QUALITY COMPETITION IN BUS SERVICES

Some Welfare Implications of Bus Deregulation

By J. S. Dodgson and Y. Katsoulacos*

Local bus services in Great Britain were deregulated from 26 October 1986, when it ceased to be necessary to have a road service licence for every route operated. The Government's rationale for the changes in the industry was explained in the White Paper Buses (Department of Transport et al., 1984), and the issues were debated in particular by Beesley and Glaister (1985a, 1985b), who were in favour of the proposals, and by Gwilliam, Nash and Mackie (1985a, 1985b), who were opposed to them.

One of the sources of contention was the likely role, and the welfare implications, of competition between buses of different sizes, and particularly between conventional sized double-deck buses and minibuses in urban areas. The White Paper, and supporting simulation modelling exercises by Glaister (1985, 1986), suggested that minibuses would have an important (and generally positive) part to play in urban transport. Using detailed data for city centre routes in London and Aberdeen, Glaister concluded that small buses would have a role to play in offering higher frequency services, usually at higher fares, than conventional buses. In many circumstances (and this result was particularly striking in the simulations for Aberdeen) the smaller buses might completely displace the larger ones. On densely-trafficked routes the bigger buses would continue to operate, though with lower frequencies. However, while many travellers would find an improved service with more frequent buses, poorer people might be worse off because of the smaller numbers available of big buses charging lower fares.

Our objective in the present paper is to study some of the potential welfare effects of bus deregulation on the basis of a model of quality competition in bus services which enables us to determine equilibrium quality and fare levels. Such models of quality competition have been developed in particular by Shaked and Sutton (1982a). Using this model, we are able to show that a competitive outcome, in which two firms operate bus services of distinct qualities in an urban area, is indeed plausible. We are then able to use the resulting equilibrium to

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analyse the possible impact of competition, as opposed to that of regulated (monopoly) operation on welfare.

We show that this will depend on two factors:

(i) The weight given by the public monopolist to profits as opposed to consumers' surplus. The higher this weight, the more likely is it that all consumers will benefit from the impact of competition.

(ii) The behaviour of total unit costs as the quality of bus service is improved relative to the behaviour of consumers' willingness to pay for these quality improvements. When total unit costs increase rapidly, even relatively to the willingness of high-income consumers to pay for quality improvements, it is likely that all consumers will find their welfare reduced with competition.

A MODEL OF QUALITY COMPETITION

Introduction

The types of bus routes we wish to analyse are urban routes with higher consumer density, where buses run at very high frequencies. This, in turn, implies that bus firms need not operate their services according to a fixed timetable, but rather that consumers need only be informed of the frequency of each service. It may then be reasonable to assume that consumers distinguish bus services in terms of a single quality variable, $q$, which represents expected journey time, which may be thought of as the difference between the time the consumer arrives at the bus stop and the time he arrives at his destination point. The value of $q$, $q_r$, for a bus service $r$ will depend on the frequency at which it is operated, in terms of headway (in minutes) between journeys, which we denote by $z$, and on the type and hence the speed of the vehicle used. For simplicity we will ignore this latter influence, and we will assume that

$$q = q(z), \quad q' < 0$$

(1)

We consider market competition between bus services when these services are differentiated only in terms of $q$. This implies a model of vertical product differentiation, where with equal fares all consumers agree on which is the best service, which is the second best, and so on. Alternative models of horizontal product differentiation in the bus industry, where consumers differ on which service they prefer when all fares are the same, have been developed by Foster and Golay (1986) and Evans (1987).\(^1\) We use our model to derive a market equilibrium in which firms choose distinct qualities (that is, frequencies) and charge different fares. In later sections of the paper we compare this market equilibrium with that which a publicly-operated bus firm might have offered.

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\(^1\) Evans (1987) considers competition between bus services within a spatial competition framework in which the product is differentiated only in terms of departure time and not in terms of vehicle size. He suggests that in such circumstances a competitive equilibrium will involve equal fares and equal headways between buses.
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Main assumptions

We consider a route between two points; we assume that the return distance is unity and that there are no intermediate bus stops. Each consumer either purchases one (return) bus trip per period or uses no bus services at all. Where the period of analysis is a single day this is a common situation in public transport, since travellers to and from work or school may choose to travel either by bus or by an alternative mode.

We will assume that consumers make their decision as to which type of bus service to use on the basis of maximizing expected utility, and will then always use the type of service which maximizes expected utility. This situation might arise where the bus services used different boarding points, or where regular passengers were able to buy discounted season tickets valid only for one type of bus.

All consumers are identical in tastes but differ in income, \( y \).\(^3\) Income is assumed to be distributed uniformly as shown in Figure 1, where \( s \) is our measure of market size. Income level \( b \) is the income level of the richest consumer, though it can also be interpreted as the maximum income of those consumers without a car in the circumstances where all consumers with an income level above \( b \) own and use a car in preference to the bus service. (Income level \( b \) will be invariant to the price and quality of bus services in the model we develop.)

Assume that \( n \) distinct services are on offer. The use of service \( r \) at price \( p_r \) gives consumers utility of

\[
q_r(y - p_r)
\]

where we rank the \( n \) services in terms of quality so that

\[q_1 > q_2 > \ldots > q_n,\]

and where it should be noted that \( q_1 \) represents the highest level of quality, and \((y - p_r)\) is the amount left to be spent on some "outside" good.

The consumer's utility will be

\[q_0y; q_0 < q_n\] (3)

if no bus service is used. We will use the following notation:

\[
\tilde{C}_r = \frac{q_r}{q_r - q_{r+1}} > 1, r = 1, \ldots , n - 1
\] (4)

and

\(^2\) Expected utility is based on expected journey time when the passenger does not know precisely when a bus will arrive. Once a passenger is at a bus stop and can observe buses, the information on how long a journey may take changes, and a passenger may revise his decision as to which bus to travel on. For example, a higher income traveller may prefer to travel by a high-frequency high-fare service rather than by a low-frequency low-fare service. However, on some occasions he might find a low-frequency bus just ready to depart and might then switch to it. Allowing for such possibilities would considerably complicate our analysis.

\(^3\) We could alternatively have assumed that consumers have identical incomes but differ in terms of a taste parameter.
\[ \tilde{C}_n = \frac{q_n}{q_n - q_0}, \quad r = n \]  

(5)

Revenue and cost functions

Let \( y_r \) indicate the income that would make a consumer indifferent between services \( r \) and \( r + 1 \) when these are offered at \( p_r \) and \( p_{r+1} \), respectively. That is, \( y_r \) is defined by

\[ q_r(y - p_r) = q_{r+1}(y - p_{r+1}); \quad r = 1, \ldots, n - 1 \]  

(6)

and by

\[ q_r(y - p_r) = q_0 y; \quad r = n \]

Thus

\[ y_r = p_r \tilde{C}_r + (1 - \tilde{C}_r)p_{r+1}; \quad r = 1, \ldots, n - 1 \]  

(7)

and

\[ y_r = p_r \tilde{C}_r; \quad r = n \]
From the utility function (2), consumers of income $y > y_r$ strictly prefer $r$ to $r+1$ at prices $p_r$ and $p_{r+1}$, respectively (and consumers of income $y > y_n$ strictly prefer $n$ at $p_n$ to getting no bus service at all). Thus, given a price vector, we can use the marginal incomes defined by equations (7) above to partition consumers into segments corresponding to the successive market shares of firms.

To clarify this, assume for simplicity that only two bus services $q_1$ and $q_2 (< q_1)$ are offered at $p_1$ and $p_2$ respectively, so that $y_1$ and $y_2$ are as shown in Figure 2. Then, at these prices, demand for trips by services 1 and 2 is given by:

$$s(b - y_1) = X_1$$  
$$s(y_1 - y_2) = X_2$$  

while $s(y_2 - a)$ is the number of consumers who do not use bus services. Using (6) and (7), we may rewrite the demand functions for the two bus services as follows:
\[ X_1 = s[b - p_1 \tilde{C}_1 + (\tilde{C}_1 - 1)p_2] \quad (8') \]
\[ X_2 = s[p_1C_1 - (\tilde{C}_1 - 1)p_2 - p_2 \tilde{C}_2] \quad (9') \]

**Revenues**

We can now define the firms’ revenue functions as follows. For firm \( n \):
\[ sR_n = \begin{cases} 
sp_n(y_{n-1} - a) & y_n \leq a \\
sp_n(y_{n-1} - y_n) & y_n \geq a 
\end{cases} \quad (10) \]

for firm \( r, 1 < r < n \):
\[ sR_r = sp_r(y_{r-1} - y_r) \quad (11) \]

and for firm \( 1 \):
\[ sR_1 = sp_1(b - y_1) \quad (12) \]

So \( R \) refers to the revenue function for a market size \( s = 1 \), and revenue is proportional to market size.

**Costs**

Assume that total operating costs of service \( r, C_r \), depend on bus-kilometres and the number of buses operated, where marginal costs per bus-kilometre are a fixed amount, \( c \), and costs per bus rise linearly with bus size (that is, capacity), and so are represented by \( \gamma B_r \), where \( \gamma \) is a positive constant and \( B_r \) is bus size. We can then write total costs as
\[ C_r = c \frac{T}{z_r} + \gamma B_r \frac{\tau}{z_r} \quad (13) \]

where
- \( T \) = number of minutes per period,
- \( z_r \) = headway in minutes for service \( r \),
- \( \tau \) = time of a return trip in minutes, and hence
- \( T/z_r \) = number of bus trips operated = number of bus kilometres (since 1 trip = 1 kilometre), and
- \( \tau/z_r \) = number of buses required.

For cost minimisation buses should be operated with a 100 per cent load factor. If this is so the size (that is, capacity) of the bus will equal total passengers carried per period of time, \( X_r \), divided by total bus trips operated, that is,
\[ B_r = \frac{X_r z_r}{T} \quad (14) \]

Substituting in (13)

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\[ C_r = c \frac{T}{z_r} + \gamma \frac{X_r z_r}{T} \frac{T}{z_r} = c \frac{T}{z_r} + \bar{c} X_r \]  

(15)  

where \( \bar{c} \) is a constant equal to \( \gamma r / T \).  
From (14), we can also express (15) as  

\[ C_r = \frac{c}{B_r} X_r + \bar{c} X_r \]  

(16)  

so that average cost per passenger is  

\[ \frac{C_r}{X_r} = \frac{c}{B_r} + \bar{c} \]  

(17)  

where it should be remembered that, with headway \( z_r \) fixed, \( B_r \) increases with \( X_r \) to maintain \( X_r / B_r \) fixed.  
Thus, given headway \( z_r \), a firm’s total cost function is a linear function of passenger trips with constant marginal and unit variable cost, \( \bar{c} \), identical for all firms.  
Note that, having determined optimal values of demand, \( X^*_r \), and headway, \( z^*_r \), we can determine optimal passengers per journey from (14); and this also yields optimal bus size, since for cost minimisation optimal bus size is \( B^*_r \).  
Figure 3 illustrates a cost-minimising firm’s unit cost curve for service \( r \) (that is, cost per passenger trip offered by this service) when operating buses of capacity \( B_r \). An increase in quality (reduction in headway) will shift the unit cost curve upwards.  

The market equilibrium  
Our objective is to determine the market equilibrium number of firms and the prices charged and qualities offered by these firms. To achieve this we split the firms’ decisions into three stages (see Shaked and Sutton, 1982a). First in stage 3 we assume that a given number, \( n \), of firms have entered the market and offer distinct qualities \( q_1 > q_2 > \ldots > q_n \). Given this we can determine Nash equilibrium prices in terms of these quality levels.\(^4\) We can then, in stage 2, determine the firms’ optimal quality levels, given their Nash equilibrium price choices of stage 3. Finally the optimal entry decision can be determined in stage 1, given the equilibrium quality and price choices of stages 2 and 3.  

But for a small difference, the above model is identical to that used by Shaked and Sutton (1982a, 1982b). The difference is that in our analysis firms face a positive unit variable cost of \( c \) in stage 3 competition, whereas in Shaked and Sutton’s papers unit variable cost is zero. However, as we show below, this is not fundamental, so our results will be similar to those of Shaked and Sutton. Thus we refer the reader to their analysis rather than derive their results.  

The most important result to emerge from the Shaked and Sutton analysis of quality competition is that, under certain conditions (all satisfied by the present

\(^4\) That is, a price vector \( (p^*_1, \ldots, p^*_n) \) such that \( p^*_i \) maximises \( i \)'s profits given all other firms' prices, this being true for all \( i = 1, \ldots, n \).
model), a limited number of firms will survive in the price equilibrium of such competition, since only a limited number of firms will be able to charge prices greater than or equal to unit variable cost and obtain, at these prices, a positive market share. To see that this holds here, consider the first order conditions for profit maximisation in stage 3. In this stage firms maximise (10) – (12) net of variable costs.

Assume that all firms except the two firms offering the two top qualities \( q_1 \) and \( q_2 \) offer their products at unit variable cost \( \bar{c} \). Revenues, net of variable costs, for firms 1 and 2 are, respectively,

\[
s(p_1 - \bar{c})(b - y_1)
\]

and

\[
s(p_2 - \bar{c})(y_1 - y_2)
\]

Maximisation of (18) and (19) with respect to \( p_1 \) and \( p_2 \) requires that

\[
b - y_1 - (p_1 - \bar{c})\bar{C}_1 = 0
\]

and

\[
y_1 - y_2 + (p_2 - \bar{c})(1 - \bar{C}_1 - \bar{C}_2) = 0
\]

From equations (7), \( y_1 = p_1 \bar{C}_1 + (1 - \bar{C}_1)p_2 \), while, given that \( p_3 = \bar{c}, y_2 = p_2 \bar{C}_3 + (1 - \bar{C}_2)\bar{c} \). Thus (20) and (21) can be rewritten as follows:

\[
b - 2y_1 + \bar{c} - (\bar{C}_1 - 1)(p_2 - \bar{c}) = 0
\]

and

\[
y_1 - 2y_2 + \bar{c} - (\bar{C}_1 - 1)(p_2 - \bar{c}) = 0
\]

The last two equations imply that

\[
b - 2y_1 + \bar{c} > 0
\]

and

\[
y_1 - 2y_2 + \bar{c} > 0
\]

Hence

\[
b > 4y_2 - 3\bar{c}
\]

Thus, for as long as \( b < 4a - 3\bar{c}, a > y_2 \), so even the poorest consumers prefer \( q_2 \) to the next best quality offered at \( \bar{c} \). Alternatively, if \( b < 4a - 3c \) in any Nash equilibrium involving the distinct qualities \( q_1, q_2, \ldots, q_n \), at most the top two will have positive market shares at equilibrium. Thus the fact that \( \bar{c} > 0 \) does not change anything of significance in the Shaked and Sutton analysis (where the above condition reduces to \( b < 4a \)). So we can, for simplicity, suppress \( \bar{c} \) and use their results directly.

As far as the price competition (stage 3) is concerned, they show (Shaked and Sutton, 1982a) that for as long as \( 2a < b < 4a \) equilibrium will involve exactly two firms, with positive market shares and with the market covered (that is, \( y_2 < a \)). In this equilibrium the low quality firm charges a price less than or equal
to the price \( (p^*) \) that the poorest consumer is prepared to pay rather than purchase no bus service at all. The price of the high quality firm is above this price (that is, \( p_1 > p^* \)), and output of the high quality firm exceeds output of the low quality firm (that is, \( X_1 > X_2 \)).

Optimal quality and entry choice
Turning to the second stage of the game where firms choose quality, \( q(x) \), and assuming that only two firms have entered the market, we can use equations (13) and (1) above to express the firms’ total cost function as \( F(q) \), where \( F'(q) > 0 \). We will also express the revenue function of a firm offering a service of quality \( q_1 \) when its rival offers a service of quality \( q_2 \) at a Nash equilibrium in prices by \( R(q_1; q_2) \). These revenue functions can be written for the case where \( y_2 = a \), as follows:
\[ R_1(q_1; q_2) = \frac{[b + a(v - 1)]^2}{4\tilde{C}_1} \]  
(22)

\[ R_2(q_2; q_1) = \frac{a[b - (v + 1)]^2}{2\tilde{C}_2} \]  
(23)

where

\[ v = \frac{\tilde{C}_1 - 1}{\tilde{C}_2} + 1 \]  
(24)

Thus our profit functions can now be defined as the difference between the revenues, defined by equations (22) and (23), and \( F(q) \). It can then be established (see Shaked and Sutton (1982b)) that, provided \( F \) satisfies certain properties (that make it "sufficiently convex") and the size of the market is sufficiently large, there is a unique equilibrium in the quality competition game, and the two firms choose distinct qualities. This conclusion is reached on the assumption that only two firms have entered the market. To complete the description of market equilibrium we need only apply Theorem 1 of Shaked and Sutton (1982b). This proves that the above three-stage game has a unique (perfect) equilibrium in which it is indeed true that exactly two firms enter.

We have described a possible market equilibrium, in which competition in bus services on a dense urban route will lead to a Nash equilibrium in which only two firms compete by offering distinctly different frequencies. We now turn to an examination of the supply of bus services under the assumption that a public monopoly is the sole supplier.

**EQUILIBRIUM WITH A PUBLIC MONOPOLIST**

In analysing the equilibrium of the public monopolist (PM), we have to face the standard problems of the choice of the monopolist's objective and the implications of this objective when he has to choose both an optimal price and an optimal quality of service. In common with other studies, we start by assuming that the objective is to maximise patronage subject to a no-loss constraint. Because many price-quality pairs will satisfy this objective, we require a secondary objective to make a comparison with the market equilibrium feasible.

Consider first the price-quality pairs which satisfy the primary objective of maximisation of patronage subject to a breakeven constraint. If it is possible to operate the bus service without losses there must be some value of headway, \( z_m \), such that, when output is equal to \( X_m \) \([z_m(b - a)]\) and the market is covered, unit cost is less than or equal to the fare, \( p^a \), which the poorest consumer is prepared to pay rather than not purchase a bus trip. From the utility function in equations (2) and (3), this fare is defined in terms of the price which for the consumer with income level \( a \) makes the utility from the lower quality service just equal to his utility from not travelling. Hence

\[ u = q_2 (a - p^a) = q_0 a \]  
(25)

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and so

\[ p^a = \frac{q_2 - q_0}{q_2} \quad (26) \]

This price is plotted against headway in Figure 4. Combinations of fare and headway above the curve will yield the poorest consumer lower utility, so he will not travel at all; combinations below will yield him higher utility.

Unit costs for the public monopolist are denoted by \( c(z, X) \). On the assumption that the increase in unit costs as headway is reduced (that is, as quality is increased) is faster than the increase in the maximum price the poorest consumer is prepared to pay, the maximum quality which the public monopolist can provide while still covering costs is indicated by the intersection of the two curves in Figure 4. This yields a minimum headway of \( \varepsilon_m \) and hence a maximum quality of \( q_m \).

On the other hand the minimum quality, \( q_m \), which the public monopolist could provide is determined by the maximum headway, \( \bar{z}_m \). This maximum headway is that which would generate enough demand to enable the market to be covered by an operator using buses of the largest capacity available; and this would enable the monopolist to minimise cost per passenger trip. This maximum headway is also shown in Figure 4.

As noted at the beginning of this section, we require a secondary objective to choose a determinate level of quality from the range between minimum and maximum levels determined above and illustrated in Figure 4. Our secondary objective is that the public monopolist chooses the quality of service which maximises profits from the maximum patronage level of output. Since to maximise patronage we have seen that he must charge a price along (or below) \( p^a \), profit maximisation requires choosing the level of headway (and hence quality) which maximises the difference between \( p^a \) and the unit cost curve, \( c \).

The attractiveness of our secondary assumption is that it allows us to consider the implications of a range of different PM objectives. Let the value of \( q \) that maximises the difference between \( p^a \) and \( c \) be \( q^* \), and let the associated value of headway (illustrated in Figure 4) be \( z^* \). If the public monopolist charges a price \( p_m = p^a(q^*) \), he maximises retained profits. In the other extreme he may charge a price \( p_m \) equal to unit costs \( c(q^*) \), where \( c(q^*) = c[z^*, s(b - a)] \); in that case all profits are transferred to generate consumer surplus through lower prices. Then the public monopolist acts as an egalitarian welfare maximiser, since at this price the welfare of the poorest consumer is maximised.

More generally, we can assume that \( p_m^* \) will be a weighted average of \( p^a(q^*) \) and \( c(q^*) \); that is,

\[ p_m^* = \lambda p^a(q^*) + (1 - \lambda)c(q^*); 0 \leq \lambda \leq 1 \quad (27) \]

where the public monopolist is a profit maximiser if \( \lambda \) equals one, and an egalitarian welfare maximiser if \( \lambda \) equals zero.

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5 Note that the level of total surplus (i.e. profits plus consumer surplus) is unchanged even though price changes. This is because demand is at its saturation level.
FIGURE 4

The Public Monopolist's Choice of Fare and Headway
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SOME POTENTIAL WELFARE IMPLICATIONS OF BUS DEREGULATION

We can now use the results we have established to consider potential effects of bus deregulation on welfare. In our introduction we identified two main camps in the deregulation debate: one, associated with the views of the White Paper, argues that the likely effect of deregulation is to increase welfare through innovation (the introduction of high quality services) and cost reductions (improvements in unit costs as load factors improve) of big bus operators. The other, associated in particular with Gwilliam et al. (1985a, 1985b), argues that the benefits of innovations in services will not be nearly as great as the White Paper suggests, and in particular that many, especially the poorer, consumers may suffer from lower quality and higher prices of bus services.

One advantage of our model of quality competition is that it demonstrates rigorously the possibility of long-run equilibria where both high and low quality services are offered simultaneously. Right away this suggests that the welfare effect of deregulation may be equivocal. In particular, it suggests that, even if deregulation increases the welfare of some consumers near the top of the income distribution, it may well reduce the welfare of consumers near the bottom of that distribution.

In comparing the public monopolist with the competitive situation we first consider the extreme case where the public monopolist is an egalitarian welfare maximiser, and so \( \lambda \) in equation (27) is equal to zero. This enables us to focus on some factors which we believe are fundamental in determining the welfare impact of deregulation. In particular we show that whether or not welfare is reduced after deregulation will depend on the relative effect of changes in quality on the behaviour of total unit cost and on the way consumers' willingness to pay changes. With \( \lambda \) equal to zero, one expects that poor consumers will lose after deregulation. When, however, total unit cost increases very rapidly relative to the willingness to pay of even the richest consumers, the market equilibrium will be associated with a reduction in the welfare of all consumers. If this is not so, deregulation may

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**Key to Figure 4**

**Curves**
- \( p^* \): the maximum fare for each level of headway which will induce a consumer of income \( a \) (the poorest consumer) to travel
- \( c(x,X) \): the unit cost curve for the public monopolist

**Points**
- \( e_m \): the minimum break-even headway
- \( f_m \): the maximum headway
- \( z_m \): the level of headway which maximises the operator's profits when the market is covered
- \( p^*(q^*) \): the fare which maximises the operator's profits when the market is covered
- \( c(q^*) \): unit cost when profits are maximised and the market is covered

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FIGURE 5

The Case Where the Welfare of all Consumers is Decreased after Deregulation
increase the welfare of the high-income consumers, though it will still be associated with a reduction in the welfare of those with low incomes.

The case where the welfare of all consumers is reduced is illustrated in Figure 5. Since the outputs of the individual firms will be below total market output of the monopolist \(X_m = s(b - a)\), the total unit cost curves of the firms after deregulation will be above that of the public monopolist. In Figure 5 we have drawn the cost curve of firm 1 as \(c(z_1, X_1)\). We have also drawn the curve indicated by \(p^b\), which is defined analogously with \(p^a\); that is, it shows the maximum that a consumer of income \(b\) is prepared to pay for any given value of \(q(z)\) rather than not consume any bus service. The difference in the slopes of \(p^a\) and \(p^b\) reflects the fact, implicit in the utility functions of the model, that willingness to pay extra for quality improvements increases with income. The slope of curve \(p^b\) as we move to the left indicates how much a consumer of income \(b\) is willing to pay for a small increase in quality so as to maintain utility at \(q_0 b\).

Finally, we have drawn the curves \(KK'\) and \(KK''\), originating at the point \((p_m^a, z_m^a)\), with \(KK'\) having the same slope as \(p^a\) (to the left of this point) and \(KK''\) having the same slope as \(p^b\). Thus, curve \(KK''\) \((KK')\) tells us how much the price of the bus service consumed by a consumer of income \(b\) (consumer of income \(a\)) should have to rise after deregulation in order to maintain his utility at the same level as before deregulation. If the quality-price combination after deregulation results in a point above \(KK''\) \((KK')\), the welfare of a consumer of income \(b\) (income \(a\)) is reduced; in the opposite case it is increased.

In Figure 5 with \(p_m^* = c\), \(KK'\) is wholly below \(c(z_m, X_m)\) and hence below \(c(z_2, X_2)\), so consumers of income \(a\) certainly lose. All consumers lose if those of income \(b\) do so. This is true in Figure 5, since \(KK''\) lies wholly below \(c(z_1, X_1)\).

In Figure 6 we consider a case where willingness to pay by the top-income consumers increases more rapidly than unit costs for \(z \leq z_m^*\). Further, we now allow \(\lambda\) to be positive, so that \(p_m^* > c(z_m^*, X_m)\). We know, from our analysis of the market equilibrium, that the price of the high quality service \(p_1\) will be greater than \(p^a\). Thus, if this firm produces a quality between \(q(z_1^*)\) and

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**Key to Figure 5**

Curves

- \(p^a\) = the maximum fare for each level of headway which will induce a consumer of income \(a\) (the poorest consumer) to travel
- \(p^b\) = the maximum fare for each level of headway which will induce a consumer of income \(b\) (the richest consumer) to travel
- \(c(z_m, X_m)\) = the unit cost curve for the public monopolist
- \(c(z_1, X_1)\) = the unit cost curve for firm 1, the high quality firm
- \(KK'\) = this curve is vertically parallel to \(p^a\)
- \(KK''\) = this curve is vertically parallel to \(p^b\)

Points

- \(z_m^*\) = the level of headway which maximises the operator's profits when the market is covered
- \(p_m^*\) = fare charged by the public monopolist

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FIGURE 6

The Case where the Welfare of Some (or all) Consumers is Increased after Deregulation
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$q(z')$ and charges a price less than the values indicated by $KK'$, top income consumers at least will gain after deregulation. On the other hand, for the case illustrated in Figure 6 the low-income consumers' welfare declines after deregulation, since $KK'$ is wholly below $c(z_1, X_1)$ (and $c(z_2, X_2)$ will be above $c(z_1, X_1)$, since in market equilibrium $X_2 < X_1$). It is, however, clear from inspection of Figure 6 that as $\lambda$ increases, so $p^*_m$ increases, and it also becomes more likely that the market equilibrium will be associated with an increase in the welfare of all consumers.

SUMMARY AND CONCLUSIONS

After noting the debate on the possible impact of competition in the provision of local bus services as a result of their deregulation in the United Kingdom in 1986, this paper has developed a model of quality competition which seeks to determine equilibrium numbers of firms, levels of quality and levels of fares on high density urban routes.

We consider market-Nash equilibria, defined as equilibria in which the fare charged and quality chosen by each operator maximises the operator's profits, given the fares charged and qualities chosen by all other operators. Under appropriate restrictions on the consumers' distribution of income, the equilibrium solution involves only two firms, offering distinct qualities of service and charging different fares.

We next consider the output level to be produced by a public monopoly operator (that is, in a pre-deregulation environment), and we note that, given an objective of maximising journeys subject to a no-loss constraint, the operator's quality and price levels are only determinate within a range. To make comparison with the market equilibrium feasible, we assume that the monopolist chooses quality to maximise the difference between his total unit cost and the price at which the market is covered. His price may be taken to be the weighted average

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Key to Figure 6

Curves

- $p^a$ = the maximum fare for each level of headway which will induce a consumer of income $a$ (the poorest consumer) to travel
- $p^b$ = the maximum fare for each level of headway which will induce a consumer of income $b$ (the richest consumer) to travel
- $c(x_m, X_m)$ = the unit cost curve for the public monopolist
- $c(x_1, X_1)$ = the unit cost curve for firm 1, the high quality firm
- $K$ = this curve is vertically parallel to $p^b$

Points

- $z^*_m$ = the level of headway which maximises the operator's profits when the market is covered
- $p^*_m$ = fare charged by the public monopolist
of this latter price (that maximises retained profit) and the unit cost at which the utility of the marginal (poorest) consumer is maximised.

Comparing market equilibrium with that of the monopolist, we find that the impact of deregulation on welfare depends on two things:

(i) The weight given by the public monopolist to retained profits as opposed to consumer surplus. The higher is this weight, the more likely is it that all consumers benefit in the market equilibrium.

(ii) The behaviour of total unit costs as bus-service quality increases relative to the behaviour of consumers' willingness to pay for such increases in quality. When total unit costs increase more rapidly than the willingness of high income consumers to pay for quality improvements, it is likely that all consumers will find their welfare reduced after deregulation.

In conclusion, we have considered a theoretical model which accounts for an equilibrium form of competition in the bus industry of the type that was predicted as being possible in a deregulated environment. This type of competition is one in which high-quality, high-fare, minibuses compete (and co-exist) with lower-fare, lower-quality, conventional buses. Competition in the deregulated bus industry has certainly increased from the rather low levels (see Balcombe et al., 1987, pp. 1, 9) experienced in the very early days after deregulation, and there has been a very rapid growth of minibus services (see, for example, Gomez-Ibanez and Meyer, 1987, pp. 71–86). But, though it should be noted that our model is concerned with long-run equilibria, the situation where different qualities of bus services compete at different fares has so far been rather uncommon; it has been more usual to find competition between operators running at similar fare levels.\(^6\) One explanation within the framework developed by our model is that the market which is relevant for analysis is that which includes all public transport demand along a particular route. That market already supplied two forms of public transport before deregulation: namely, high-quality high fare taxis and low-quality low-fare bus services. Since our model predicts that at most two qualities of service can co-exist, given certain ranges of the income distribution, this interpretation of the model would suggest that there is very limited scope for further bus operations with distinctly different mixes of fare and quality.

REFERENCES


\(^6\) That is, of the type predicted in the papers by Evans (1987) and Foster and Golay (1986).
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