mildner (1998); Fingleton et al. (1998); Kang (1998);
— Radbone (1998) and others.

5 Towards a new model of regulation: an agenda for future work

Following the disappointing results of deregulation, the idea that it would be better to search for new rules to re-regulate the sector - instead of relying on a pure return to the free market - is gaining more consensus.

In fact, there seems to be a vast agreement on the need to rethink the regulatory schemes, in particular with respect to the structure of incentives directed at guaranteeing predetermined standards in the provision of the service.

However, in the vast literature on taxis, except for a few interesting insights (Arnott (1996); Fingleton et al. (1998)), little attention has been devoted to the development of optimal regulatory mechanisms.

Also in this paper we limit ourselves to mention some of the main elements that should be considered and to put forward, mainly as an agenda for future work, a first provisional discussion of the fundamental ingredients of a new model of regulation.

A first point might be stressed: a new regulatory design would have better chances of success if supported by a higher degree of contestability of the market, which could be attained stimulating competition from sectors producing close substitutes of the traditional taxi service (taxi-busses, collective taxis, hire cars, moto-taxi, and so on), which should be left free to operate in an unregulated regime. This form of "external" competition should be fostered to reduce the informational rents of the taxi operators.

The regulatory framework would be characterised by a two distinct principal - agent relationships: at a first level, the relationship is between the regulator and the regulated private firms, while, at the second level, the relationship is between the companies and the taxi drivers.

The latter one has received greater attention in the literature (see, for instance, Arnott (1996)). The problem is mainly, although not exclusively, of moral hazard and the incentive mechanism can be drawn along lines by now consolidated in the literature. This will take different forms on account of the relationship that links the drivers to the company (the two main hypothesis are that of a taxi driver being a member of a cooperative or an employee of a taxi company, H*ä*ckner and Nyberg (1995)).

More complex problems arise at the first level of the hierarchy. In the first place, it is necessary to define the structure of the market in terms of the optimal number of operators: would it be preferable one large company operating as a regulated monopolist or a number of operators? In answering the question, two main issues should be addressed, the first one related to

technology, the second one, instead, to the nature of the informative problem.

With regards to the first issue, it could be assumed that a single firm could enjoy density economies in terms of waiting time and that, therefore, a regulated monopoly would be the efficient solution[43]. Some authors (Schroeter (1983); Arnott (1996)), however, suggest that diseconomies of dispatching could emerge, due to problems of coordination and to limited scheduling capacity. While this would support a different solution, it is reasonable to think that technological developments lower the importance and the effect of these diseconomies: highly computerised systems should be able, at least in principle, to deal effectively with peaks in demand.

With regard to the second issue, it should be assumed that the number of agents operating in the market does not modify the nature of the informative problem. It could, however, influence the design of the incentive mechanism.

A relevant distinction concerns the type of service that the taxi operators are required to offer. This in fact, could be either homogeneous or differentiated.

In the first case, the existence of more companies will consent to take advantage of the correlation among their costs to reduce the information rent: a scheme conditioning the incentives of each firm to the performance of the others - a case amply treated in the literature - would achieve this objective. In a limit case, assuming that operators are risk neutral, that it is impossible for them to collude and that the correlation between costs is perfect, the first best solution (the one that would be implemented in the absence of the informative problem) would be achievable without any cost for the regulator.

As the more relevant obstacle to this outcome is the possibility of collusion between different operators, it is necessary to search for a costly "collusion proof " incentive mechanism.

Thus, in formulating the choice between leaving the market to a single agent or letting more companies operate, the cost, for the regulator, associated to the possibility of collusion should be balanced against the benefits deriving from the possibility to take advantage from the correlation among the costs of the various operators. In this case the determination of the optimal number of agents becomes endogenous to the construction of the optimal incentive mechanism.

The model of a single and undifferentiated taxi service should however be overcome in favour of a segmentation of the sector, which should provide different products at different prices[44]. A first, important dimension of possible

[43] Arguments in favour of delegating the provision of the service to a single operator can be found in Yang and Wong (1998) and La Croix et al. (1986).

differentiation of the service concerns waiting time. The greatest limit of all the literature on taxis is the reference, in the judgement of efficiency, to the "representative consumer", which allows to assign a unique value of waiting time to different individuals. Instead, in a world of heterogeneous consumers, with a given distribution of the value of waiting time, any hypothesis of a unique monetary price for the service would be inefficient.

Probably the most relevant improvement in efficiency in the taxi market will be possible only when a proper system of tariffs' differentiation in relation to scheduled (and effective) waiting time is defined.

Besides waiting time, however, a number of other factors might contribute to differentiate the quality of the service: the type of car, the level of comfort, the provision of auxiliary services (on board fax, telephone or computer, etc.).

Thus, in the perspective of a multi-product taxi service, the reasons supporting the choice of a plurality of operators are even stronger. A market structure with more than one firm - each providing a specific type of service with a different pricing system - would be preferable to a regulated monopoly for two main reasons: on the one hand, it would eliminate the risk of cost padding, typical of a multi-product monopoly; on the other hand, it would allow the regulator to take greater advantage, in terms of reduction of informative rents, from the forms of "external competition" mentioned above, which are specialistic in their nature.

[44]This is one of the main goals of some designs of reform that are currently being implemented in some European countries, such as the Netherlands, Sweden and Italy.

References

Arnott, R. (1996). Taxi travel should be subsidized. *Journal of Urban Economics*, 40:316–333. 2, 5, 24, 24, 25

Beesley, M. E. (1992). *Privatisation, regulation and deregulation*. Routledge, London.

Beesley, M. E. and Glaister, S. (1983). Information for regulating: the case of taxis. *Economic Journal*, 93:594–615. Reprinted in M. E. Beesley 1992, Ch. 8. 5, 6

Bergantino, A. S. and Longobardi, E. (2000). The drawbacks of deregulation in the taxi market: evidence from the international scenario and the Italian experience. In *Urban Transport 2000*. WIT Press, Southampton. 18

Boroski, J. W. and Mildner, G. C. S. (1998). An economic analysis of taxicab regulation in Portland, Oregon. Report, Cascade Policy Institute. 1-34. 15, 20, 20, 20, 21, 21, 23

Brunstad, R. J. (1991). The taxi market - excess capacity and insufficient supply. Discussion Paper 11/91, Norwegian School of Economics and Business Administration. 2, 4, 5, 13, 13, 13

Cairns, R. D. and Liston-Heyes, C. (1996). Competition and regulation in the taxi industry. *Journal of Public Economics*, 59:1–15. 2, 4, 5, 12

Carlton, D. and Perloff, J. (1994). *Modern industrial organization*. HarperCollins, New York. 16

Chiang, A. C. (1974). *Fundamental methods of mathematical economics*. McGraw-Hill, London, 2nd edition. 9

Consumer Policy Institute (1997). Putting customers first: taxicab reform in the Greater Toronto Area. Report, Toronto, Canada. (Internet). 16

De Vany, A. S. (1975). Capacity utilization under alternative regulatory restraints: an analysis of taxi markets. *Journal of Political Economy*, 83:83–94. Reprinted in Mohring (1994), Ch. 4. 2, 3, 5, 6

Dempsey, P. S. (1996). Taxi industry regulation, deregulation and reregulation: The paradox of market faliure. *Transportation Law Journal*, 24(1):73–120. 19, 20, 20, 21

Douglas, G. W. (1972). Price regulation and optimal service standards. The taxicab industry. *Journal of Transport Economics and Policy*, 20:116–127. 2, 5, 6, 12, 13, 13, 13

Fingleton, J., Evans, J., and Hogan, O. (1998). The Dublin taxi market: Re-regulate or stay queuing? Blue paper, Policy Institute, Dublin. 12, 15, 16, 20, 20, 23, 24

Frankena, M. and Pautler, P. (1986). Taxicab regulation: an economic analysis. *Research in Law and Economics*, 9:129–165. 20, 20, 21, 21

Gaunt, C. (1996). Taxicab deregualtion in New Zealand. *Journal of Transport Economics and Policy*, 30(1):103–106. 20, 21, 21

Gärling, T., Laitilia, T., Marell, A., and Westin, K. (1995). A note on the short term effects of deregulation of the Swedish taxi-cab industry. *Journal of Transport Economics and Policy*, 29(2):209–214. 20, 20, 21, 21

Goldsmith, S. (1997). Regulation and the urban market place. *Regulation*, (1). 16

Häckner, J. and Nyberg, S. (1995). Deregulating taxi services. a word of caution. *Journal of Transport Economics and Policy*, pages 195–207. 2, 3, 24

Holle, P. (1997). Taxi deregulation would benefit public. *The Winnipeg Sun*. 15

Kahn, A. E. (1975). *The economics of regulation - Vol.2*. John Wiley and Sons, Inc., New York. 16

Kang, C. (1998). Taxi deregulation: an international comparison. Technical report, ITF House. 14, 15, 16, 17, 17, 18, 19, 19, 20, 20, 20, 21, 21, 23

La Croix, S. J., Mak, J., and Miklius, W. (1986). Airport taxi service regulation - an analysis of an exclusive contract. *Transportation*. 25

Ministry of Transport (1991). Taxi industry-progress report. Technical report, Wellington, New Zealand. 20

Mohring, H., editor (1994). *The Economics of Transport*, volume II. Edward Elgar Publishing Limited, University Press, Cambridge.

Morrison, P. S. (1997). Restructuring effects of deregulation: the case of the New Zealand taxi industry. *Environment and Planning A*, 29:913–928. 20, 20, 20

Orr, D. (1969). The "taxicab problem": A proposed solution. *Journal of Political Economy*, 77(1). 2

Price Waterhouse (1993). Analysis of taxicab deregulatuion and re-regulation. Report prepared for the international taxicab foundation, Washington D.C. 20, 20, 20, 20, 21

Radbone, I. (1998). Looking at Adelaide's taxi industry. *Road and Transport Research*, 7(2):52–59. 15, 23

Schroeter, J. R. (1983). A model of taxi service under fare structure and fleet size regulation. *The Bell Journal of Economics*, pages 81–96. Reprinted in Mohring (1994), Ch. 3. 4, 4, 5, 5, 25

Shreiber, C. (1975). The economic regulation of taxicabs. *Journal of Transport Economics and Policy*, 9:268–279. 2, 12, 17

Taylor, D. W. (1989). The economic effects of the direct regulation of the taxcicab industry in Metropolitan Toronto. *Logistics and Transportation Review*, 25:167–179. 15

Teal, R. F. and Berglund, M. (1987). The impact of taxicab deregulation in the USA. *Journal of Transport Economics and Policy*, 21(1). 16, 20, 20, 20, 21, 21

Toner, J. P. (1996). English experience of deregulation of the taxi industry. *Transport Reviews*, 16(1):79–94. 20, 20

US Federal Trade Commission (1984). An economic analysis of taxicab regulation. Staff report, Federal Trade Bureau of Economics, Washington D.C. 14

Viscusi, W. K., Vernon, J. M., and Harrington, J. E. (1996). *Economics of deregulation and Antitrust*. MIT Press, Cambridge, Massachusetts, 2nd edition. 16, 16

Walters, S. J. (1993). *Enterprise, government and the public*. McGraw-Hill, Inc. 16

Yang, H. and Wong, S. C. (1998). A network model of urban taxi services. *Transport research - B*, 32:235–246. 25