The Industrial Organization of Local Bus Services: A Survey of Economic Evidence

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Executive Summary

This report has two main objectives. First, it is aimed at providing an overview of the characteristics of the bus industry as it appears in the academic literature. Second, it proposes a set of empirical tests of the main results drawn from this literature review in support of a wider empirical investigation of the U.K. local bus service industry.

Some relatively clear-cut results are suggested by the economic literature. First, bus companies exhibit increasing returns to scale, especially smaller firms. Moreover, economies of density and economies of scope are found to be significant. Second, the demand for bus-transit is not elastic in the short run, and becomes more elastic in the long-run. Third, the theoretical literature suggests that characteristics of the bus transport industry restrict competition between operators and therefore prevent the industry from being contestable. As a result, local operators can benefit from monopolistic power and are not threatened by potential entry. Fourth, bus operators tend to compete more on frequencies, than on prices. Since consumers generally catch the first bus that arrives at a bus stop, there is limited scope for competition on prices at the route level. Fifth, bus operators behave strategically to maintain their monopolistic power on routes where several operators are present. In particular, operators propose random time schedules, which allow them to keep prices high.

Starting from the observation that many results in the literature are theoretically derived and that empirical tests are often missing, we propose a series of empirical investigations that could be implemented on the available data. More specifically the idea is to suggest methods for testing the main null hypotheses that can be drawn from our review of the literature, with the objective of enabling the detection of possible predatory or collusive practices or the absence of consumer harm.

Introduction

In most countries, local transport services by bus, which are a major component of regional passenger transportation systems, are subject to the scrutiny of policy makers for at least two contextual reasons. First, while the passenger transport services have always been highly regulated, the public transportation policy is now experiencing deregulation and/or privatization in an industry where urban transport companies are heterogeneous in their ownership status, which can be public or private, as well as in the diversity of transport modes they offer (bus, train, underground, and tramway). Second, while the modal share of bus transport services has been declining for several decades in most developed economies, the growing environmental concern raises the calls for promoting urban mass transit (as opposed to private car).

The Competition Commission is conducting a study with the aim of deepening the understanding of the functioning of competition in the local bus transportation industry in the UK and to evaluate its effectiveness. The Commission contracted us (*i*) to provide an overview of the competitive constraints that are at work in the industry as discussed in the economic literature, and (*ii*) to propose empirical tests to check whether the intuitions provided by the economists are in line with the reality of the industry. To address these various issues, in the first three sections of this text we survey the economic literature on bus competition, emphasizing the case of UK when possible. We suggest that earlier contributions, proposed in the late eighties, (i.e., just after the deregulation of the industry) are very often based on unrealistic assumptions, mainly chosen because the authors lack of a sufficient perspective on the effects of deregulation. Hence, we focus on the most recent literature, which we attempt to survey as completely as possible. The objective is to draw the main conclusions or results which are shared by the analysts or researchers on how this economic activity functions. In the last section, we propose some methods to empirically test these main predictions of the economic literature. Note that the implementation of these tests, aimed at understanding the strategic behaviour of bus operators and the rationale of consumers' decisions is conditional on the availability of data that the Competition Commission can collect during the present enquiry.

The study is summarized as follows. Section 1 reviews what it is empirically known about the technological features and the economic performance of bus operators.[1] Technological measures like economies of scale or measures of performance like the level of technical efficiency, and more specifically identification of their determinants, are crucial in a context of structural changes in the bus industry. Several questions have been addressed in the literature in order to understand what regulatory or ownership regime is best suited to this industry in different countries. Research has mainly focused on the merits of public versus private bus operations, on the desirability of regulatory reforms, on how to reduce costs and subsidies, and on the effects of introducing competitive tendering in the industry. We first define the technical and performance measures we refer to in this survey and which have been the focus of the literature on the topic. We then give the most important results to which most studies converge. That is to say we present the findings on operators' efficiency, and on the ownership, regulatory and competitive factors affecting the performance of these firms. We finally describe the main discrepancies in approaches and methodologies which can affect the results of a performance analysis and we propose some research leads which we think could improve the accuracy of such studies. The main result of this section is that bus companies exhibit increasing returns to scale, especially smaller firms. Moreover, economies of density and economies of scope are found to be significant.

Section 2 focuses on the analysis of demand for urban transport services. Most western countries have experienced a decrease in the demand for urban passenger transport in the last decades. This effect is due to an increase in real income resulting in a higher level of car ownership and utilization, and to the ongoing process of residential suburbanisation and employment decentralisation experienced in the large cities making private car more suited to commuters. However, the growing level of congestion in the cities and its implications on the environment have now raised a tendency to limit the use of

[1] Note that De Borger and Kerstens (2006), Brons et al. (2005) and Berechman (1993) have surveyed the literature on technical efficiency for bus transit.

private car to the benefit of urban transit modes, such as bus, metro and light rail. This explains the large interest in the analysis of demand for urban transport - and bus services in particular - during the last decades. The main focus of the literature on the subject has been to compute the most accurate measure of bus demand elasticities with respect to price. The values of these elasticities, as well as income or service elasticities, have some crucial decisional implications as they are indicators of level of potential competition. We first provide some definitions of the elasticities we analyse in detail in this chapter. Second, we survey the most general and relevant results found in the literature on the topic. Table 2.1 summarizes the approaches and main results from the articles under analysis. Third, we describe how the various studies differ in their methodology, and fourth we present a critical evaluation of the different approaches and emphasize the crucial aspects to be taken into account in a thorough analysis of market demand and elasticities. We conclude that the literature suggests that the demand for bus travel is inelastic in the short-run, and becomes more elastic in the long-run.

After having explored the determinants of operators' costs and consumers' demand, we present the competition issues. In Section 3, we reach the conclusion that the literature indicates that the characteristics of the bus transport industry restrict competition between operators. The suggestion is that the industry is not contestable: Local operators usually exert monopoly power; they are not threatened by potential entry and receive high profits. We emphasize in this section the fact that the economic literature is unanimous when stressing the different factors which prevent the industry from being contestable. In particular, the existence of barriers to entry, the existence of sunk costs, the implementation of practices which consist in raising rivals' costs, the fact the incumbents enjoy economies of experience, economies of scale, economies of density, and economies of scope, and the fact that incumbents can respond in price changes very quickly do not favour entry.

We then observe that the literature focuses on the idea that operators compete in frequencies, not on prices. Over small distances, it is suggested that consumers are more sensitive to waiting times at the bus stop and pay less attention to price differences. If this is true, operators will compete in frequencies and propose usually the same prices. In general, the economists believe that operators have limited scope for meaningful product differentiation that could make consumers loyal. A consumer generally catches the first bus that arrives at a stop. In the extreme case where this is true, and fares have no effect on consumers' choices; there is no competition on prices between bus operators.

Finally, we review articles which examine how transport operators behave strategically to maintain their monopolistic power on routes where several operators are present. In particular, operators propose random time schedules and consumers wait for the arrival of the next bus. Hence, prices are high, unless they are disciplined by other transportation modes such as private car, cycling or walking. Random frequencies have to be expected since each operator has an incentive to drive just in front of the others. Thus, bunching cannot be an equilibrium. A profile where each bus is alone in a position cannot be an equilibrium either since buses have an incentive to fall back and drive just in front of the next bus that is following behind. These techniques are known as head running and leapfrogging, and are similar to randomizing the arrival of an operator at a bus stop.

Starting from the observation that most results in the literature are theoretically derived and that empirical proofs are scarce, the last section lists a set of empirical investigations that could be performed. More specifically we propose suggestions of how to test the main null hypotheses that can be drawn from our review of the literature, namely:

1. The industry is characterized by economies of scale, scope, and density.
2. The industry is not contestable.
3. Operators do not compete on prices.
4. Operators do compete in frequency.

These different assumptions can be tested by means of econometric methods using available data. Without the data to hand, it is not possible to design very specific methods. Hence the idea is to suggest a set of tests that are manageable and standard, and allow for the detection of possible predatory or collusive practices or the absence of consumer harm.

1 Cost and production analysis

Box 1.1: Cost and production analysis: Main lessons from the literature

Bus-transit companies exhibit increasing returns to scale, especially smaller firms. Moreover, economies of density and economies of scope are found to be significant in the industry. As a result, larger companies have important cost advantages over smaller firms.

1.1 Definitions

Economies of scale, economies of density and economies of scope are key structural elements to describe in economic terms the technology behind an industry. Economies of scale are defined as the increase in total costs brought by an increase in the firm's scale, that is to say in both output and the network size, holding the factor prices constant. Economies of density measure the relative increase in total cost resulting from an increase in output, holding all input prices and the network size fixed. The distinction between scale and density economies is particularly important in network industries. In these cases, a company's size (or scale) is related to both its output level and its network size, which do not necessarily vary together according to a simple one-to-one relationship. For this reason, it is useful to distinguish cost changes that occur uniquely because of output changes within a fixed network and cost changes resulting from a proportional change in both network and output. In the presence of economies of scope, a multi-output firm is more economical than separate specialized firms. In the case of urban transport services, a multi-output firm would be a multi-modal firm, offering services from different transport modes such as bus, metro, or light rail. Economies of scope can result from the joint utilization of inputs, and more specifically in the urban transit industry from the use of similar equipment such as wires, or similar skills such as driving, management and network maintenance. Such synergies also apply to activities like advertising, scheduling and ticketing.

The level of *technical efficiency* is the usual measure to evaluate the performance of firms. It is defined as the degree to which operators are able to reach the highest possible output levels that can be achievable with given inputs. In economic terms, one says that a technically efficient company operates on its production frontier. Efficiency can be estimated based on parametric and non-parametric methods to determine production or cost frontiers. The two most popular approaches in the literature are the stochastic frontier analysis (SFA) and the data envelopment analysis (DEA), respectively.

Finally, in the literature, the definitions for the output variables differ. Either supply indicators (e.g., vehicle-kilometres or seat-kilometres), demand-related output measures (e.g., passenger-kilometres or the number of passengers) or multidimensional output definitions are used. De Borger and Kerstens (2006) discuss in detail the choice of output measures.

1.2 Technological characteristics

Let us first review some characteristics of the technology for bus transport services, such as returns to scale, economies of density and economies of scope. It is a common result that bus companies experience increasing returns to scale. (See Farsi *et al*. 2007, Farsi *et al.* 2006, Filippini and Prioni 2003.) More specifically, it seems that smaller firms benefit from increasing returns to scale, as opposed to larger firms which exhibit constant or even decreasing returns. (See Kerstens, 1999, Matas and Raymond 1998, Viton 1997.) For the British bus industry, Cowie and Asenova (1999) estimate that small companies of fewer than 200 buses experience some economies of scale. They also find that the size of such returns varies with the company type (whether it is public limited, private limited, municipal). Sakano and Obeng (1995) find increasing returns to scale for the U.S. urban transit industry. Overall a significant number of empirical studies are in line with a U-shaped average cost function exhibiting increasing returns to scale for the smaller operators, which become constant and finally decreasing as companies' size increases.

In most empirical studies, economies of density are frequently found regarding the bus companies' technology. As already pointed out, the distinction between economies of density and economies of scale is very important in industries that provide their services over a network. In these cases, the firm size is more closely related to the size of the network than to the output provided over that network. For this reason it is important to distinguish cost changes that occur because of output changes only and cost changes that occur because of a proportional network and output change. Among studies which estimate that bus companies fail to operate at an efficient density are Farsi *et al.* (2006) and Filippini and Prioni (2003) on the Swiss market, Matas and Raymond (1998) for Spain and Shaw *et al*. (2005) for Taiwan. It appears that bus operators could obtain cost-saving benefits by extending their output scale.

Some articles have focused on the multi-modal side of the industry and have asked whether a bundling of operations from different urban transport modes (bus, train, metro for instance) is preferable to a separated configuration. They converge to the conclusion that economies of scope are significant in the industry, and that their results are in favour of integrated multi-modal operators. Farsi *et al.* (2007) conducted a study in Switzerland and found increasing returns to scale in almost all outputs. They consider that these returns, combined with cost complementarities, can be considered as a suggestive evidence for natural monopoly. Viton (1993) also finds positive economies of scope and concludes that together with the nature of economies of scale, they support the formation of larger multi-modal systems in the San Francisco Bay Area.

1.3 Efficiency

The recent literature on performance of operators of local bus services shows that there still exists a substantial level of inefficiency in this industry. However, huge differences exist over time and across countries. Cowie and Asenova (1999) find a high degree of inefficiency in the British bus industry which they interpret as an indicator of wasteful competition. However, Cowie (2002) estimates that the average efficiency has improved in the U.K., suggesting that mergers may have allowed existing group companies to operate closer to the optimal level of output. Heseltine and Silcock (1990) for the British metropolitan PTCs, find that the main total unit cost reduction was achieved by productivity improvements. Working on a sample of Spanish cities, Garcia-Sanchez (2009) finds that a majority of municipalities are technically inefficient, mainly due to scale inefficiency. This is a similar result to Kerstens (1999) who indicates that inadequacies in scale are the major source of poor performance in her sample of French urban transport service operators. Some studies though are more optimistic in their measurements of efficiency, in particular in the UK. Viton (1997) finds that 80% of bus systems are efficient in the U.S. Wunsch (1996) who compares 178 European urban transport companies claims that two British firms, in the cities of Manchester and Sheffield, are among the first on his list in terms of technical performance. However, he takes into account only dominant bus companies and he admits that his result depends crucially on data quality. Most studies underline the dispersion in the efficiency measures they obtain within the same country or area. (See Kerstens 1999, De Borger and Kerstens, 2006, with the exception of Salas, 1998, who finds that, in Sweden, the levels of efficiency are very similar among companies.)

1.4 Private / Public ownership

Contrary to a common argument, there is substantial evidence in the literature that private bus companies do not operate more efficiently than public companies. Ownership type does not seem to be a crucial determinant in the firms' performance, as shown in Garcia-Sanchez (2009), Odeck and Sunde (2001) on the Norwegian market and Viton (1997) who shows that U.S. public and private systems share the same distribution of technical efficiency. Fazioli et al. (1993) found no relation between technical efficiency and ownership among a sample of Italian urban transit firms precisely because of the absence of effective competition for both public and private operators and strong regulation. Filippini and Prioni (2003) underline that the results in their study on a Swiss sample depend on the specification of output and network variables. However, if we can assert there is no strong evidence of a higher efficiency for private firms, some studies do estimate they perform better. Cowie and Asenova (1999) find privately owned firms are not? more technically efficient, although they exhibit a considerable level of managerial efficiency. They find that values of increasing returns to scale for small companies not only vary with the ownership type (public/private) but also with the actual form of private ownership. Relevance of ownership as a determinant for performance is also found in Kerstens (1996) and De Rus and Nombela (1997) on the French and Spanish market respectively. At this point, the literature is considered inconclusive regarding the impact of ownership type on efficiency.

1.5 Subsidies

There is some evidence that subsidies are associated with an increase of operating costs. In particular, Kerstens (1996) corroborates this assertion when analysing a sample of French urban transit companies. Sakano and Obeng (1995) on U.S. transit systems report that subsidies lead to excess use of labor relative to capital and excess use of fuel relative to capital and labor.

1.6 Incentive contracts

Several recent studies have revealed the positive effects of incentive contracts on technical efficiency. In Kerstens (1996), empirical findings confirm the importance of appropriate incentives in contracting for monopoly. Risk-sharing agreements seem to stimulate the performance of organizations. These results for French operators are confirmed by Gagnepain and Ivaldi (2002a) who develop a method which should help to clarify the choice of regulation in the urban transport industry. They conclude that cost-plus contracts are dominated by any type of second-best contract. These results are in line with those of Roy and Yvrande-Billon (2007) who find that operators under cost-plus contracts exhibit a higher level of technical inefficiency than operators under fixed-price agreements. De Borger and Kerstens (2006) survey other European studies which exhibit that high-powered incentive contracts improve efficiency.

1.7 Competitive tendering

The available evidence suggests that competitive tendering may improve performance, although recent research indicates that cost savings have more chances to happen after the first round of tendering so that further rounds could yield new cost increases. These results are exhibited by Hensher and Wallis (2005) who review the international successes and failures of competitive tendering from ten developed countries. De Borger and Kerstens (2006) in their survey give a more detailed description of the effects of competitive tendering.

1.8 Methodologies / Discrepancies

It is important to bear in mind that all these performance analyses differ in several aspects. First, there exist several approaches to estimate efficiency on the basis of observed data. Efficiency, as measured by a deviation from the unobserved cost or production frontier, can be estimated by means of parametric and non-parametric methods aimed at determining the production or cost frontiers. On the one hand, parametric methods require the specification of a functional form for the frontier, a popular one being the flexible translog cost function. On the other hand, non-parametric approaches do not need to specify a functional form; they construct the frontier by enveloping the data on inputs and outputs by piecewise linear hyperplanes, as proposed by the extensively used data envelopment analysis (DEA) method. Both methodological strands have advantages and weaknesses, related to the presence (or not) of measurement errors or the requirement to specify functional forms. A detailed description and discussion of these frontier methodologies are presented in Lovell (1993) and Brons et al. (2005) respectively.

A second source of differences in the measurement of efficiency comes from the definition of the output variable. A significant number of studies conclude that operators' performances differ substantially depending on the output specification considered. Supply indicators (e.g., vehicle-kilometres or seat-kilometres) or demand-related output measures (e.g., passenger-kilometres or the number of passengers) have been used.

A third crucial aspect in the model specification for measuring efficiency is that models should account for relevant measures of service and network characteristics. Bus-transit services have been recognized as very heterogeneous across countries and even cities. This is confirmed by De Borger and Kerstens (2006) and Brons et al. (2005) who find significant and consistent effects of the type of database, region and output measurement method. Fourth, some authors underline the need to decompose the measures of efficiency into its several components (allocative and technical). For example, Viton (1997) suggests that the result of similar efficiency distributions between private and public firms might hide the fact that private systems would be more allocatively efficient. Also, according to him, the distinction between managerial and organisational efficiency seems relevant in this industry, particularly in measuring the impact of ownership type on efficiency. This conclusion is confirmed by Cowie and Asenova (1999). (See also Gagnepain and Ivaldi, 2002b.)

1.9 Further research

Although the literature on measuring efficiency in the urban transport industry is extensive, some aspects still have to be investigated more thoroughly. An international comparison on the effects of deregulation and competition on efficiency would be of high interest. Also, only a few studies take into account the presence of other transport modes on the market. Indeed, the presence of economies of scope and the call for limiting private car traffic to the benefit of urban modes because of environmental policies make this multi-output aspect of the industry particularly relevant. Further analysis of the decomposition of efficiency into its several components to better understand the effects of ownership and deregulation on efficiency seems to be a next step in the research agenda.

Box 2.2: Cost and production analysis: Main comments

The models should account for relevant measures of service and network characteristics as bus services have been recognized as very heterogeneous across cities. The presence of other transport modes should be taken into account if the industry exhibits significant economies of scope. The choice of the output variable(s) is crucial and should reflect both supply and demand attributes.

2 Demand analysis

Box 2.1: Demand analysis: Main lessons from the literature

The demand for bus-transit is inelastic in the short run, and becomes more elastic in the long-run. Substitution effects of small magnitude exist between service alternatives.

2.1 Definitions

In this section, we review the different values of bus demand elasticities found in the literature. The own-price elasticity of demand of bus service is defined as the percentage change in demand resulting from a one percent change in fare, given that all other variables remain constant. As this percentage is lower, greater or equal to one (in absolute values), then demand is said to be inelastic, elastic, or constant, respectively. An elastic demand means passengers are sensitive to a small variation in price and are willing to give up travelling with that specific travel alternative. Note that the elasticity of the demand that a firm faces is always more elastic than the aggregate elasticity of market demand. This is because there are fewer substitutes for a product at the market level than at the firm level. An example would be the substitution between competing bus services on a market as opposed to substitution between different transport modes on this market.

Measures of cross-price elasticities of demand give a precise level for the substitution patterns between competitors. For example, the cross-price elasticity from bus to car tells us the percentage increase in car demand following a one percent increase is bus fare. In the bus-transit industry competition can come from other bus operators, as well as other transport modes (train, metro, car...).

Finally, some values of income and service quality elasticities are also computed in the literature. The income elasticity measures the responsiveness of bus service demand to a change in the income of bus travellers. It is calculated as the ratio of the percentage change in demand to the percentage change in income. Service quality elasticity is defined as the percentage change in local transport demand resulting from a one percent change in service quality, such as seat-kilometres or frequency.

2.2 Own price elasticities

It is a common result in the literature that the demand for bus-transit is not elastic in the short run. Most studies on bus-transit own-price elasticities converge to a value of -0.4 and this result is summarized in four surveys on urban demand by Goodwin (1992), Oum *et al.* (1992), Dargay and Hanly (1999) and Balcombe *et al.* (2004). The database on transport demand elasticities of the Bureau of Infrastructure, Transport and Regional Economics, Australia (2002) is gathering a lot of data.

These studies emphasize that authors now agree on the necessity to consider dynamic changes in these own-price elasticities. All studies allowing elasticities to vary over time, that is to say, allowing demand to adjust to changes in price in the long-run, have converged to the conclusion that demand in the long run is more elastic than demand in the short run. The role of dynamics in urban transport demand is the objective of the survey conducted by Goodwin (1992) who estimates that long-run elasticities range between 1.5 to 3 times higher than short-run elasticities. He concludes that it is required to use a time-dependent specification for the demand. In the literature (Goodwin 1992, Balcombe *et al.* 2004) the long-term response should be expected in a period of 5 to 20 years according to the authors. Only Matas (2004) on the Spanish market finds that 95 percent of the effects are realized within 3 years. As shown in Table 2.1, the values for long-term own-price demand elasticities vary from -0.4 to -1.3. However, values significantly greater than 1 are rare in the literature. Among the articles displaying the highest values are Romilly (2001), Dargay *et al.* (1999) and Gilbert and Jalilian (1991) on the British market. On the other hand, a study conducted by Deb and Filippini (2010) on the Indian market leads to relatively small values of long-run elasticities which the authors interpret as the effect of the low level of development in India and the fact that public transport is still a necessity there.

That long-term are higher than short-term elasticities has the following implications. First, the full behavioural response to fare changes cannot be properly identified by means of unlagged time-series models. Now demand models estimated on cross-section of individual data can only reveal long-run price elasticities. Second, in this industry, the range of responses open to people is larger in the long run. Car ownership decisions require time to be implemented. It is well known that this dynamic aspect of demand is an important consideration in implementing policy strategies.

Another important finding of the literature on own-price elasticities for bus-service demand is that the estimated measures vary with the type of ticket purchased by customers. The common result is that demand for a single ticket is more elastic than demand for a travel pass. Instead of building a price index to analyse the impact of a change in this price on demand, some authors have disaggregated these effects with respect to the different categories of tickets available to the customers. De Rus (1990) estimates fare disaggregated elasticities for bus-transit in Spanish cities and finds that data disaggregated by ticket fare provides a deeper understanding of demand responses. As he finds that price sensitivity decreases as we move from single tickets to the travel pass, he concludes that an aggregate approach fails to allow explicitly for shifts in demand between ticket types and that the role of cross-effects between ticket-types is key for the pricing policy. These results are in line with other studies on aggregate data, like Tegner and Holmberg (1998) on the Swedish market, and on micro data as in Hensher (1998) and Taplin *et al.* (1999). However, these last two analyses report smaller values for the elasticities. Matas (2004) in a more recent article with aggregate data on the Spanish market confirms these previous results and concludes that there is scope for a more efficient non-uniform pricing policy with positive effects on demand while minimising the negative effects on revenue.

2.3 Cross-price elasticities / Substitution effects

A change in fare for a transport mode can lead a customer to switch to another competitor, within the range of all available urban transport modes available (private car, train, bus, metro, or others). These substitution effects between travel modes are important when analysing competition and we present here the main literature findings on these measures.

The common result in the literature is that these substitution effects between modes are of a small magnitude in the short run. However, some authors consider that these findings, combined with higher long-run own-price elasticity for car and bus use, make modal shifts more feasible than often assumed (Goodwin, 1992). Hensher (1998) who distinguishes between fare classes finds that, in the Sydney metropolitan area, the largest cross-elasticity between private car and train travel pass is 0.335 in the event of an increase in the price of car utilization. He also finds that there are more changes between modes for a given fare class than between fare classes within modes. The strongest cross-mode substitution for a given fare class (excluding car) occurs between train and bus single tickets with cross-elasticities of 0.067 and 0.057 for train-to-bus and bus-to-train respectively. Taplin *et al.* (1999) who aim at improving the methodology presented in Hensher (1998) estimate that the most significant differences observed between the two approaches are a large decrease in the elasticity of demand for car with respect to the price of a ticket for a single trip called Bus Single (from 0.066 to 0.018), and a large increase in Bus Single with respect to car cost (from 0.116 to 0.212). Matas (2004) looks at cross-price elasticities between ticket types and between transport modes. According to his results, bus users are sensitive to both bus and underground prices and quality, whereas underground users are only sensitive to underground characteristics. However, he also concludes that there is not enough information to understand the impact on modal shifts from car to public transport. Dargay and Hanly (1999) observe that the cross-elasticity between bus patronage and motoring costs appears to be negligible in the short run and about 0.3 to 0.4 in the long run. According to them there is some price substitution between bus and car use, although comparatively small. Balcombe *et al.* (2004) observe in London an asymmetric relationship between rail and bus, and between bus and underground. They also find that in other urban areas public transport use is sensitive to car costs but car use is much less dependent on public transport costs. Oum *et al.* (1996) in a study of the Dutch urban market estimate that the relative price of private car must rise significantly to induce a significant number of car drivers to switch to public transport modes.

2.4 Trip purpose / Peak and off-peak demand

Fare elasticity is different for different journey purposes. Trips made to go to work or to school are considered as peak demand, whereas trips for leisure or shopping are much more flexible in the time of the day and correspond to an off-peak demand. One would expect fare elasticity to be higher for off-peak demand than for peak demand where customers do not have much choice but to travel. In their review of the literature, Balcombe *et al.* (2004) observe that the mean off-peak elasticity for buses (precisely, -0.5) is at least twice the peak elasticity (i.e., -0.2) for the UK and outside. This is in line with the World Bank report by Oum *et al.* (1990).and a literature review by Fowkes *et al.* (1993). Ivaldi and Viauroux (1999) also find significant differences in urban trip purposes.

2.5 Income elasticities and car ownership effect

Dargay and Hanly (1999) observe that, in the UK, the income elasticity for bus services, which includes car ownership effects, is negative in the long run. This is in line with the literature and suggests that bus transport is an inferior good. (See Bresson *et al.*, 2003, Balcombe *et al*. 2004.) The negative long-run elasticity reflects the effect of income through its positive effect on car ownership and use, and the negative effect of the latter on bus patronage. They estimate that income elasticity ranges between -0.5 to -1 in the long run. However, as car ownership approaches saturation the income elasticity can be expected to become less negative. Romilly (2001) finds a positive value of 0.61 for his long-term income elasticity, suggesting that the economic growth has outweighed the inferior good aspect of the service. Matas (2004) also finds a positive value for the income elasticity (precisely, 0.15) in Spanish cities. He explains the difference with Dargay and Hanly (1999) by the higher population density of Spanish cities which makes them better suited to public transport use than to car use.

2.6 Service Elasticities

Regarding service elasticities, Matas (2004) estimates a service elasticity of 0.24, although he explains that, in aggregate studies, a very crude proxy for the quality of service is used, and it is difficult to give an adequate interpretation of the estimated elasticities. Quality is defined in different ways in different studies making uneasy the comparison of their values which are ranging between 0 and 1. De Rus (1990) finds a high coefficient of variation between the different cities. According to Deb and Filippini (2010) and as expected from the literature, service quality is the most significant policy variable as it has the largest impact on travel demand. Bresson *et al.* (2003) show that, in France and in the U.K., fare and service elasticities are of a similar magnitude (although opposite in sign), so that an increase in fares combined with an equivalent increase in service (vehicle kilometres) would have only marginal effects on patronage.

2.7 Methodologies / Discrepancies

As reported in Table 2.1, several approaches are used in the literature to compute reliable measures for urban transport demand elasticities. There is common agreement that variances in values for the different elasticities are influenced by several factors, both related to methodological aspects and to features of the industry. In particular Nijkamp and Pepping (1998) have carried out a comparative analysis of elasticity values of transport demand resulting from twelve studies in various countries. Their analysis indicates that the difference between aggregate (macro-) and disaggregate (micro-) models, as well as with other assumptions, explain the variance in the values of elasticities across studies. They also find that the country involved, the number of competitive modes, and the type of data collected are important factors in accounting for the level of elasticities. These conclusions confirm the findings of Oum *et al.* (1992) who survey the elements that impact the estimation of demand elasticities in different studies. Oum *et al.* emphasize the need to take into account intermodal competition because, otherwise, own-price elasticities are biased upward as they would reflect in part the intensity of intermodal competition. They also underline that different functional forms can result in widely different elasticity estimates, even with the same set of data. Note that models also differ with the choice of the definition of the dependent variable (whether one considers journeys or passengers-kilometres) and the way fares are aggregated into a price index. They observe that results differ according to the area or country under analysis, which have their own features (in particular for their urban-transit services). This is why they highlight the fact that disaggregated data would lead to a wide range of elasticities as they would reflect unique market conditions. Dargay and Hanly (2002) find a considerable variation in the fare elasticity across counties, ranging from 0 to -3 in the long run. Bresson *et al.* (2003) in their comparative study between France and the U.K. confirm the relevance of taking into account countries' heterogeneity. The study by Dargay and Hanly (1999) corroborates the findings of Nijkamp and Pepping (1998) and Oum *et al.* (1992). First they find a large variance of elasticities across counties in the U.K.; second, they conclude that estimated elasticities from different studies are not directly comparable. More precisely, they assess it is inappropriate to apply the value of an estimated elasticity for different circumstances or to average the values of elasticities from different studies.

2.8 Further research

The preceding review of the literature on urban transport demand highlights some areas for improvement in the methodologies adopted so far. First, models for disaggregated data have rarely been estimated and they would constitute a considerable enhancement in urban demand studies. They would allow us to capture the specific effects of the markets under scrutiny, such as different ticket fares, trip purposes, and customer categories. An aggregate elasticity hides these specific effects. Second, more structure could be applied to the models and the interaction between supply and demand could be taken into consideration. Third, the literature suggests that a comprehensive representation of the market is important as we observe significant differences in characteristics across cities. Competition from other modes should be taken into account to avoid bias in the measures of elasticities. Fourth, functional forms have to be chosen carefully as they can lead to very different results, even applied to a same dataset. Econometric testing of different model alternatives would be a useful part of the research agenda.

Box 2.2: Demand analysis: Main Comments

A comprehensive representation of the market is important as we observe large differences in urban characteristics across cities. Competition from other modes should be taken into account for measures of elasticities not to be biased. Models for disaggregated data would constitute a considerable enhancement in urban demand studies by allowing the capture of the specific effects of the markets under scrutiny. More structure could be applied to the models and the interaction between supply and demand usefully taken into consideration.

Table 2.1: Urban transport elasticities: Summary of relevant studies

Article	Period	Geographical area	Data	Model and Estimation	Modal competition	Dynamics	Fare types	Dependent variable	Own Price Elasticities	Comments
Goodwin P.B., 1992	n/a	n/a	n/a	Survey Source: Academic journals, books, reports...	Car, public transport	Yes	No	n/a	SR (6-12 months): -0.37 MR (4 years +): -0.55 LR (5-30 years): -0.65	
Oum, T.H., Waters, W. G., and Yong, J.1992			Disaggregate data	Survey Source: Academic journals. Disaggregate discrete choice models	Car, bus, Rail	No	No	n/a	Bus: -0.01 to -0.58 (Urban transit: -0.01 tp -0.78)	Lower than direct demand models with aggregate data. There is no short-cut to obtaining reliable demand estimates for a specific transport market without a detailed study of that market.
Gilbert, C.L. and Jalilian, H.1991	1972-1987	London		Aggregate demand system	Competition between bus and underground. No car.	Yes	Yes	Journeys	SR: -0.839 LR: -1.378	One of the highest values in the literature
Hensher, D.A., 1998	1995	Sydney	Mixture of RP and SP data	Ticket/mode choice, HEVL, MNL	Competition between bus, train, car. Some passes include a ferry ride.	No	Yes	Journeys	Bus single ticket:-0.141 and -0.357 depending on model	Slightly lower than other studies. Demand for other bus tickets much less elastic than for single tickets
Nijkamp, P. and Pepping, G.1998		Norway, Finland, the Netherlands and UK		Survey (12 studies: logit, nested logit, linear OLS, translog, discrete choice, MNL) Meta-analysis	Competition between bus, tram, metro, train	Yes	No	Journeys	Min: -0.15 (UK) Max= -0.8 (Neth)	Factors affecting elasticities are: aggregated vs disaggregated models, model assumptions, the country involved, number of competitive modes, and the type of data.

Tegnér, G and Holmberg, I.1998	1973-1996	Stockholm	Aggregate time-series monthly data	Logit, Non-linear price index, 2-steps procedure	Competition between public transport (aggregated) and car	No	Yes	Journeys	Composite elasticity Card: -0.35	Elasticity averaged over 23 years. Cash-coupons are the most price-sensitive.
de Rus, G.1990	1980-1988	Spanish cities (Madrid and Barcelona excluded)	Monthly aggregated data	Double-log, semi-log demand functions, static and dynamic	Public transport aggregated (Bus, rail)	Yes	Yes	Journeys	Static, aggregate: -0.16 to -0.44 Dynamic: SR similar to static, MR higher than SR	Aggregate elasticity higher than conditional elasticities (distinction between ticket types)
Taplin, J.H.E., Hensher, D.A. and Smith, B.1999	Cf Hensher 1998	Cf Hensher 1998	Cf Hensher 1998	Cf Hensher 1998 + second stage procedure to adjust elasticities	Cf Hensher 1998	Cf Hensher 1998	Cf Hensher 1998	Cf Hensher 1998	Bus single adjusted elasticity: -0.34	The change in elasticities is substantial for some ticket categories (bus travel ten)
Deb, K. and M. Filippini 2010	1990-2001	22 states in India	Aggregate unbalanced panel dataset	Static and dynamic log linear models	Competition between bus and private vehicles (car, two-wheelers, jeeps)	Yes			Static: -0.354 to -0.46 Dynamic: SR: -0.374 LR: -0.523	LR elasticities smaller than usual, due to India's specificities
Dargay, Hanly et al., 1999	National: 1974-1996 Regional: 1985-1996	Great-Britain, national and regional level	Aggregate annual time-series	Error correction constant elasticity, structural models	Bus, underground, car, trains	Yes		Bus journeys per capita Passengers kilometres per capita	Error correction model SR journeys: -0.33 to -0.40 SR pax: -0.18 to -0.19 LR journeys: -0.62 to -0.95 LR pax:-0.43 to -0.92 Similar results for the structural model	No measure of bus service is used for the national models. Variation in elasticities among regions Elasticities sensitive to model specifications

	1987-1996	English counties (46)	Panel data, Operators related data	Partial adjustment Fixed Effects, Random Effects, and Random Coefficient models. Log linear, semi log models		Yes		Bus journeys per capita	SR= -0.3 to -0.4 LR= -0.7 to -0.9	Considerable variation in the fare elasticity across counties - a range from 0 to over -3 in the long run.
	1988-1996	Areas	Cohort time-series, PTE data	Partial adjustment model		Yes	Yes	Bus journeys	SR: -0.24 LR: -0.52	Authors had less success with this database
Dargay, Hanly, 2002	1986-1996	46 counties in the UK	Combined time-series cross-section data for English counties	Partial adjustment model. Fixed and random effects. Constant and Variable elasticity models	Bus, car	Yes	No	Journeys per capita	SR: -0.4 LR: -0.9	Demand is more price-sensitive at higher fare levels
Matas, 2004	1979-2001	Aggregate annual data	Aggregate annual data	Double-log demand function, SUR estimation	Competition between bus and underground. No car.	Yes	Yes		SR Bus -0.21	Elasticity higher for single ticket than for travel pass. LT=3 years
Bresson, Dargay et al., 2003	England: 1987-1996 France: 1986-1995	Panel data	English counties (46), French urban areas (62)	Log-log and semi-log models, Random coefficient approach, Bayesian shrinkage estimators.	England: Bus France: Bus, subway, train	Yes	No	Journeys per capita	SR: -0.2 to -0.5 LR: -0.5 to -0.8	Public transport demand is relatively sensitive to fare change. Considerable variation in elasticities among areas within each country (probably due to differences in definitions of areas, modes etc...)

Romilly, 2001	1953-1997	UK except London	Annual time-series	Log linear model, estimated as a single equation Auto Regressive Distributed Lag model after corrections for cointigrating relationships.	Bus, car	Yes	No	Journeys per capita	SR:-0.38 LR:-1.03	The positive effects of deregulation *per se* on fares and passenger journeys are broadly cancelled out by the negative effects of subsidy reduction.
Balcombe et al. 2004		Mainly UK		Survey	Bus, metro, suburban rail	Yes	No		Bus SR: -0.43 Bus MR:-0.56 Bus LR:-1.01	
Oum et al. 1996	1977-1991	Netherlands	Monthly time-series	Translog reciprocal indirect utility function	Car, rail and Bus + Tram + Metro (BTM)	No	No	Trips expenditure	BTM (compensated demand elasticities): -0.8	Bus, tram and metro are aggregated into 1 public transport mode (BTM)

3 Competition analysis

3.1 Entry

Box 3.1: Entry: Main lessons from the literature

The industry is not contestable. Hence, local operators often experiencemonopoly power; they are not threatened by potential entry and can therefore receive higher profits.

As a general rule, a firm enters the market only if it can earn positive profits. When entry happens on a significant scale, it is expected that the incumbent reacts. In the early deregulation period, the literature focusing on the UK bus competition suggested that entry may be a relevant issue and has shed light on several cases of entry in local markets. Entry usually occurs on the periphery of the incumbent's main market area, particularly if the incumbent has a local reputation.[2] Some smaller operators have attempted to enter on a small scale hoping not to invoke a response from the incumbent firm. The literature suggests however that entry strategies have been unsuccessful in most cases. (See Preston, 1988, for an early analysis. Note that the literature does not provide any further evidence of successful entry in the 90s or the 00s.)

To explain why entry was unsuccessful in the early deregulation period and why it was scarce in the years following deregulation, an important argument is that the industry is not perfectly contestable. As an indication that the industry is not contestable, we list as a first step the usual conditions which guarantee that a market is perfectly contestable. As a second step, we discuss why these conditions seem not to be met in the bus transportation industry.

[2] Note moreover that, during this period, several factors have favoured entry; these factors are: The management of the entrant firm has personal knowledge of the area chosen for entry; or the entrant may have hired former employees of the incumbent firm. Beesley (1990) notes that the population density and the incumbent's initial market power are other factors which influence positively the likelihood of entry.

According to Shepherd (1984), Baumol (1987), and Banister (1997), a perfectly contestable market requires the following conditions:

- Entry is free;
- Entry is perfectly reversible, i.e., sunk costs are zero;
- The incumbent and the entrant have access to the same technology;
- The incumbent and the entrant have equal access to all customers in the market, i.e., consumers are not loyal to the incumbent's products; the services of the incumbent and the entrant can be easily accessible (for instance bus terminals can be used by all operators);
- There is an active second hand market for capital assets (e.g., the entrant has access to "cheap" buses for its rolling stock);
- The regulator imposes time lags to prevent sudden changes in prices or withdrawal of services by the incumbent firm, e.g., "hit and run" strategies, where the entrant enters the market over a short period and enjoys high prices, can be implemented.

In a contestable market, any attempt by incumbent firms to earn excessive profits would be unsuccessful. Furthermore, even if there is just one firm offering the service, this firm would be engaged in average cost pricing and have zero profits. If positive profits were obtained, competitors would enter the market and undercut the incumbent's prices and profits. Hence, the important idea is that the mere *threat* of entry forces the incumbent not to behave as a monopoly despite the intrinsic properties of the market which enable it to do so.

The economic literature is unanimous in stating that the local bus transportation industry is not perfectly contestable. In the very first years of deregulation, Preston (1988), Button (1988), Beesley (1990), and Evans (1991) suggest that many factors prevent the markets from being contestable:

- Existence of barriers to entry: The access to bus stations and the use of travel cards have acted as barriers to entry; the incumbent may have more convenient terminal positions; entrants may not obtain access to bus stations; information points may be manned solely by the incumbent firm's staff and entrant firms may be located at the least attractive stands in the bus station; other practices include the blocking of a rival's bus, occupying a stand or using couriers to persuade customers to use one company's buses in preference to another. Barriers to entry may have been underestimated at the moment of deregulating the market.

- Existence of sunk costs: Trained staff (managerial, administrative and platform) is costly. An entrant finds it difficult to hit and run if its employees are not highly qualified.[3]
- Practices which raise rivals' costs: Operators may withhold surplus buses from the second hand market, hoping that the price of old buses would increase as their availability decreased, hence making entry to the local market more difficult.
- Economies of experience, economies of scale, economies of density, and economies of scope: The incumbent may have a larger network than the entrant and may therefore be able to offer more attractive area-wide tickets than the entrants; the incumbent may be better known.
- Incumbents can reduce prices very quickly (usually within 24 hours).

During the 90s, these initial intuitions are confirmed. Evans (1990 and 1991) insists on the fact that the incumbents can change their prices immediately in response to entry since operators are allowed to change fares without notice. As a result, incumbents can enjoy super-normal profits on high density routes. Moreover, the "experience" input is essential to explain the tactical advantage of the incumbent firm, given that it is usually better informed about different aspects of providing the service. Beesley (1990) claims that barriers to entry are numerous: For instance, garage locations and other property rights play a key role since they directly affect the likelihood that local markets can be opened to competition. The law may itself impede entry: For instance, entrants are required to remain at least 6 weeks in the market; sub-contracting to drivers is restricted.

Banister (1997) contributes to this view of the industry when he states that the characteristics of the industry and the strategic actions of the incumbent both impede the local transport market from being contestable. In addition to the previous factors, Banister proposes the following characteristics:

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[3] Highly skilled employees are so important in the production process that it is not uncommon to observe bus operators attempting to recruit a rival's staff by offering higher wages and better work conditions.

- The need to replace the ageing bus fleet, which requires greater capital investment than the smaller companies are able to obtain or willing to risk;
- The fear of competitive disadvantage of the smaller operators against the larger operators is more pronounced in the bus industry;
- Large and small companies do not have access to finance on equal terms. Incumbents tend to have weaker risks of bankruptcy than entrants because they have a larger size and have a bigger purse. The incumbent may own routes elsewhere which earn high profits which can be used to cross subsidize more less competitive routes;

At the same time, Banister sheds light on the possible actions to be taken by the incumbent to reduce the arrival of entrants; these actions are:

- Build up consumer loyalty;
- Establishing a reputation for toughness by maintaining a presence in the market;
- Reorganize the network so that economies can be obtained;
- Maintain ownership of fixed assets such as terminal, booking and maintenance facilities.

Banister thus concludes unambiguously that "*the theory of contestable markets does not apply to the bus industry. In 1985 it may have been attractive to accept the contestability arguments, but this does not seem to be true anymore ten years after, since the size of operations seems important. The role of the small operators is reduced to competing through the tendering process for the socially necessary services.*"

After 2000, the initial propositions listed above, on why the industry is not contestable, are corroborated and new claims are made on why the industry is not competitive. First, De Borger and Kerstens (2006) suggest that the rolling stock capital of entering firms has the characteristics of a sunk cost. More importantly, the incumbent's strategic actions impede entry:

- Incumbents can easily cut prices and adjust schedules;
- The incumbent operates the fixed facilities (a central bus station for instance) available that are crucial to exploit network economies (interconnections between different lines or sets of lines), given that the demand structure is characterized by complementarities between lines.

Second, Langridge and Sealey (2000) emphasize the idea of the economies of experience enjoyed by the incumbent. They note that the confederation of Passenger Transport (the major lobbyist for bus operators, see http://www.cpt-uk.org/) believes that the incumbent operator always has an advantage over the entrant though knowledge and experience, resources (staff), infrastructure, and reputation.

New strategic behaviours are emphasized as well. Some of them are related to the idea of combining competitive services and subsidized concessions allocated to operators though competitive tendering. In particular, Langridge and Sealey (2000) note that entrants could minimize barriers related to lower knowledge and experience by entering from a contiguous market in which they had already gained some knowledge and experience and/or entering a local bus market on a small scale, which could be achieved by obtaining contracts with the local authority.[4] At the same time, many incumbents are eager to enter into the new quality partnerships with local authorities, even if this entails supporting high costs of investment in new vehicles and related infrastructure. This suggests that they are looking for long term partnerships through the creation of local monopolies.

Finally, as suggested by Van der Veer (2002), under entry threats, the incumbent may run more buses and increase the frequency of the service (compared to a situation where it is protected from entry) to avoid leaving profitable gaps. Wang and Yang (2005) corroborate these findings; they suggest that deterrence through an increase of the service level is a dominant strategy for an incumbent under various market conditions, which in turn explains the high levels of service in the U.K bus industry. Accommodation occurs mostly on routes where demand is high. Blockaded entry occurs on routes where demand is low.

Box 3.2: Entry: Main Comments

The economic literature is unanimous in suggesting that the industry is not perfectly contestable. We are confident that arguments which go against this proposition will be difficult to produce. However, the results discussed in this section come from theoretical

[4] They also shed light on the fact that, if the incumbent is unsuccessful in the tendering process, it may attempt to provide subsequently a commercial service in order to force the withdrawal of the rival of the tendered service.

frameworks in most cases. Although some case studies are discussed, no empirical evidence is provided. There is therefore scope for more empirical testing of the contestability of the industry.

3.2 Competition in price or frequency

Box 3.3: Competition in prices and frequency: Main lessons from the literature

Over small distances, consumers are more sensitive to waiting times at the bus stop and pay less attention to price differences. As a result, operators compete mainly in frequencies and usually propose the same prices.

Early theoretical models on bus competition have usually been based on strong assumptions which were in most cases unrealistic:

- All operators face the same costs;
- All operators and passengers have complete information about services and fares;
- Operators have information about demand;
- Each passenger has a preferred departure time but is indifferent between backwards and forward rescheduling;
- Traffic conditions are such that journey times are the same throughout the day;
- Departure times and fares of other operators are fixed.

(See Evans, 1987, and Preston, 1988, for a survey.)

Moreover, it has been suggested that service quality matters and is therefore a key factor in bus competition. (See Dodgson *et al.*, 1992 and 1993, Dodgson and Katsoulacos, 1988, Bly and Oldfield, 1986, and Glaister, 1985 and 1986.[5]) In particular, minibuses have been considered as relevant actors in theoretical frameworks with quality differentiation, where competition can be implemented on a horizontal perspective where firms compete in fixed time schedules and prices. On one hand, regular buses were thought as cheap and slow services, while minibuses were associated with lower travel time and higher prices.

[5] See also Nash (1985), for a discussion of Glaister's assumptions. A more recent contribution on differences in service quality is Yang *et al*. (2001). It is not clear however whether the authors refer to the U.K. bus transportation industry.

These different assumptions have been, to various degrees, criticized later on. The most important criticisms have been related to the assumptions of quality differences and price competition. Preston (1988) suggests that consumers have difficulties in perceiving quality differences. Moreover consumers' loyalty to a particular firm seems to be unrealistic: Users usually board the first bus that arrives. A model's outcome of two firms offering distinct qualities of service and charging different fares has not been as common as might be expected.[6] Such a model of competition would probably be more relevant in explaining inter-modal competition.

Thus, it seems to have been accepted that competition has tended to take the form of service wars with fares matching. Competition has focused on frequency because selective increases in service are easier to implement and more difficult to match than changes in fares. Passengers board the first bus that arrives, hence making frequency the key factor for competition. Competition in fares has been mainly restricted to branded ticketing such as system passes, return ticketing, multi-rider tickets or discount vouchers; branded ticketing is thus seen as a tool for operators to increase the consumer's incentives to be loyal to one specific company.- it is an attempt by operators to develop strategic barriers to entry. (See Fernández and Muñoz, 2007.)

Later on, many authors, such as Van Reeven and Janssen (2006) and Wang and Yang (2005) have confirmed these early intuitions. Price competition (and therefore price reduction) is not particularly prevalent in the UK bus industry.[7] Operators have limited scope for meaningful product differentiation that could make consumers loyal.

However, on long distance services such as intercity bus services, consumers' loyalty and price competition (through higher services quality) are more relevant. In this case, quality matters, and ticket prices constitute an important fraction of the generalized price paid by consumers. Hence, product differentiation on long-distance routes makes

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[6] Note that, currently, there are a number of low cost/'no frills' bus companies in towns across the UK that compete with higher quality offerings by the larger operators. (e.g. Whippet bus in Cambridge).

[7] Recently, price competition models have been proposed by various authors. See for instance Zhou *et al.* (2005). Their model is however more relevant to describe bus operators' habits in developing countries such as China and other Asian countries or modernized cities with high-density population such as Hong Kong and Singapore.

entrants resistant to pricing and scheduling responses of incumbent operators. Scheduling competition is more stable in this case.

Box 3.3: Competition in price or frequency: Main Comments

The comments are similar to the ones provided in Box 3.2. The economic literature is unanimous in rejecting the general assumption of quality and price competition and advocating models of frequency wars. The results are the outcomes of theoretical models and no empirical evidence is provided. Empirical tests would therefore be very useful.

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3.3 Random schedules

Box 3.4: Random schedules: Main lessons from the literature

Operators propose random time schedules and consumers wait for the arrival of the next bus. As a result, prices are high, unless they are disciplined by other transportation modes such as private car, cycling or walking.

The previous section suggests that competition mostly takes the form of frequency wars. Analysts then go a step further when they explain that the arrival time of a bus at a stop is random.

Oldale (1998), Ellis and Silva (1998), Gomez-Lobo (2007), and Van Reeven and Janssen (2006) all agree on the fact that the incentives for price competition are weakened, even if more than one operator is present on a local transport market. Two main reasons explain this result: First, users do not particularly care for quality difference, and second, they incur a cost if they want to shop around for the lowest priced bus. Contrary to Evans (1987) which assumes that operators' services are scheduled, these authors consider some degree of uncertainty surrounding arrival times at bus stops. In their model, users arrive at a stop and will wait for the arrival of the next bus; an important assumption is that the distribution of passengers over the time space is uniform, i.e., there are no masses of passengers clustered around departure points.The optimal reaction of the bus operators consists then of randomizing arrival schedules at the bus stop, and setting the highest possible prices.

Given that consumers do not differentiate one bus company from another, random frequencies have to be expected for the following reasons: Some buses may bunch together or some may be alone at a given position in time and space. In the first case, each operator has an incentive to drive just in front of the others. Thus, bunching cannot be a solution. A profile where each bus is alone in a position cannot be an equilibrium either, since buses have an incentive to fall back and drive just in front of the next bus that is following behind. These techniques are known as head running and leapfrogging.[8] Hence, randomizing the arrival at a bus stop is the best strategy for each operator competing on the same route, and this forces the rivals to guess the arrival time of their competitors. A striking example is the case of Manchester, where the first two years of deregulation were characterized by services changing between 1500 to 2000 times annually. Bus companies cannot credibly provide timetable information. In these conditions, competition does not guarantee low prices.

Box 3.4: Random schedules: Main Comments

To avoid random arrivals at the bus stops, a solution could consist of providing a common timetable to the consumers so that they could coordinate their arrivals. Indeed, it is unlikely that consumers could coordinate in reality by themselves without any sort of intervention. However, the absence of a common timetable appears to be a market failure as competitors on the transport services market do not have incentives to cooperate. This suggests that one cannot address the question of evaluating the effectiveness of competition without taking into account the regulatory environment.

[8] Other older "bad habits" of bus operators are discussed in Forster and Golay (1986). They entail "hanging back" (the buses go slowly so as to pick up as much traffic as possible), "missing out a bus stop" (if the driver decides that there are to few passengers to stop for), "turning" (an nearly empty bus turns around before the end of the route and go back in the opposite direction), or "overtaking".

4 Agenda for an empirical investigation

The economic literature proposes a number of arguments as to why bus competition might be limited in the UK. Several reasons could explain such a situation: First, the technology used in the industry favours large and experienced operators and therefore impedes the entry of new competitors on an equivalent scale. Second, the fact that the transportation service occurs on short distances restricts the incentives of the consumers to look for the cheapest operator and/or the company offering the highest quality standards. Price competition is therefore likely to be very limited, even on routes where more than one operator is present. Note that, where there is no regulation providing incentives to bus companies to comply with the time schedules, there is no guarantee of a proper coordination of consumers at bus stops, which again limits the scope for competition.

Here we sketch out some possible empirical tests of the main results discussed so far. As pointed out above, most of the contributions drawn from the economic literature are theoretically derived, although based on experts' knowledge and experience. Although these theoretical arguments are intuitive and convincing, they often wait to be empirically validated. Our purpose is to indicate potential avenues of investigation but it is understood that it is only with the actual data in hand that the econometrician can properly design and implement specific statistical tests.

4.1 Testing for the contestability of the market

Test of null hypothesis 1:
The industry is characterized by economies of scale, scope, and density.

It is well known that if a technology exhibits increasing returns to scale, then the associated industry is highly concentrated or is operated by a single firm. In this case, the presence of too many production units prevents the efficient size of the industry being reached, which could be socially costly. Without entering into the details of this theory, this result invites evaluation of the level of economies of scale and scope, which is usually performed by means of the estimation of a cost function that provides the economic representation of the technology. For instance, the operating cost of the operation unit - defined as an operator *i* at depot *d* and period *t* - can be specified as

$$C_{idt} = C\left(y_{idt}, S_{idt}, W_{idt}, \ \xi_i, \ \psi_d, \omega_t \middle| \gamma\right) + \varepsilon_{idt},$$

where y_{idt} is the level of transport services provided by the operation unit which can be measured in terms of number of passenger-miles, S_{idt} defines the size of its network in terms of seat-miles for instance, W_{idt} is its vector of input price comprising for instance indexes of unit labor, energy, maintenance and capital costs, and are ξ_i, ψ_d and ω_t fixed effects respectively specific to the operator, the depot, and the time period. After estimating the cost function, economies of scale *ES* and economies of density *ED* can be respectively measured as

$$ES_{idt} = \left(\frac{\partial \ln C_{idt}}{\partial \ln y_{idt}}\right)^{-1} = \frac{1}{\varepsilon_{idt}^{y}},$$

$$ED_{idt} = \left(\frac{\partial \ln C_{idt}}{\partial \ln y_{idt}} + \frac{\partial \ln C_{idt}}{\partial \ln S_{idt}}\right)^{-1} = \frac{1}{\varepsilon_{idt}^{y} + \varepsilon_{idt}^{S}},$$

where ε_{idt}^{y} and ε_{idt}^{y} are the elasticities of costs with respect to output level and network size respectively. Estimating a simple Cobb-Douglas cost function could be enough to obtain estimates of these measures, but it is known that this specification generally provides a very poor approximation of the cost function. To evaluate economies of scope, one needs to estimate a multi-output cost function. For instance, one could specify the operating cost function of operator *i* at period *t* as

$$C_{idt} = C\left(y_{it}^{1}, y_{it}^{2}, \ ..., y_{it}^{n}, S_{idt}, W_{idt}, \xi_i, \omega_t \middle| \gamma\right) + \varepsilon_{it},$$

where y_{it}^{j} is the production at depot *j*. There are cost complementarities if the marginal cost at depot *j* decrease when output at depot *k* increases. if

$$\frac{\partial^2 C}{\partial y^j \partial O y^k} < 0.$$

which could give rise to economies of scope. Otherwise there are cost anti-complementarities.

In production analysis applied to network industries, analysts have often used the Translog cost function to estimate multiproduct technologies as it is easy to implement while being sufficiently flexible. (Among many others, see Ivaldi and McCullough, 2001, and the references there.) Other specifications present interesting features. For instance, the McFadden cost function allows evaluation of the sunk costs of a technology or simulation of the outcomes of various industry structures. (See, among many others, Ivaldi and McCullough, 2008.)

To conclude this section, we can make two remarks. First, data at the depot or firm level are required to estimate a cost function. Now, the question of the adequate level of disaggregation to measure output in a network industry is still open and subject to research. Second; we view good understanding of firms' cost functions as an important element of an investigation of the bus industry. However, it is important to recall that such an exercise is not immune from other constraints that the firms are facing, like the regulatory conditions. For instance, the local regulators may impose different quality targets, or the driving conditions may vary from one urban network to another, and this may explain cost differences across local areas. Moreover, at the moment of estimating the cost function, it is important to make sure that the operators produce homogeneous services. If differences exist, they should be identified through additional variables in the cost function.

4.2 Testing for predatory pricing

Test of null hypothesis 2:

The industry is not contestable.

A first set of empirical evidence supporting the non constestability of the bus industry is obtained if the existence of economies of scale, density, and scope is confirmed through the estimation of a cost function.

A second set of evidence can be achieved though the detection of predatory pricing: Following Motta (2004), predatory pricing implies that the incumbent sets low prices for a period and sacrifices short-run profits, so that the entrant believes that positive profits cannot be obtained. When the entrant leaves the market, the incumbent then increases prices and reaches high profits again, which in the long run outweigh possible losses incurred by foreclosing entry.

Note that observing that entry occurs is not enough to conclude that the market is competitive or that there are no predatory practices. To properly detect predation, prices should be compared to marginal and average costs. Following Motta, a test of predation could be implemented as follows. First, from the estimated cost function, we can evaluate total and marginal costs. Second, actual prices must be compare to these estimated costs: i) If the price is above total average costs, then the presumption is that the firms are not taking predatory actions; ii) if the price is below total average costs but above marginal costs, then predation should not be presumed, but the burden of proof is on the side of the competition authority; iii) If the price is below marginal costs, then there is a case for predation.

Note however that these tests should not be applied without taking into account the regulatory and competition constraints. Indeed regulation of prices and services or competition from other transport modes could clearly affect the pricing strategies of bus companies. Note also that, in some economic situations – for instance in the case of two-sided markets – prices can be below marginal costs at equilibrium without any effect of predatory practices.

4.3 Testing for the impact of market structure on prices

Test of null hypothesis 3:
Operators do not compete on prices.

According to the theory, companies do not compete on prices at the route level in the short run. There are at least two ways to test this assertion. There is a direct approach that consists of estimating a structural model of the industry that comprises a demand function and a pricing equation. The model can be estimated under two sets of assumptions on conduct, either price competition or collusion, that give rise two types of pricing equations. Then, if the theory is correct, a specification test should conclude that the two alternative assumptions are statistically equivalent in explaining the data generating process. This approach can be implemented using models specified along the line of the econometrics of differentiated products markets. (See Davis and Garces, 2010, for a presentation of these models.) To our knowledge, this approach has never been implemented for markets of local bus services. It is not clear if it can be performed on available data at route level.

There is also an indirect approach that it is easier to carry out. It is indirect in the sense that it tests a necessary condition not a sufficient condition, namely that the number of firms on the market has no effect on the price level. This approach relies on two strands of the literature. First, it refers to the structure-conduct-performance paradigm which states that the structure of a market (and therefore its degree of concentration) determines the operators' pricing conduct and therefore their profitability. The ability to obtain significant profits is inversely related to the number of firms and their market share, and thus is positively correlated with concentration. How operators' prices depend on the competitive forces at play on a specific route is therefore the core issue that needs to be addressed. These competitive forces are captured through several explanatory variables. Second, for a more precise specification of the regressions, the indirect approach also refers to the literature on the hedonic price model that comes from consumer theory. The premise of the model is that a product may have many attributes that the consumer values. As a result, prices may be decomposed into the effects of different characteristics linked to supply and demand.

By means of a regression analysis, the level of the dependent variable, namely, the logarithm of the price of a service on a specific route, is decomposed into a linear combination of explanatory variables, weighted by their corresponding parameters, and an error term. As each service is observed at least once, the dataset required to estimate this regression needs to be a panel dataset.

The equation is a reduced form in the sense that it is not directly derived from on an economic model, but it is driven by the underlying theories mentioned previously that guide the selection of variables that are candidates for explaining the levels of prices. In a very compact way, the equation can be expressed as follows:

$$\ln p_{ikt} = g\left(Entry_{kt}, Lenght_{kt}, Density_{t}, Demographics_{t}, Inputprices_{t},\ \xi_{i}, \psi_{k}, \omega_{t}, \varepsilon_{ikt} \middle| \beta\right),$$

where p_{ikt} is the price of operator *i* on route *k* at period *t*, β is a vector of parameters to be estimated and $Entry_{kt}$ is a dummy variable that takes the value one if more than one operator is present on the route and the value zero otherwise. The variables - $Lenght_{kt}$, $Density_{t}$, $Demographics_{t}$ and $Inputprices_{t}$ - which provide, respectively, the length of route *k* at period *t*, the density of the bus network at period *t*, the demographic characteristics of the population using the network at period *t* and the levels of unit costs of the company at period *t*, control both for supply and demand effects. The terms ξ_{i}, ψ_{d}, and ω_{t} are fixed effects specific to the firm, the route and the time period respectively, and ε is an error term. These fixed effects should account for the potential presence of unobserved heterogeneity. They should capture differences in the unobserved characteristics of bus companies related to their productive efficiency, the productivity of their inputs, the cost reducing activity of the bus manager, or the unobserved operator's pricing strategies. Time fixed effects should capture price effects that are time specific and affect all productive units, like inflation. Finally, route fixed effects capture unobserved characteristics of the geographical area under consideration.

If operators do not compete on price, as suggested by the economic literature, a non-significant *long-lasting* relationship between the price and the entry variable should be obtained.

One of the possible drawbacks of this approach is a potential problem of endogeneity. Indeed, even if one controls for demand and supply factors, the entry decision can be directly linked to the levels of prices so that the level of entry itself cannot be treated as an exogenous variable. A simple solution to this problem is to implement a two-step procedure where, in a first step, one estimates a probability model of entry and, in a second step, one introduces in the price equation - specified as before - the estimated probability of entry so generated in place of the dummy variable indicating the level of entry (namely, $Entry_{kt}$).

4.4 Testing for the impact of market structure on frequencies

Test of null hypothesis 4:
Operators do compete on frequencies.

To show that the presence of more than one operator has an effect on the levels of frequencies, which is a measure of the quality of service, a possible approach is to follow the same reasoning as proposed in the preceding section but this time applied to the logarithm of the frequency of service of an operator on a route at a certain period of time.

This hypothesis can also be tested by means of a structural model fitted on a set of data on routes and services offered by different suppliers. Suppose that the profit of a company *i* on the route *R* of a network is given by

$$\pi_i = \pi\left(p, f_i, f_{-i} \,|\, Q_R, q_R\right),$$

where p is the price paid by the customer whatever the bus s/he is catching, f_i is the frequency provided by firm *i*, f_{-i} is the vector of frequencies provided by firm *i*'s competitors on the entire route or on some part of this route, Q_R and q_R are the market sizes on the section of route *R* where firm *i* is a monopoly and is in competition respectively. Possibly Q_R and q_R can be equal and in general depend on the network structure which needs to be specified. Several more precise specifications of the profit function given above can be proposed. From this profit function, one can derive the optimal level of frequency provided by each operator depending on the presumed conduct of firms present on route *R*, given the network structure associated with this route. In other words, one can obtain the optimal level of frequency of firm *i* when it competes on frequency or when it tacitly colludes with the other firms present on route *R*. Depending on the situation, one can obtained a different expression for the optimal profit function depending on the network structure and the market size.

This simple model allows, by observing the state of the market, estimation of the parameters of the profit function and hence a study of the entry decision since one can infer from the presence of a firm on a route that it is making profit or from its absence that it has considered entry as unprofitable, given the conduct of firms on route R and given its network structure. (See Cerasi, Chizzolini and Ivaldi, 2010 for a similar model applied to the banking industry.) Moreover, a specification test could be implemented to detect whether competition or collusion is more likely to represent the data generating process. In case this test favours collusion, it would invite the competition authority to search for confirming evidence or the companies to provide counter-arguments.

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