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Evaluating the Long Term Impacts of Transport Policy: The Case of Bus Deregulation

by

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Thesis for the degree of Doctor of Philosophy

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ABSTRACT

FACULTY OF ENGINEERING AND THE ENVIRONMENT

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Talal Almutairi

The 1985 Transport Act, by which the British local bus industry outside London was deregulated, is considered as one of the most pioneering reforms of public transport policy in the world. The deregulation package (which also included privatisation and subsidy reduction) was controversial and was subject to heated academic debates over how successful it would be (and consequently has been) in reversing the deteriorating performance of local bus services since the Second World War. This debate specifically focused on issues concerning the efficiency of service provision, quality of service, and overall welfare.

In addition, the contrasting regulatory system adopted in London (competitive tendering) has given opportunities for researchers to evaluate and compare the outcomes of these contrasting systems and draw conclusions over the impacts of such regulatory reforms on the local bus industry in Great Britain. Commentators began to evaluate regulatory experience as quickly as the end of the first year after deregulation. However, the amount of research has declined as time has passed. The key fundamental questions, which the current research is trying to answer, are: what are the longer term impacts of the deregulation policy, how successful was it in achieving its objectives and what lessons can be drawn after more than 20 years? These questions can be answered by carrying out cost-benefit analyses of deregulation policy compared to the counterfactual as well as to the alternative regime adopted in London.

A key issue when examining long term changes is that of the counterfactual – what would have happened if the changes had not occurred? Econometric models of the demand, fare and cost for local bus services in Britain (London and the rest of the country) are outlined and used along with extrapolative methods for some key input variables such as bus kms and subsidy to determine counterfactuals. A large number of dynamic demand models have been estimated, considering both fixed and random effect, and using a variety of estimation methods including the Feasible Generalised Least Squares procedure (FGLS-AR(1)) and the Panel Corrected Standard Error (PCSE-AR(1)) method. In addition to Partial Adjustment Models (PAM), several Error Correction Models (ECM) were developed. Some analyses of subsidy and of costs are also outlined. The developed fares models are used to assess the impact of changes in subsidy (in terms of revenue support and concessionary fare reimbursements). The cost models

are used to determine the extent to which costs are determined by external factors (such as fuel prices) or partially external factors (such as labour costs). This then permits the examination of welfare change by estimating changes in consumer and producer surpluses as well the impacts on government, bus workers, and society as a whole.

Our finding is that there are net welfare decreases outside London, by contrast, welfare increases are found in London irrespective of whether subsidy changes impacts are included or excluded. We find that bus reforms in London have been more welfare enhancing than the reforms in Great Britain outside London, where deregulation led to substantial welfare losses in the first decade of the reforms (1985/6 to 1995/6). From the second decade onwards there are smaller losses. However, the results are sensitive to the specification of the modelling system and assumptions made concerning the counterfactual for the deregulated area in particular. This work confirms the sensitivity of the long term evaluation of transport policy to assumptions concerning the counterfactual and trends in demand, supply and prices. Any policy lessons inferred from these long term evaluations therefore need to take these sensitivities into account

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DECLARATION OF AUTHORSHIP

I, Talal Almutairi

declare that the thesis entitled

Evaluating the Long Term Impacts of Transport Policy: The Case of Bus Deregulation

and the work presented in the thesis are both my own, and have been generated by me as the result of my own original research. I confirm that:

- this work was done wholly or mainly while in candidature for a research degree at this University;
- where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated;
- where I have consulted the published work of others, this is always clearly attributed;
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1. Introduction

Trips by local and non-local buses make up more than two thirds of all public transport trips, and 7% of all trips in Great Britain are made by bus, compared with 3% by rail and underground (NTS, 2011). Bus is therefore the main mode of public transport everywhere in GB except in inner London.

However, bus patronage in Great Britain has been in long term decline since the 1950s. The 1968 Transport Act was the first major policy intervention since the 1930s. The Act introduced bus subsidies for the first time, with the aim of supporting publicly owned operators to continue providing bus services that were becoming increasingly unprofitable. Nonetheless, the Act failed to halt the declining trend in bus use, and public bus operators were accused of inefficient application of the subsidy, which leaked into higher wages and lower productivity (Bly *et al*., 1980; Turk and Sullivan, 1987). Furthermore, rising operating costs and reductions in services contributed to the problems of the bus industry and flagged up the need for policy reforms.

1.1 Background to the mid-1980s policy reforms

Margaret Thatcher's Conservative government's (1979-1990) response to the situation was to expose the industry to the forces of the free market, by deregulating the system, combined with a wave of privatisation and commercialisation of publicly owned operators. The government also diminished the power of Passenger Transport Authorities (PTAs), given to them by the 1968 Transport Act, to plan and operate bus services. Their role was largely limited to providing user information, administration of system-wide ticketing and tendering "socially necessary" services that would not be provided commercially.

It was argued in the White Paper of 1984 (DfT, 1984) that deregulation and associated competition "in the market" would reverse the upward trends in bus subsidies, fares and operating costs, while encouraging service innovation (e.g. deployment of minibuses), and hence would halt the decline in bus patronage. London was excluded from this regulatory system, for many reasons, and instead a competitive tendering system was gradually adopted. The deregulation was given legislative force by the 1985 Transport Act. The Conservative government of 1990-1997 did not bring in any significant regulatory change.

The 2000 Transport Act, adopted by the Labour government that came to power in 1997, had only a minor impact on bus usage (and did not change the previous deregulated system). The

2008 Local Transport Act represented an attempt to rectify the failings of the 2000 Act, specifically to make Quality Bus Contracts (QBCs) easier to implement. Again, the impact was minor. Thus, the provisions of the 1985 Transport Act are those that, to a great extent, prevail today, and the industry problems[1] that led to this and other policy reforms of the mid-1980s still largely exist.

The exclusion from deregulation policy of London, where a different policy was adopted, makes it a good case for a comparative study. It is also worth comparing the big bang approach to the bus system outside London (where the main reforms were introduced in less than two years) with the much more gradual approach in London (where the reforms took at least ten years).

1.2 Aims and Objectives

From the very first, developments in Britain have attracted much interest. It was the first major example in Europe of 'deregulation' (in price and quantity control), both of express coach services (from 1980) and of local bus services (from 1986). In addition, a striking contrast has existed over the whole period since 1986 within Britain, between London (which retains a regulated system, with competitive contracting of individual routes) and the fully-deregulated system elsewhere in mainland Britain.

The deregulation package was controversial and stimulated heated debate when first proposed in the 1984 White Paper. This materialised into a series of papers (mainly Banister, 1985; Gwilliam et al., 1985a and b; Beesley and Glaister, 1985a and b) advocating the case either for or against the proposed changes (White, 1995). The underlying issue in the debate was the degree to which the different regulatory regimes (deregulation or competitive tendering) and the associated forms of competition (on or off the road) would produce the best possible outcomes. The continuing debate has attracted academics, planners, policy-makers and others from the local bus industry, adding to its diversity and vigour.

Transport, as in many other sectors, exhibits a relative paucity of policy evaluation and where such evaluation does occur it tends to focus on short run effects. Bus deregulation in Great Britain is no exception. There was a slew of studies of the early effects (e.g. White, 1990; Mackie et al., 1995; Romilly, 2001) but none in recent years, no doubt because, as Pawson (2002) suggests, 'evaluation research is tortured by time constraints'.

[1] These included sharp increases in costs and subsidies, as well as reductions in services. Patronage is still declining, particularly in metropolitan areas.

However, the long term is precisely the time frame for evaluation of a policy's final objectives, whereas evaluation of the short- to medium-term effects is important but limited.

Indeed, since the last attempt to evaluate the policy (Romilly, 2001), which used data that stopped in 1997, a decade after deregulation, the trends in operating costs and subsidy have been reversed. Thus, the policy outcomes and impacts in the long term differ from those seen earlier in the process.

The aim of this thesis is to evaluate the long-term impacts of transport policy, for which the impacts of British local bus deregulation policy since the mid-1980s present a good subject. Although there are no specific definitions of long-term (or, for that matter, of short or medium term), many authors agree that the short run is one or two years and the long run around 12–15 (although sometimes as many as 20) years, while the medium run is usually around 5–7 years (Balcombe et al., 2004; Paulley et al., 2006). Some twentythe introduction of the 'Buses' White Paper and the 1985 Transport Act are a long enough time to permit long-term evaluation of their outcomes.

This aim can be achieved by pursuing the following objectives:

1. Examine the long term trends in key variables such as patronage, fares, service output (vehicle-kilometres), operating costs and subsidy in Great Britain outside London, and comparing these with the 'control' area of London.
2. Determine the 'counterfactual' (what would have happened in the absence of the policy intervention) through the application of demand, fare and cost models.
3. Undertake a cost-benefit analysis of bus deregulation in Great Britain outside London and of competitive tendering in London, by examining the impact on operators, bus users, labour and government (and the taxpayer).
4. Attribute costs and benefits to specific elements of the bus deregulation package, in particular isolating the separate impacts of deregulation and reductions in subsidy.
5. Determine the implications for future policy.

1.3 Key Methods

This research covers the time period from 1985/6, the last year before the market was deregulated, up to 2009/10. To understand how reform has affected the bus industry in the long term and for how long these impacts have persisted, the research examines the long-term trends in the main indicators of the local bus industry and then performs a cost-benefit analysis (CBA) that takes into account the broader impacts on key groups in the industry. This methodology is meant to provide a deeper understanding and offer plausible explanations of the policy impacts.

The methodology involves developing demand, fare and cost models, using the available data to predict the trends in these variables under the counterfactual scenario, namely a regime that continued to be regulated. By comparing these trends to those observed in reality, the impact of the reform can be calculated through a CBA. In particular, the benefits to bus users, operators, workers and the government (or the taxpayer) are identified. The methodology is outlined in further detail in chapter 4.

Although the research methodology involves substantial use of econometrics, it does so only to determine the counterfactual scenario. This is not an econometric research project.

1.4 Structure of the Thesis

This research seeks to evaluate the policy reforms in the local bus market in Great Britain, with particular emphasis on the impact of bus deregulation policy outside London. The next chapter gives some background about policy interventions in the British local bus industry in the mid-1980s. Chapter 3 reviews the outcomes of these interventions from a historical perspective by examining the short-, medium- and long-term trends in key indicators of bus services. The research methodology is described in chapter 4 and the econometric modelling of demand, fares and costs in chapters 5 to 7. Extrapolation of some key input variables is detailed in chapter 8. Chapter 9 explains how the counterfactual scenarios are built and an analysis of welfare or benefits may be found in chapter 10. Chapter 11 offers conclusions and recommendations

Owing to space limitations, some detailed results have been removed to the Technical Appendix, which is available on request.

2. Background: The 1985 Transport Act

After a brief review of the history of the British local bus industry and policy development in an attempt to track the historical background of the industry problems, this introductory chapter outlines the provisions of the 1985 Transport Act and the preceding proposals of the White Paper. It then highlights the main points of arguments for and against these proposals in the mid 1980s.

2.1 History of British local bus industry

2.1.1 The pre-1930 era

At the end of nineteenth century the first motor buses established their operations in Britain. At that time, the local authorities were investing heavily in tramways. It was in 1916 when an area-wide bus companies first appeared, and soon replaced the horse buses. After only three years, the motor bus started a decade of rapid expansion in all urban areas between 1919 and 1929 (Hibbs and Bradley, 1997).

As a result of the increasing number of bus operators competing "on the road", and the lack of adequate regulations in the bus industry, the competition transformed into a wasteful form of competition in terms of dangerous driving practices (Gwilliam, 1964), such as "hanging back" and "crawling" (the buses moved slowly in an attempt to pick up as many passengers as possible, otherwise the following bus would collect them). Other examples are bus stop "missing out" and "racing" other buses - the driver would miss out a bus stop whenever he felt that the number of passengers waiting at the stop was too small, and unviable, and race other buses to obtain more potential passengers at stops farther ahead. More dangerous practices were "passing", "overtaking", "tailing or chasing"(driving slowly behind another bus to overtake it or to move in front of it rapidly at the bus stop), "leapfrogging or jockeying"(each bus trying to pass or re-pass the other), "head-running"(scheduling the bus operations just ahead of the rival's bus schedule), "schedule-matching"(matching the rival's bus schedule), "nursing"(trying to take as many passengers as possible away from the rival's bus by running a bus along with it; in extreme cases it may include forcing the rival's bus into the ditch), and "blanketing" (squeezing the rival's bus by running two buses, one ahead of rival's bus and the other just behind it) (Foster and Golay, 1986).

The rapid growth of bus traffic and the dangerous driving practices in the 1920s were also associated with a considerable increase in accidents involving buses, both among buses and between buses and passengers, as well as the congestion problem on urban roads (Glaister and Mulley, 1983).

Given that, the situation of bus industry in the late 1920s raised concerns, particularly by the Ministry of Transport, over the inadequate safety regulations and the uncontrolled growth of small bus firms (Hibbs and Bradley, 1997).

In parallel, railway companies and local authorities, who had invested heavily in tramway infrastructure, sought protection of their investments from the competition by bus operations, and hence called for regulation of the local bus industry. Their arguments were based on two main equity concerns; first, they argued that the rail system needed some essential protection in order to operate efficiently, given that it is characterised by high sunk/low marginal costs. Second, road users were not charged adequately for their use, in the same way as rail users are. These arguments were compounded by the interests of larger bus operators in terminating the "on road" competition, in order for them to enjoy monopoly benefits in the market; hence they used their resources to regulate the market (Mulley, 1983). Later, these pressures resulted in cartel representation in the Royal Commission on Transport (1929-1931) (Hibbs and Bradley, 1997; Mulley, 1983).

In general, the demand for regulating the bus industry was driven by three major concerns. First, the safety regulation in the bus industry had been perceived by the Ministry of Transport to be unsatisfactory. Bus safety performance had deteriorated dramatically, where the industry was characterised at that time by too many small operators, which caused the high number of accidents and congestion problems in many areas (Hibbs and Bradley, 1997). Given that, prior to 1930, there were limited regulations by which the local authorities were able to regulate the motor bus industry. These regulations were based mainly on the Town Police Clauses Acts of 1890, created to regulate the horse-drawn bus industry, and 1947, originally created to regulate taxicabs (Preston, 1988).

Second, the competition "on the road" changed into wasteful forms, including dangerous driving and undesirable practices. Third, the rail and tram industries demanded protection from ‘unfair’ competition, in their view, with bus systems. Nevertheless, the latter concern had not been taken into account as a basis for regulation reform, but it brought great political pressure on the legislators (Mackie and Preston, 1996, p 2-3).

Consequently, a proposal of regulation of the bus industry by the means of licensing system was provided, as a Parliamentary Bill, to the Royal Commissions on Transport (1929-1931) and which later became the Road Traffic Act 1930.

2.1.2 The Road Traffic Act 1930

The Road Traffic Act 1930 established, for the first time in Britain, the regulation of bus operations as well as other passenger-carrying motor vehicles. The new bus regulations consisted of two main parts: service quality control (of vehicle, operator, and driver) and quantity control (of number and type of services). Following that, a long-term state intervention remained for another fifty years. Despite the British Transport Commission’s role between 1947 and 1953, and the provisions of the Transport Act of 1968 and Local Governments Acts of 1972 and of 1973, the Road Traffic Act 1930 legislations concerning local bus industry had not been significantly changed until the 1980 Transport Act was introduced (Preston, 1988; Hibbs, 1997).

As part of the Road Traffic Act 1930 legislations, the Traffic Commissioners were created to represent the newly-established thirteen areas. Traffic Commissioners were granted the power to control the bus market entry by the means of Road Services Licences (RSLs) (Mackie and Preston, 1996, pp 3). The (RSLs) system was used as a form of quantity control by which all operators planning to run their services in any part in the bus route network were required to obtain a licence before they were allowed to run their operations. Quality control regulations were also introduced by the Act through the introductions of three service quality licences aimed at maintaining high safety standards. These include vehicle maintenance, financial viability of operations, and driver's public service vehicle (PSV) licences (Banister, 1985; Robbins and White, 1986).

Under the (RSLs) system, the operator who had been granted a licence would be protected from outside competition (entry) as a reward for carrying the responsibility of maintaining a comprehensive and integrated service network in its area. This was usually achieved by employing a cross-subsidy system so that the operator had to run services on unprofitable routes and compensate the profit losses from the profitable ones. In addition, fare scales and service timetables are specified by the Traffic Commissioners and attached to the granted Road Services Licence (Preston, 1988).

Chester (1936) commented on the licensing system after the Road Traffic Act 1930, stating that there were three principles usually included in licensing. First, *Priority*: the Traffic commissioners usually award a route licence after specifying the firm that has the best capability to run services in efficient way. Second, *Protection* protects that firm from outside competition. Third, *Public need*: in return for the first two principles (advantages), priority and protection, the firm would carry the responsibility for ensuring service continuation on unprofitable routes together with profitable ones in order to meet public needs.

Overall, the licensing system created stability in the British bus industry in consequence of the standards required by the RSLs system, and planned and coordinated service networks emerged across the country, as well as significant improvements in safety records after the turmoil and high accident rate experienced by the industry in the 1920s (Mackie,1983). However, the licensing system provided protection for incumbent operators who consequently formed monopoly operations and constrained market competition, notably in urban areas (Banister, 1985).

2.1.3 The Post-War Era (1947-1979)

The bus industry in Britain after the Second World War was strictly controlled - and mostly owned - by the state (local metropolitan/municipal authorities). The investments in the local bus market and on the public transport in general, were very low during the war period and the private sector's financial standing was too weak to sustain provision of local bus services without state intervention; the whole economy was suffering and fuel was rationed. Therefore, government interference to provide integrated and coordinated public transport networks under a central planning authority had been seen as necessary in such circumstances (Mackie, 1997). This was put in place by the new, post-war Labour government's plan which launched a programme of nationalisation of public transport and created the British Transport Commission (BTC), which later acquired, under the Transport Act 1947, three large bus operators. The Act provided power to the BTC to maintain an efficient and integrated public transport network within Great Britain.

Since then, a long period of slow and continuous changes had started and extended until the 1980s. In the post-war period, from 1947 to 1979, a view in favour of a mixture of market intervention (as a means to attain social and economic targets) dominated the political scene. The view was shared by both Conservative and Labour governments; they differed only in terms of the extent to which intervention was justified. This approach was reflected in the bus market, where publicly owned firms were running their bus services along with other private operators, fares and investments were strictly controlled, and bus market regulations were increased and rationalised (Mackie, 1997).

Thus, until 1969, the ownership of bus companies, in most urban areas outside large conurbations, was split amongst local governments, public holding companies, and private firms. More specifically, the local bus industry was dominated by two major bus groups: the state-owned Tilling Group, owned by the British Transport Commission, and the British Electric Traction (BET), with many scattered small local municipal and private operators.

However, simultaneous changes in private travel patterns since the mid 1950s and a substantial increase in private car use led to a substantial decline in bus usage. This in turn resulted in large increases in operation costs per passenger and bus fares, to compensate the loss in revenue. The increasing gap between the operator's revenue from fares and operation costs meant that bus industry's profitability as a whole became negligible. This in turn led to growing demand for further government intervention and more control over bus operations to ensure uninterrupted bus services (Bayliss, 1999).

The government responded through the 1968 Transport Act provisions which altered the bus industry structure towards further sharp growth of public control and ownership of bus operations. The 1968 Transport Act included the foundation of the National Bus Company (NBC) and the Scottish Bus Group (SBG) as public authorities and holding companies, and set up the Passenger Transport Authorities (PTAs) and executives (PTEs) to take over public transport control and operations in four large urban communities, comprising several cities and towns (Greater Manchester, Merseyside, Tyne and Wear, and West Midlands). Later, the number rose to seven after three more PTA/PTE were established in Greater Glasgow, in 1973, and in both West and South Yorkshire, in 1974.

By the first of January 1969, the 1968 Transport Act provision of creating the NBC was implemented by merging a state-owned company, Transport Holding Company with another privately owned company, BET. The process resulted in 66 bus companies being operated as subsidiaries under the NBC in the 1969. In 1970, Country Bus Services of London Transport were also acquired by the NBC; at this time it was operating more than 40% of bus services in the whole of Britain except Scotland, and its operation was concentrated in smaller towns, rural areas, and on the periphery of larger cities. The Scottish Bus Group had the same experience in Scotland, while London Transport (LT) dominated the bus service operations in London (Cowie and Asenova, 1999; Bayliss, 1999).

As a consequence of the 1968 Transport Act, the local bus ownership and operations in Britain were mainly in the hands of publicly-owned bus operators (the NBC, SBG, PTEs, LT and local municipal operators), with a scatter pattern of small private firms. These public operators enjoyed monopoly protection and had no competition with each other, even in areas where more than one firm was operating. Also, fare and time schedule changes were restricted by Transport Commissioners, which led to a decrease in the number of private firms operating in the market and made market entry practically impossible (Savage, 1993).

The government intervention, through the 1968 Transport Act, had not improved or stopped the declining levels of bus services or their usage; however, it ensured the continuation of services through more public control over bus service provisions and direct subsidies for local bus services. The industry became very dependent on the subsidies provided by local governments and hence subsidies grew rapidly in the 1970s, particularly in metropolitan areas. The situation augmented further and more services became vulnerable to closure, which in turn led to a transfer in the remaining responsibility of service planning from bus operators to the local authorities or to the Passenger Transport Authorities through the Local Government Acts of 1972 and of 1973 (Mackie, 2001, p. 25). The local authorities and PTAs maintained service networks in their areas by means of revenue support payments (external subsidy) and further regulations of fares and time-schedules in order to meet public need. It was argued that the increasing use of subsidies was justified to avoid loss in services and control fare levels to ensure that bus users were charged at acceptable levels. At that time, bus services in all rural areas and in some parts of the network in several cities and towns were largely dependent on subsidies; otherwise the services in these areas would have had be terminated (House of Common, 1999).The use of cross-subsidy (internal subsidy) by operators was also encouraged; however, this put the transport authorities in a trade-off situation, since the use of cross-subsidy increased bus user benefits on unprofitable routes at the price of other bus user benefits in profitable ones (Mackie and Preston, 1996, p. 6).

2.1.4 The local bus industry in 1979 - The Problem

At the end of the 1970s - five decades since the regulations of local bus were first introduced through the 1930 Road Traffic Act and a decade of public dominion over the ownership and control local bus operations as a result of 1968 Transport Act - the performance of the bus industry was at the lowest level since the 1930s. There were growing concerns that the government interventions through the two previous Acts had over-restricted the bus industry, created and protected monopolistic activities, and misallocated the available resources. These concerns were strengthened by the continuing decline in bus service demand since the mid-1950s, and the constant growth in external subsidies and operating costs during the 1970s as well as the declining revenues (DoT, 1984; Bayliss, 1999).

Bus patronage declined dramatically from its peak in the 1950s; the figure of annual passenger journeys by bus in 1952 - of over 13 million - was halved by 1979, as illustrated in Figure 2-1.

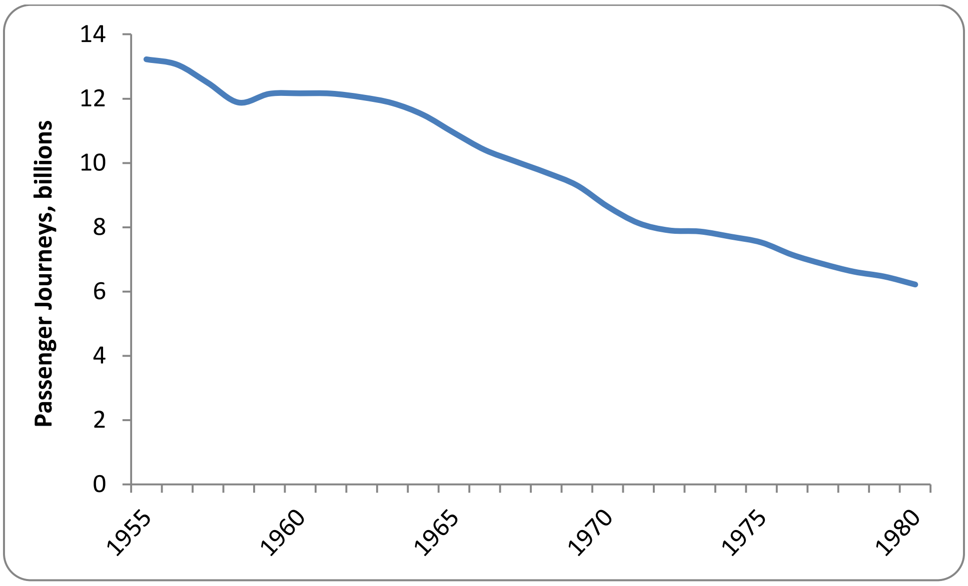

Figure 2-1 Decline in bus patronage in Great Britain since the 1950s' peak (passenger journeys, 1955-1980).

Source: DfT (2009b)

By contrast, the overall personal travel by all modes was increasing significantly over the same period, and had doubled in less than two decades between 1952 and 1970 in terms of total distance travelled. Combined with the long term decline in bus use, this led to a substantial fall in the market share of buses and coaches in the transport market; see Figure 2-2.

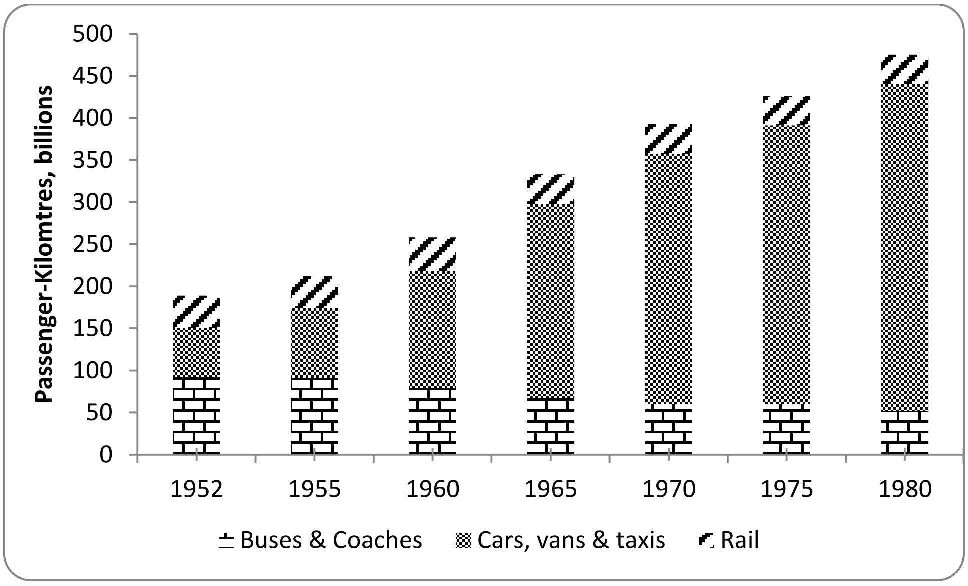

Figure 2-2 Passenger kilometres travelled by mode.

Source: (DETR, 1999, Annex B table 1).

All this had taken place in parallel to significant increases in fares - about 30% in the 1970s alone – and subsidies as revenue support increased from £10 million in 1972 to £520 million in 1982; this accounts for a thirteen-fold increase in real terms (DoT, 1984; Banister, 1985).

As a result, the financial performance of the bus industry was severely affected; only 10-20% of routes were financially viable, while the continuation of services became strongly dependent on subsidies provided by the local authorities to fill the increasing gap between the revenues from fares and operating costs (Savage, 1993). Subsidies were accounting for 30 to 35% of the costs in the urban areas, and around 20% in the municipal and rural areas. Added to that was the declining revenue from bus fares as a result of the falling passenger numbers, which resulted in more cuts in bus services provided (in terms of vehicle kilometres run), as illustrated in Figure 2-3.

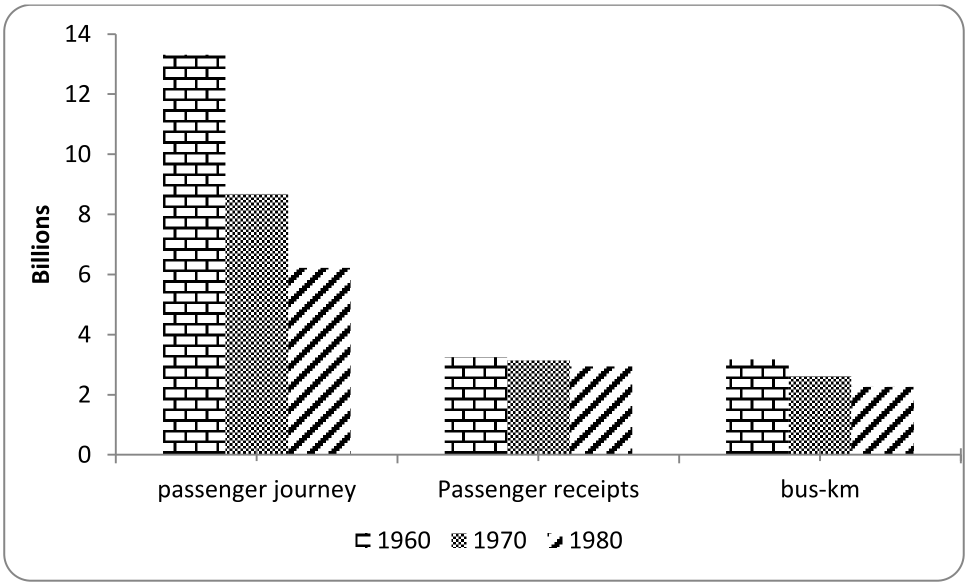

Figure 2-3 Declining trends in demand, revenue, and bus kilometres, 1960-1970, (millions). Passenger receipts at 1997/8 prices.

Source: (DETR, 1999, Annex B table 1 and 6)

The original purpose of subsidies was to improve the mobility of low-income households and to halt traffic congestion growth. Therefore, subsidies were paid to operators in order to keep fares at a low level and in the meantime to maintain an acceptable level of service quality (Savage, 1993).

Nevertheless, the increasing need for the subsidies paid by the local authorities brought with it an increasing degree of political control by these bodies. Consequently, by the late 1970s, the scene emerged in the bus industry whereby it was controlled by many transport bodies with conflicting roles and aims; these bodies included bus operators, traffic commissioners, local authorities and PTAs, and central government (Mackie, 1983).

All these negative outcomes raised doubts about the feasibility and flexibility of the current system of route service licensing and may point to its failure. This in turn initiated a demand for an alternative and more efficient regulatory system. Many alternatives were suggested including competitive tendering and full deregulation (Mackie, 1983).

Although there was agreement over the needs for reform of the regulation in the bus industry, and over that the principle of using competition forces in the bus market is essential to produce efficient services; the form of changes (the appropriate model which employs competition in an efficient way) was a hotly debated issue.

Nevertheless, it should be noted that other secular factors had contributed to the long-term decline in bus use. The most important of these factors had been the sharp growth in car ownership, sparked by the simultaneous increase in wealth following the Second World War. Over the same period during which bus journeys showed a sharp decline, the level of car ownership in Great Britain increased dramatically from 2.5 million (cars and vans) in 1952 to 15.7 millions by 1982 – this is more than six times the 1952 figure (Mackie, 1997).

Banister (1985) identified other secular factors, such as the higher standard of living, reverse movements/shift of home and work places back to the suburbs, and changes in the market towards a high technology market. Except for the first factor, it is difficult to estimate their impacts.

2.1.5 1980 Transport Act – The proposed solution (the first step):

The newly elected Conservative government in 1979 chose to deal with the bus industry problems of deteriorating patronage, increasing cost and subsidy levels, and falling levels of service, by deregulating the supply side of the industry, through “on the road” competition as a tool to secure an efficient local bus network.

Overall, the government approach consisted of three main parts: reducing public expenditure by discontinuing the revenue support (subsidy) which used to be paid for the public bus operator, increasing the commercial discipline in the market through privatisation of publicly-owned bus companies, and encouraging competition among bus firms by reducing entry barriers.

To achieve these targets, the government deregulated the local bus industry in Britain outside London in two stages by the 1980 and 1985 Transport Acts. The latter introduced full deregulation of local bus services; this was preceded by partial deregulation through the former act which had also fully deregulated the coaching (long distance or express bus services) industry as well as excursion and tour operations.

The government deregulated the express bus services (with minimum travelled distance of 30 miles) through the 1980 Transport Act. The Road Service Licence (RSL) for both express bus services and excursion and tour operations was abolished by the Act, which also removed the licensing requirement for small vehicles (below 8 seats capacity) (Banister, 1985).

With regard to the local bus services, the government had taken the "first step" toward full deregulation of "local" bus industry. The previous responsibility of the applicant (operator) to prove that its operation would not be against the public interests was shifted to the objector (Traffic Commissioner) – shift in burden of proof. Traffic Commissioners had to assess the transport condition of the network as a whole to prove that the applicant was acting against the public benefits before it could refuse to grant a licence (Mackie, 1983).

The 1980 Transport Act also abolished fare control of local bus services. Operators could now set their fares on a commercial basis without any restriction from the transport authorities, except in the situation where the operator's behaviour could affect public welfare or there was a destructive fare competition between operators (Mackie, 1983).

The regulation change brought by the 1980 Transport Act has significantly affected the express service industry. In the short run, fare levels were reduced, service innovations emerged, investments in better quality vehicles became greater than before, and demand for services grew (Fairhead *et al.*, 1983; Robbins and White, 1986). The "Buses" White Paper (DoT, 1984) argued that the positive outcomes of the deregulated express services were achieved through the emerged "competition in the market" where the users benefited the most.

In the early stages of deregulation of the express services, there was fierce competition, particularly in fares, between the new-established British Coaching Consortium and the pre-existing incumbent operator (National Express); this resulted in large fare reductions and a higher level of service quality on the inter-urban routes, which encouraged more express service patronage, mainly from the railway market (Cross and Kilvington, 1985; Bayliss, 1999).

Nevertheless, the competing operators neglected the small cities and towns in favour of high patronage routes between large cities, and the incumbent operators, who enjoyed the advantages of better marketing and a more integrated and comprehensive service network, have enforced their domination over the market. Unfortunately, competition did not last long and came to an end; patronage fell later, even below the 1979 level, after three years of high growth rate between 1980 and 1983 (Bayliss, 1999). Cross and Kilvington (1985) noted that

> "In general terms, competition has been patchy and short term. Given the experience of those independents entering the market since deregulation, further outbreaks of competition on regular-frequency services seem unlikely".

Similar patterns of competition were observed in the excursion and tour operations. The market structure was dominated by smaller private operators, in contrast to the coaching market, who demonstrated a high-ability response to user's needs and to the changes in the newly deregulated market. Again the competition settled down later.

The 1980 Transport Act, in a preparation step for full deregulation, allowed for local authorities to establish "trial areas" within their areas in which the requirement of local bus providers to attain the Road Service Licence (RSL) was abundant, leading to the situation in which the operators have the freedom of running their services on any route and at any time. The local bus market became completely open to entry on those trial areas, except for some quality control regulations of both vehicle and driver. In practice, three trial areas were set up in parts of Norfolk, Hereford and Worcester, and Devon (Mackie, 1983).

There were variations of the impact of deregulation in these trial areas (see for example: Evans and Hoyes, 1984; Fairhead and Balcombe, 1984; Evans, 1988), and there were some difficulties in extending the lesson learned from these limited areas to the whole country. In the rural parts of the trial areas, the results were neutral, while in town areas the results were positive.

The impact of the deregulation in the trial areas was fully studied by the Transport and Road Research Laboratory (TRRL) in 1984 (Fairhead and Balcombe, 1984). The study reported that both revenue support and fare levels fell, while service levels increased; the deregulation experience in the trial areas also created opportunities for innovations in new services. However, the study noted that the situation was still unstable and no certain conclusion can be drawn. In the meantime, some adverse outcomes were reported in terms of congestion in town centres and some difficulties in the implications relating to concessionary fare schemes.

The "limited" local bus deregulation outcomes in the trial areas, in conjunction with the outcomes of the deregulated express services industry as well as excursion and tour operations, supported the view in the 1980s in favour of full deregulation of local bus industry which argued that the industry would perform better if the deregulation experience was extended to include it. Such a growing view coincided with the government's tendency towards the deregulation policy as materialised in the "Buses" White Paper in 1984 which represented the basis upon which the government introduced the full deregulation of local bus services in all areas of Britain outside London through the 1985 Transport Act (Bayliss, 1999).

2.2 The deregulation of local bus industry

2.2.1 Introduction

The "immediate" outcomes of deregulation of express bus services by the 1980 Transport Act, which also set trial areas where local bus services was deregulated, were perceived by the "Buses" White Paper in 1984 as positive and encouraging. Thus, the Conservative government went further on their plan by proposing, through the White Paper on "Buses", the extension of deregulation policy to include the local bus services in all areas of Great Britain outside London. The underlying aim behind such fundamental regulatory changes was to halt the long-run decline in bus patronage since the mid-1950s and alongside with reversing the sharp growth rate in trends in operating costs and public supports for bus services which characterised the 1970s. The proposed regulatory reforms came into effects in October 1986 through the Transport Act of 1985 after heated debates over the White Paper's proposals. The debate extended further in subsequent years over the policy outcomes.

2.2.2 The Transport Act - The proposed solution (the second step):

Local bus operations in whole areas of Britain, except London, have experienced the most radical regulatory change since the 1930s through the 1985 Transport Act. The Act deregulated and privatised the supply side of bus services, on the basis of the preceding "Buses" White Paper (DoT, 1984) introduced by the Conservative government. The deregulation began on 16 October 1986, also known as D-day.

The essence of the Act was to stimulate high rate entry to the local bus market by removing competitive restrictions, in terms of entry barriers. It was assumed that this could be achieved by putting an end to quantity control, by the abolition of Road Service Licensing, which had been in force since the 1930s and by the commercialising and privatisation of publicly owned bus companies in the market.

This would lead to more "competition in the market" and hence efficiency improvement in service provision. This in turn would reduce service costs to bus users (fares) and taxpayers (subsidy) and improve service quality (Banister, 1985).

There were also stricter regulations on safety standards, quality control and competitive behaviour. The expansion of commercial operations in the bus industry was complemented by a system of competitive tenders for subsidised social needs services in the non-commercial part of the network.

2.2.2.1 Limiting regulator’s power and expansion of commercial operations

Formerly, the Passenger Transport Authorities (PTAs) in Metropolitan areas outside London, and the Local Authorities (LAs) in other areas, had the control of network planning (routes, time schedules) and fare setting. The coordinating role was terminated by the Act, since the Conservative government claimed that comprehensive planning was not appropriate for commercial services since the “freed” market would respond to passenger needs (Banister, 1985). After the D-day, the responsibilities of PTAs and LAs were amended and mostly limited to the parts of the network that were loss making, with services needing to be supplied by tendered services, and the provision of concessionary fare scheme.

The government was aware that not all services would be provided commercially and that there would be some gaps in services due to the unprofitability of some routes. In these cases, the authorities were to specify the routes and times of services and set the fare levels and then subsidise the service through a tendering process, as long as those services were socially needed and not provided commercially. Usually these gaps appeared on the unprofitable routes or at the time of the service when the demand is low, such as early morning or late in the day, on Sundays and remote areas with low population density. Commercial operators were able to run services in response to demand or profitability with no obligation to continue services whenever the operator felt it was commercially unviable.

In the parts of the network where the services were provided commercially, the transport authorities had no control over the services, apart from the provision of concessionary fares for the elderly, school children and the disabled. The difference between the concessionary fare and the full fare was paid to the bus operators by the Local Authorities. The Act extended the concessionary fare schemes to include all operators.

It was also recognized that rural areas would suffer the most from loss in services, due to low demand, after deregulation. Therefore, in rural areas, all operators would receive transitional financial support, per bus-kilometre, for their registered services. However, this was to be gradually reduced and ended in four years after deregulation. The amount was 4p per kilometre in 1986/87 declining subsequently (Hills, 1991). In England, the Rural Development Commission was to make a grant of *£1* million a year to encourage innovative services in rural areas, this in addition to the basic grant. A similar approach was adopted for rural areas in Scotland and Wales.

The PTAs/LAs were no longer allowed to operate bus services. The Transport Act 1985 obliged the PTAs to hand over their operating role to separate "arm’s length" operating companies.

The abolition of the Road Service Licence allowed operators to decide when and where to operate a service or halt, and set what fares they wanted. This was assumed by the authors of the White Paper to reduce entry barriers to the local bus market, to encourage more entry to the market, and to reach the desired level of market competition. Yet, the bus operators still had to register their new services and provide route information to the traffic commissioner. They had to specify service timetables, bus stops and vehicle types. The registered routes should be run by the operator accordingly, with a 42 day notice required for any change or withdrawal of service.[2] All the same, the Transport Act had reduced the regulator’s power (the Traffic Commissioners), through abolition of the licensing system.

2.2.2.2 Stricter quality control

The Transport Act 1985 removed the bus industry’s exemption from the Restrictive Trades Practices Act of 1976 and reinforced safety standards and quality control regulations. The Secretary of State was given the responsibility for appointing the Traffic Commissioners to monitor quality and safety issues as well as disciplinary matters. The operator had to meet regulations regarding drivers, vehicle condition and facility maintenance. In addition, operators were subjected to rules governing undesirable practices and set terms about bus stop/station locations potentially congested areas.

[2] Public Service Vehicles (Registration of Local Services) Regulations 1986 (SI 1986/1671).

The Traffic Commissioners were also able to attach strict conditions to operator's licences, and if any registered service was not running as it was supposed to, then the issue could be investigated by the traffic commissioner. The commissioners could not, however, oblige the operator to run a particular service or specify a particular location for a bus stop.

2.2.2.3 Privatisation

As part of Transport Act 1985, the deregulation of the local bus services was combined by the privatisation of the publicly owned bus companies, such as National Bus Company (NBC) and the Passenger Transport Companies (PTCs). The Scottish Bus Group (SBG) was not privatised by the Act but by the Transport Act 1989 (Scotland). These companies were running most of the network in 1985/86; 96 percent of passenger journeys were provided by the publicly owned companies (DoT, 1986).

The objective of deregulation was assumed to be to increase the competition in the market by removing entry barriers. Commercialisation and privatisation of the public sector was supposed to benefit from the private sector's better management system. By privatising and dividing these large public operators into smaller sizes, private capital participation was encouraged and barriers to entry were lowered as the incumbent's size was reduced.

The 1985 Act included provision for the privatisation of state owned National Bus Company subsidiaries, which were running most inter-urban and rural routes as well as some urban areas outside of the PTA/LA control in England and Wales. The Act allowed for the NBC to decide its own path to privatisation. The NBC subsidiaries were restructured into seventy-two smaller, arm's length companies, and by April 1988, they had been sold to the private sector, in management buy-outs or employee buy-outs. About forty NBC subsidiaries were bought through either management buy-out or employee buy-out schemes only. £323 million was the total revenue from privatisation of the NBC, at a net profit of £89 million after all debts and expenses were taken into consideration. However, some critics claimed that the total value of the National Bus Company subsidiaries had been underestimated (PAC, 1990).

Similarly, the Scottish Bus Group (SBG) has been divided into 10 companies in 1989 by The Transport Act 1989 (in Scotland) as a preparation step for privatisation. After two years later, all companies had been sold to the private sector resulting in £90 million total profit. Again the selling process was criticised because of the high cost associated with the process (NAO, 1993)

In the seven metropolitan areas outside London, the Passenger Transport Executives (PTEs) had responsibility for operating, planning and funding the majority of Passenger Transport Companies (PTCs) in their own individual areas. After deregulation, these companies were required by the Act to restructure and operate at arm's length from the PTEs. A further requirement by central government led to the privatisation of the PTE's bus operating companies by selling them to the private sector.

In the non-metropolitan areas outside London, where local bus companies were run and owned by the Local Authorities, the bus companies were commercialised and then included in the privatisation wave. However, a few municipal-owned companies were not privatised and continued to operate under the municipal ownership, notably in larger cities outside the PTE areas, such as Cardiff, Edinburgh, and Nottingham.

2.2.3 London

London was an exception in the Transport Act 1985. While local bus services in the rest of the country were deregulated, London was subsequently expected to follow the same track[3] (DoT, 1991). Nonetheless, a different approach was adopted for London through a competitive tendering system under the 1984 London Regional Transport Act. The Conservative Government postponed the bus deregulation in London until it lost the election in 1997 (Matthews *et al*., 1999). The 1999 Greater London Authority has reinforced the continuity of the competitive tendering system, which gives franchise rights, generally for three-year period, to the winning operator on a tender basis. At the same time, the tendering authorities in London have full control over fares, service levels, ticketing, passenger information and network planning (DoT, 1991).

As a consequence of the sharp increases in costs per bus kilometre and total subsidy paid for London Transport (which controls both buses and the underground) in the period between 1963 and 1979, the Conservative Government proposed fundamental regulatory changes in London through the 1983 White Paper "Public Transport in London" (DoT, 1983). Unit costs in London increased by 68% in 12 years only - between 1970 and 1982 - while subsidy increased thirteen fold over the same period (Glaister, 1997, p165). The changes proposed by the White Paper came into effect under the 1984 London Regional Transport Act.

[3] Indeed, in March 1991 a consultation paper 'A Bus Strategy For London' issued by the Department of Transport, setting out proposals to deregulate London's bus services.

Since 1970, the operation of London bus services has been under the direct control of the Greater London Council (GLC) and provided by London Transport (LT) which was answerable to the GLC. The 1984 London Regional Transport Act shifted most of the responsibility for bus services from the GLC to the newly established London Regional Transport (LRT). LRT created a new private company, London Buses Limited (LBL), operating at arm's length to control and run bus services (TAS, 2007). The Act was also obliged LRT to follow a competitive tendering process whenever it decided it was appropriate to contract out any services. Indeed, LRT contracted out a package of 13 of its bus routes through tendering on October 1984; this was followed by another 10 routes two years later (Glaister, 1997, p 167). The bids for tendered routes were made by independent operators and LBL, which was also considered as an in-house operator responsible for running services in the non-tendered part of the network.

When deciding which route to be tendered, the principal reason considered by LRT was the availability of independent operators who were able to run the service at lower unit costs than LBL (Glaister, 1997, p 167). Other factors reported by Glaister include routes patterned by low load factor (passenger per bus), high costs, and low frequencies. LRT decided to follow a "gradual approach" when reforming the London bus market (towards full tendering regime) for three reasons

- to be able to assess the impacts on a regular basis,
- to avoid the inability of planning staff to cope with rapid process; and
- to avoid swamping the markets by a massive wave of route tendering.

In a preparatory step towards privatisation, the LBL were disaggregated into 11 smaller units in 1989 and sold to the private sector in 1994 (TAS, 2007).

2.2.4 The debates sparked by the "Buses" White Paper:

Nash (1993) summarised the White Paper's arguments as follows:

> "Basically, the argument for deregulation rested on the generally assumed superiority of competition over monopoly. At its simplest, this argument would lead to reduced fares and increased output".

In the words of the White Paper (para. 1.12):

> "New measures are needed urgently to break out of the cycle of rising costs, rising fares, reducing services, so that public transport can win a bigger share of this market. We must get away from the idea that the only future for bus services is to contract painfully at

large cost to taxpayers and ratepayers as well as travellers. Competition provides the opportunity for lower fares, new services, more passengers. For these great gains, half measures will not be enough. Within the essential framework of safety regulation and provision for social needs, the obstacles to enterprise, initiative and efficiency must be removed. The need to act is urgent".

The regulatory reform, proposed by the White Paper, sparked long debates between a number of academic researchers and policy makers interested in the effects of such major policy change.

For example, an academic debate followed the publication of the White Paper, raising contrasting views of the anticipated results of the changes and about what methods should be adopted to attain optimum welfare to bus users, the government, and providers.

There was no argument over the essential need for improvement in local bus services, the key question was what the best way to achieve the desired results which taking into account the overall society's welfare. The debate got tense over whether the competition, "in the market" as proposed by the paper, was the best way for local bus services to achieve optimal results (Banister, 1985).

Competition normally brings benefits of improved cost efficiency and innovation. Real costs had been steadily increasing in the bus industry, and a reduction of up to 30% following increased productivity and lower wage levels[4] was forecast. Innovation was expected to take the form of an increased range of service qualities and fares, with particular emphasis on the introduction of high-quality, high fare minibus services (Glaister, 1985).

Another particular feature of the previous regime which should be noted was the widespread use of cross subsidisation[5] to support services on unprofitable routes and at unprofitable times of day. It was argued that this practice hastened the decline of the industry by leading to unnecessarily high fares and low service levels on the densely used routes that formed the core business of the industry and that it was likely that it favoured the better off rural and suburban dweller at the expense of the poorer inner city dweller. It was also believed that it was more democratic to support unprofitable services by explicit and transparent external subsidies (Nash,

[4] This is another debatable issue when evaluating the policy outcomes. Are lower wages "pure benefit" to the industry or "transfer of benefits" from bus labour to operator (employee to employer). Thus, White (1990) strongly argued this should be assumed as "transfer" when cost benefit analysis is carried out. Similar argument was made by Gwilliam *et al.* (1985a).

[5] Implies that profitable routes on the network finance the unprofitable routes.

1993). However, where there are budget constraints, cross subsidisation may be welfare enhancing.

2.2.5 The proponent's view

Gwilliam *et al.* (1985a) summarised the main points of the White Paper in four propositions as follows

1. "Deregulation will produce a competitive market".
2. "Competition will substantially reduce costs".
3. "A competitive market will improve resource allocation".
4. "A competitive market will not cause any significant undesirable spin off".

In the first proposition, the main argument of the proponents of local bus deregulation, such as Beesley and Glaister (1985 a, b), is based on the "contestability of the local bus market". It was assumed that the principal entry barrier was a "regulatory" barrier (in particular the licensing system) rather than an "economic" barrier. The deregulation policy removed this barrier by abolishing the operator requirement to obtain a Road Service Licence, and hence the deregulated bus market is argued to be highly contestable as a result.

Moreover, the proponent argued that the economic entry barriers in terms of sunk costs, capital costs, use of technology, and minimum efficient scale were low in the bus industry (Beesley and Glaister, 1985a,b). Consequently the new entrant could enter or exit with ease at any time. Thus, it was anticipated that widespread competition would prevail, predominantly in densely urban areas and to a lesser degree in rural areas, and patterned by high entry rates to the market; particularly by the private firms previously operating in other transport service markets, such as excursion and tour, private hire, and express services (Preston, 2003, p.159).

In cases where the assumption proved to be wrong (with no competition on the road and a monopoly operator remaining dominant on an exclusive bus network), it was claimed that market contestability, by means of the threat of potential entrants to the market, would force the incumbent to operate in an efficient and competitive way so that no profitable gap could be taken up by new entrants, who may adopt permanent entry or a hit and run strategy. On the whole, the community would benefit from a change in operator behaviour in the sense of better quality and lower fares bus services.

In the second proposition, the White Paper assumed that improvements in both productive and dynamic efficiencies would be among the positive changes that competition would bring with the deregulation of the local bus services. Substantial reductions in costs were expected to result from improvements in productive efficiency.

The White Paper anticipated a 30 percent reduction in costs mainly from improved labour productivity and cuts in wages, ending the long-lasting growth in bus operation costs. It was argued that private operators are more efficient than public owned operators in terms of service operating costs. The estimated level of reduction in costs by the White Paper was articulated heavily on the results of a study carried out by the TRRL, which showed that the unit costs of private operators were about 30-40% lower than those of public operators such as NBC (Tunbridge and Jackson, 1980). This was also supported by another study performed on an Australian private bus operator which showed a more significant difference in unit costs between the private and public operators (Wallis, 1980).

The White Paper stated that the privatisation and deregulation of local bus services would increase private sector participation and hence allow for the private firm's efficiency in cost by operating the bus services at, or close to, the minimum cost (productive efficiency). It is also argued that private firms are more innovative than publicly owned operators in terms of ticket and service types, and working practices (dynamic efficiency) and that should also lead to further reduction in cost (Preston, 2003, p159-160). The public bus operators in the previously regulated system were accused of inefficiencies in response to changes in bus user choices, such as providing higher bus frequencies, new fare structures and collection systems, and differentiated services through mini and midibuses, or creating new innovative solutions to any operating problem issues on which private firms have the advantages. The White Paper argument about private operator "productive" and "dynamic efficiencies" has been also sustained by evidence from previous studies on cost reduction observed in the deregulated trial areas (Fairhead and Balcombe, 1984).

In the third proposition, it was claimed that improved resource allocation through better fare-service combinations would result by introducing competition in the market and eliminating cross subsidy which was widely used in the pre-deregulation era

The proponents of deregulation argued that cross subsidisation produced unproductive and inequitable outcomes. The continuation of service provision in rural and low demand routes/times was at the expense of the high patronage routes in densely populated cities with undesirably high fares and low service levels. Thus, it was argued that part of the deregulation policy concerned with the removal of cross subsidy would bring more desirable outcomes in terms of social equity, since bus travel costs would be reduced in high patronage areas, where bus-dependent low income households are concentrated, with direct external subsidy in the parts where there are fears of service cuts. This outcome was in contrast with the argument that the poor were financing the rich pre-deregulation (Donald and Pickup, 1991)

Finally, in the fourth proposition, it was argued that the deregulation of bus services would not bring negative consequences such as an increase in pollution, congestion and accidents (Preston, 2003, p61). The White Paper suggested that quality and safety regulations would be enforced by the transport authorities and that would minimize any negative side effects of the deregulation policy.

2.2.6 The Opponent's View

The White Paper propositions met strong and contrasting views, mainly from Gwilliam *et al.* (1985a and b) and Savage (1986). While the White Paper propositions stressed on how competition could cure the regulated system's failure, the case against deregulation was based on the argument that the local bus market characterised by features which undoubtedly would not allow for such problems to be solved efficiently through free market mechanism alone. These characteristics include entry barriers, bus operator behaviour in the competitive market, and the necessity for subsidies on bus service provisions (Nash, 1993). There was another strong argument related to central planning and the ability of a comprehensive tendering regime to produce results that overweigh those that deregulation would bring.

One of the main views opposing deregulation appeared in the academic paper of Gwilliam *et al.* (1985a). They tested the foundations of the White Paper's four propositions in an attempt to evaluate the validity of the assumptions and evidence. In the end they rejected all of the assumptions and criticised the evidence used to support them.

2.2.6.1 Contestability Arguments

In disagreeing with the first two propositions, they argued against the commercial bus industry's contestability because of the incumbent's natural advantage. Thus, competition in the local bus market would not occur, and even if it did, it would be limited temporally and spatially.

In addition, the competition was expected to deteriorate into a wasteful form of predatory behaviour, such as time scheduling and price matching intended to cause revenue loss and force competitors out of the market. Short reaction period means that the incumbent can match the entrants' fares and service levels quickly. Hit and run entry unlikely to be feasible. This is in contrast to the White Paper's argument that deregulation would produce a competitive environment in which any tactics by the incumbent operators to terminate competition would be inefficient and would be avoided in the future.

It can be noted that the contrasting views are not debating the possibility of wasteful behaviour appearing after deregulation, which is expected anyway, but over its ability to deter entry and inhibit competition. This totally depended to the extent to which the market is contestable.

Also, the White Paper evidence of potential competition (and cost reductions) in the deregulated local bus services was based on the experience of express bus deregulation under the 1980 Transport Act (see for example: Fairhead *et al.* 1983, Kilvington 1983, and White, 1984). The use of this experience as evidence was criticised by Gwilliam *et al.* (1985a), who doubted that any lesson from express bus business experience could be applied to local bus services because of the different characteristics of the two markets. Bus service regulation in the 1930 Act was proposed to protect bus services from deterioration in safety standards and congestion unlike the express bus industry which was regulated to prevent any competitive threat to rail services. Therefore, the express bus industry is commercially attractive and has the potential to attract more entries, as soon as it is deregulated, than the local bus industry. In addition, the express bus market does not receive any governmental financial support, since it is economically viable unlike the local bus services. Finally, the express bus market has greater sensitivity towards price and quality changes compared to local bus services. As a result, this would lead to more competition in terms of fares and quality in this market.

Two main reasons were given by Gwilliam *et al.* (1985a) to explain their rejection of the market contestability assumption; the argument of small capacities in many small bus markets and the large establishing size for most incumbent operators. First, in some small local bus markets, entry barriers would arise because of the limited capacity of these markets. The capacity would probably be exceeded by the number of competing bus operators, and hence the market would not be able to maintain the competition in the long run. Secondly, another entry barrier may materialise when some incumbents gain advantages from pre-existing position on the market, in some areas where the incumbent has established its operations in the pre-deregulation period and has maintained some domination over most or parts of the bus service network. From that it was concluded that any competition, if existed, would be both temporally and spatially restricted.

In response to Gwilliam *et al.* (1985a) argument about small capacity markets, Beesley and Glaister (1985a) restated that even in the small markets such as on a thin rural route, the local bus market is still contestable.

It was argued that since the sunk costs in the bus industry are mainly capital costs in terms of bus vehicle, which should be considered as fixed costs rather than sunk costs. Also, deregulation would create more freedom for new flexible contract terms in vehicle ownership and hiring, separate-time shifts, part-time jobs, etc. Therefore, this flexibility will allow for small operators to freely enter and exit the market, particularly in smaller markets. This in turn would increase the contestability of these markets, in contrast to the previous regulated system which ceased these opportunities.

As regards the second reason that incumbent has advantage in term of large starting size, Beesley and Glaister (1985a) responded that the main factor that inhibited bus market contestability under the previous regulatory regime was a statutory entry barrier in terms of the licensing system. This in turn was responsible for the incumbent's size advantage. This barrier was abolished by the deregulation policy. Thus, it cannot be used as evidence of inability of the deregulated regime to produce market competition. Although the authors admitted that there is still a possibility of one operator running the bus network exclusively, they doubted that any super normal profits could be earned by this operator, otherwise it would attract several entries to the network. In conclusion, they assumed that the market is perfectly contestable

In general, one of the main determinants of market contestability is the size of entry barriers, mainly the sunk costs. Many forms of sunk costs were argued to exist in the bus industry such as physical capital costs, market knowledge, and publicity. There were arguments about operators having difficulties in obtaining suitable depot location as well as equity concerns in terms of all operators having access to the bus station, but was not assumed to represent a significant entry barrier (Nash, 1993). It is believed that market knowledge and publicity are among the main entry barriers to the market in which the incumbent operators have the superiority over the new entrants (Button, 1988).

The deregulation policy amended the responsibility of local authority to include the provision of both time tables and service network maps covering all current operators; and this would limited any incumbent's publicity advantage. Yet, there were doubts that such responsibilities would be fully fulfilled in practice (Nash, 1993). Therefore, economies of scale in term of both publicity and information providing was argued to exist on the bus market and gives an advantage to the incumbent operator (Nash, 1993).

2.2.6.2 Competition would reduce costs

On the second proposition, the White Paper's anticipation of a 30 percent reduction in cost through efficiency improvements was drawn from a study comparing the total costs of public operators and independent operators. This was also rejected by Gwilliam *et al.* (1985b) as it neglected the effect of different work environment for different type of operators on their total costs.

It was assumed that if any cost reduction in bus operations could be achieved from competition as the White Paper anticipated, it may be considered as a transfer rather than as absolute gain in efficiency. The cost efficiency improvement was assumed to be achieved in two ways, either by lowering the labour wages or by increasing their productivity. Either way, reductions in cost involve partial or total transfer in gains, rather than real efficiency gains. Lower labour wages are actually a transfer in gains from bus workers to bus users or tax payers, while increase in productivity is partially a transfer from bus workers, in a less attractive work environment, and the rest is absolute gain in productive efficiency (Gwilliam *et al.*, 1985a).

It was argued by the proponents of deregulation that, in total, employment in the bus industry would increase as well as aggregate earnings levels after the deregulation. This is because deregulation would encourage entries, innovative products, and expanding route networks, whilst the regulated system used to protect labour wages at the expense of consumer and society welfare (Beesley and Glaister, 1985a)

In disagreeing with this point, Gwilliam *et al.* (1985a) expressed their concerns that the anticipating cost savings would be mostly at the expense of level/quality of service provided; particularly in evenings, on Sundays, and in rural areas where patronage levels are low. They doubted that new wages structures would yield higher employment rates, so that the jobs lost due to loss in service provided would be compensated.

2.2.6.3 Efficient resource allocation

The contrasted views over how optimum resource allocation can be achieved concentrated on the case for or against subsidy to ensure fare/quality combination, the feasibility of minibuses, and service coordination and network integration.

The opponents of deregulation stressed the crucial role of external and internal subsidies to local bus services. They believed that "open" competition is inconsistent either with the first best optimum solution or with the second best solution of maximising social benefits subject to a budget constrain, which required external subsidy and internal (cross) subsidy respectively. Thus, competition would not produce an efficient allocation of resources and so the third proposition that a competitive market would improve resource allocation was rejected (Gwilliam *et al.,* 1985a).

Additionally, the White Paper assumption that external subsidies for bus services had reached an unacceptable level was also rejected, since it did not take into account the external economy of scale related to user costs (the Mohring effect). The larger scope of cost benefit analysis, which includes all main parties in the industry, would illustrate the actual benefits of external subsidies

In the view of the proponents of deregulation, the extensive use of external subsidies in the regulated regime was seen as inefficient, and had been increasing without reasonable justifications. They supported the approach of shifting external subsidy expenditure to the parts of the network where the use was justified (e.g. compensating for loss-making routes) (Beesley and Glaister, 1985a)

The White Paper also called for the removal of cross subsidies, based on an inequity argument, stating that “requires some passengers to take on their shoulders the burden of maintaining services for other bus users regardless of their ability to do so"

Moreover, it accused the use of cross subsidy for deliberate high fares on high patronage routes, where operator produce more than the normal profit (leading to a decline in bus use, assuming -0.3 price elasticity, but also an increase in revenue)

It is generally agreed that cross subsidy does not always favour public interest, but it is argued that it is socially beneficial and necessary as a second best solution if subsidy are constrained by government budgets. However, Gwilliam *et al.* (1985b) doubted that the system proposed by the White Paper could be successfully based on the fact that it proposed to replace the previously external and internal subsidy by a new diminished external subsidy specified to parts of the network where the loss making services occurred. They argued that "some degree of cross-subsidy is a lesser evil than the widespread cuts in service which will otherwise occur ".

On another issue, Gwilliam *et al.* (1985a) disagreed with the claim that successful (quality) competition through minibus entries onto the local bus market would emerge after deregulation. They demonstrated that minibuses have high unit costs, and are generally considered as an expensive transport service; many people would prefer the other cheaper bus type. Minibuses are unable to compete with low cost conventional buses unless there are barriers preventing the operational viability of the latter, such as on low demand rural routes. Otherwise, particularly in dense urban areas where demand is high, minibus opportunities to compete with large buses is weak, except in the case where they operate with high load factors, by running services at peak times only, and cutting services at low demand periods. However, such operations have negative impacts on road congestion as well as on fare levels and service frequency for large buses, which have to increase fares and reduce service levels to compensate for patronage loss.

Beesley and Glaister (1985b) agreed with the argument that minibuses are only feasible when operating at a high load factor, but they argued that both bus types can operate in the meantime, where demand may be split, according to how individual bus user values time.

The impact of deregulation on bus service coordination and network integration was one of the main concerns of deregulation policy opponents (Nash, 1988). Under the 1968 Transport Act, the transport authorities had the power to ensure coordinated public transport, taking into account bus user needs. This task had been maintained by means of timetable coordination, patterned by appropriate service frequencies, all-operator ticketing schemes, and extensive information (Tyson, 1990). Deregulation reduced the responsibility of transport bodies in the deregulated areas (Passenger Transport Authorities in Metropolitan areas) and left the task largely to the free market.

The White Paper asserted that if there is any loss of integration, it would be small, because of the free market's immediate response to customer needs in terms of comprehensive information and connecting services. However, public transport integration benefits go beyond this, according to opponents' views. A transport authority is required to coordinate routes, time schedules and fares to maximise social benefits. Such benefits cannot be achieved through the free market alone, because services in open markets are charging based on profits rather than on user needs. Furthermore, through ticketing requires revenue sharing between operators and side-payment schemes, which are too complicated to be applied in the unregulated market.

Overall, the case for subsidy is built on specific criteria of bus service market (service quality). In particular, both service frequencies and time schedules require a specified timing agreement among all participant operators. Such agreement is difficult to achieve in the free market. Therefore, the opponents of deregulation believed that responsibility for bus service planning should go to the transport authority, which should coordinate service frequencies and time schedules in order to maximise bus service benefits. This argument is supported theoretically by the concept of the Mohring effect, according to which as the frequency of services increases, the quality of service increase and consumer benefits rise as a result of decreased waiting time and user's general cost (Mohring, 1972). This supports the case for subsidising bus services as the optimum best solution of maximizing net user benefits. In contrast, deregulation policy called for subsidy removal on commercial parts of bus service networks, which is assumed to represent the majority of the network, with no appropriate alternative by which services could be financed, internally or externally, to offset loss of subsidy and ensure continuity (Nash, 1993).

However, the proponents of deregulation assumed that an appropriate fare-service combination would occur in the new market (Beesley and Glaister, 1985a). In this case, however, the free market's ability to provide a similar kind of combination was questionable (Gwilliam *et al.*, 1985b). The opponents believed that the removal of subsidies, both external and internal, would result in an inappropriate combination of fares and services (unreasonably high fares and unnecessary additional services. This arises because competition in local bus market is likely to be small group (Monopolistic/Oligopolistic) resulting in too many services at too high fares (Evans, 1987).

2.2.6.4 No undesirable spin-off effects

Regarding the fourth proposition, there were some concerns that there would be adverse effects of deregulation in terms of deterioration in safety standards, increased congestion, and loss of services (Gwilliam *et al.*, 1985b).

Even though the White Paper called for tighter safety regulation, still there were some issues that caused concern. For instance, the large number of small operators anticipated by the paper to enter the market combined with the low maintenance facility's capacity in bus markets was believed to affect safety standards. In the meantime, the transport body's responsibility to maintain these standards would become substantial as a result of the rise in operator numbers. Moreover, minibuses would cause considerable congestion inside the dense urban areas, and effect both journey time and operating costs (Gwilliam *et al.*, 1985a); this contradicts the White Paper's assumption about the limited effect of congestion after deregulation.

Based on the experience of the deregulated trial areas, the White Paper concluded that there no loss in services would occur:

"...in each of the (Trial) areas, the county has been able to obtain better value for subsidy payments, and in none has deregulation brought the loss of service which some predicted" (Para 1.9).

The White Paper asserted that the removal of the undesirable cross subsidy associated with the regulated system would not be associated with loss in services apart from on limited routes, where the loss of the removed cross subsidy benefits would be compensated for by direct external subsidy in the effected routes. This argument unconvinced the deregulation opponents (Gwilliam *et al.*,1985b).

2.2.6.5 Central planning

The opponents of deregulation restated the importance of central planning to increase the welfare of bus consumer as well as the society as whole. Evidence of the vital roles of service integration, system coordination and economies of density in local bus market were used to support the arguments (Gwilliam et al., 1985a and b; Savage, 1986). A counter argument by Beesley and Glaister (1985a) stated the free market has the tools to respond to consumer needs and would compensate for any loss in benefits of central planning. Moreover, they criticised the functionality of systematic planning, where planners are assumed to have the ability to optimise the benefits of market outputs in the interests of the public through a network planning). They stated that “theoretical considerations have had little impact on the outcome in practice” (Beesley and Glaister, 1985b).

2.2.7 Competitive tendering system

The critics of deregulation policy, and the White Paper, focused on viability of the proposed system of “competition in the market", as a means of generating desirable changes. It was suggested an alternative of competitive tendering system with "competition for the market" would obtain most of the benefits attributed to competition without the major weaknesses of the proposed system (Gwilliam *et al.*, 1985b). Here, it should be noted that the debated views are not over the role of competition to obtain desired changes but over the means by which competition would be applied in the bus market. In the words of Gwilliam *et al.* (1985b) "The choice is not simply complete deregulation versus the status quo—there is a middle way".

The assumed advantage of competitive tendering is that it retains the transport authority’s ability to plan the public transport network in an efficient way whilst allowing for competition in management and operation. Thus, the regime could avoid the loss of service coordination and network integration through central planning whilst allowing for fare-service combination control and cross subsidy benefits associated with "competition for the market".

As there were critics of the proposed "competition in the market", there were also critics of the alternative system, "competition for the market". Beesley and Glaister (1985a), in their criticism of the tendering regime proposed stated that no effective competition could be produced in a tendering system unless there were some provisions allowing for contestability, and these provisions could only be met by preceding the tendering process by a deregulation competition, otherwise, the desired competition would fail to be achieved. Three reasons were proposed for that.

First, the “competition” would be limited to existing operators protected by the existing regulatory restraints. Also, collusion between large operators may occur. In response, Gwilliam *et al.* (1985b) claimed that any profit from franchising contracts would go to Local Authorities rather than to large operators. They also claimed that there was a large base of alternative small private operators, mainly in the coaching business who owned in aggregate a substantial number of buses and coaches, which could create potential competition with existing local bus operators on profitable route franchises, given that franchising contracts give more protection to smaller operators than on the road competition does.

The second reason put forward is that unnecessary delays and a higher possibility of collusion would be caused by the gradual approach which would be expected to occur when the implementation role in the tendering system was left to the existing authorities. This assumption was based on a similar experience with the London Regional Transport’s approach of tendering system. The counter response was that the benefits from gradual change to the system would be superior to those of immediate change, based on the output of any policy change being uncertain. Gradual application would allow the regulators to learn from the processes.

Thirdly, over time, there would be a possible risk of “capture of the franchiser by the incumbent franchisee” (Beesley and Glaister, 1985a). The response was that the capture risk is small in the local bus market because of the availability of many small and short time contracts that can be easily monitored. In addition, the “fair trading” provisions proposed by the White Paper for the deregulated system could also be applied to the franchising system, and that would reduce any collision threats (Gwilliam *et al.*, 1985b).

2.2.8 Theoretical Arguments

Overall, it can be argued that the essence of the academic debate is based on two contrary views regarding the proper shape of “regulation” to local bus industry; controlled or regulated industry versus free or unregulated market. Both views have been built on some theoretical background which worth to heighted briefly in this section.

2.2.8.1 The view of regulating the industry

The first view is in favour of the regulation of bus services through a direct government control. It suggests that public interest could be taken into account when the services are planned, the bus service operations may regulated in a way that the regulators have the ability to integrate the bus services and specify bus fares and time schedule in accord to maximise society welfare. In the meantime, such a system would allow for the regulator to prevent any "market failure" (Preston, 2003, p160). Market failure is believed to be significant in the local bus market (Gwilliam *et al.*, 1985). In the local bus industry, wasteful competition, externalities, natural monopoly, lack of information and equity are examples for which government intervention is required to prevent market failure.

Competition in unregulated bus market is argued to take a form of excessive services, rather than fare competition, resulting in inappropriate fare-service combination and expected to have negative impacts on safety. Operators usually concentrate on the short-run costs/prices at the expense of long-run stability of the service/market (Mackie, 1997).

In a natural monopoly market, the large operators are expected to benefit from the economies of scale, costs is decreasing as operator's market share is increasing, and firms reduce their unit costs by seeking to merge or acquire other smaller operators, hence competition would be unsustainable (Mackie, 1997). In this case the market regulation is necessary to prevent monopoly's exploitation at the expense of the bus consumers (in such cases higher fares and lower service level than optimal are expected) (Glaister, 1997, p137).

Externalities exist in the local bus industry, in terms of congestion and environmental pollution, and so the free market mechanism could not be used as a regulatory system, otherwise it would lead to an inefficient resource allocation. The argument is that when the marginal social costs are calculated, it takes into account any costs or benefits to society associated with the externalities. However, in the free market, the private firms focus only on the marginal private cost and neglect the social dimension (Mackie, 1997).

Although it is agreed that information is an essential factor in bus provision, in fact, it is associated with substantial costs to both consumers and producers. The regulation of the market can be justified if information is imperfect or there are information asymmetries. Finally, equity arguments, in terms of bus service accessibility for all users, call for some sort of intervention to ensure continuity/accessibility of services (Mackie, 1997).

Other advantages of regulation is that it allows for cross subsidy system which has the ability to increase the net welfare under the external subsidy constraint (Gwilliam *et al.*, 1985) as well as allowing for second best pricing solutions in cases of externalities such as congestion where traffic is diverted from car to bus (Preston, 1988). It also creates market stability and improves safety, for instance the high stability and low accident record observed after the 1930 Transport Act (Mackie, 1983).

Industries that have dense operation or are associated with externalities are the most affected by regulation. The bus industry is characterised by both. Therefore, it was argued that the 1930 Act was based on the "public interest" with emphasis on safety issue (Preston, 1988).

2.2.8.2 The view of free market's mechanisms

On the other hand, a second view calls for the use of the competitive market's mechanisms as a regulatory system, and a retreat of state intervention. The supporters of this view argue that any intervention in the market would affect the market balance and would cause unwanted "regulatory failure" which has far more negative impacts than "market failure" (Preston, 2003, P160).

This view is based on theory of contestable markets, appeared at the beginning of the 1980s in parallel to the proposed policy reforms in bus market. It states that in a market where there are no sunk costs associated with market entry, nor are there other entry constraints, only the efficient firms, with no cross-subsidy and optimum product mixture, would be able to survive in the market competition. Consequently, the monopoly would act in an efficient manner as if there is actual competition (Baumol, 1982). According to this theory, the government should only remove any barrier of market entry that may effect the competitive behaviour in the market (Gwilliam, 1989). Moreover, such government intervention should allow for "regulatory failure" defined as capture of regulators by the regulated.

The local bus industry is vulnerable to many forms of regulatory failure. For example, some firms or groups from other competing industries may expected to protect their operations against bus services competition by applying pressure on the bus regulators to obtain regulation outcomes according to their own interests, while the bus user benefits will be ignored. It is believed that rail and tram operators used their resources to obtain bus regulation by the 1930 Act (Preston, 2003, P160).

The view against regulation suggest that the regulatory failure would result in productive inefficiency (high cost and low productivity), allocative inefficiency (improper fare/services combination), and dynamic inefficiency (through lack of innovations) (Preston, 2003, p160; Mackie, 1997).

Regulation was accused for generating productive inefficiency in the market in that as regulations seek to protect the market, it would unintentionally protect labour. Restrictive working practices in the British bus industry in the pre-deregulation era are a good example. It may also lead to subsidy leakage into higher wages and lower productivity (Bly *et al*., 1980; Turk and Sullivan, 1987). It also believed that the standard fare system used in the regulated market would probably cause an excessive use of cross subsidisation in the market and hence result in high fare and low service level in the profitable routes, inefficiency in resource allocation, (Mackie, 1983). The regulation, or public ownership, was also blamed for inefficiency in responding to bus consumer needs and lack of innovation (dynamic inefficiency), mainly due to low staff productivity and unrestrained expansion of the public sector (Berechman, 1993).

More disadvantages of regulation identified by Kahn (1970) include labour union's overstated power and overinvestment. All these disadvantages of regulation were believed by the White Paper to apply to the local bus industry and were used as evidences of old regime failure.

2.2.8.3 Concluding remark

Although the two contrasting views were supported by theoretical evidence, however, it can be concluded that "The essence of the debate was empirical rather than theoretical" (Tyson, 1992). Therefore, the empirical outcomes of the regulatory reforms should be reviewed against the theoretical arguments that emerged in the debates.

2.2.9 Conclusion

The most important changes in local bus industry since the 1930 were proposed by the White Paper on "Buses" which paved the way for dramatic reform in the local bus market through the 1985 Transport Act. However, the proposed changes are controversial and stimulated long debate among the members of academic institutions and experts of bus industry. This chapter reviewed the background of the regulatory reform by the 1985 Transport Act in the mid 1980s and its provisions as well as the theoretical arguments and assumptions for and against the reforms appeared in the preceded White Paper and the associated debates.

Overall, the debate has not been over the need for regulatory reform of the local bus services, but, according to Banister (1985) “over the means by which such a service should be provided, in the best interests of the user and at less cost to the ratepayer and taxpayer”. The debate was over what form of regulatory system, and the associated form of competition, would achieve these objective in the best possible way.

However, as emphasised by some commentators (e.g. Tyson (1992)), the principal underlying theme of the debate over the regulatory reforms was more empirical than theoretical. Thus, in the next chapter, the evolution and outcomes after the implementation of the reform will be reviewed.

3. The policy outcomes

3.1 Introduction

In the second chapter we looked at the background of the policy reform (deregulation package) in the British local bus industry outside London and the associated debates as well as a brief overview of the simultaneous changes in London's regulatory regime (competitive tendering), without which it would not be possible to fully understand the reasons and objectives underlying such massive policy changes.

In this chapter we look at the policy outputs and their evolution after implementation. We will try to assess these outputs against the policy objectives as advocated by the Conservative government through the 1984 White Paper and the consequent Transport Act in 1985 and against the main propositions that arose in the associated academic debates. The review in this chapter builds on previous studies carried out by academic, governmental and industrial bodies and published bus statistics up to 2009/10. The review focuses on changes in the trends of the main five indicators of local bus services (operating costs, subsidies and grants, fares, level of service in terms on bus kilometres, and bus ridership), it also looks at changes in market structure (ownership). The next section of this chapter reviews the early outcomes of the regulatory changes, the immediate outcomes and up to five years since the D-day. Section three concentrates on medium term outcomes, the first decade since deregulation. The longer impacts, over the second decade, are described in section four.

3.2 The Early Outputs of Deregulation

The implementations of the 1985 Transport Act have brought immediate and profound changes in local bus industry. The early outcomes, during the first few years after deregulation, revealed substantial reductions in operating costs which exceeded in some areas the anticipated 30% fall as anticipated by the White Paper. This has been together with a significant fall in external subsidy. Also, new innovation in service type (mostly introduction of mini-buses) and operating practices (separate working shifts) have been emerged and service level in term of vehicle kilometre has been increased.

For instance, these results may be translated as a success of the deregulation policy. For example, Hills *et al. (*1991) in his study, early findings on the effects of deregulation of bus services in Scotland, reported that after a year, most of the government goals have been achieved, at least in the short term; such as increasing competition and reduction in both unit cost and subsidy expenditure. Moreover, many of the expected negative impacts, which the opponents of deregulation policy predicted to be associated with such policy, have not emerged (e.g. higher levels of congestion and accidents).

However, Hills *(*1991) also observed that deregulation was associated with great instability of the services. Bus users were suffering from frequent changes in service's routes and time-schedules and no evidence showed that these effects of deregulation were expected to slow down in near future.This was on the contrary with the situation in the pre-deregulation era when the regulated bus services were integrated, coordinated and stable. He also noted that the large conurbations experienced greater and more rapid changes than other areas.

And more importantly, the long term decline in demand since 1950s had been accelerated in the years just after deregulation. Also, a large number of mergers was observed since deregulation, contrary to the Government's target of developing a more competitive environment through introducing more size-equivalent competitive operators and preventing any possible competition deterrence by a firm's size advantage.

3.2.1 Cost

Halting and reversing the continuous increases in unit costs observed during the 1970s was among the primary objectives of the massive changes to the bus industry structures and policy in the 1980s. When the White Paper (DoT, 1984) was introduced, one of its main arguments for deregulating the bus industry was heavily articulated on the view that the removal of the regulatory entry barriers would allow for higher levels of competition in the market, and that would lead to anticipated reductions in costs by 30 percent.

In practice, this anticipation was very close to the real reduction in operating cost experienced by many bus operators notably in metropolitan areas (White, 1990; White and Turner, 1991). As illustrated in Table 3-1, Metropolitan areas reported the highest savings and English shires came next, whilst the lowest saving in deregulated area was observed in Scotland.

Table 3-1 Early changes in key local bus indicators by area caused by the policy reforms, 1985/6 - 1987/8, (%).

Change in	London	English Mets	English shires	Scotland	Wales	GB	Outside London
Unit costs	-12%	-27%	-19%	-18%	-21%	-21%	-23%
Total subsidy*	-22%	-29%	-20%	-8%	-21%	-23%	-25%
Real fares**	-8%	22%	0%	-5%	-9%	2%	5%

Level of service	2%	7%	19%	16%	10%	13%	14%
passenger	5%	-16%	-3%	-4%	-4%	-6%	-10%

*Public Transport Support (PTS) and Concessionary Fare Reimbursement (CFR). **Average revenue per trip excluding CFR. Source: White and Turner (1991), (Beesley, 1991), and the Public Transport Statistics Bulletins published by DfT (various edition).

Interestingly, further analysis by operator type resulted in very similar results of those for area level (Heseltine and Silcock, 1990; White and Turner, 1991). Figure 3-1 illustrates changes in operating costs by operator type.

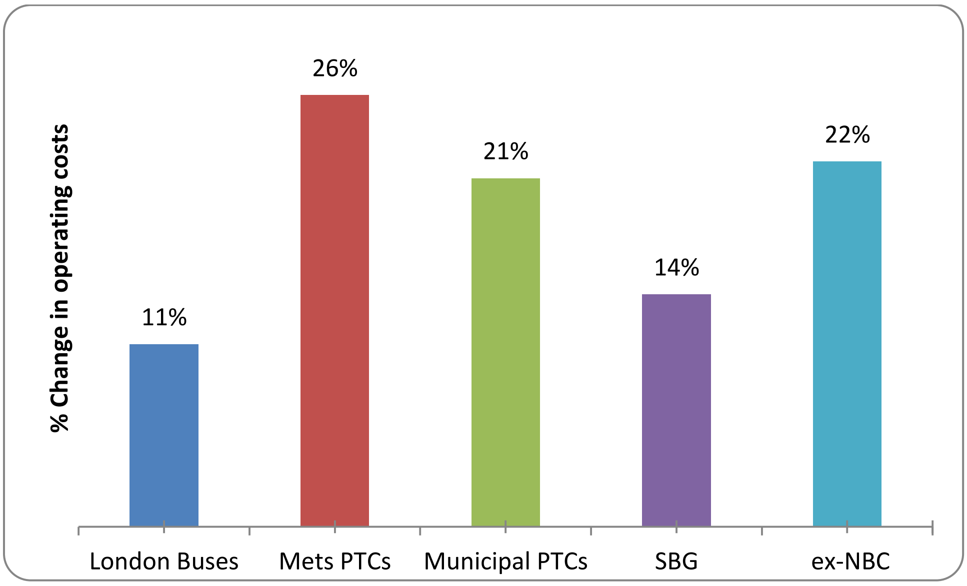

Figure 3-1 Reductions in operating costs by operator type (%), 1985/6-1987/8.
Source: White and Turner (1991).

3.2.1.1 Sources of cost reductions

The deregulation and privatisation of the local bus market have put pressure on operators to improve their operating efficiency to survive in the new competitive environment. There are many sources for observed reductions in cost but the most important has been the improvement in staff productivity and lower labour wages. The analysis carried out by Heseltine and Silcock (1990) on the PTCs operators in the Metropolitan areas showed that two third of the total unit cost reduction, 19 percent of the total 30 percent, has resulted from the improvement in labour productivity in the period 1985/6 to 1987/8, mainly from the non-platform staff, as shown in Figure 3-2.

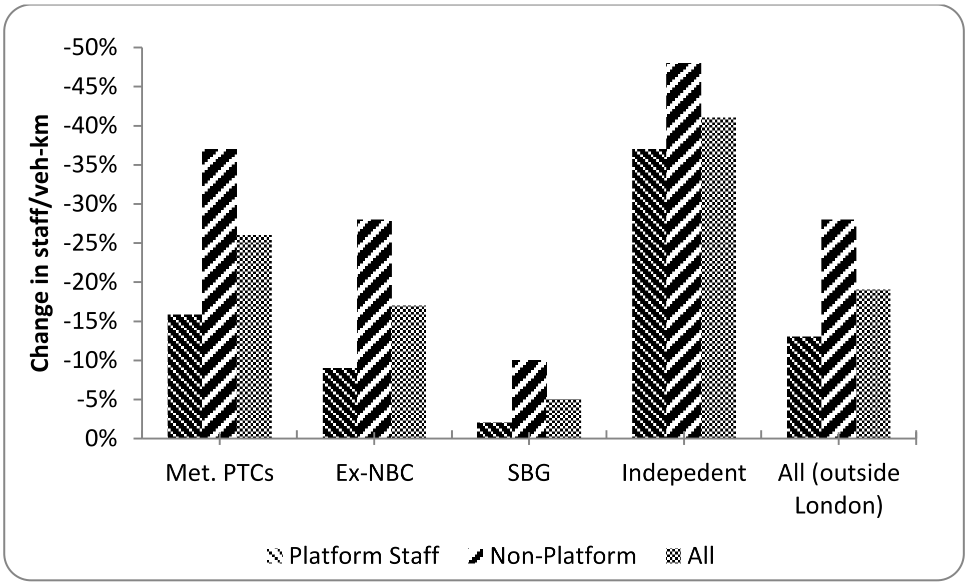

Figure 3-2 Improvements in staff productivity by employment type (%), 1985/6-1987/8. Source: Heseltine and Silcock (1990).

As the Scottish Bus Group (SBG) showed the least reduction, it can be concluded that privatisation (rather than deregulation[6]) was the main factor of labour productivity improvement since the SBG had not yet been privatised during this period of time. Table 3-2 demonstrates productivity improvement by operator type using different measures of productivity. Except for SBG again, it is very noticeable that the change in productivity per member of staff was much higher than those per bus (vehicle).

Table 3-2 Productivity changes by operator type, 1985/6-1987/8.

Measure of productivity	*Metropolitan PTCs*	*Ex-NBC*	*SBG*
Veh.km/employee	+34%	+18%	+5%
Veh.km/driver	+19%	+8%	+2%
Veh.km/vehicle	+7%	+2%	+12%

Source: (Heseltine and Silcock, 1990).

Another important source of cost reductions has been a decline of wage rate after deregulation. The same study found that up to one sixth of the total cost reduction can be attributed to lower wages, it should be noted that there was variation between different types of operators with the highest rate of decline in wage calculated for the PTCs operators.

It has been argued by Savage (1993) that the discontinuation of national collective bargaining, negotiations between an employer and labour union representatives concerning an improvement of work conditions or wages, at the time of deregulation had weakened the labour union power.

[6] Defined here as Road Service Licence removal.

The local labour market became the new controller of the wages and working conditions of the bus industry labour force

The findings on labour productivity improvement and loss in labour wages were supported by other studies (e.g. by White, 1990) who reported an increase in productivity in term of vehicle kilometre per staff member by 26 percent in the period 1985/6 to 1988/9. Fall in average weekly earnings for bus driver by about 9% is also reported, contrasting a corresponding increase of 7 % for all manual workers in the Great Britain in the period 1985/6 to 1988/9. Table 3-3 shows percentage changes in average weekly earnings in the first 3 years of deregulation.

Table 3-3 Changes in average weekly earnings, 1986-1989

Type of labour	*Changes in real weekly earnings*
Bus and coach driver (GB)	- 9%
London Buses Ltd (drivers and conductors)	+2%
All manual workers	+7%

Source: (White, 1990).

Most of the non-labour costs are considered as variable cost (tyres, vehicle parts, fuel and maintenance) and may vary according to bus kilometres. New quality and safety standards, mainly the tighter vehicle standards, introduced by deregulation policy made any cost saving from these variable costs unlikely (Kennan, 1989). Therefore, much of the cost reduction was achieved through labour costs (and reduced fuel prices).

However, there have been some non-labour sources of cost reduction including bus-vehicle life extension and change in fleet structure. The regulatory change reduced entry barriers as well as subsidies, this created uncertainty in both the viability of provision of bus services commercially and the final shape or structure of the network. Therefore, many operators were reluctant to invest in new fleet replacement until the market achieved some degree of stability and that led to an extension of vehicle life with an increase in fleet age average and hence instant cost saving.

Further cost saving was made through change in fleet structure toward an increase in smaller vehicles (especially minibuses) and a decrease in larger vehicle (especially double deckers). The increased use of minibuses reduced maintenance cost and allowed the replacement of large maintenance facilities and depots required for the conventional large buses by smaller and cheaper out of town facilities. Also, new maintenance practices were adopted, such as subcontract maintenance (Gwilliam, 1989).

Another non-labour sources of cost reduction has been falling fuel prices. White and Turner (1991) calculated a reduction of operating costs by 3 percent due to fall in fuel costs alone. White (1990) calculated a saving of £85 million for all areas Britain in the financial year 1988/89 because of the fuel cost saving.

It could be argued that the reduction in costs related to fall in fuel prices and lower wages could be attributed, in large part, to external factors rather than to deregulation policy. White (1990) estimated, between 1985 and 1988, falling costs of fuel (after fuel duty rebate) of almost 50 percent in line with oil global market prices. He also attributed the fall in wage level to the high unemployment rates in most parts of Great Britain in the same period.

3.2.2 Subsidy

The policy reform was accompanied by a simultaneous change in overall government public expenditure, with tighter spending policies including those on public support of bus services.

The early outcome of deregulation showed significant reductions in subsidies which had some effect on the local bus industry (on fare in particular), the effect had been partially offset by the cost reduction discussed before. Between 1985/6 and 1987/8, the total subsidies fell by 25 percent in the deregulated areas, again Scotland showed the least change as shown in Table 3-1. The highest subsidy reductions observed in the large conurbations. Beesley (1991) explained that by the fact that PTC companies in metropolitan areas had implemented sharp rises in fares in face of the high subsidy cut compared to other areas[7].

Less positive results were obtained when subsidy per passenger journey was used as an indicator, given that ridership declined sharply over the same period unlike bus kilometres. Almost the entire savings on subsidies were associated with reduced Public Transport Support, whilst concessionary fares only changed marginally.

After six years of deregulation, White (1993) reported that public transport support (revenue support at that time) fell by about 56% between 1985/86 and 1991/92. However, it should be noted that the sharp decrease in revenue support has led to some growth in concessionary fares, in attempts by Local Authorities to offset the reduction effect, and therefore the overall spending of concessionary fares for the whole of Britain increased to £400 million by the 1991/92.

[7] The significant falls in operating costs observed in Metropolitan areas has also contributed to reduce the impacts of subsidy cut.

In London, a significant fall in subsidies was also observed, but for different reasons. Both ridership decline and service level increase in London were below the rest of Britain, thus, revenue was higher in London which compensated the reduction in subsidy (White, 1993).

At that time, the substantial reduction in total subsidies could be seen as an achievement of the government public spending policy. However, the significant increases in the number of local bus routes registered commercially (more than 85% of the total bus network outside London) along with a fall in tendered service costs would put more pressure on bus operators' ability to continue reducing costs, and make profits. Therefore it was doubted that, in the long run, a reduction in subsidy and operating cost could last (White, 1993). That would put the government in a trade-off between public expenditure saving or quality bus services.

3.2.3 Fare

Although there was substantial reduction in operating costs, there was also simultaneous reduction in subsidy which means that minor changes in fares were expected. In practice, the bus fares increased considerably in Metropolitan areas (see Table 3-1), thus bus users have not benefited from any reduction in fares after deregulation as claimed in the White Paper. This result is opposite to the outcome of express bus deregulation after the 1980 Act when the sharp reduction in fare level had emerged and which the White Paper built its argument on (White, 1993). However, such jumps in fares were more noticeable in areas that had adopted low fare schemes, which were not possible after deregulation (Savage, 1993).

Fare setting had prevailed in all Local Authorities before deregulation, particularly in large conurbations. Many low fare schemes were evident in areas such as Merseyside (Liverpool), and South Yorkshire (Sheffield). Thus, higher increases in fares were observed there[8]. The power of fare setting was removed from the Local Authorities by the 1980 Act and bus operators could set any fares they wanted to on their registered commercial routes on the bus network.

Data on Table 3-1 shows that the Metropolitan areas demonstrated the largest increase in average real fares among the deregulated areas (22%), here the effect of subsidy reduction was most noticeable. No increase was observed in the rest of the country.

[8] Even before the deregulation was implemented, in April 1986 substantial fare increases were reported in some of the ex-PTE areas, where bus users had benefited from no increase in fares since 1975 (Bayliss, 1999).

Uses of concessionary fares, by disabled people and pensioners, grew after deregulation. In large conurbations, the proportion of bus users on concessionary fares was almost 25 percent to 30 percent of all local bus users (White, 1993).

In London, a reduction in fare levels occurred, mainly because of the widespread use of travelcards which counterbalanced the increases in cash fares (White, 1993). In Scotland, different pattern of fare and ticketing type change was observed. Many operators introduced reduced prices for multi-journey tickets and discounted return fares to attract frequent travellers to their operations. Albeit, there has been a few occasions when lower single fares have been launched, notably in areas experiencing competition (Hills, 1991).

It must be recognised, however, that the effect of fare level change on passengers has depended to some extent on what type of group the passenger fall into. Taken as a whole, the elderly and disabled people have suffered less, due to the growth in concessionary fare use. However, young people travelling at peak time, and paying the full fare, suffered the most (Hills, 1991).

There were concerns that the fare increase would affect, largely, low income families with one or no car who are dependent on bus services to commute to work and for other daily life needs. In an attempt to assess the impact, a study by Donald and Pickup (1991) was undertaken for the Merseyside Passenger Transport Executive, on low income households on Merseyside in the early stage of deregulation. They concluded that, fare levels should be cheaper for social needs, yet, the Local Authority's ability to control fares was limited. They could no longer support a low fare policy[9] nor could they force companies to offer discounted tickets or travelcards, since this is up to the operator to decide on commercial merits. This was another disadvantage of the deregulation policy; the social need for an integrated and affordable bus service conflicted with the operator's commercial stance which oriented to maximise profits.

The "competition in the market" introduced by the 1985 Transport Act, instead of the "competition for the market" as in London, forced operators to compete for a larger share of bus users on their own networks or otherwise they would lose to competitors. Therefore, the operators" marketing effort was oriented towards building brand loyalty through introducing single-operator pass ticketing schemes valid only to its operational network. As a result, the use of multi-operator pass ticketing schemes declined soon after deregulation. This is in contrast with the prevailing schemes of "multi-modal" and multi-operator pass ticketing in the pre-

[9] which was outlawed after deregulation as it was claimed that it would inhibit competition,

deregulation era (Hills, 1991). Savage (1993) found that, after five years of deregulation, the multi-operator pass ticketing schemes had been negatively affected. Accordingly, it is possible to argue that this was one of the disadvantages of the deregulation policy.

3.2.4 Level of service (VKM)

In the period preceding deregulation, services were broadly provided by public companies, and the supply of local bus services (vehicle kilometres) was declining. Thus, one of the principal provisions in deregulating the bus services outside London was that the abolition of the licensing procedure would free up and increase the supply side of the local bus market, mostly due to high entry rate to the market anticipated to be associated with competition.

In reality, the service level increased substantially, although faster in remote areas than in urban areas. After only two years of deregulation, an overall increase of 14 percent was observed in the whole of Britain outside London – see Table 3-1. However, patronage had declined 10 percent in the period between 1986 and 1988 (White and Turner, 1991). The direction of the contrasting trends between bus service level and patronage was also observed by White (1993) and McGuinness *et al.* (1994), who noted that the increase of service level was associated with decrease in bus use by the same figure of 22 percent between 1986 and 1992. It could be concluded that this inconsistency between these outputs may be explained by the "on road competition" characterised by an increasing number of operators competing on a limited number of high patronage routes (Headicar, 1989). In such competition, more services were not uncommon. Evans (1990) reviewed three case studies where serious competition occurred (the towns of Lancaster, Preston and Stockton-on-Tees) and found that sharp increases in vehicle kilometres had not been accompanied by demand increases, thus, bus occupancy sharply decreased.

The same direction of findings was indicated by Savage (1993), who noted that a high increase in service level had, in many cases, been associated with high competition between operators. In the absence of official statistics on competitive mileage, the only evidence used was the observed congestion resulting from competition in the city centres of Glasgow, Sheffield, Stockton-on-Tees and Poole. He also noted that the main sources of increase in vehicle kilometres were by the either the extra mileage operated by new entrants or the incumbent strategy of service swamping to deter new entries.

Interestingly, Savage (1984) anticipated, based on theoretical argument, that deregulation of the market would lead to negative impacts in terms of fall in load factor and overall loss in economic welfare. He built his conclusion on the fact that the local bus industry is patterned with inelastic frequency elasticities and operator tendency to adopt a "head running" strategy. In reality, the output of the early stage has confirmed the theoretical argument.

Another source of service level increase was the provision of new innovative services, particularly the sharp growth in minibuses used on high frequency routes (McGuinness *et al.*, 1994 and Savage, 1993). It was also found that further vehicle kilometres by conventional buses also contributed into the overall increase in service levels (White, 1993).

Data over longer period showed the same patterns of change in vehicle kilometres (White, 1993). Overall, the Metropolitan areas showed the lowest increase in vehicle kilometres (by 15%). This figure was also shared by London, while the highest figure was observed in Wales (26%), Scotland (25%) and the English Shires (22%), between 1986 and 1992.

It is unclear whether the pattern of service networks also changed after deregulation. It was suspected that the most extra vehicle kilometres were on a few pre-existing routes, due to the competition on the most profitable routes, rather than expand to cover more areas. As a result, this may have led to more concentrated bus networks with some service loss, as was feared earlier by opponents of deregulation, on less patronised routes and in remote areas or at specific times of the day and week (e.g. early morning, late night and Sundays). Alternatively, could have been some filling in of gaps in the network – to blockade entry.

3.2.5 Patronage

The new bus policy implications brought many positive outcomes, specifically on the supply side. However, the main challenge was the ability of these changes to halt the long-term decline in bus patronage (since the 1950s). Early evidence after bus deregulation showed that there were more buses with fewer numbers of riders than pre-deregulation.

A sharp drop in bus use occurred after deregulation, in particular in the first year immediately after deregulation. White and Turner (1991) reported an overall decrease in passenger journeys by 6% in Britain as a whole between 1985/86 and 1987/8, but this includes an increase of 5 % in London. When London is excluded, the figure goes up to about 10% of reduction. The greatest loss in patronage outside London was in Metropolitan areas at 16% and the least was in the English Shires, at 3%, as shown in Table 3-1.

Two years later, White (1993) found that bus patronage continued its decline which fell by 22% in the deregulated areas between 1985/86 and 1989/90. Again the Metropolitan areas were the most affected, experiencing a decline of 28%. A further decline in patronage was also observed in the English Shires, Wales and Scotland (by about 15%). Surprisingly, the gain in patronage in London was transformed to a marginal loss of 0.3%[10].

It was clear that the long-run decline in passenger journeys has not been halted. Moreover, the gradual decline of about 3% per annum in the 1980s accelerated after deregulation. A 4% per annum decline in passenger journeys has been experienced in the deregulated areas (McGuinness *et al.*, 1994).

In Metropolitan areas, where the greatest drop in patronage occurred, fare levels increased significantly, while minor increases were observed in the rest of Britain. The increase in the cost of travelling by bus has affected mainly the travel pattern of low income families, who represent the majority of bus users (Donald and Pickup, 1991).

Another possible explanation of the hastened negative trend in patronage is that deregulation brought with it turmoil of changes in route networks (Savage, 1993). The early stage after deregulation was associated with frequent changes in bus service networks, lack of information and unreliability in services leading to change in passenger travel patterns and modal shift from bus This is in contrast to steady, well-known, and affordable services provided in the pre-deregulation period (Donald and Pickup, 1991).

Additionally, loss-making services at early or late times of the day or at the weekends, and loss of network integration[11] contributed to the problem. The rapid changes were most noticeable in Metropolitan areas, while slower and gradual changes in services appeared in other deregulated areas (White, 1993).

Although competition has generated more vehicle-kilometres, it was not accompanied with higher demand. Overall, the demand level carried by both incumbent operators and new entrants was less than the level in pre-deregulation period (Hills, 1991). The data on passenger journeys by operator type confirms this finding where the independent operators' gains in ridership were due to transfer from other older operators rather than gain from new potential passengers attracted by improvement in fare and/or service quality (White and Turner, 1991).

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[10] Probably, due to the interruptions caused by the privatisation and tendering process started in the late 1980s in London.
[11] Integration had been maintained in the pre-deregulation era through multi-operator tickets

To assess the effect of deregulation on demand more precisely, other simultaneous changes in fare and service level should be taken into account, using conventional elasticities. Thus, several attempts have been made in this subject (White, 1990; White and Turner, 1991; Tyson 1992; Savage, 1993).

White and Turner (1991) have adopted a simple demand function which incorporated conventional assumptions of fare and service level elasticities. A short-run fares elasticity of -0.3, confirmed by previous studies of Goodwin (1988), and a service level elasticity of 0.4 were assumed along with an annual compound decline in ridership of 1.5% per annum[12]. The forecasted changes in ridership were then compared with the changes in actual ridership over a two year period, between 1985/6 and 1987/8. They found that substantial reductions in actual patronage were much more than what was forecast, specifically in Metropolitan areas (16.2% and 9.8% respectively). Lower differences, between the actual and predicted demand, was estimated in the other deregulated areas. In fact, some growth would have had been expected because of the significant increase in service level in these areas (for example in the English Shires the expected change was a growth of 4.3%, while in practice the change was a fall of 3.3%). Following White and Turner (1991) and using the same methodology and assumption, another study by Savage (1993) confirmed the same findings.

In 1992, a similar assessment was carried out by Tyson (1992). His findings were in line with the previous studies. Again, the observed number of ridership was much lower than what was anticipated by the demand function for the areas outside London.

Given that, it can be concluded that the deregulation of local bus services has not just failed to halt the long-term decline in bus usage but has also hastened the rate of that decline. This conclusion has been strengthened by the contrasted results from the London experience which has not been deregulated. A study by White (1990), using a similar method, found that the observed ridership level in London was higher compared with what would be expected.

3.2.6 Bus industry restructuring

The main principle of privatisation (not deregulation) the local bus services under the 1985 Transport Act was to restructure the bus companies ownership and control in an attempt to pave the way for a high rate of entry to the deregulated industry, and hence stimulate more competition in the market .

[12] This basic decline percentage had been observed long back since the1950s.

In practice, however, the industry structure had been moving to a more concentrated ownership in a few large group companies. It seems that the reforms, instead, encouraged large number of mergers and acquisition waves. The incumbent operator behaviour toward the new rivalry by the new entrants was to acquire the competed firm instead of continuing competing for more passengers through lower fare and improved quality. And if the acquisition strategy had been difficult, the incumbent operator tries to merge with the smaller operator. In fact, these strategies did not stop at that level; mostly it encouraged the new larger established firm to seek for further possibility of acquisitions or mergers (McGuinness *et al.,* 1994).

3.2.7 Competition

When the White Paper had been introduced in 1984, it assumed that a remedy to the industry problem would be through the introduction of large dose of competition into the market. It was argued that deregulation would bring with it widespread competition and would increase the rate of entry to the market by reducing entry barriers. And even if competition did not materialise, the threat of market entry would force the incumbent operator to operate in efficient way to ensure that no profitable gap has been left behind which may attract new entrants. This, in turn, would also reduce fares in competed routes

In practice, the widespread competition was not emerged as the White Paper claimed. In terms of bus kilometres, only 3 percent of routes experienced “on road competition” in the first year after deregulation (Gomez-Ibanez and Meyer, 1987). The figure was tripled in the second year, Balcombe *et al.* (1987), but this was the optimum peak the competition has reached and since then the competition starts declining (Evans, 1990). Thus, Evans concluded that "competition has therefore always been the exception rather than the norm".

However, some evidences of competition, with spatial and temporal variations, were documented by some commentators. Overall, the well-patronised routes experienced the most competition in contrast to the low-demand services provided usually in the evenings, on the weekends and on rural areas which experienced very rare competition. Therefore, the most competed routes were in large urban areas such as Manchester, Liverpool, Sheffield and Glasgow where frequent entries to the market by either new operators or adjacent firms were materialised, despite the fact that the incumbent operators in Glasgow and Sheffield succeeded to terminate these competition through acquiring or merging with the new entrant (Savage, 1993). Additionally, fierce competition, but with few new entries by independent operators, was noticeable where there were network contact between two or more large public operators (for example, in Edinburgh). In general, areas where independent operators had successful entry to the market were previously dominated by only one single public operator (Hills, 1991).

These few observations contrasted with rare or short-lived competition that patterned most deregulated areas. There were few well-documented case studies where broad competition was witnessed immediately after deregulation. “On the road” competition was reported in few small towns, such as Preston by Mackie and Preston (1988) and Lancaster and Stockton both by Evans (1990). All these towns showed evidences of active competition particularly in most profitable routes, where operator’s opportunity of earning super-profit was high in pre-deregulation era. The form of competition in these towns was characterised by fare matching, with coordinated fare increase in later steps, and by higher bus frequency. As a result, frequency was doubled and waiting time fell dramatically, to the benefit of bus users. However the competition did not last so long and ended after a while. Moreover, the incumbent was always in advantage over the new entrant operator in terms of local knowledge, strategic location of bus station, financial standing, and use of travelcard (Mackie and Preston, 1988). The incumbent was able to cause some financial loss to the entrant and drive him out the market.

Overall, it could be concluded that the outcome of competition was against the White Paper assertions that competition, or its threat, would be widespread and that would oblige all operators to improve their operating efficiencies and service quality, and hence the bus market will benefit from that. Instead, the competition threats resulted in unwanted operator’s behaviour of adopting short term policies, including wasteful competitive behaviour, in attempt to maintain their market share (CIT, 1993).

Also some undesirable behaviours emerged in the early stage of deregulation, including that incumbent adopted certain strategies to terminate existing competition and deter future entry, such as service "swamping" and fare matching. The former strategy, excess service frequencies, is usually associated with revenue loss for both incumbent and entrant but since the incumbents have an advantage in the sense of better financial standing, the entrant mostly give up in the long run and in many cases were bought up by the incumbent (Evans, 1990). A fare matching strategy was also used, but with subsequent fare increases above the inflation. Thus, reductions in fares in competed routes had been limited and short-lived with no fare differentiations between high and low demand routes, unlike the White Paper anticipations (Evans, 1990).

3.2.8 Conclusion

At the early stage of the deregulation experience, it was both too difficult and early to draw clear conclusion about the effects of the policy reforms on the industry due to the contradictory outcomes as well as to the short period of evaluation (compared to a fifty year period of unchanged regulations). The turmoil in service provision and market structure made any evaluation difficult. However, some overall conclusions are possible. In summary the following outcomes emerged at the early period of deregulation. As the policy makers such as Beesly and Glaister claimed, unit costs (per kilometres) and subsidy levels were substantially reduced. Such positive outcomes in supply side, combined with an increase in service level (in terms of bus-kilometres), were in contrasts to corresponding outcomes on the demand side. Conversely, instability and unreliability of service and fare increases were among the main reasons behind the dramatic falls in bus demand, sharper than would be expected, especially in the period immediately after deregulation (White and Turner, 1991).

Some losses in services occurred in the weekends and evenings, combined by continuing alterations of service's routes and timetables and lack of passenger information, that made any attempt by passengers to cope with such changes of service provisions difficult and hence they perceived bus services since deregulation as unreliable and some ceased traveling by bus while other reduced the number of journeys by bus (Donald and Pickup, 1991). In the meantime, there were some other aspects of service improvements given that service frequency expanded in some parts of the network which also covered more residential estates, particularly in small to medium towns, because of the new trend of replacing large conventional bus by smaller and more frequent minibus (Savage, 1993).

It is clear that the increase in total bus kilometres was condensed on a few routes rather than resulting in more frequent services and wider network coverage. Service losses (both in spatial and temporal terms) in other routes led to reduced networks. There are some exceptions in some smaller towns where deployment of minibuses contributed to an expansion of network coverage. Donald and Pickup (1991) reported that Merseyside experienced continuous changes in service provisions, about 90%, in the commercial part of the network in 1987 only.

Sharp fare increases in the areas experienced the highest demand drop (e.g. some metropolitan areas) contributed to the alarming drop in bus use, but overall the fare level slightly increased, in line with inflation.

In conclusion, given the contradiction between the outcomes of deregulation policy, it is clear that further time was needed for the industry to stabilise following massive regulatory changes after a half century under heavy regulations. Commentators at the time still disagreed and the heated academic debates continued, however, the outcomes were broadly in between the two extreme sides. It is useful here to quote from the debated sides. Gwilliam (1989) argued that

> "deregulation has proved neither as successful as its proponents hoped nor as damaging as its critics feared."

While Beesley (1991) blamed the residual regulatory and the simultaneous changes of public expenditure for the negatives outcomes of deregulation stating that

> "...present subsidy and procedures are a major impediment to entry, reinforced by regulatory inhibitions to vertical disintegration and site acquisition. The importance of other obstacles to freer bus markets was largely unforeseen when the principal deregulation move of removing quantity restrictions was made."

3.3 Medium-Term Impacts (The First Decade)

This section covers the medium term impacts, of changes brought by the policy reforms, during the first decade (up to the mid-1990s).

3.3.1 Cost

The trends in unit costs observed just after deregulation has continued over the first decade (medium term). Falls in unit costs exceeded the government's anticipated percentage of 30%, were observed in all areas (White, 1995).

Table 3-4 The changes in key local bus indicators by area after a decade since the policy reforms, 1985/6 - 1995/6, (%).

Change in	London	English Mets	English shires	Scotland	Wales	GB	Outside London
Unit costs	-47%	-48%	-38%	-40%	-42%	-44%	-43%
Total subsidy*	-60%	-46%	-23%	-32%	-37%	-44%	-38%
Real fares**	12%	38%	4%	10%	-3%	14%	17%
Level of service	29%	21%	30%	23%	30%	27%	26%
Pass. journey	4%	-34%	-18%	-25%	-20%	-20%	-27%

*Public Transport Support (PTS) and Concessionary Fare Reimbursement (CFR). **Average revenue per trip excluding CFR. Source: (Bayliss 1999; DETR, 1999; DoT, 1996).

As shown in Table 3-4, dramatic falls in real operating cost per vehicle kilometre of bus services were reported in all areas of Great Britain, unit costs fell by 44% on average across Great Britain.

Metropolitan areas showed the largest drop - 48 percent - in unit costs. Nonetheless, this percentage did not take into account some "transferred" costs (such as the responsibility of planning, marketing, and provision of passenger information) which have been moved away from bus operators (PTCs) in the Metropolitan areas after it was split from the Passenger Transport Executives (PTEs) by the 1985 Transport Act. PTEs have remained accountable for such responsibilities in addition to other significant costs resulting from the former employee's pensions and other administrative functions. Therefore, White (1995) believes that the large drop in unit costs in metropolitan areas "may be slightly exaggerated" and small part of this reduction should be attributed to the changes in cost definitions rather than the effects of deregulation.

It was suggested that these areas had the greatest scope of cost reduction as they had been dominated for a very long time by large public operators in the pre-deregulation time. Given that they had been protected from outside competition under the regulation system at that time, the performance of such large public operators was patterned by inefficient productivity and high unit costs, particularly labour wage rates (NERA, 1997; White, 1995). In Scotland, Wales and English Shires the reductions in costs were also substantial; around 40 percent.

Further analysis using another indicators of unit costs (costs per passenger journey shows superiority of London's bus services performance over the rest of the country), as illustrated in Table 3-5. Cost saving is significant in London – by 39% over the period.

Table 3-5 Operating costs per passenger journey, (1986/7-1996/7) at 1996/7 prices.

	London	**Mets**	**Shires**	**Scotland**	**Wales**	**Great Britain**
% change in unit cost	-39	0	-1.5	-5	-14.5	-9

Data allow for the rebate on fuel duty and including depreciation of vehicles. Source: (DETR, 1999, Table 27).

3.3.2 Subsidy

Similar to unit costs, subsidy falls observed in the early term have continued in the first decade. As illustrated in Table 3-4, subsidy to bus services in Great Britain reduced significantly by nearly 44% between 1985/6-1995/6. While concessionary fare compensation remained almost unchanged, the whole reduction in government expenditures can be entirely attributed to the fall in Public Transport Support (PTS) alone, which reduced by 65% over the period (NERA, 1997).

The largest drop in subsidy in Great Britain as a whole was reported in London, about 60% between 1985/6 and 1995/6. However, it increased for a short period in the early 1990s, possibly associated with restructuring and redundancy costs (White, 1995; Simpson, 1996).

3.3.3 Fares

Fares increases were observed in the medium term in all deregulated areas, except in Wales. Some operators raised fares sharply in order to compensate for loss in revenues from the lost bus users (Bayliss, 1999). The large increase in bus kilometres and the dramatic fall in public subsidy offset any gains created by absolute reductions in unit costs, leaving no room for any fall in fare levels and adding high pressure to operator's profits (Mackie *et al.*, 1995).

Again, the greatest increase in real fares, of 38% between 1985/6 and 1995/6, was found in Metropolitan areas, while much lower increases of 12%, were estimated in London. However, during the early to mid 1990s, the rate of fare increases was hastened more in London than in the rest of the country (NERA, 1997). Other area of the country experienced lesser changes, 10% in Scotland and 4% in the Shires. A reduction of 4% is estimated for Wales, see Table 3-4.

3.3.4 Service Level

Over the decade since deregulation, there has been a manifest increase in level of services, in terms of bus kilometre run, in all areas of the country, driven largely by the substantial reductions in unit costs per kilometres which allowed for extra profitable services. Overall, there was about a 25% increase over the period (Simpson, 1996), but high degrees of diversity in spatial and temporal patterns of the service expansions cannot be detected by the aggregate figure (Mackie *et al.*, 1995).

As shown in Table 3-4, all areas showed a significant increase in bus kilometres over a decade since deregulation. However, the time pattern of this growth contrasted between London and the deregulated areas. Most the growth occurred in the first 2 years since deregulation in all areas outside London, while steady growth was noticed in London throughout the period.

3.3.5 Patronage

In contrast to its success in reversing the costs and subsidies trends, the deregulation policy failed to reverse, or even halt, the historical trend in bus patronage (NERA, 1997). Table 3-6 shows the percentage changes of the long-run trend in demand since 1955, in terms of passenger journey. It can be observed that the historical decline in demand trend was hastened since deregulation. Nevertheless, it declined at a slower rate between 1990/1 and 1995/6 than in the period immediately following deregulation. Although the figures are aggregated for all areas in Britain, the observed trend was strongly influenced by the loss in ridership outside London, as almost constant level has been reported in London since the mid 1980s.

Table 3-6 Historical decline in passenger journeys in Great Britain, 1955–1995/6

Year	**Bus trips**	**% change every 5 years**	
1955	13225		
1960	11166	-15.6%	
1965	10938	-2.0%	
1970	8643	-21.0%	Avg. change before 1985/6 (10.6%)
1975	7524	-12.9%	
1980	6216	-17.4%	
1985/86	5635	-9.3%	
1990/91	4844	-14.0%	Avg. change since 1985/6 (11.8%)
1995/96	4378	-9.6%	

Source: Derived from DETR (1999, table 2).

Further attention to changes in bus use in the period between 1985/6 and 1995/6 is given in Table 3-4. Figure 3-3 shows the percentage change (year by year) in passenger journeys in the deregulated areas as a whole. Besides the initial large drop in passenger journey in the first year (7% in 1986/7), the decline was hastening until the peak in 1990/1, and has started to slow down since then. The large initial drop in bus use, in 1986/7, can be attributed to transitional shock due to major policy reform (deregulation) and the associated instability in services.

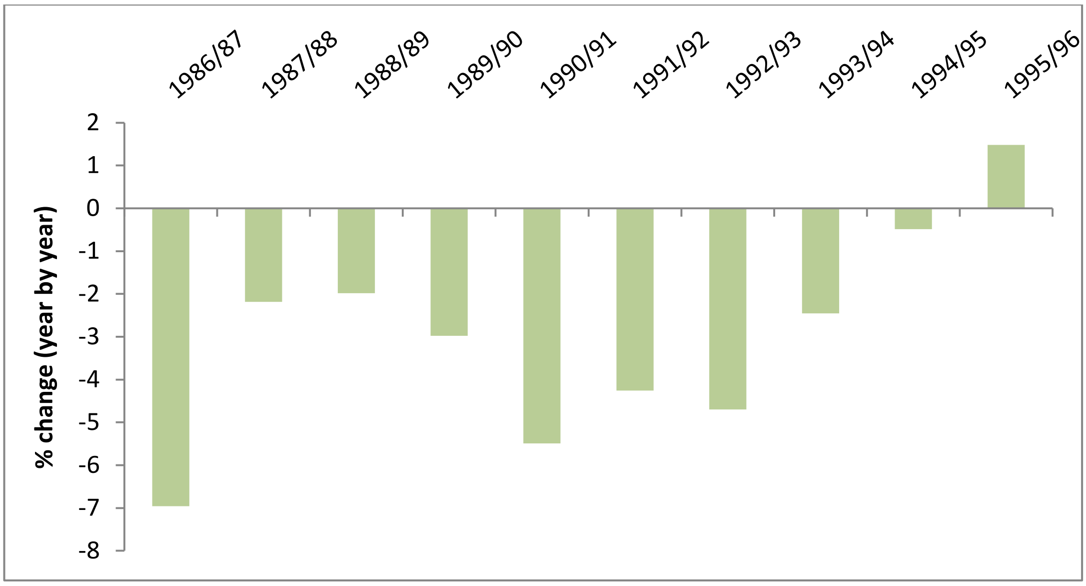

Figure 3-3 Percentage change (year by year) in passenger journeys in GB outside London since deregulation. The odd rise in 1995/6 had not sustained.

Source: derived from (DETR, 1999, table 2)

3.3.6 Comments on the medium-term impacts

The review of the medium-term outcomes of the bus industry deregulation has shown mixed and contrasting outcomes, in similar patterns to that observed just after deregulation. Signs of relative stability of demand and service level were observed, but large wave of merger and acquisitions has worked against market stability leading to market concentration in few large operators.

Over the decade following deregulation, the industry performed in a way that does not totally coincide with any debated views preceding the implementation of the deregulation policy in the mid 1980s.

Overall, the deregulation policy did well in terms of the supply side; it succeeded in reducing costs and subsidy levels considerably, and in increasing bus kilometres, although the latter had not been productive in the sense of attracting more passengers and may have involved duplication of services. Nevertheless, in terms of aspects about which bus users are highly concerned, deregulation was a failure. It failed to bring fares down, to halt the decline in bus use, or to improve the quality of service provided. As a matter of fact, it negatively affected these matters, since demand fell at a faster rate since deregulation (faster than any conventional factor or model would have suggested), fares rose sharply in large urban areas, and service quality deteriorated (aging fleet, instability of services, lack of information and appropriate ticketing system). That considerably diminished any benefits achieved from reductions in costs and subsidies.

White (1997) concluded the outcomes of deregulation during the first decade in one sentence "A policy which produces far more bad outcomes than good ones is, overall, a poor policy". Nonetheless, some evidence at the end of that decade implied reverses in these trends which indeed required a longer time before it could be accurately assessed. These changes include a rising level of investments in fleet renewal and decelerating of demand declining rate (about 2% a year in the mid 1990s corresponding to the 4% rate prior to 1992/93 (Bayliss, 1999)). In the meantime, there were doubts about the possibility of further reductions in cost and subsidy in forthcoming years, as well as when and how the 1990s merger wave would end.

Therefore, it is sensible to extend the evaluation further and attempt to disaggregate the assessment to better understand the factors behind the success and failure of such an experience.

3.4 The Longer Impacts

This section looks at some of the longer outcomes of the policy reforms, up to 2009/10. There are clear reverse in the trends of costs, subsidies, and service level. The reversal of the patronage trend is less noticeable in the deregulated areas but very clear in London. The impacts of the policy reforms witnessed over the first decade were not sustained in the longer term.

This may indicate that the longer term impacts of the observed policy reforms are largely contrasting with the short to medium term outcomes. Alternatively, it may be concluded that the impacts of the policy reforms have been exhausted.

Table 3-7 The changes in key local bus indicators by area in the long term, up to 2009/10, (%).

	Interval	London	English Mets	English shires	Scotland	Wales	GB	outside London
Unit costs	1995/6 - 2005/6	32%	10%	4%	-13%	0%	14%	3%
	1985/6 - 2009/10	-24%	-35%	-24%	-38%	-30%	-26%	-32%
Total subsidy*	1995/6 - 2005/6	340%	-9%	52%	69%	233%	90%	29%
	1985/6 - 2009/10	88%	-35%	108%	94%	155%	42%	24%
Real fares**	1995/6 - 2005/6	-6%	42%	45%	-3%	-20%	17%	34%
	1985/6 - 2009/10	-4%	70%	49%	-1%	-2%	25%	52%
Level of service	1995/6 - 2005/6	31%	-19%	-3%	2%	-2%	-2%	-7%
	1985/6 - 2009/10	76%	-4.6%	27%	29%	12%	24%	16%
passenger journey	1995/6 - 2005/6	58%	-19%	-5%	-4%	-10%	7%	-11%

	1985/6 - 2009/10	94%	-45%	-13%	-28%	-30%	-5%	-30%

*Public Transport Support (PTS) and Concessionary Fare Reimbursement (CFR). **Average revenue per trip excluding CFR. Source: Department for Transport statistics bulletins (various editions).

3.4.1 Cost

The first decade after deregulation was patterned by a sharp decline in patronage and hence by diminished total revenue from passengers, and that forced operators to lessen such an impact by cutting costs significantly through enhancing staff productivity and lowering labour wages, supported by parallel drops in fuel prices at that period (DfT, 2006a). By doing so, bus operators succeeded in bringing down the rising level of average operating costs per kilometre in the pre-deregulation era.

However, since the late 1990s, efficiency improvements were exhausted and were no longer able to cushion the falling revenue from passengers. On top of that, a more unfavourable situation appeared through the tightening labour market and rising fuel prices, which meant any further reductions in costs unlikely to occur. Operators had no choice other than to increase fares and cut services, while local transport authorities had to increase spending on bus services to maintain appropriate fares and service levels (DfT, 2006a). Trends in costs started unavoidably, to reverse again after an initial period of levelling out as shown in Figure 3-4.

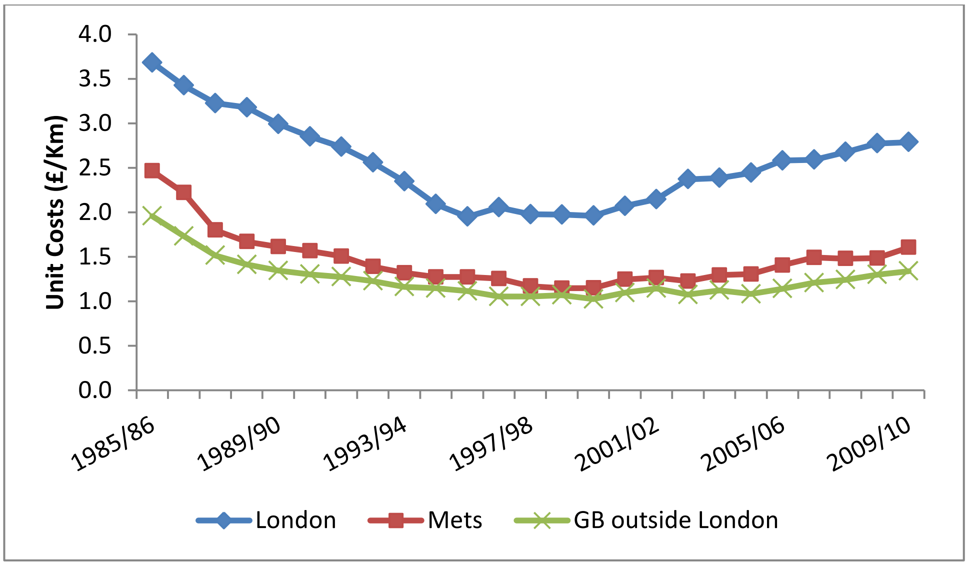

Figure 3-4 Bus operating costs per kilometres in GB, 1985/86 - 2009/10, at 2008/09 prices. Source: Department for Transport statistics bulletins (various editions)

The rising unit costs nationally in recent years are driven mainly by the increase in labour wage level, following its decline throughout the late 1980s and 1990s, in contrast to corresponding wage levels in other industries. Other factor to have contributed to such an increase was rising fuel prices (DfT, 2006a). In London, in particular, some unique factors resulted in a cost base higher than in elsewhere. Besides its tighter labour market, London's policy of maintaining a modern fleet with high quality vehicle standards in its competitive contracts, in addition to the high congestion and more peaked services relative to the rest of the country, led to the country's capital having a higher unit cost of operating bus services (White, 2009).

It should be noted however, that such analysis of trends in costs per kilometre does not take into account the change in load factors, which would give more favourable results for London. As London showed, in contrast to the rest of the country, substantial growth in ridership resulted in a higher load factor, which in turn was reflected in a considerable fall in operating costs per passenger journey since deregulation. It decreased by 28% in real terms in London between 1985/6 and 2004/5, whilst it increased by 8% in Britain outside London (Eddington, 2006).

3.4.2 Subsidy

Another trend reversal, in subsidy levels this time, noticeable since the mid 1990s. It seems that the initial reductions in subsidies were not sustained in recent years, as the decline in ridership (in the deregulated areas) and the reverse in cost trend emerged in an industry with less profitability, and hence required higher levels of fares and subsidies (DfT, 2006a). For that reason, bus subsidies in recent years have been playing a very crucial role in the bus operator's revenues, reversing the subsidy trend back to a similar pattern to that in the pre-deregulation era.

Overall, bus subsidies (PTS and CFR) almost doubled between 1995/6 and 2005/6, as shown in Table 3-7. PTS, in particular, increased threefold. This type of subsidy is responsible for such sharp increase in overall public expenditures. London reported the sharpest increase in PTS, however from a very low base in 1995/96. The extreme low level of PTS in London in the mid to late 1990s (virtually no subsidy in 1997/98) reflects the sale wave of public bus operators (before 1994/95 these were funded by TfL) to the private sector, and hence no more support was provided as these firms were privatised. Gradually, these firms received public support as they started winning bids during the tendering process from TfL itself as it was turned into a tendering authority for the London bus network (DfT 2006c, table 5). Wales and English shires were also experienced high increases in PTS, whilst only the Metropolitan areas showed a small decrease.

A small increase, compared to the PTS, was reported in CFR (11% over the decade). Nonetheless, in view of the fact that mandatory concessionary fare schemes in England became effective from April 2006, this was predicted to increase by £350 million (or 50%) in the first year alone (DfT, 2006a). In practice, 44% increase in CFR was observed in 2006/7 before the trend stabilised again. The highest increase observed in English Shires, within which most of the concessionary passengers reside.

In terms of total subsidy required, deregulated areas performed better than London over the second decade, specifically in the second half. Nonetheless, this observation does not consider the efficient allocation of subsidies, given the declining level of ridership and services in these areas, quite the opposite to the case in London. In London, bus services are stimulating more ridership, are steadily expanding, and have better quality in almost every aspect: e.g. the fleet age in London in 2005/06 was significantly low (4.8 years) - half the corresponding figures for PTE and Britain outside London (9.4 and 9.3 respectively) - and while the percentage of buses with CCTV was 89%, it was only 36% in PTE areas and 25% in areas of Britain outside London (DfT, 2009, table c).

The deregulation succeeded in controlling public expenditure by keeping it at a low level. Nevertheless, the operators responded to falling ridership outside London by cutting some commercial services, while replacing such loss by local authorities through subsided service appears to have lagged behind, given their limited budget while the price of subsidised service contracts were growing sharper than inflation growth (DfT, 2006a).

3.4.3 Fares

The overall pattern of trends in bus fares in the first 10 years since deregulation was continued in the second decade, see Figure 3-5, except from a temporally decline caused by the introduction of free concessionary scheme in 2006/7. Detailed changes in bus fares by areas up to 2009/10 are illustrated in Table 3-7.

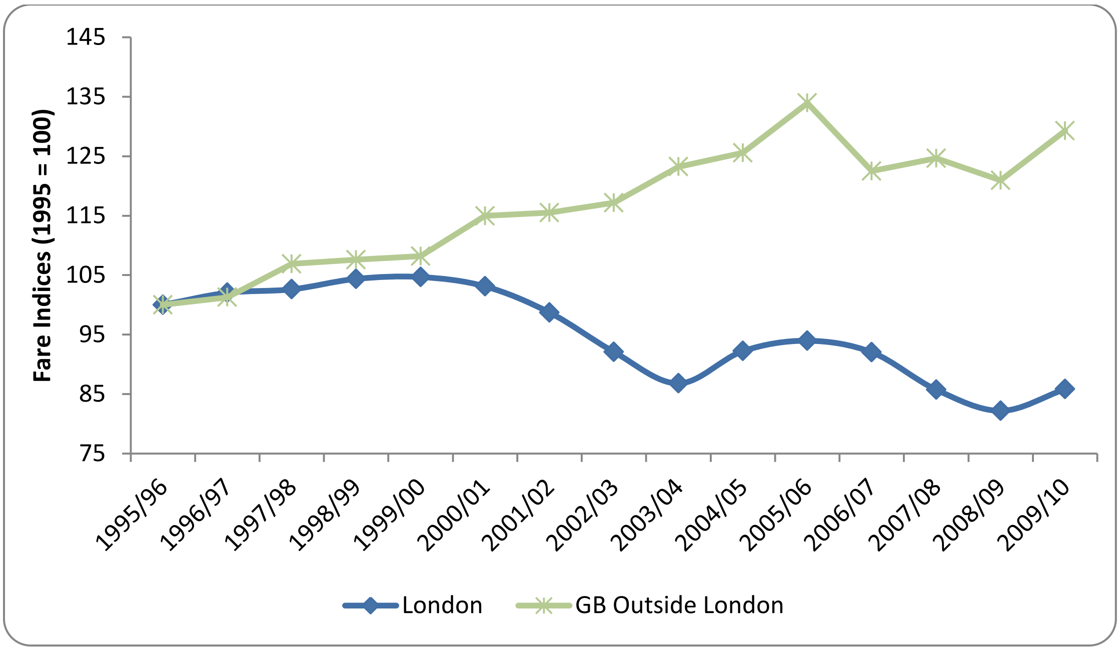

Figure 3-5 Fare index in GB, 1995/6 - 2009/10, (1995/6=100).
Source: derived from Department for Transport statistics bulletins (various editions).

Outside London, fare increases over the period can be explained partially by simultaneous increases in labour and fuel costs, as in most cases these costs were passed to bus users through higher travel costs, but were also possibly caused by the operators' desire to protect their profits against declining bus demand by increasing fare levels, assuming inelastic demand in the short term (NERA, 2006).

In London, fare level was stationary before started to decline since the early 2000 with one exception in 2004/5 when a sudden increase was observed (reflecting a comprehensive improvement in bus services introduced in the early 2000s in parallel to the introduction of Congestion Charges scheme in central London).

In general, the impacts of concessionary schemes have been minor in the deregulated areas, however, disaggregate figures show different impacts in Scotland and Wales than in England. Whilst the impacts were minor in English Shires and Metropolitan areas, where operators preceded the introduction of the "free" scheme in 2006/7 by increasing fare level, significant decreases in fares are observed in Wales and Scotland where the "free" schemes introduced in April and October 2002 respectively, see Figure 3-6.

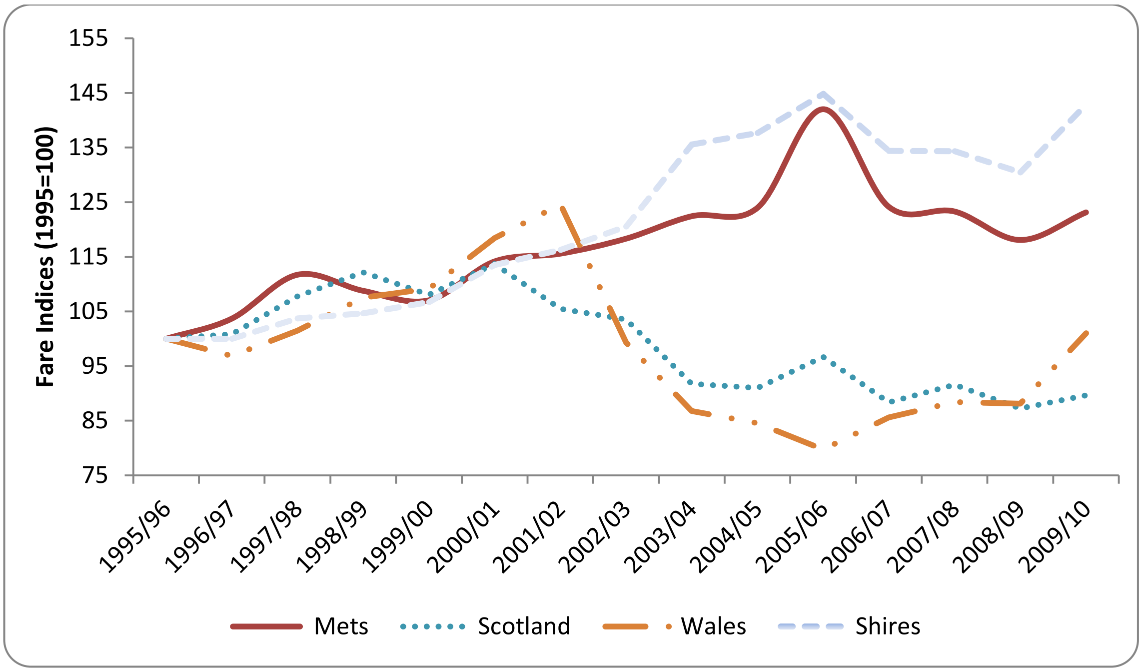

Figure 3-6 Fare trends in the deregulated areas, 1995/6 - 2009/10, (1995/6=100).
Source: Department for Transport statistics bulletins (various editions).

3.4.4 Service Level

Another reverse in trend was also observed in the second decade this time for service level. For the first time since deregulation, bus kilometres started to decline. That was by virtue of the large reduction in service level in Metropolitan areas, see Figure 3-7.

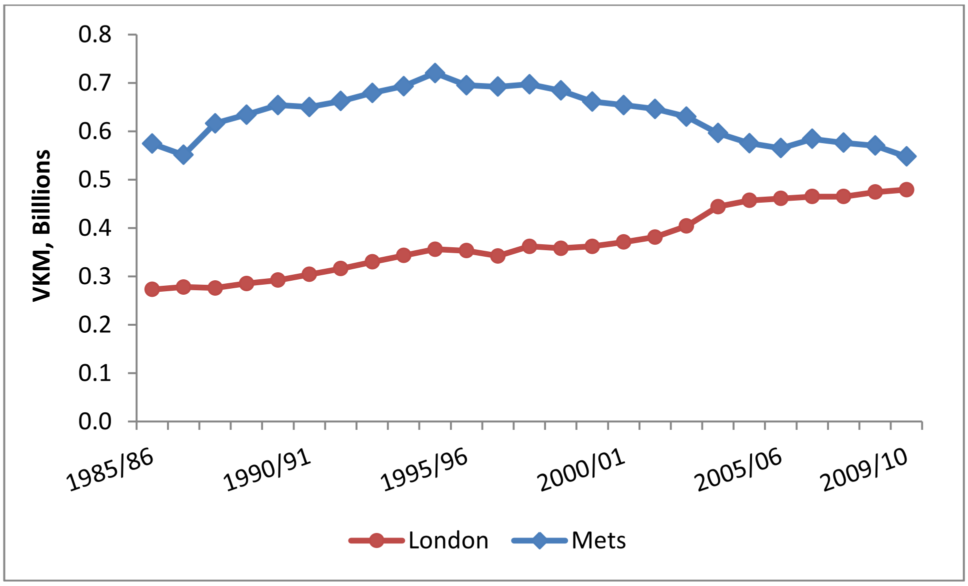

Figure 3-7 Trends in vehicle kilometres, 1985/6-2009/10, billions.
Source: Department for Transport statistics bulletins (various editions).

Again, London outperforms the rest of the country, where a substantial increase was observed. A more positive picture of bus operation expansion in London was that to a great extent it occurred in the evenings and at night, since bus use at those time of the day increased significantly by about 65% and 100% correspondingly between 1999/2000 and 2005/6 (White, 2009).

As presented in Table 3-7, minor changes were observed in other deregulated areas between 1995/6 and 2005/6, whilst some increases are observed everywhere except in Metropolitan areas accompanied the introduction of free concessionary schemes (operators increased services in order to attract further concessionary trips).

A possible explanation for the large reduction in bus kilometres in Metropolitan areas is that the high loss in ridership caused many operators to cut commercial bus services in most affected areas, whilst transport authorities in these areas were unable to compensate such a loss in services through subsidised operations, given the increase in the prices of tendered contracts above inflation rate (DfT, 2006a).

3.4.5 Patronage

As shown in section 3.3.5, the deregulation policy failed to halt the loss in demand, which continued even more sharply than the historical declining trend. However, for the first time since the policy interventions in the mid-1980s, the overall trend in bus use in whole Britain started to stabilise in the mid 1990s before a reverse in the trend was witnessed since the early 2000s (up to 2008/9), see Figure 3-8.

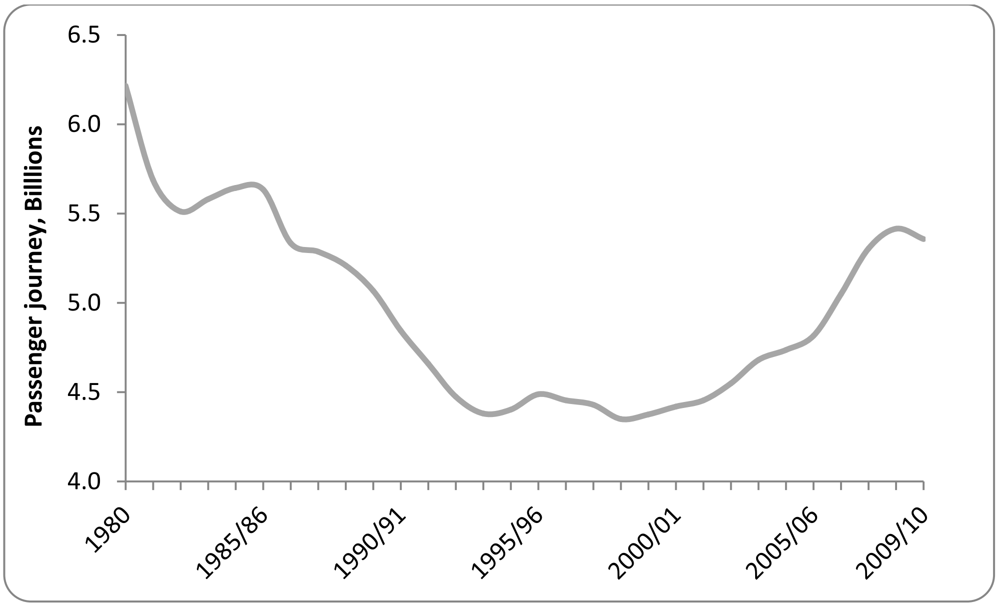

Figure 3-8 Trend in passenger journey by bus in GB, 1980-2009/10, (millions).
Source: Department for Transport statistics bulletins (various editions)

However, as illustrated in Figure 3-9, the observed reverse in the long-term trend was attributed to the London experience, while a minor demand increases observed in the deregulated areas (In the Metropolitan areas the demand continued to decline, but to a lesser extent relative to the earlier period. Detailed changes in bus trip by areas are illustrated in Table 3-7.

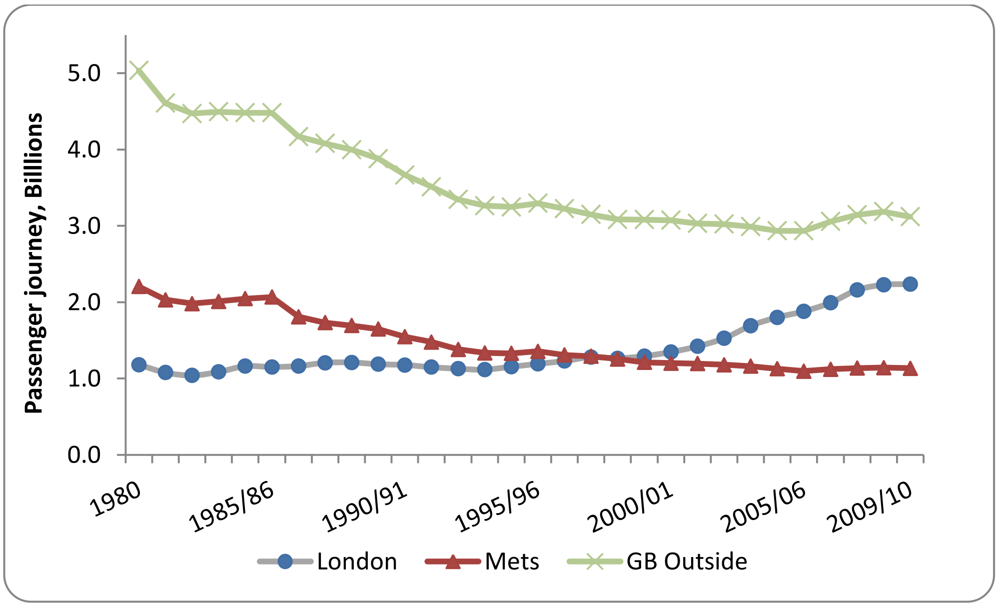

Figure 3-9 Local bus services: passenger journeys by area,1995/6-2005/6, (millions).
Source: Department for Transport statistics bulletins (various editions).

There are some success stories in few small areas outside London, such as York, Cambridge and Brighton and Hove, where the fall in demand was halted and reversed. Nonetheless these are too few cases which have little impact on the overall trend (DfT, 2006a).

The ridership fall outside London meant a failure to the government target ‘growth in every English region’ which was part of its Ten Year Transport Plan in 2000 (DETR, 2000). The plan, which was set as Public Service Agreement Target (PSA3), also included the overall aim of increasing local bus use in Britain by 10 percent by 2010, amended in 2002 to include light rail, with a compound overall target of 12% increase of the two modes between 2000 and 2010. In 2005, joint study between the Audit Commission and the National Audit Office (NAO) reviewed the industry performance based on these targets, and concluded that although the aim of an overall increase in bus demand is likely to be met (given the performance of bus services in London), the part of the plan which seeks for an increase in patronage in every English region was found to be unattainable, given the underperformance of bus services in the deregulated areas (NAO and AC, 2006). However, the Department for Transport was counting highly on the expectation of higher growth in passenger journeys as a result of the free concessionary scheme implemented in April 2006 to achieve the planned targets before the plan’s deadline, set as 31st March 2011. Yet, the performance of bus services outside London failed again and the PSA Target was abolished.

3.4.6 Comments on the long-term impacts

Since the late 1990s, the changes brought by the deregulation policy were exhausted and the policy is no longer able to deliver the same outcomes. Contrasting outcomes of the short to medium term with that of the longer term are apparent. There are some evidences of a reverse in the trend patterns of the main indicators of bus services which dominated over the first decade after deregulation.

For the first time since the mid 1980s, the overall trend in bus use demonstrated noticeable growth. Although that is wholly attributed to London figures, all areas in Britain showed a slightly positive development in bus demand driven by the introduction of free concessionary travel schemes in 2006/7. Whilst the London’s policy of competitive tendering succeeded in significantly boosting bus use at a higher rate than in the previous decade, the declining rate in trend of passenger journeys was reduced in all areas outside London, and temporarily increased (unfortunately, latest data shows the scheme has only boost the bus uses between 2006/7 and 2008/9).

What was undesirable, on the other hand, was the decline of services; again London showed a positive outcome here with a significant increase in the number and length of operated services. Another significant change was a reverse in the trend of unit cost, which had declined substantially during the first decade, as a result of stiffer labour market conditions (White, 2008), and may indicate that the capacity of potential cost reduction was exhausted. Finally, a very sharp growth in subsidy was observed in London, while the declining trend started to reverse in the rest of the country; this indicator (and to lesser extent unit costs) show superiority of the deregulation policy over the competitive regime. However, the increase in subsidies[13] observed in London was a result of a massive improvement of service network since the early 2000s.

As far as ridership, fare level and quality of services are concerned, the London experience outperformed that of the rest of the country; whilst deregulation policy seems very efficient in terms of unit costs and required subsidies. Yet, the evidence suggests that the impacts of policy reforms (deregulation policy in particular) are exhausted in the longer term (since late 1990s or early 2000s).

3.5 The final conclusion of in-depth literature review

The importance of the controversial experience in British local bus industry under deregulation policy as seen by the academic researchers was best described by White and Turner (1991) that "may be seen as a grand experiment to test a theory."

The underlying objective of the deregulation package policy was intended, by the government, to halt and reverse the historical deteriorating performance of local bus services outside London through the means of "on the road" competition (or in other words by allowing the market forces to work as the only regulator of the industry).

However, the experience has emerged in contradictory outcomes which require a wider evaluation against the desired objectives before any conclusion of a success, or a failure, of the policy can be drawn. The assessment should take into account the wider impacts of the policy, not only on bus users and operators but also on other affected parties (the government or public expenditures, bus labour). The impacts of subsidy (on fares and demand) as well as wages and fuel prices (on operating costs) should be isolated.

Given the uniqueness and nature of such reform, many researchers rushed to evaluate the deregulation policy impacts just after it was implemented. However, it can be noticed that commentators started to lose the interest in evaluating the policy impacts after the first decade

[13] It should be noted that, however, subsidy in London started from a very small base in the mid to late 1990s.

(except for broad analysis of major trends). The last comprehensive study used data that stopped in 1997 (Romilly, 2001). Thus, updated evaluation through cost and benefit analysis is both beneficial and essential at this stage, in attempts to capture the longer impacts of deregulation, given the major changes in trends of major bus service indicators since the late 1990s and early 2000s (such as trends in operating cost, subsidies, bus kilometres, and demand). More importantly, the deregulation policy still has effects and has neither proved to achieve the desired objectives behind its implementation nor admitted to be a failure and replaced by a more successful one.

However, it should be borne into mind that this is not a straightforward task given the nature of the deregulation package as implemented in the British bus industry since the 1986. This was emphasized by many commentators such as Beesley (1991) and Mackie *et al.* (1995). Beesley described it as:

> "The simultaneous changes of policy in 1985, deregulation, subsidy change and reduction, and privatization make it hazardous to interpret changes in the UK local bus industry"

Since privatisation is always argued to be as an integral part of deregulation policy that proposed by the Buses White Paper (Romilly, 2001). The impacts of subsidy reductions should be separated before any assessment can be carried out. This issue is tackled in more details in the methodology section.

Another important issue when carrying out the evaluation over this period of time since deregulation is the relatively long time gaps between the policy implementation and the proposed evaluation.

4. The Methodology: Evaluation and Costs and Benefits Analysis

4.1 Evaluation

4.1.1 Introduction

The aim of this research is to evaluate the long term impacts of the bus deregulation policy. The role of "evaluation" was defined by the Treasury's new Green Book (HMT, 2003) as:

> "[to] examine the outturn of a policy, programme or project against what was expected, and is designed to ensure that the lessons learned are fed back into the decision-making process. This ensures government action is continually refined to reflect what best achieves objectives and promotes the public interest."

The Green Book, Appraisal and Evaluation in Central Government, which used by the Department for Transport (DfT) as the core basis of its guidance Transport Analysis Guidance - TAG (DfT, 2011), emphasised that, when a policy is implemented, it should be subject to a comprehensive ex post evaluation. When an evaluation process is carried out, it usually follows the same procedure applied in the economic "appraisal", yet it differs by focusing on performing a cost-benefit analysis based on actual data, or outcomes, rather than on predicted data based on what is projected ex-ante. The book also provided some outlines of a process to be followed in any transport evaluation. The outline, which is reflected in the current research, is as follows:

> "1. Establish exactly what is to be evaluated.
> 2. Choose alternative management decisions and counterfactuals.
> 3. Compare the outturn with the target outturn, and with the effects of the chosen alternative and counterfactuals." (HMT, 2003)

It also stated that:

> "Evaluation requires management initiative (sometimes political commitment) and intensive monitoring. The thoroughness of an evaluation should depend upon the scale of the impact of a policy, programme or project, and to some extent on the level of public interest."

This is the case for the mid-1980s policy reforms both outside London and within. The deregulation policy, in particular, has both large-scale impacts and a high level of public interest as it affects a large number of bus operators and consumers, in addition to bus workers and government (and taxpayers); this in turns has attracted much attention (and long debates) among politicians, policy makers, researchers, and other interested groups.

4.1.2 **Establish what is to be evaluated**

Overall, the activity which will be evaluated is the long term impacts the welfare of key groups that have been directly affected by the policy reforms. These groups include bus users, service operators, government and local authorities, bus workers, and lastly society as whole. Further details of what is to be evaluated are given when explaining the cost-benefit analysis (particularly in section 4.3.2 and Table 4-1), but we will broadly highlight it here.

The government (as well proponents of deregulation) asserted through the 'Buses' White Paper (DoT, 1984) that the deregulation will substantially reduce operating costs and improve resource allocation without any significant undesirable spin-off effects (Gwilliam *et al*., 1985). In addition, as pointed out by Bayliss (1999), deregulation was argued in the White Paper to improve service level and lower fares and, hence, to halt the long term decline in patronage since the 1950s.[14]

It was also argued by Glaister (1991) that one of the main objectives of deregulation policy was to reduce the expanding level of public spending on local bus services in line with the reform of the government's fiscal policy at that time.

Thus, deregulation should at its core have:

- reduced operating costs, to the benefit of the bus operator (by increasing producer surplus), but perhaps at the expense of bus workers;
- improved service level and reduced fare and consequently increased demand, to the benefit of bus users (consumer surplus), but also with some impacts on bus operators' revenue and total costs (producer surplus); and
- reduced subsidy, to the benefit of the government and the society as whole (through deadweight efficiency gains associated with the reduced subsidy) but at the expense of the bus operator.

Gains for any group could occur at the expense of another group (e.g., cost savings due to lower labour wages) and some gains are caused by external factors (e.g., diesel prices dropped in parallel to the policy reforms, but this was caused by external factors, in line with global oil

[14] "with better services and with lower fares more people are likely to go by bus" (Department of Transport, 1984).

market prices). We should consider this when evaluating the overall impacts of the policy reforms. White (1990) was the first to stress this concept:

> "Not all cost changes during this period were due to deregulation…It is important to distinguish transfer effects from economic gains or losses."

Further details of this "transfer" concept and how we dealt with this issue are presented in 10.3.1.2

4.1.3 What is the target outturn, alternative and counterfactuals?

Overall, there were no specific and measured target outturns of the deregulation policy.[15] Thus, a comparison with the target outturn is not possible[16]and we should therefore move on to perform comparative assessments with one or more alternative and counterfactuals. Yet we first need to specify the "alternative" management decisions and the "counterfactuals".

In fact, there is an "alternative" management decision or regulatory regime (competitive tendering) that has been simultaneously applied in London, which was excluded from the deregulation regime (see 4.1.3.1). Thus, there is no need to specify or configure an "alternative" as London's experiment with competitive tendering can be used as an "alternative" and compared to the deregulation outcomes.

Determining the counterfactual—what would have happened in the absence of the policy intervention—in both London and the rest of the country could be problematic (see 2.1.3.2). However, the counterfactual can be constructed or predicted through the application of demand, fare, and cost models (along with some extrapolative methods to forecast the values of some input variables in these models such as bus km and subsidy under the counterfactual). Also, the treatment of subsidy changes requires the determination of another counterfactual.

4.1.3.1 Alternative

In London, an alternative regime of comprehensive competitive tendering was adopted and implemented on a gradual basis following the 1984 London Regional Transport Act. Interestingly, London's experience with competitive tendering achieved some of the positive outcomes of deregulation, such as cost reductions, but also avoided its failures, such as fare

[15] Other than a rough prediction, by the White Paper (DfT, 1984). of a 30% reduction in operating costs.
[16] Yet a broad comparison with the last year before the policy reform is possible. Therefore, the research started by examining the outcomes of the policy in terms of changes in trends of bus demand, costs, service level, fares, and subsidies compared to the year 1985/6; see Chapter 3.

increases and demand losses (Matthews *et al.*, 2001). Although it achieved significant reductions in costs and level of required transport support and maintained an efficient and integrated network of services, it maintained and increased its ridership. Matthews *et al.* (2001) stated that the trends in demand and costs can be greatly explained by the different regulatory systems adopted in London and the rest of the country. London was supposed to follow the rest of the country and be deregulated, but the success of the competitive tendering system as well as its position as the capital of the country stopped such a plan. That, fortunately, allowed the use of the London experience in tendering as a comparison with deregulation in the rest of the areas.

4.1.3.2 Counterfactuals

The counterfactual can be defined as what would have happened in the absence of the policy intervention. This assumes the prolongation or continuation of the old regulatory regime as actually observed before the mid 1980s policy reforms in London and the rest of the country.

In addition to determining the main counterfactual (as previously defined), a strong argument inspires the consideration of another counterfactual situation. The deregulation policy was in fact a package of reform[17] that consists of deregulation (removal of RSL requirement), privatisation and commercialisation of bus operations, and subsidy reduction; the latter component is controversial and might need to be isolated. Beesley and Glaister (1985a) and Glaister (1997, p. 146) argued that subsidy reductions were part of the government's overall public expenditure plans and not part of the deregulation policy package and that the White Paper “accepted the premise that bus subsidies are to be kept in line with the Government's overall public expenditure plans” and hence it should be considered as separate from deregulation policy which itself is the best way to reduce the impacts of such reductions on service quality and fares charged to bus users (Gwilliam *et al.*, 1985b).

According to Glaister (1991),

> “the prime motivation for the policy was actually to change things on the supply side in order to meet global requirements for subsidy reduction whilst minimising damage to passengers through fare increases and service reductions.”

Romilly (2001) criticised any drawn conclusion based on evaluation of deregulation policy that does not isolate the effects of subsidy reduction:

[17] The same applies to competitive tendering in London.

> "This evaluation is not clear-cut, however, since government macroeconomic policy caused significant reductions in subsidy to the bus industry concurrent with deregulation. It can be argued that it is the reduction in subsidy, rather than the lack of competition, which caused fares to increase. If this is the case, then the evaluation of deregulation should allow for the effects of subsidy reduction."

Although Mackie *et al.* (1995) questioned some issues associated with Glaister's argument, they admitted that "subsidy removal is a serious confounding problem when it comes to assessing the impact of deregulation". They further noted that it is important to distinguish between the broad question, namely:

> "what if the entire trajectory of bus subsidy and regulation policy had been different?"

and the more specified one:

> "given the rest of the strategy, was deregulation (i.e. open entry to the market) a good thing?"

Therefore, the following scenario or argument as best described by Mackie *et al.* (1995)—namely, that "subsidy reductions were not part of the deregulation policy package but were a requirement of fiscal policy"—will be considered when the regulatory reforms outside London and within are evaluated. By doing so, we are seeking to isolate the impacts of subsidy reduction from the aggregate impacts of the whole policy package.

Now, under this scenario (hereafter, "replaced subsidy"), subsidy will be assumed to be unaffected by the policy reforms. This would lead to a higher subsidy level than what was actually observed (which in turn would lead to lower fares and hence higher demand than actually observed).

4.1.4 **Comparative assessments against alternative and counterfactuals**

Finally, an assessment or evaluation (through a cost-benefit analysis) of bus deregulation in Great Britain outside London and of comprehensive tendering within London will be undertaken by examining the impact on bus operators, users, the government, bus workers, and society as a whole (further detailed in 4.3). The aim of the evaluation is to examine how the deregulation policy (and the alternative competitive tendering regime in London) has changed the welfare of key groups in the local bus industry. The year-by-year assessment will compare the cost and benefit of the "actual" scenario (what was actually observed under the new policy) and the “counterfactual” scenario (as previously explained and used as the “reference” scenario).[18]

It is also understood that the outcomes of such massive policy reforms are expected not to occur exactly as planned or predicted at the time they were proposed partially due to the "state of the world" (policy assumptions are always less representative of the "real life" situation) or because local transport authorities might not fully fulfil their responsibility through policy implementations.

4.2 Methodological approach

A key issue when examining long-term changes is that of the counterfactual: What would have happened if the changes had not occurred? Thus, the methodology starts by using a modelling framework in which aggregate models of demand and fares are estimated, based on time series/panel datasets covering all regional areas of GB. The aim of this approach is to build or predict the counterfactual scenario (similar to a do-nothing scenario in an engineering project appraisal) using these estimated models in addition to using some forecasting (or, more accurately, extrapolative) methods and assumptions to forecast some key input variables.

In addition, another scenario needs to be structured in order to isolate the impacts of subsidy reductions from the rest of the deregulation policy components. The need to isolate these impacts is driven by some strong arguments raised in the literature (as detailed in 4.1.3.2). Other arguments related to the concept of “transfer” benefits required the estimation of some cost models, particularly to isolate the impacts of changes in labour wages and fuel prices (considered as transfer benefits rather than pure economic benefits; see 10.3.1.2).

Once all considered scenarios are configured, it becomes possible to perform an overall cost-benefit analysis to evaluate the long term impacts of the policy interventions in GB outside London and within London. Figure 4-1 presents an outline of the research methodological approach. It should be noted that this research is not intended to examine econometrics in-depth; indeed, simple modelling approaches, if sufficient, would be preferred. However, we found that estimating the required models based on the available time series collected for the local bus in GB require more complex estimation methods than those initially suggested, as demonstrated in the econometric modelling chapters (5 to 7). Suffice to say, a number of static and dynamic

[18] Another assessment will compare “the replaced subsidy” scenario and the “counterfactual” scenario to isolate the controversial subsidy reduction impacts (as detailed in 5.1.3.2).

demand models have been estimated, considering both fixed and random effect as well as using a variety of estimation methods[19] and model specifications.[20]

In sum, we have structured three different scenarios for both the deregulated area and London:

- The "actual scenario", as actually observed since the policy interventions in the mid 1980s.

- The reference scenario is the "counterfactual scenario" which assumes no policy interventions in the mid 1980s and the continuation of previous policies (i.e., the prolongation of regulated systems). In this case, the values of some key input variables are extrapolated (since the mid 1980s) and substituted in the costs, fare, and demand models. Chapter 9 provides further details.

  We also examined a third scenario, in order to isolate the impacts of subsidy reductions, which assumes that the policy interventions have not been combined by any reductions of subsides. We refer to this scenario as the "replaced subsidy" scenario. In this scenario, the reduction in subsidies is "replaced" or compensated, and subsidy values are extrapolated since the mid 1980s (see Chapter 9). All other input variables are used as actual. As the impacts of subsidies are explicitly incorporated in the fare model, which is estimated for that purpose, the new subsidy values will be substituted in the fare model whilst the predicted fare values will be substituted in the demand model to predict new demand values.

The second and, to a lesser extent, the third cases are empirical scenarios relying on the forecasting assumptions we made and, for that reason, should be perceived as analytical of the potential changes to the considered regulatory context. Nonetheless, we believe all the assumptions are made with sensible cautions.

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[19] e.g., Feasible Generalised Least Squares procedure (FGLS-AR(1)) and the Panel Corrected Standard Error (PCSE-AR(1)).

[20] Partial Adjustment Models (PAM) and Error Correction Models (ECM).

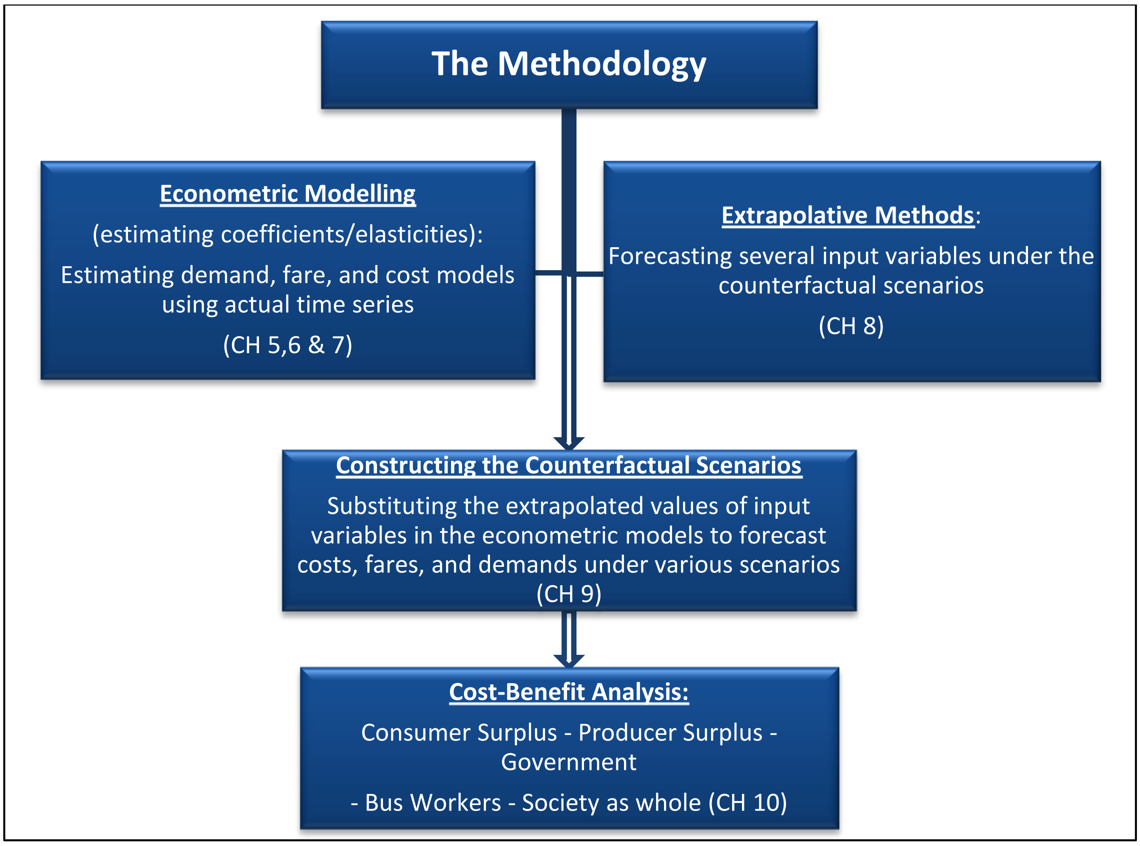


Figure 4-1 Summary of the research methodological approach.

4.3 Cost-Benefit Analysis (CBA)

4.3.1 The use of CBA in transport

The use of CBA was first included in the transport literature in 1844, when French engineer Jules Dupuit (1844, 1952) proposed this analysis in his procedure for evaluating a transport project. In the UK, CBA has been widely and extensively used in many transport projects since the 1950s and 1960s (e.g., development of the motorway network (Coburn *et al.*, 1960) and Victoria Line of the London Underground (Foster and Beesley, 1963)). The CBA methods have been continuously improved until they became a core part of many appraisal and evaluation guides in the UK, including the HM Treasury's book (The Green Book, Appraisal and Evaluation in Central Government) and the DfT's guide (i.e., TAG). The CBA has been also an essential part of various guides for appraising and evaluating major highway and public transport schemes in many part of the world. Examples include Transport Canada's handbook "Guide to Benefit-Cost Analysis in Transport Canada" (Wilson *et al.*, 1994) and the EU's project "Developing Harmonised European Approaches for Transport Costing and Project Assessment (HEATCO)" (Bickel *et al.*, 2006).

4.3.2 Nature of the CBA

The HM Treasury, in their Green Book guide, defines CBA as an "analysis which quantifies in monetary terms as many of the costs and benefits of a proposal as feasible" (HMT, 2003). CBA procedures include the net estimate of total costs against total benefits of a proposed or evaluated activity. Both costs and benefits are expressed in monetary forms and discounted to reflect the real value of money over the time of the assessment period.

One way of recording the impacts of any transport project is to include them in the Appraisal Summary Table (AST), which values the quantifiable items in monetary terms while listing the qualitative information without any estimation. However, the Department of Transport recognises that it is unfeasible to weigh all the impacts of the transport project listed in the AST (e.g. the impacts on landscape and heritage of historic resources cannot be monetised). Instead, the DfT admitted that the CBA, as defined by HMT's Green Book, should not include all the recorded impacts in the AST. The CBA will include at present, as suggested by Department for Transport's (2011) guidance, only monetary terms and should be considered as the only evaluation tool when the final decision is made. The guide provided general instruction of what should be included and excluded in monetised cost benefit analysis, as shown in Table 4-1.

Table 4-1 What should be included and excluded in monetised cost-benefit analysis

What is included and excluded	Comments related to current research
includes changes in consumer travellers' journey time, fares and other changes	This is included in the calculations of changes in consumers' surplus through changes in fares and demand. However, changes in travellers' journey time is out of the research scope; besides, the lack of such data will not permit this calculation.
includes impacts on private sector providers' revenues and costs	**These impacts will be considered** in the calculations of changes in producers' surplus**.** **In addition,** the effects of changes in labour rents and fuel prices will be determined separately.
includes changes in the numbers of accidents	Will be neglected since the number of accidents has been minor in the local bus industry over the period of assessments.

subsumes the accessibility impacts to the extent that the cost-benefit analysis takes account of all significant behavioural responses	It was investigated to determine if this could be valued in monetary form (bus users have suffered from the instability of services as well the cut of unremunerated services, but this has decreased as the market stabilised). However, there is no particular method or sufficient data to value these impacts. Assessment of accessibility impacts might be suggested for future work
usually excludes journey ambience impacts	
currently excludes - impacts on local air quality and greenhouse gas levels, although the Department expects to publish monetary values for these sub-objectives in the future; - reliability impacts as methods of estimating these and values of changes in reliability have yet to be determined, although the Department expects to publish advice in the future which will enable monetised estimates of reliability impacts to be derived for some studies; - impacts on landscape, townscape, heritage of historic resources, biodiversity, water environment, physical fitness and journey ambience as no money values for these have yet been established by the Department; - any wider economic impacts, including impacts on land use; and - the impacts on integration with land-use policies and other government policies.	

Source: Department for Transport (2011)

The adopted approach in the current research is to estimate demand, fare, and cost models that capture the bus consumers' and providers' behaviours as subjected to the considered policy under study, the alternative and the counterfactuals. It then determines consumers' and producers' surplus of welfare change as results of various policy states.

Layard and Glaister (1994, p.4) suggested in their book *Cost-benefit analysis* that:

> "In any cost-benefit exercise it is usually convenient to proceed in two stages:
> (a) Value the costs and benefits in each year of the project;
> (b) Obtain an aggregate 'present value' of the project by 'discounting' costs and benefits in future years to make them commensurate with present costs and benefits, and then adding them up."

4.3.3 Consumer surplus as measured in the cost and benefit calculations (in monetary terms)

The principles of CBA related to the calculations of user surplus are specified by SACTRA (1999) to include the following:

> "1- Travel demand and cost forecasting, without and with the intervention being appraised;
> 2- The method of calculating user benefits/disbenefits from the changes in travel demand and costs; and
> 3- The process of valuing the changes in user benefits/disbenefits in money terms."

From these principles it can be realised that the concepts of "the travel demand curve which relates the amount of travel to the cost of travelling" is fundamental to the consumer surplus measure of welfare change due to policy intervention. The rule of half (RoH), the most widely used method,[21] depends on the travel demand curve to calculate user benefits.

4.3.3.1 Rule of half (RoH)

To illustrate the underlying concept, let us consider the following illustration basically derived from the CBA of Dupuit's bridge example. The example is modified in order to suit the local bus demand curve as shown in Figure 4-2.

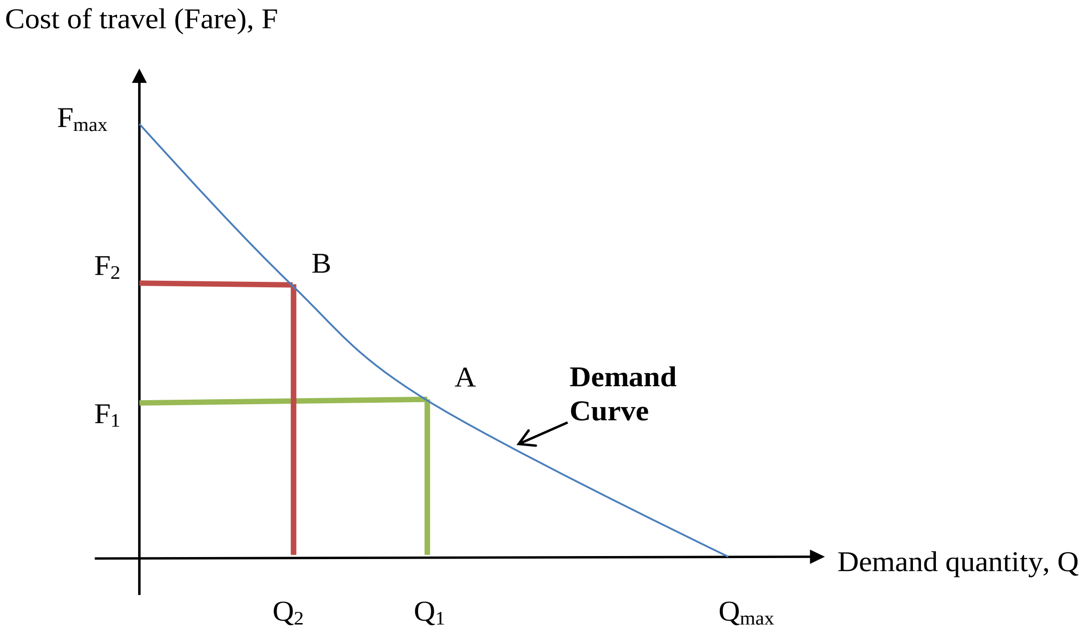


Figure 4-2 The local bus demand curve

In Figure 4-2, Q_{max} represents the maximum number of trips made by a bus passenger over a specific time period if the fare is zero whereas F_{max} is the fare level at which all passengers stop travelling by bus. F_1 is the initial fare level and Q_1 is the associated level of demand. The equilibrium point on the demand curve corresponding to this price–demand combination is represented by point A. Assumes If the fare is increased to F_2, the demand will consequently decrease to Q_2. Point B reflects the new equilibrium state. The aim now is to calculate the consumer's welfare loss as a result of this fare rise (or the consumer's move from point A to B).

<u>Upper limit of the consumer's welfare loss</u>

[21] An example in the UK is the software Transport User Benefit Appraisal (TUBA) which uses a matrix based on the RoH method to determine network-wide user benefits.

- When the fare is increased from F_1 to F_2, the number of trips consumers prefer will shrink to equal Q_2 instead of Q_1 (fewer trips can be made with the same budget due to the higher fare level).
- The price-quantity equilibrium will then move from point A to B.
- If the users are forced to hold their initial number of trips (Q_1) to maintain the same utility regardless of their budget, the price–quantity equilibrium should presumably be at point C in Figure 4-3 (above the demand curve).
- Consequently, the bus consumer will pay more to keep their normal number of trips before the fare increase. In other words they have to pay an extra amount equal to [(F_2-F_1)*Q1] or the area represented on the figure by the rectangle shape (CA F_1F_2).
- As in real life, consumers will not hold their demand level and decrease their use to Q_2, and the previously determined area will specify the upper limit of the consumers' welfare loss rather than the actual loss.

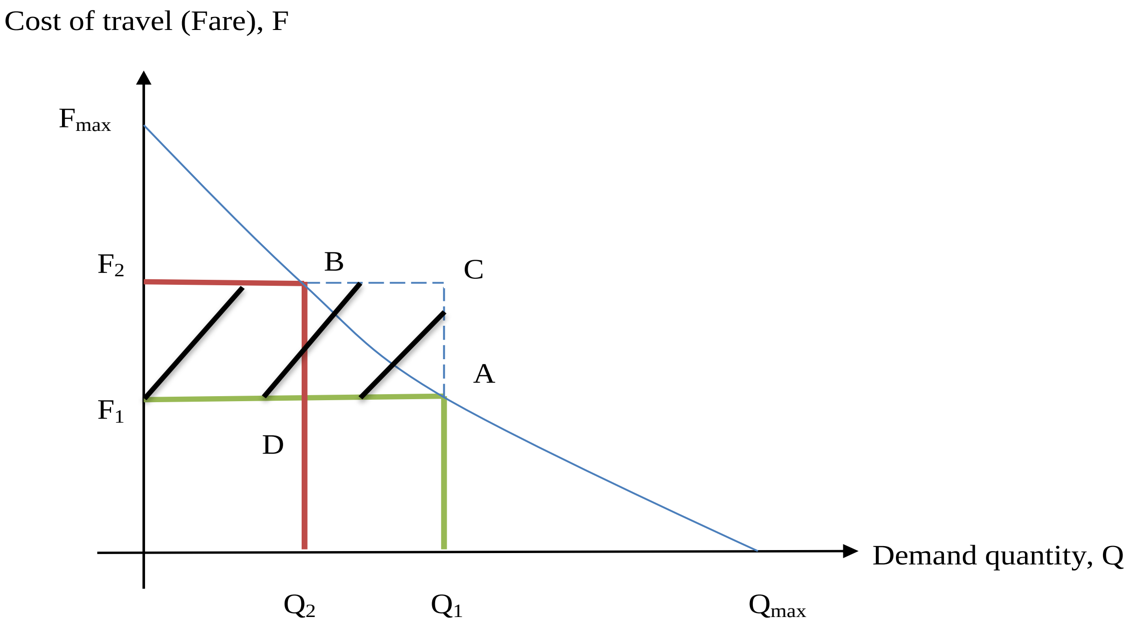


Figure 4-3 Upper limit of the consumer's welfare

Lower limit of the consumer's welfare loss

- Oppositely, when the fare decreases from F_2 to F_1, the number of trips consumers prefer will jump to equal Q_1 instead of starting level at Q_2 (extra trips can be made using the same budget due to the lower fare level).
- The price–quantity equilibrium will move from point B to A.

- If the users are forced to hold their number of trips to Q_2, the price–quantity equilibrium should presumably be at point D in Figure 4-4 (below the demand curve).
- Consequently, the bus consumers will pay less to keep their number of trips before the fare decrease. In other words, they have to pay a lower amount equal to $[(F_2-F_1) * Q_2]$ or equal to the area represented on the figure by the rectangle (BDF_1 F_2).
- As in real life, consumers will not hold their demand level and increase their use to Q_2, and the previously calculated area will specify the upper limit of the consumers' welfare gains rather than the actual loss.
- Simultaneously, this also equals the lower limit of the consumers' welfare loss due to the fare increase from F_1 to F_2 (or movement from A to B).

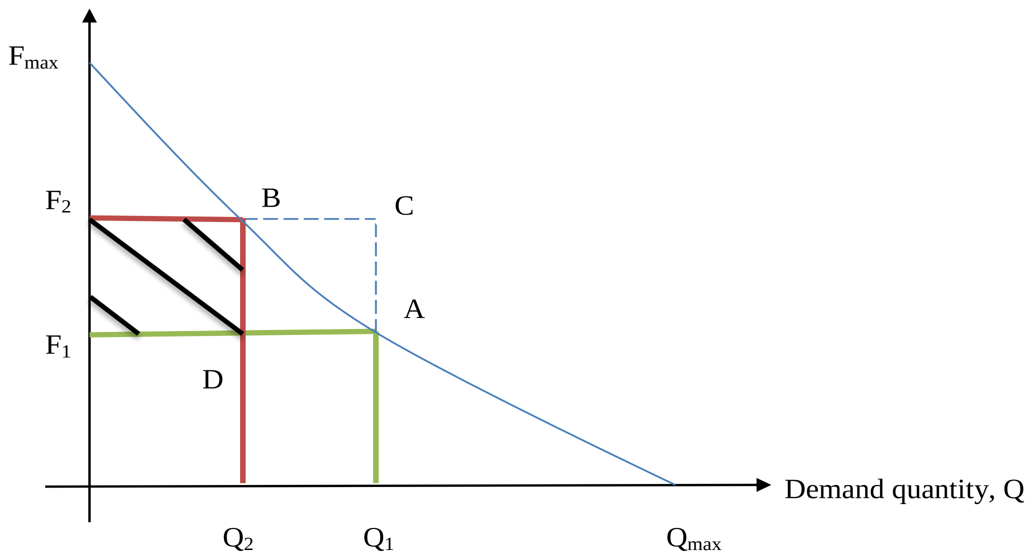


Figure 4-4 Lower limit of the consumer's welfare loss

In summary, when the fare increases from F_1 to F_2, it will be associated with consumers' welfare loss. The upper limit of this welfare loss can be estimated as $[(F_1-F_2)*Q_1]$. The hatched area in Figure 4-3 illustrates this limit. The other (lower) limit of the consumers' welfare loss can be estimated as $[(F_1-F_2)*Q_2]$. The hatched area in Figure 4-4 illustrates the lower limit.

The consumers' total surplus measure of welfare change (in monetary terms) is calculated as the arithmetic average of these two estimates (rule of half) as:

Equation 4-1

$$\Delta CS \cong \frac{1}{2}[Q_1 + Q_2][F_1 - F_2]$$

Figure 4-5 demonstrates consumers' surplus measure of welfare change, the hatched trapezoidal (F_1ABF_2). In other words, the welfare change is equivalent to the area between the two fare levels and left of the demand curve.

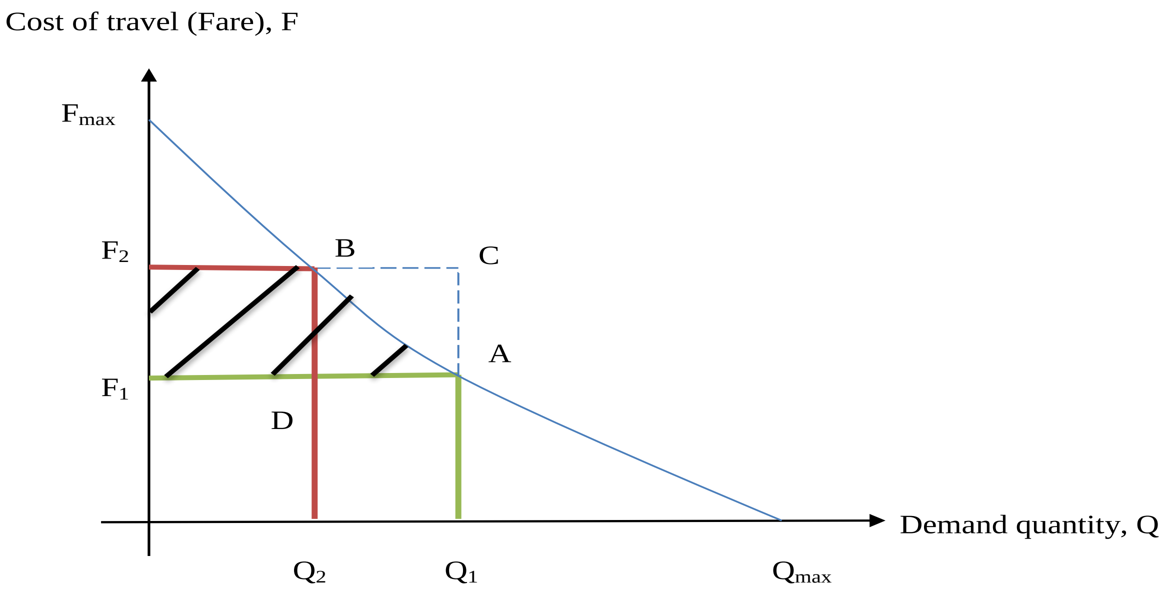


Figure 4-5 Consumer's surplus measure of welfare change

In the previous equation, we simplified the calculation of the shaded area by assuming the demand curve between point A and B to be linear. The part of the demand curve specifies the right side of the trapezoidal area and has a curve shape rather than a linear line, as shown in Figure 4-6. In practice, it might be very difficult to accurately estimate this. However, the difference is very minor and can be neglected, for small price changes and inelastic demand, as is the case here.

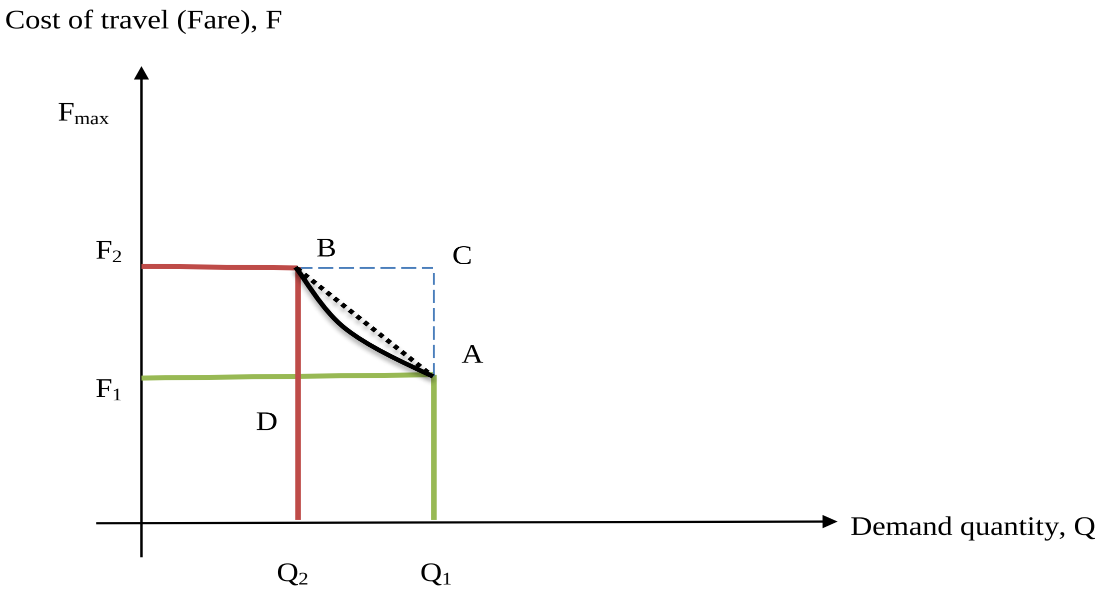


Figure 4-6 The shape of demand curve between the two equilibrium points

In case of demand shift

Thus far, we have focused on welfare change (gain or loss) based on movement on the same demand curve. Yet, the possibility exists of a demand curve shift due to factors other than change in costs of travel (fares). This may include an increase in income or improvement in service level or deterioration/interruption of service due to adverse impacts of deregulation (captured by the deregulation policy dummy). The two cases are highly possible in our situation as the income is the same in all our scenarios whereas the service level is different in the actual and counterfactual scenarios.

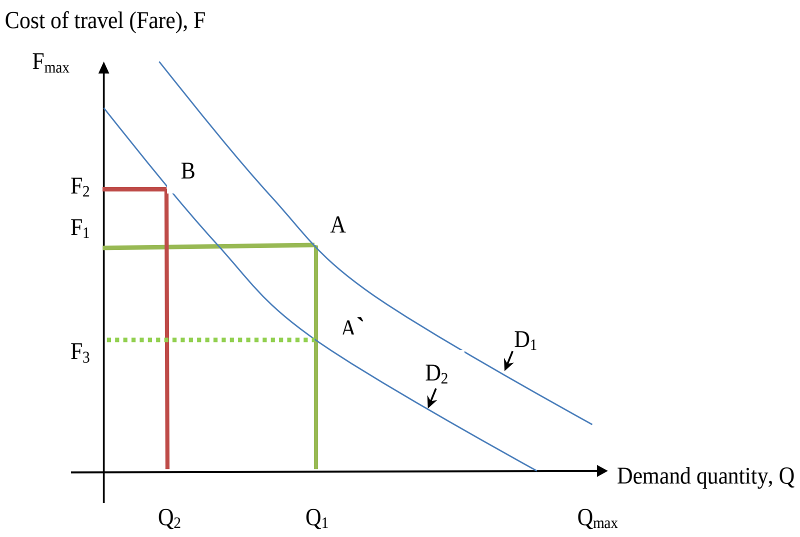


Figure 4-7 Consumer’s surplus measure of welfare change after a demand curve shift

As illustrated in Figure 4-7, the welfare loss resulting from a movement from point A on the demand curve (D_1) to point B on the “shifted” demand curve (D_2) is equal the trapezoidal area $F_2BA`F_3$. The concept is that the calculated loss (from A to B) after a shift in demand curve should be equal to that calculated as a result of movement “on the same curve” from A` to B, where A` has $Q = Q_1$ but lies on demand curve (D_2). In order to calculate the trapezoidal area or the change in consumer surplus we need to determine F_3. This is possible by substituting $Q = Q_1$ using the demand model that will be estimated in the next chapters in order to calculate the corresponding fare F_3. Thus, the consumer surplus in case there is a demand shift will be equal:

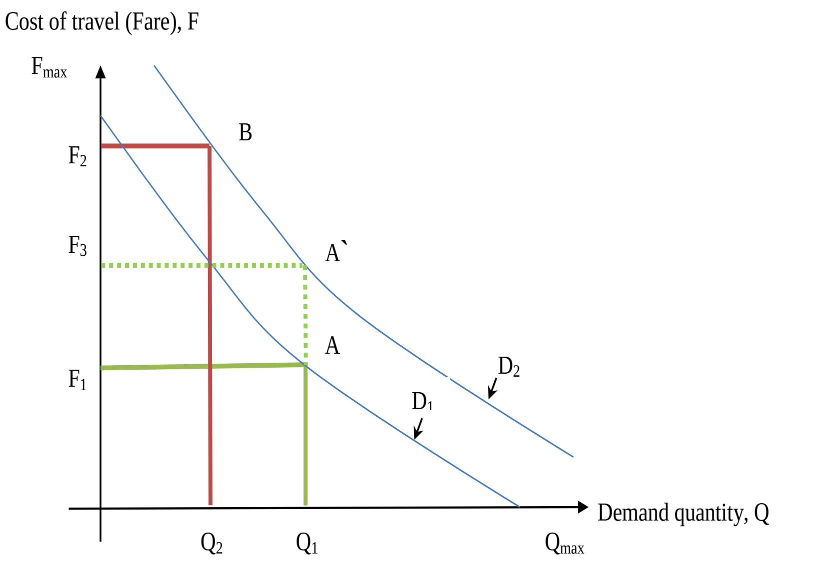
Equation 4-2

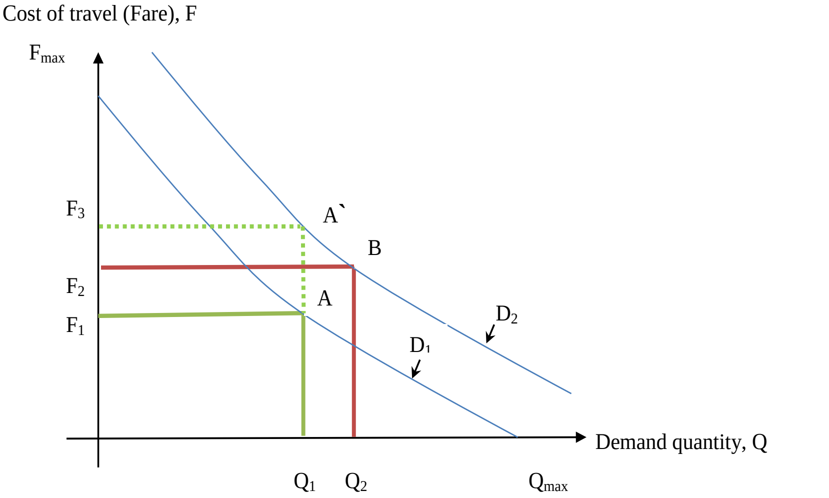
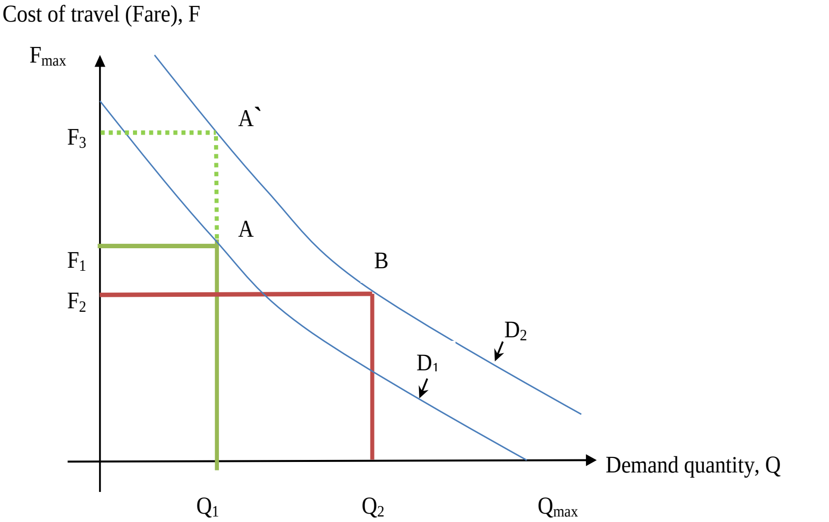
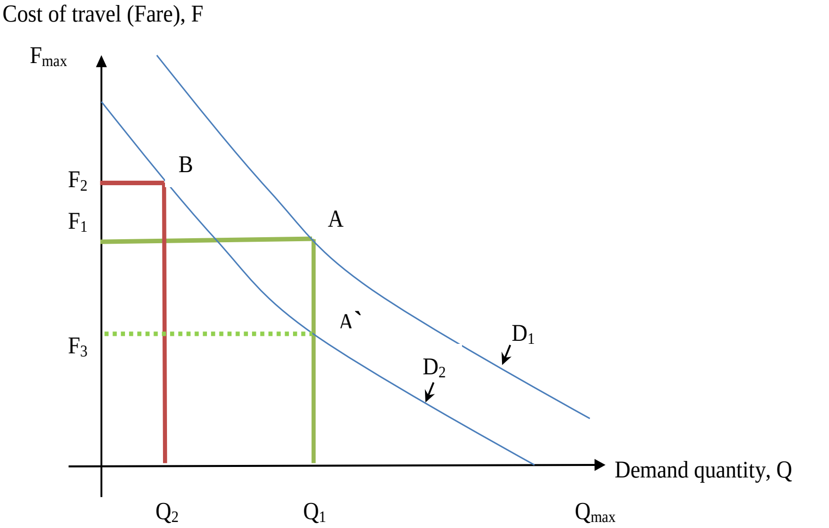
$$\Delta CS \cong \frac{1}{2}[Q_1 + Q_2][F_3 - F_2]$$

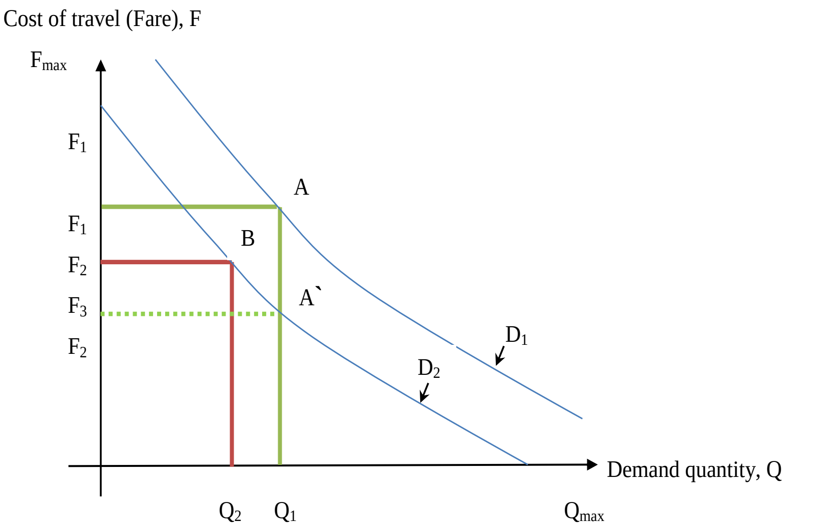
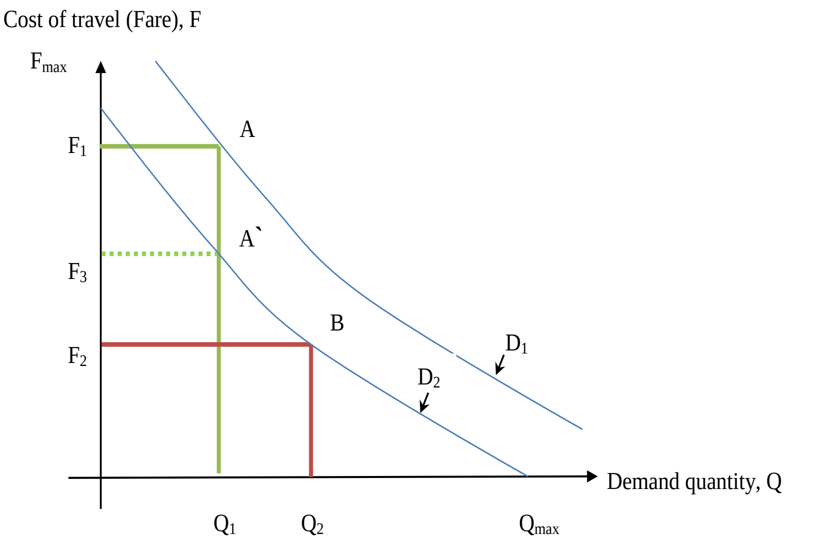
It should be noted that Figure 4-7 assumes that there is an inward shift in demand curve, a decrease in fare ($F_2 < F_1$), and a decrease in demand ($Q_2 < Q_1$). However, there are 6 possible cases as illustrated in

Table 4-2. In every case the consumer surplus can be calculated using the same formula in Equation 4-2.

Table 4-2 the six possible cases of demand shift

Case	Changes	
1	Outward shift, Fare increase ($F_2 > F_1$), Demand decrease ($Q_2 < Q_1$) There is welfare loss equals the trapezoidal area $F_2BA`F_3$	

2	Outward shift, Fare increase ($F_2 > F_1$), Demand increase ($Q_2 > Q_1$) There is welfare gain equals the trapezoidal area $F_3A\`BF_2$	
3	Outward shift, Fare decrease ($F_2 < F_1$), Demand increase ($Q_2 > Q_1$) There is welfare gain equals the trapezoidal area $F_3A\`BF_2$	
4	Inward shift, Fare Increase ($F_2 > F_1$), Demand decrease ($Q_2 < Q_1$) There is welfare loss equals the trapezoidal area $F_2BA\`F_3$	

5	Inward shift, Fare decrease $(F_2 < F_1)$, Demand decrease $(Q_2 < Q_1)$ There is welfare loss equals the trapezoidal area $F_2BA`F_3$	
6	Inward shift, Fare decrease $(F_2 < F_1)$, Demand increase $(Q_2 > Q_1)$ There is welfare gain equals the trapezoidal area $F_3A`BF_2$	

There is little limitation to the RoH method. Nellthorp *et al.* (2005) noted that

> "The Rule of a Half breaks down when the assumptions upon which the methodology is based are undermined. The two principal assumptions are:
> - The demand curve is linear [the change in costs (fares) is small]; and
> - Demand for travel exists in the before and after situation."

Both assumptions apply to our analysis. The principal condition under the first assumption is that the change in costs (fares) is small[22] (as a rule of thumb, <25%). In all our consumer surplus calculations carried out on a year-by-year basis, the changes in travel costs are very small between the compared scenarios. In a situation when the RoH breaks down, an alternative is the

[22] Nellthorp *et al.* (2005) explain this condition as that, the larger the changes in travel costs, "the less reliable the linear approximation to the demand curve becomes" (see Figure 4-6).

numerical integration (NI) method (Nellthorp and Hyman, 2001). However, Nellthorp *et al.* (2005) cautioned that:

> "The numerical integration is a simple pragmatic solution rather than the theoretically best approach—which requires the ability to integrate the demand function—which is often more complicated to do."

4.3.4 Producer surplus and other groups' welfare changes

A summary of how producer surplus and other groups' welfare changes are calculated in the CBA of the policy reforms is presented in Table 4-3.

Table 4-3 Illustration of how producer surplus and other groups' welfare changes can be calculated in the cost-benefits analysis.

Variable	Notes
Change in total cost (TC) (£)	For the actual, counterfactual, and replaced subsidy scenarios, the letters are based on the outputs of the estimated cost model. ΔTC_{actual} = Actual – counterfactual $\Delta TC_{replaced\ subsidy}$ = Replaced subsidy - counterfactual
Change in total revenue (TR) (£)	For the actual, counterfactual, and replaced subsidy scenarios, the letters are based on the outputs of the estimated fare and demand models. ΔTR_{actual} = Actual – counterfactual $\Delta TR_{replaced\ subsidy}$ = Replaced subsidy - counterfactual
Change in total subsidy (SUB) (£)	Counterfactual subsidy is forecasted through extrapolative methods. ΔSUB_{actual} = Actual – counterfactual * Under the "replaced subsidy" scenario, there is no change in subsidy, as the subsidy level is assumed to equal that forecasted under the counterfactual
Producer surplus – change in profit	$\Delta PS = \Delta TR + \Delta SUB - \Delta TC$
Welfare change to bus workers – cost savings due to change in staff earnings (£)	$\Delta TC_{due\ to\ change\ in\ wages} = \Phi\ \Delta TC$ = Actual TC - Forecasted TC (by the cost model assuming counterfactual values for the labour wage variable only; values of other explanatory variables are assumed as actual), see also 10.3.1.2. Φ = Proportion of the change in total costs that is due to changes in labour wage The purpose is to isolate the saving caused by labour wage as this is in fact a "transfer" of welfare between the operators and bus workers rather than pure welfare gains. *Although fuel prices have been significantly reduced since the policy reforms and there are cost savings due to reduced fuel prices caused by external factors rather than by the policy reform, we will calculate the total costs under the counterfactual scenario using these reduced fuel prices. By

	doing so, we will avoid the attribution of this saving to the policy reforms (see 10.3.1.2).
Welfare change to the government or local authorities – change in granted subsidy	Equals to (- ΔSUB)
Avoided deadweight loss which would have had occurred if subsidy has not been reduced – welfare gain to the society as a whole	Assuming a shadow price of public funds of around 1.2 (after Dodgson and Topham, 1987) Deadweight efficiency adjustment (DEWA) = - ΔSUB * 0.2.
Overall welfare change to the society as a whole	Equals an algebraic summation of all above plus the consumer surplus (which calculated by the RoH method): $\Delta W = \Delta CS + \Delta PS - \Delta SUB * 1.2 - \Phi\ \Delta TC$

1986/7 is the first year after the policy change and when the calculation of welfare change will start.

5. The Basic Demand Model

5.1 Introduction

In assessing the long term impacts of bus deregulation policy, one of the main objectives of this research is to determine the counterfactual scenario: what would have happened in the absence of policy interventions in the mid-1980s. Also, another counterfactual scenario is considered to isolate the impacts of a specific element of the deregulation policy package, namely subsidy reductions, from the rest of the package.

In order to achieve that, this chapter will estimate a “forecasting” model that can predict the demand[23] in the British local bus travel market. This dynamic model incorporates possible variables that explain the actual variations of bus use and its developments over the time period of the study, since 1980. Consequently, the estimated demand model will be used to model (or predict) the two counterfactual scenarios explained earlier given various assumptions about input variables.

In the following sections, we will start by explaining some features desired in the model and some difficulties caused by data availability, and the proposed solutions. This will be followed by both model specification and functional form. Also, other modelling issues and modelling priorities will be discussed in some detail. Finally, the empirical estimation will be presented.

5.2 Dynamic Approach

By specifying a dynamic approach we recognise the importance of dynamics in users’ behaviour when choosing to (or ceasing to) travel. Habit of inertia, uncertainty and lack of proper information on alternative travel modes, and other travelling costs (e.g. costs of search, transaction, adjustments) are all considered to be common arguments for such approach (Dargay, 2007). It is recognised that the changes in users’ travel behaviour, in response to changes in bus travelling conditions, is a slow process shaped over time rather than instantaneously.

In most cases, the nature of many transport datasets led many researchers to estimate static models in their analyses of transport demand. For example, cross sectional analysis, employing only cross-sectional data, is very useful in specifying the differences between units (e.g. firms or regions) in terms of transport demand. However, its major drawback is that demand variations over time cannot be captured by such data.

[23] Similarly, a forecasting model to predict fare level will be estimated in 5.2

A static model is inefficient in modelling actual variations in demand. Because the model assumes that the long term equilibrium relationship is determined solely through variations across units while its evolution over time is omitted (Goodwin *et al*., 2004). This assumption neglects the fact that factors affecting travel demand are highly dynamic and constantly changing. It is reasonable, therefore, to expect their influences on demand to take some time before some sort of equilibrium is achieved. Hence, the conflict between static assumptions and the dynamic nature of the transport demand would result in a biased estimation of the model's long term outputs (Dargay and Vythoulkas, 1999). Specifically, in a static model the consequent calculation of consumer surplus required in the cost-benefit analysis (CBA) would be biased (Dargay and Goodwin, 1995).

This problem does not appear in the dynamic model, which utilises time series, or combines time series and cross section data. The main advantage of this approach is that it allows for gradual influences of changes in explanatory variables to appear in the model outputs. Under the proper specification, the time horizon required for these effects to fully take place over time can be determined. In the meantime, the proportion of such influence at any specific point in time in the future can also be determined. For instance, the change in fare in year (t) will have its gradual influences on demand not just at this year but also in all successive years (t+1, t+2,.., etc However, these will diminish until eventually they are negligible.

Another advantage is the ability to distinguish between the short run effects of changes in demand determinants and the long run effects or elasticities. Short run elasticity can be defined as the immediate effects of changes in demand factors on bus use, usually within the first year. Long run elasticity is considered as the accumulative effects of these changes on bus demand at the long run equilibrium state, or practically as near as can be estimated to this equilibrium. In terms of transport demand literature, Goodwin's (1992) work was the first attempt to highlight the importance of distinguishing the effects of changes at different time perspectives. This concept was also emphasised by the later work, e.g. Dargay and Hanly (1999, 2002).

These advantages of the dynamic model provide very beneficial means for the evaluation process, particularly from the perspective of transport policy evaluation, which the current research is about. Estimating the speed of process and time scale of response to a policy intervention are as important as its size (Dargay, 2007). In our case, the amount of change in demand in response to deregulation policy may need to be estimated in both the short and long run.

This concept was also illustrated in (Dargay, 2007) as follows

"The investigation of the intertemporal response of individuals to changes in their personal circumstances or to various policy measures requires dynamic modelling strategies based on observations of behaviour over time".

Thus, it can be concluded from the above discussion that adopting a dynamic approach when estimating the demand model is both essential and beneficial. In practice, the most widely applied technique to model the dynamic behaviour is to include a lagged value of dependent variable on the right hand side of the demand equation. Other alternative techniques include the use of higher order of lags (higher than one) or including lagged values of the independent variables along with the dependent variable (Balcombe *et al*., 2004). These alternative techniques will be investigated in our analysis.

5.2.1 The dynamic process

Initially, let us consider a static demand model as follows:

Equation 5-1

$$Q_{it}^{*} = (\alpha + \beta X_{it} + \varepsilon_{it})$$

Where Q* is the dependent variable assuming it is at its long-run equilibrium level, X_{it} is a vector of the k explanatory variables for pooled data of (N) regional areas (i =1; . . ;N) over (T) annual observations (t =1; . . . ; T), and (ε_{it}) is error term.

To allow for dynamic behaviour when modelling the bus demand, a lagged dependent variable (a state variable or inertia of state) must be incorporated in the model. The lagged dependent variable (Q_{t-1}) can be defined as the number of bus trip per person in the previous year (t-1).

5.2.2 Lagged adjustment

The concept employed when estimating the dynamic bus demand model is that effects of changes in explanatory variables on bus demand do not occur at once; instead the demand responds to these effects gradually over time before it reaches the long-run equilibrium level.

Thus, bus patronage in year (t) should not be determined solely by changes in its determinants in the same year but also by changes of those determinants in the past. Figure 5-1 illustrates how the effects of changes in demand determinants influence bus demand in a gradual way and fade over time. In this illustration, the lagged adjustment process between the initial demand level and long-term equilibrium was completed over eight years. However, the exact period of time may vary from model to other and can be determined using the long-term multiplier, as will be shown later in this section.

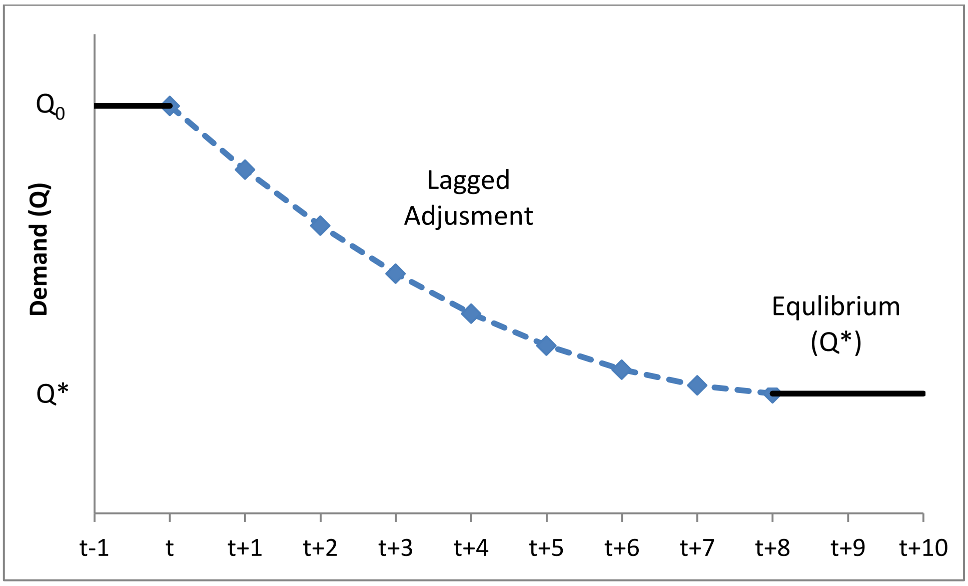


Figure 5-1 How the effects of changes in demand determinants influence bus demand in a gradual way and fade over time.
Source: A modified figure, original source: Fearnley, N. & Bekken, J.T., (2005). Long-term demand effects in public transport. In European Transport Conference.

We included independent lagged variables for bus fares, income, service quality, and motoring costs in the initial model but none of these proved significant. This is due to many factors explained in Green (2003). First, these lagged explanatory variables may consume most of the degrees of freedom. Second it may cause serious multicollinearity problems. Finally, the residual may be serially correlated. Therefore, only the dependent lagged variable, bus demand for year t-1, was included while all other independent lagged variables were excluded in the final specification.

Assume that the relationship between the actual demand level and long-term equilibrium state is given by the following equation (Dargay and Hanly, 2002; Green, 2003):

Equation 5-2

$$Q_t = Q_{t-1} + \theta\,(Q_t^* - Q_{t-1}) \quad or \quad (Q_t - Q_{t-1}) = \theta\,(Q_t^* - Q_{t-1})$$

Where (θ) is speed of adjustment, or lag weight, and ($0< \theta <1$). The adjustment coefficient ($1- \theta$) reflects the difference between the actual bus patronage and the long-run equilibrium level due to lagged adjustments of bus demand to changes in explanatory variables, for example due to change in income level.

When substituting Equation 5-1 into Equation 5-2, this result is a partial adjustment equation which can be expressed as follows:

Equation 5-3

$$Q_{it} = (\alpha + \beta\, X_{it} + \varepsilon_{it}) + \theta\, Q_{it-1}$$

Where (Q_{it}) is actual demand level, (Q_{it-1}) is the lagged dependent variable.

The dynamic process is represented in the previous model (Equation 5-3) by the added term on the far right-hand side of the equation, ($\theta\ Q_{it-1}$). It implies that historical effects of changes in explanatory variables in all past years are incorporated in the demand level of the last year (t-1). Given that demand in year (t-1) has also been determined by changes in year t-1 and t-2, and so on for other periods (Dargay and Hanly, 2002).

5.2.3 Short and long-term elasticities

The new term not only allows for the lagged adjustment to past changes in explanatory variables (e.g. fares and service variables), but also makes direct distinction between long and short run elasticities from the equation possible.

Simply, the short run elasticity of bus demand with respect to each explanatory variable is as follows:

Equation 5-4

$$\eta^{SR} = \beta \ \ (for\ double \log form)$$

Where short run elasticity under double log specification is estimated directly and equals the coefficient of the explanatory variable. The long run elasticity can be calculated by means of the short run elasticity and the adjustment coefficient (1- θ) as follows:

Equation 5-5

$$\eta^{LR} = \frac{\eta^{SR}}{(1-\theta)}$$

where the smaller the value of speed of adjustment (θ), the faster the actual demand is reaching the long-run equilibrium level (Q*), and the smaller the difference between short and long term elasticities. In other words, given that ($0< \theta <1$), the closer the value of (θ) to zero, the shorter time it takes for adjustment of demand for changes in its determinants. The closer the value of (θ) is to 1, the more likely infinite time is required for adjustments.

5.2.4 Constant and variable elasticity

Using the double log form, the above elasticities should be interpreted as constant elasticities. However, variable elasticity, changing based on the explanatory variable level, can be easily estimated if needed[24].

[24] In this case, the short run elasticity will be (βx) and long run elasticity [βx/(1-θ)], Dargay and Hanly (2002).

5.2.5 The dynamic (lagged) effects in the future

Another advantageous feature of the dynamic model using a partial adjustment equation is that the number of years t required to close a certain proportion (p) of the gap between the long term equilibrium and initial value of demand (y_t) can be estimated by the following formula (Balcombe *et al*., 2004) :

Equation 5-6

$$t = \frac{\ln(1-P)}{\ln(\theta)}$$

Also, it may be desired to calculate the time horizon required for these effects to fully take place and reach the long term equilibrium (full adjustment). This can simply be done by using a proportion close to 1, e.g. 0.99.

5.3 An aggregate demand model

We move, now, to the issue of desired level of disaggregation which can be modelled. Ideally, the estimation of disaggregate demand models, as small as city or area level, would be desirable. To achieve this, a comprehensive and detailed dataset should include information on all explanatory variables disaggregated by every area of the country and over a very long period of time are required. Given that, any implemented level of disaggregation should be restricted by the available datasets.

Regrettably, the available datasets published by or obtained from the different transport bodies in Great Britain lack such required details[25] and makes such estimation impossible. In reality, it would also be difficult to collect such datasets in the future, given the commercial nature of the local bus industry that resulted after deregulation. The private bus operators are generally unwilling to share transport data at this level of disaggregation as it may be used by their competitors and affect the competition level. If any of this data becomes available for any transport body, it will be kept confidential for the same reason. The authors of Public Transport Statistics Bulletin (DfT, 2009) commented on this issue that "It is not possible to publish all of the information that has been collected, to protect commercial confidentiality of transport operators..."

For the current research, relatively aggregate bus data (by wide regions or the whole GB) can be utilised based on data availability. Nevertheless, any chosen approach is reliant upon the research objectives and aggregate model that sufficiently serve the current research purposes.

[25] Sometimes transport disaggregate data are available but lack consistency, as it does not cover the whole period of study (since 1980s).

In our case, the estimation of an aggregate demand model will provide the proper tools (forecasts) required to evaluate the deregulation policy as it was applied to a broad area of the country (GB or GB excluding London). Thus, no area or region-specific inference is derived but instead countrywide conclusions are made. The advantages of aggregate transport forecasting model is best described by Dargay (2010) that

> "The main advantage of an aggregate model in comparison to a more detailed geographically-defined model, however, lies in its simplicity and transparency. It is also relatively easy to run, so that different scenarios can be examined."

5.4 Data shortage and pooling procedure (panel)

So far, we have specified a dynamic and aggregate demand model. The initial adopted methodology (time series regression) requires transport data collected over an adequate period of time. Unfortunately, there are some doubts over the consistency of the available data before 1980. Transport data before 1980 are either missing for some variables or unreliable due to substantial change in data collection methodology, leaving us with only 30 observations for each variable (between 1980 and 2009).

Reliable estimates of model parameters may not be possible from such a relatively small number of observations[26]. In the meantime, there is a number of similar time series available for wider regional area of the Great Britain. Transport time series are available for the following regions: English Metropolitan areas, English shires, Wales, Scotland, and London.

Hence, the problem can be resolved by pooling time-series and cross-section data, this will result in a form of panel data. Rather than employing a single aggregate time series transport data, we can estimate a demand model by combining time series data for different areas of the country.

It should be borne in mind, however, that although the data is adequate, when pooled together, to estimate an aggregate demand model, it is not large enough to be used in estimation of separate demand model for each of these regional areas (pure time series analysis).

[26] This was confirmed by the result of initial time series modelling process. This issue is common in the literature, for example, Beck and Katz (2004) described their time series of 40 annual observations that "our time series are fairly short".

5.4.1 Advantages of panel data

By using panel data in the model estimation, not only will the number of observations be increased but consequently the degree of freedom also. This, in turn, will significantly enhance the reliability of the estimated model parameters and increase the degree of diversity in the data (Dargay and Hanly, 2002; Frees, 2004). By taking a closer look at the data we can notice that there are clear variations among areas as well as over time. Conventionally, transport data is more variant among areas than over time.

Other advantages of using panel data is that the increased number of observations is expected to reduce the potential risks of multicollinearity problems and to allow for more complex and dynamic behaviour in the model. The determination of dynamics of response adjustment is possible with panel data, while it is impossible using cross sectional data (Bresson *et al*., 2004). Thus, it is very appropriate for understanding transition behaviour or to model more complex behaviour.

Another desired feature of panel data is its ability to minimise the effects of aggregation bias, most local bus data in GB are aggregated at regional area level. Finally, panel data allows for the modelling of the heterogeneity between individuals (across different areas) or within individuals over time (temporal change). However, heterogeneity should be properly controlled (e.g. using fixed effect methods) which otherwise may cause biased model estimates (Bresson *et al*., 2004).

The downside of such data structure is its degree of aggregation with respect to elasticity interpretations. It presumes that different areas have the same demand elasticities (Dargay and Hanly, 2002; Holmgren *et al.*, 2008).

However, our approach is to estimate the coefficients in a panel framework and then use the estimated parameters to simulate country fitted values. No region-specific inference is derived but instead country conclusions. This approach will also mitigate the impacts of the heterogeneity issue among different regions included in the panel.

5.4.2 Heterogeneity: Applied techniques to control for unobserved effects

When cross section data and time series are combined to obtain a panel data, two types of information about the subject are obtained: within and across individuals (areas). This additional information provides a useful tool that can be utilised in the process of model estimation. However, this approach, of pooling data, should be used with caution. The possible heterogeneity (unobserved effects or differences between individuals (areas) as a result of any omitted variables) should be properly addressed to benefit from such variations; otherwise it would cause problems (Greene 2003).

Applying the technique of ordinary multiple regression during the panel data analysis is possible. However, the coefficients estimated through such a methodological approach may suffer from omitted variable bias. This problem may appear in the case where there are unobserved variables (whether unknown or uncontrolled for) not included in the analysis. The unobserved effects may influence the predicted variable and potentially may cause significant bias to the estimated model's parameters. Therefore, in any model estimation using panel data, heterogeneity (unobserved effects) needs to be controlled. These effects may have a spatial and/or temporal dimension. The researchers may be interested in modelling change in regressors within each individual (area) over time while trying to control across area differences, this is called a one-way fixed or random individual effect model. Conversely, the researcher may try to model variations across individuals (area) and seek to hold time variations; this is called a one-way fixed or random time effect model. There is a third case that employs two-way effect models if the researcher is interested in both spatial and temporal dimensions.

In this research, we adopted a methodological approach which takes into account this methodical issue (heterogeneity). The chosen approach starts by initially estimating a model of bus demand using a technique of Pooled Ordinary Least Square (POLS). In a later stage, two techniques able to control for any unobserved effects or heterogeneity across individuals (areas) were used. But no technique was used to control for unobserved effects within an area over the time, as these effects in particular need to be modelled. Thus, the applied methodological approach allows modelling (observed) effects within areas, whereas (unobserved) effects that vary across areas are controlled.

Based on the above discussion, the two employed techniques can be defined as one-way Fixed and Random Effect. The main advantage of these techniques is that both can isolate the unobserved effects of any omitted, time-invariant, variables in the model, no difference if these are recognised or not by the researcher. This allows us to estimate a model for bus demand using pooled time series of different regional areas of Britain without any concerns regarding any heterogeneity between these areas (Greene, 2003).

The unobserved effects across areas, if they exist, will be captured as area-specific constant terms (intercepts) or area-specific random errors (error terms), using fixed or random effect model respectively. On the other hand, if no heterogeneity is presented, then pooled regression will give an efficient and unbiased regression.

In the current research, when estimating the model coefficients, the focus is more on within individual (area) variations over time rather than across individuals (areas). Provided that the main aim of the research is to tackle the long-term impacts of deregulation policy on the demand for buses in the whole area outside London. Determining the approximated differences between areas in terms of policy impacts will be desirable; however this cannot be captured by the employed aggregate data. Highly disaggregated data over longer time periods is required to account for that. As indicated earlier, based on comprehensive investigation, this data does not exist or is not available [DfT refused to give access to STAT100 dataset for this research for confidential issues].

5.4.2.1 Fixed Effect Model (FEM)

After the initial model estimation using pooled regression technique, we also estimated a Fixed Effect model (FEM) to control unobserved effects across individual (area-specific effects). The FEM employs a specific intercept for each individual (area) to capture these effects. The underlying assumption employed by FEM is that unobserved effects may differ between areas but are fixed within area over time (time-invariant). For example, there should be no change in the availability and quality of the provision of information on bus services over the time within each area. This variable may influence the bus demand, but is not included in our model as a result of limited data availability. Nevertheless, the differences of the variable values between areas are allowed as it is controlled for by the fixed effect technique.

Because of this restriction, FEM is very efficient in controlling any unobserved or uncontrolled variables that are stable over time. But it fails to do so if these omitted variables are time-variant. On the other hand, the opposite restriction applied to the observed effects (the explanatory variables included in the model) which should be changing over time, to utilise these variations to determine the parameters throughout the estimation process. Otherwise, these variables would be excluded from the model in the process (statistically, the coefficients would be insignificant and dropped from the equation). Thus, variables such as race or sex, which are constant over time, cannot be used here as an observed (explanatory) variable. Nevertheless, we have no interest in observed time-invariant variables, e.g. race.

The attractive feature of FEM is that the unobserved effects can be correlated with regressors since it is included in the intercept terms not as a part of the error terms. Thus, one of the main assumptions of OLS, of no correlation between regressors and error terms, is still valid.

5.4.2.2 Random Effect Model (REM)

Consequently, we also estimated a random effect model (REM), which mainly differs from FEM in that the unobserved effects are hypothesised to be uncorrelated with other regressors included in the model (Mundlak, 1978; Wooldridge, 2002). In this case the random effect across individual (areas) or over time are captured in error variances; hence it uses a common intercept for all areas. If the error is correlated, this will be a major violation of OLS assumptions.

In terms of controlling the unobserved effects, the random effect model (REM) is superior to the fixed one, as seen by Hsiao (2003), in that it gives better efficiency which results in smaller standard error and greater statistical power.

The textbooks of panel analysis such as Wooldridge (2002) or Baltagi (2008) explain the differences between the two techniques using a slightly complicated formula. A simpler and more applied/practical approach to explain this is adopted here. It is recognised that the details go far beyond this approach, and the mentioned references are appropriate for such details.

5.4.2.3 Differences between FE and RE (specification)

In terms of model speciation, the difference between the FEM and the REM lies in the interpretation of unobserved effects. The FEM places the unobserved effects as a component of intercept terms, by assigning individual (area) specific intercept, while the REM incorporates these effects in a compound error term, adding error variances to the error term. Both models assume that slope and coefficients are common between individuals.

The following example illustrates the theory behind the two techniques; assuming a basic model as follows:

Equation 5-7

$$y_{it} = \alpha + \beta X_{it} + \varepsilon_{it}$$

where:
y_{it} = Dependent variable
α = Intercept term
β = Vector of coefficients for predictor variables
X_{it} = Vector of including (K) predictor variables
ε_{it} = The error terms
i = Represent individual (area) , 1, 2,..., N
t = Time period, 1, 2,..., T

In panel data analysis, the error term has two components that both act differently. On top of the random error for each observation, which is always used in the basic model (ε_{it}), there is another error component that accounts only for unobserved effects in the panel data and can be donated as (u_i).

In the Fixed Effect Model (FEM), the functional form will be as follows:

Equation 5-8

$$y_{it} = (\alpha + u_i) + \beta X_{it} + \varepsilon_{it}$$

Where u_i is individual (area) specific effects, due to the omitted time-invariant variable, and can be correlated with X_{it}. If the time-specific variable is added to the model, the form will be:

Equation 5-9

$$y_{it} = (\alpha + u_i) + \beta X_{it} + \delta\gamma_t + \varepsilon_{it}$$

Where γ_t is time-specific variable. Whereas in the Random Effect Model (REM), the form will be as follows:

Equation 5-10

$$y_{it} = \alpha + \beta X_{it} + \delta\gamma_t + (\varepsilon_{it} + u_i)$$

Where u_i is individual (area) specific random element, uncorrelated with X_{it}. Table 5-1 illustrates the main differences between the Fixed and Random Effect models. It can be noticed that the error components, u_i, are added to the intercept in the FEM and added to error term in the REM.

Table 5-1 Summary of the main differences in Fixed and Random Effect models

	Fixed Effect Model	Random Effect Model
Intercept	Varying across groups and/or times	Constant
Error variances	Constant	Varying across groups and/or times
Slopes	Constant	Constant
Estimation	LSDV, within effect method	GLS
Hypothesis test	Incremental F test	Breusch-Pagan LM test

Source: (Park, 2009)

The fixed effect model is estimated more efficiently by the least squares dummy variable (LSDV). Other estimation methods include "Within Effect" and "Between Effect", but they are less efficient than LSDV (Park, 2009). The random effect model, on the other hand, requires more complex estimation methods. If variance structure among groups, (Ω) matrix, is known, then generalized least squares (GLS) can be used as an estimation method. However, in most cases the (Ω) matrix is unknown and feasible generalized least squares (FGLS) is the efficient alternative method. The FGLS method takes into account the correlation of, both within and between area, error terms (Andersson, 2007). Among many possible estimation methods for FGLS, the maximum likelihood estimator is widely used. Other methods include the Wallace and Hussain (1969), the Wansbeek and Kapteyn (1989) and the Swamy and Arora (1972) methods, see Baltagi and Chang (1994) and Baltagi *et al*. (2002) for in-depth details.

5.4.2.4 Tests

After the fixed and random effect models are estimated they should be tested individually, to ensure their assumptions are met, and against each other, to decide which model controls unobserved heterogeneity more efficiently. The (incremental) F test is used to test for any fixed effect across individuals (areas). The null hypothesis of the test is that all constant terms for different individuals (areas) are equal to zero, and there is no area-specific effect. If the null hypothesis is rejected we can confirm that there are fixed effect in the panel data and FEM is superior over Pooled Ordinary Least Square (POLS) model.

Random effect are tested by Lagrange Multiplier (LM) test developed by Breusch and Pagan (1980). In the one-way random group effect model, the test has a null hypothesis that the group specific error variances are zero (H_0: σ_u^2 =0), (Park, 2009). If the null hypothesis is not rejected then (POLS) model can estimate unbiased and efficient model parameters.

Finally, the trade-off between the two models was based on a Hausman test (Hausman 1978). The null hypothesis examined by the test is that the individual effects are uncorrelated with the predictor variables in the model; if the hypothesis is rejected then a fixed effect model is more efficient than a random effect model.

5.5 Model specification

Specification of the demand models used to analyse the bus travel market should be built on a theoretical background but also constrained by research purposes and data availability. The transport demand models observed in the literature show wide diversity of their specifications; see Oum (1989) for in-depth details. The TRL practical guide (*The demand for public transport*) does not set strict rules, it states that

> "There is no general rule or consensus among researchers in the field as to either the functional form of the demand equation or the variables which should be used to obtain the best explanation of the demand. These questions have to be resolved by empirical analysis, i.e. by testing various forms and specifications against observed behaviour using statistical techniques". (Balcombe *et al*., 2004, p39)

We will adopt this approach by which different model specifications (restricted by data nature and availability) will be estimated and the model that gives the most robust and plausible estimates will be considered.

5.5.1 What explanatory variables should be included

Various model specifications are considered before settling on the final specification. The initial specification of the demand model defines demand (measured in bus passenger trip per capita) as a function of service quality, costs of travel of bus and alternative competing mode (private car), disposal income, car ownership and historical level of demand itself. Service quality is expressed by aggregate proxy of bus kilometres weighted by population. Bus cost as perceived by user is represented by total revenue receipt, excluding Concessionary Fare Reimbursement (CFR), per passenger journey. The main alternative mode available for local bus users is assumed to be private car. The cost of travelling by car is reflected by the motoring cost index for Great Britain, comprised of car ownership and running costs adjusted for general inflation using the GDP deflator.

The United Kingdom Gross Domestic Household Income (GDHI), normalised by population to obtain per person indicator, is used as a measure of disposable personal income. Car ownership is estimated as the number of private cars per capita. As was done to the service quality variable, the dependent variable is normalised by population to achieve better proxy of demand and account for different population density in different regions, hence changes in population is also accounted for in the model. Also, a lagged dependent variable is included to achieve dynamic specification; this will be discussed in further detail later. All monetary variables are converted to 2008/9 prices. This results in the following initial specification of the dynamic model:

Equation 5-11

$$Q_t = f(F_t, VKM_t, I_t, CC_t, CO_t, Q_{t-1}),$$

where,

Q_t = Total number of bus passenger journey per capita in year t (passenger journey per capita);
F_t = Revenue from bus user per bus trip in year t (pence per passenger journey);
VKM_t = Total vehicle kilometres per head in year t (Km per capita);
I_t = Gross Disposable Household Income (GDHI) per capita in UK (£ per capita per year, real);
CC_t = Private car costs, motoring cost index (1980 = 100, real);
CO_t = Ownership of private car, number of cars per capita (cars per capita);
Q_{t-1} = Total number of bus passengers journey in year t-1 (passenger journey).

In addition to the previous determinant of the bus demand, a deregulation dummy variable is included in the model to capture the impacts of deregulation policy in the area outside London.

Another set of dummy variables are included to account for the unobserved effects between different regional areas from which the data were collected. These areas are English Metropolitan areas, London, English shires, Wales and Scotland. The underlying methodology employed by any dummy variables is that it assigns value of one for all observations that meet the condition (e.g. area), and zero otherwise. Thus for the set of area dummy variables the perfect collinearity problem arises. To avoid that one dummy variable for one of the included areas must be omitted and this area will be used as the reference area (Dargay and Hanly, 2007). English shires will be the reference area in this model.

Finally, a time trend variable is also specified in the model equation to account for the sustained downward trend observed in the bus demand[27]. Thus, the final specification of the dynamic model is as follows:

$Q_t = f(F_t, VKM_t, I_t, CC_t, CO_t, Q_{t-1},$ *Deregulation dummy, regional dummies, Time trend* $)$

5.6 Functional form

In earlier transport studies, the common form employed in modelling aggregate models were log-linear (or double log) and linear forms, and to a lesser extent the semi-log form. The linear functional form has been widely applied in the 1980s, whereas double log form is the most frequently used in more recent studies (e.g. Romilly, 2001; FitzRoy and Smith, 1999; Matas, 2004; Abrate *et al.*, 2009). Some studies, such as Bresson *et al*. (2004) and Dargay and Hanly (2002), utilised a semi-log form.

The double log form is superior to the alternative forms in terms of simplicity of elasticity interpretations. Demand elasticities with respect to each explanatory variable are easily interpreted from the model as they simply equal the coefficient of the variable. Another advantage is its ability to model a non-linear relation between the dependent and independent variables, given that it uses the logarithm values of the variables rather than the absolute values to define the linear relationship. This feature allows for modelling of a more complicated relationship compared to other forms (Clements *et al*., 1994; Oum, 1989).

The downside of this functional form is that it employs an assumption of constant demand elasticity with respect to each variable; the elasticity does not change across different values of the variable. The linear functional form is only superior here; elasticity is variable and dependent on the variable's values but it fails to capture non-linear effects whenever it appears between the demand and any variable included in the model (Oum, 1989). Bearing in mind that obtaining direct demand elasticities with respect to fare, service quality and income are desirable in any model specification, the double log form best serves this feature.

[27] Furthermore, Dargay and Clark (2012) justify the inclusion of the time trend in transport demand models as "it allows for any changes in travel over time that are unrelated to the other explanatory variables included in the model".

5.7 Other modelling issues and priorities

Choosing the right methodological approach for the purpose of estimating local bus demand model using panel data is not straightforward. In the following paragraphs, we will highlight these issues in some detail.

As controlling for heterogeneity is important in empirical research using panel datasets, fixed effect (FE) and random effect (RE) models appropriately handle this estimation issue (Baltagi and Pesaran, 2007). Nevertheless, these are basic panel models and should be considered a starting point for our model selection procedure rather than as final models.

Besides the heterogeneity, models estimated using panel dataset may be accompanied by compound error structures. The OLS estimator assumes spherical errors in any estimated equation. The non-spherical errors (heteroscedasticity, serial correlation, and cross-sectional dependence or contemporaneous correlation), if present in the dataset, may cause inefficient estimation of the coefficients and biased standard errors (but not biased estimates of the coefficients). Therefore, these issues should be investigated using proper post-estimation tests, and if detected, they should be corrected using alternative estimator(s). It should be noted that standard tests applied for normal time-series models cannot be applied here and modified versions capable to handle panel datasets should be used (furthermore, in our case it should also be suitable for an unbalanced panel).

We also recognised the argument that the dynamic panel models (including lagged dependent variable) may not be efficiently estimated by fixed or random effect. Instead, Difference Generalized Method of Moments (Arellano and Bond, 1991) or System GMM estimators developed by Blundell and Bond (1998) could be used.

However, both estimators are valid and designed for panel datasets that have a large number of cross-sectional units ($N \rightarrow \infty$) and small number of observation over time (T), otherwise, this would lead to an over-identification problem[28]. Also, Bruno (2005) concluded that

> "A weakness of IV and GMM estimators is that their properties hold for N large, so they can be severely biased and imprecise in panel data with a small number of cross-sectional units. […]. On the other hand, earlier Monte Carlo studies (Arellano and Bond (1991), Kiviet (1995) and Judson and Owen (1999)) demonstrate that LSDV although inconsistent has a relatively small variance compared to IV and GMM estimators."

[28] The results of the Sargan test of overidentifying restrictions performed after the model estimation using Difference GMM and System GMM estimators confirmed this issue.

Beck and Katz (2004)[29] concluded that

> "Monte Carlo analysis shows that for typical TSCS data that fixed effect with a lagged dependent variable [OLS or PCSE with Fixed Effect] performs about as well as the much more complicated Kiviet estimator [IV estimator], and better than the Anderson-Hsiao estimator (both designed for panels)."

An alternative estimator that is able to estimate the unbiased dynamic model is the corrected LSDV estimator (LSDVC) developed by Kiviet (1995) and Bun and Kiviet (2003). Based on the Monte Carlo experiment, Judson and Owen (1999) proved that the corrected LSDV estimator is more efficient to both GMM estimators when N is small. Bruno (2005) extended the LSDVC method to unbalanced panel dataset.

Nevertheless, Judson and Owen (1999) concluded, based on their Monte Carlo analysis, that LSDV (which is equivalent to OLS with fixed effect) is recommended in a case T=30 and the panel dataset is unbalanced, see Table 5-2. This is exactly the case in our dataset (unbalanced and T=30). Thus, our premises are that the basic dynamic model estimated using OLS with fixed effect method is unbiased[30].

Table 5-2 Summary of recommendations of Judson and Owen (1999) based on Monte Carlo experiment

	Time dimension of the panel		
	T ≤ 10	**T = 20**	**T = 30**
Balanced panel	LSDVC	LSDVC	LSDVC
Unbalanced panel	GMM	GMM or AH	LSDV*

AH=Anderson-Hsiao (IV) estimator. * This meets our panel dataset dimension.

Another important aspect that should be borne in mind in our methodological approach is that there is some distinction between conventional panel dataset and TSCS (time series cross section) employed in this research. The former usually involves many cross sectional units (N) and a very small number of observations over time (T), whilst the latter is patterned by small (N) and Large (T). Such a difference has important implications in practice. Most estimators and tests were developed for panel data; as most panel data had large N (e.g. National Travel Surveys or Household Surveys).

As more data is collected over time, new estimators were modified (or developed) for TSCS. Furthermore, our datasets are unbalanced (gaps caused by missing data for specific years or regions). This causes some problems as some estimators/tests do not handle such gaps. Fortunately, many

[29] As well as Beck and Katz (2011).
[30] All of the above dynamic panel model estimators have been used to re-estimate our basic model that is estimated using LSDV [OLS with FEs], however, the outputs are omitted due to space limitations.

studies recently shed light on this issue and recent update of some statistical software packages involve modified methods extended to allow for such gaps in the panel datasets.

There is a strong case for re-estimating the models using panel data, with one model including London and another model excluding it. London should be treated with some caution (for example London is not deregulated, has a well-established metro system, and has a strict car policy unlike other regional areas). Why London was included in the first place? There are many reasons for this. The inclusion is justified to increase the number of observations as well the need to model the London demand for comparison purposes (with the deregulated areas).

Furthermore, the differences (the observed and unobserved effects) should be correctly treated in the above model specifications. The observed effects, namely the different bus policies, should be controlled by the deregulation dummy variable specified in the models; zero value is assigned to London. The unobserved effects, such as differences in parking availability or the availability of efficient competing mode (metro) should be treated by the applied estimation methods (Fixed or Random Effect).

5.7.1 Modeling Priorities

Given the panel estimation complexity explained above, modelling priorities should be set before starting the model estimation process. First, we focus on the proper specification of the model based on theoretical background and data availability, unworried about the error structure in this stage. Second, we control the variance by specifying dummy variables and unit effects, if justified, in an attempt to offset the variance to the structural term of the model rather than leaving that to be explained by the error terms. In other words, if we understand the data that was employed to achieve our research objectives, then we may better explain the variations in the basic part of the model, for example by using dummies and/or panel effects, instead of leaving the error term to explain a large portion of these variations. At this point we should be confident that our model does not suffer from an under-specification problem as this poses the most serious danger to obtaining an accurate model inference. Third, only at this stage should we deal with any non-spherical error structures in our model, which may cause inefficiencies but unbiased coefficients (βs).

Following the proposed modelling priorities, the estimation of local bus demand model will consist of three stages. First, an estimate of the model using panel datasets and conventional panel estimators (pooled, FE, RE) that account for any heterogeneity that appears in the panel. Then, the structure of the error term will tested, if found to be non-spherical it will be re-estimated using alternative advanced estimators able to correct for these types of errors, such as Feasible Generalised Least Square (FGLS) and Panel Corrected Standard Error (PCSE). This step will involve the application of specific tests to check for heteroscedasticity, cross-sectional dependency and autocorrelation problems.

In all above estimates, static specification of the model will precede the dynamic specification, in order to compare the significance of each specification and better understand our data/demand behaviour. Similarly, in models utilising panel datasets, the panel should include London once and exclude it in another trial. Lastly, the model specification that includes time trend as an explanatory variable trend (hereafter specification 1) will be considered along with similar specifications that exclude this variable (hereafter specification 2).Figure 5-2 summarise model specification and panel dataset utilised during the estimation process.

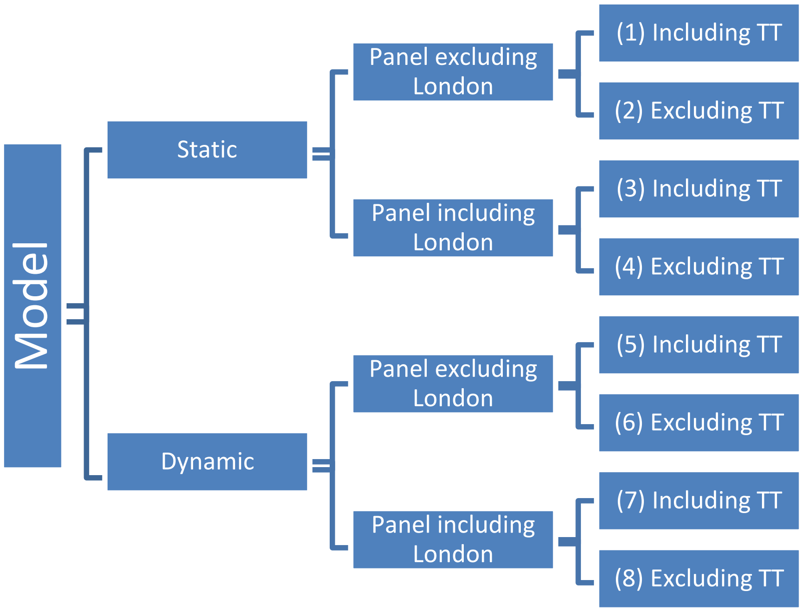


Figure 5-2 Modelling approach

5.8 Estimation of basic model

5.8.1 Introduction

The demand for bus services in Britain is modelled using three different panel estimation techniques; Pooled OLS, one-way Fixed Effect, and one-way Random Effect. The first methodological approach employs pooled OLS regression technique to analyse the panel data. The second and third approaches account for heterogeneity across regional areas to allow for modelling the demand based on within area variations in explanatory variables over time.

Initially, time series regressions were performed using aggregate time series data that covers the whole area of GB (or GB excluding London). The estimated model was statistically poor given the relatively short number of observations. Although annual observations over 30 years seem reasonable and adequate to evaluate the long term impacts of the transport policy, such time span (t=30) may be not long enough to get a robust estimate in perspective of a time series analysis. Given that, it is not surprising that initial estimation of a demand model using time series methods has failed to reveal a robust model. Similar conclusions are drawn for time series model estimations for each individual region when more disaggregated time series representing the five regions are employed, with the exception of London[31].

This issue is common in the literature, for example, Beck and Katz (2004) stated that

> "Given that our time series are fairly short (perhaps 30 or 40 years at most), it is asking a lot of the data to estimate separate dynamic parameters for each unit. Thus, as always, there is a trade-off between parsimony and verisimilitude. The situation is not any different for time series."

Only then, we moved to panel data analysis. For the first series of panel regressions, dataset of area outside London were split to Metropolitan areas and non-metropolitan area to estimate the previously described models. Additionally, a second series of regressions were estimated using panel data combining London's time series to the panel dataset. Again, these initially estimated panel models have not performed well in modelling the actual change in bus demand over the period of study. However, utilising all available disaggregate data for all regional areas of Great Britain have significantly improved the results of the estimated model. Figure 5-3 illustrates the various data sets used during the model estimation process.

[31] The time series analysis failed to result in significant model parameters for individual regions of English Mets, English shires, Scotland, and Wales as divided by published statistics in DfT's bulletins. This is basically because time series data collected for each of these regions covers wide and diverse areas. Metropolitan areas include six large conurbations outside London whilst shires include the rest of smaller cities and rural areas in the country. Scotland and Wales are separate countries which include diverse areas of urban and rural. This diversion may be hard to be included in one single homogeneous time series (for each variable). In contrast, London is homogeneous and relatively small, contiguous and governed by single transport body and policy regime. Thus, time series analysis is possible for London only.

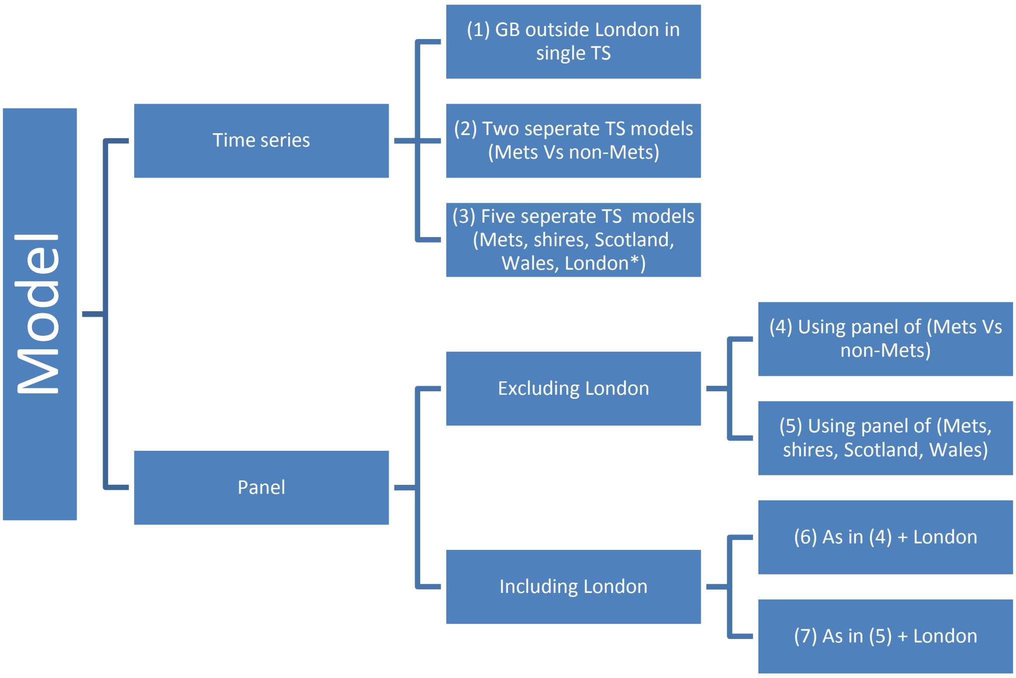


Figure 5-3 Illustration of data sets used in during the model estimation process.
In (2) & (4), non-Mets combines data of English Shires, Wales, and Scotland in single series. Only (5) and (7) are considered in the final panel model estimation stages. * Only the time series model for London gives robust estimate.

The data set used in the final estimation procedures consists of five time series for each variable representing five different regional areas covering Great Britain. The annual observations of dependent and independent variables were collected for former English Metropolitan areas, English shires, London, Scotland and Wales over a time period between 1980 and 2009/10. The results are panel data of almost 145 observations for each variable. However, this is slightly unbalanced panel as a very few years have incomplete sets of observations for specific area. For example, values for the fare variable for Wales in the early 1980s are missing.

The final form of the relationship between the bus patronage, or more specifically the average bus trip per capita, and the explanatory variables are expressed in Equation 5-12 to Equation 5-14. The bus demand variations are explained by two internal variables, namely bus fares (average passenger revenue per trip excluding the Concessionary Care Reimbursements, CFR) and service level (approximated using total bus-vehicle kilometres per head of population). Three other external factors were incorporated in the model; disposable personal income level (Gross Domestic Household Income GDHI per capita), motoring costs (using index of all motoring costs), and car ownership per capita[32]. Other explanatory variables are lagged dependent variable (to allow for dynamic behaviour

[32] Unfortunately, for these three variables, consistent disaggregated data by regions over the whole period of study are not available and instead common aggregate time series for GB are used for all regions. For example, disaggregate car ownership by region is only available since 1992; 12 years are missing resulted in series with

of lagged adjustments) and deregulation policy dummy variable (to account for the impacts of bus deregulation policy). Finally, regional dummy variables is only included in the FE equation to control for area-specific heterogeneity, while this is assumed as a component of error tem (u_i) under RE estimation method.

Pooled OLS:

Equation 5-12

$$Ln\, Q_{it} = \alpha + \beta\, Ln\, F_{it} + \beta\, Ln\, VKM_{it} + \beta\, Ln\, Income_t + \beta\, Ln\, MC_t + \beta\, Ln\, CO_t + \theta\, Ln\, Q_{it-1} + Deregulation\ dummy + \varepsilon_{it}$$

Fixed effect model:

Equation 5-13

$$Ln\, Q_{it} = \alpha_i + \beta\, Ln\, F_{it} + \beta\, Ln\, VKM_{it} + \beta\, Ln\, Income_t + \beta\, Ln\, MC_t + \beta\, Ln\, CO_t + \theta\, Ln\, Q_{it-1} + Deregulation\ dummy + Regional\ dummies_{i-1} + \varepsilon_{it}$$

Random effect model:

Equation 5-14

$$Ln\, Q_{it} = \alpha + \beta\, Ln\, F_{it} + \beta\, Ln\, VKM_{it} + \beta\, Ln\, Income_t + \beta\, Ln\, MC_t + \beta\, Ln\, CO_t + \theta\, Ln\, Q_{it-1} + Deregulation\ dummy + (u_i + \varepsilon_{it})$$

Assuming the same values of income, motoring costs and car ownership for all regional areas included in the model, other explanatory variables (fares, service level) are varying between areas. The intercept is constant for all area except in fixed effect model specification, where the intercept is assumed to be variable across areas. The variable intercepts in FEM are captured by the regional dummy variables; English shires are the reference area in the model. All models are specified in log-linear functional forms, except for dummy variables. The estimation results using double log functional form are shown in the next subsections. Finally, the above speciation is re-estimated after a slight modification to include time trend variable to capture effects on demand that have not been included by other explanatory variables.

5.8.2 Estimation results

Motoring costs and car ownership variables are insignificant[33] under all specifications and were excluded from the results of models. Also, will focus on the results of model specification 2 as we found the inclusion of time trend is very justified (the time trend is very significant under all model

small time dimension. Including such short disaggregate in the panel make it severely unbalanced and consequently affect the model estimation outputs.

[33] Mainly, as the former show very low variations over the period and commonly used for all regions in the panel. Whilst, the disaggregate data of the latter is only available since 1992 and show very high multi-correlation with income variable.

results; hence it explains some trend in the demand not capture by other explanatory variables and should be included as explanatory variable).

5.8.2.1 Static model

For ease of comparison with the dynamic models displayed in the next sections, it is sensible to explore briefly the results of the static models. Based on the results reported in Table 5-3, the corresponding coefficient of the variable is very significant. Thus, there is trend in bus travel over time not described by the other explanatory variables specified in the demand model. All other coefficients are significant (at least at 10% level) with the expected signs. These results apply for all estimation methods (POLS, FE, and RE). The fixed effect method gives the most significant parameters. The preference of using the FE is confirmed by the associated statistical tests; see the lower part of the table. With regards to regional dummy variables, they are estimated under the FE model only and are highly significant for all areas except for Scotland which are significant at the 10% level. However, the main objective of including the regional dummy variables is to control the unobserved effect across the different area rather than explaining the change in demand.

5.8.2.2 Concluding remarks on static models

Overall, the estimated static models have revealed significant results. Yet, these results should be interpreted with caution. In fact, in all estimated models, the error term is suffering from the presence of two types of non-spherical errors (as will be illustrated later, all models show both serial and contemporaneous correlations in their error terms). The presence of these errors poses clear violations of the standard OLS assumptions (Wooldridge 2002; Greene 2003; Baltagi 2008).

One way to correct for serial correlation is to include a lagged dependent variable (LDV). The inclusion of LDV is desirable as this may reduce the problem of serial correlation on one hand whilst also introducing the dynamic behaviour in the model which is intended in this research. Therefore, the same estimation methods will be repeated for a dynamic model (hopefully this would solve the issue) before we move to correct for any non-spherical error, if required, using alternative advanced methods.

5.8.2.3 Dynamic Model

There are many reasons to investigate the dynamic features of the local bus demand as detailed earlier. The estimation results in Table 5-4 show that all coefficients are highly significant. The main finding is that the dynamic behaviour of demand is confirmed as the lagged dependent variable, incorporated in the model as one of the explanatory variables, was significant under all model estimation approaches. The results indicate that the level of bus patronage in previous year, or state dependence, is an important determinant of bus demand during the period of study and positively correlated. Again, the test results suggest the model estimated using the Fixed Effect method as the most efficient model. [Again, to compare between these models three conventional tests are used (Baltagi, 2008), as shown in Table 5-4]

Table 5-3 Static model: estimation results of bus demand models, specification 2 (including time trend).

	Panel (A) – Including London						Panel (B) – Excluding London					
Variable	Pooled (POLS)		**Fixed Effect (FE)**		Random Effect (RE)		Pooled (POLS)		**Fixed Effect (FE)**		Random Effect (RE)	
	Coeff.	sig	Coeff.	Sig	Coeff.	Sig	Coeff.	sig	Coeff.	Sig	Coeff.	Sig
Ln(S)	0.954	***	1.069	***	0.965	***	1.100	***	0.241	***	0.503	***
Ln(I)	-0.798	*	-1.779	***	-1.343	*	-2.199	***	-1.273	***	-0.466	***
Ln(F)	-1.101	***	-0.403	***	-0.621	***	-0.875	***	-0.239	***	-0.532	***
Deregulation DV	-0.466	***	-0.220	***	-0.354	***	-0.184	***	-0.066	***	-0.112	***
Time trend	0.021	*	0.033	***	0.023	**	0.046	***	0.015	***	0.054	**
Regional DV:												
London DV			0.596	***								
Mets DV			0.288	***					0.877	***		
Scotland DV			0.031	0.680					0.722	***		
Wales DV			-0.181	***					-0.018	(0.317)		
Tests:												
F	369		745				244		1948			
R2 (Adj.)	0.937		0.981				0.923		0.994			
Overall			0.852		0.937				0.537		0.927	
-within			0.782		0.693				0.943		0.756	
-between			0.879		0.978				0.969		0.959	
(Incremental) F Test for Fixed Effect	78.06 (0.000)		Rejects POLS in favour of FE				350.00 (0.000)		Rejects POLS in favour of FE			
Breusch Pagan Test for Random Effect	123.25 (0.000)		Rejects POLS in favour of RE				251.66 (0.000)		Rejects POLS in favour of RE			
Hausman Test	350.24 (0.000)		Reject RE in favour of FE				320.04 (0.000)		Reject RE in favour of FE			
AIC			-278.37						-341.72			
BIC			-261.12						-328.60			

Coefficients significant at 1% (***), 5% level (**), 10% (*). Numbers in parentheses are *p* values for test of significance.

Table 5-4 Dynamic models: estimation results of bus demand models, specification 2 (including time trend).

Variable	Panel (A) – Including London									Panel (B) – Excluding London								
	Pooled (POLS)			Fixed Effect (FE)			Random Effect (RE)			Pooled (POLS)			Fixed Effect (FE)			Random Effect (RE)		
	Coeff	Sig.	LT Elasticity	Coeff.	Sig.	LT Elasticity	Coeff.	Sig.	LT Elasticity	Coeff.	Sig.	LT Elasticity	Coeff.	Sig.	LT Elasticity	Coeff.	Sig.	LT Elasticity
$Ln(Q_{t-1})$	.938	***		.872	***		.923	***		.924	***		.695	***		.766	***	
Ln(S)	.057	***	0.92	.145	***	1.14	.109	***	1.42	.083	***	1.09	.114	*	0.37	.094	***	0.40
Ln(I)	-.152	***	-2.45	-.303	***	-2.37	-.201	*	-2.61	-.301	***	-3.96	-.560	***	-1.84	-.411	***	-1.76
Ln(F)	-.068	***	-1.10	-.099	***	-0.78	-.085	***	-1.10	-.063	***	-0.83	-.108	***	-0.35	-.072	***	-0.31
Deregulation DV	-.067	***		-.065	***		-.066	***		-.050	***		-.046	***		-.049	***	
Time trend	.006	***		.009	***		.007	***		.009	***		.011	***		.011	***	
Regional DV:																		
London DV				.039	(.189)													
Mets DV				-.002	(.923)								.196	***				
Scotland DV				-.014	.(615)								.153	**				
Wales DV				-.031	***								-.023	*				
F	7816			4946						4742			3624					
R^2 (Adj.)	.997			.998						.996			.997					
Overall				.997			.997						.997			.997		
-within				.970			.970						.973			.970		
-between				.999			.999						.999			.999		
Durbin-Watson	1.772			1.685						1.967			1.703					
(Incremental) F Test for Fixed Effect				2.67 (0.035)			Rejects POLS & confirm FE						5.56 (0.002)			Rejects POLS & confirm FE		
Breusch Pagan Test for Random Effect				0.04 (0.840)			Rejects RE & confirm POLS						0.00 (0.978)			Rejects RE & confirm POLS		
Hausman Test				11.61 (0.071)			Rejects RE & confirm FE						20.02 (0.003)			Rejects RE & confirm FE		
AIC				-533									-423					
BIC				-513									-404					

Coefficients significant at the 1% (***), 5% (**), 10% (*). Numbers in parentheses are *p* values for test of significance.

5.8.3 Initial findings based on the empirical results of the conventional panel approach

- There is strong evidence of dynamic behaviour of bus demand

The results indicate that the level of bus patronage in previous year, or state dependence, is important determinant of bus demand during the period of study and positively correlated.

- Inclusion of time trend as explanatory variable improves the model

The regression results show that adding time trend significantly improve the model. The coefficient of the added variable is very significant and information criteria (AIC and BIC) support this conclusion. Theoretically, the time trend variable should capture changes in local bus demand that are not explained by other explanatory variables.

- Faster adjustment of demand outside London to changes, and smaller the difference between short and long term elasticities

It can be clearly noticed that there is faster adjustment of demand to change in explanatory variables outside London than within, as indicated by the smaller value of speed of adjustment (θ), equivalent to coefficient of the lagged dependent variable. This was confirmed by the higher short-term elasticities and lower long-term elasticities of demand (with respect to fare and service) when London is excluded from the panel dataset and only deregulated areas are represented[34]. This may be explained by that modal shift from bus to car (the competitive or alternative mode to bus) is easier outside London than within London.

- There is heterogeneity in the panel (area-specific unobserved effects) and the Fixed Effect model is the most suitable specification to control it

In addition to the standard pooled regression, the conventional Fixed and Random Effect methods are used during the model estimation process in order to investigate the issue of panel heterogeneity. There is strong evidence, both statistically and theoretically, that confirm the presence of fixed (area) effects in the panel data sets. Using the proper statistical tests, there is evidence of fixed effect across areas suggested by the incremental (F) test, thus, the pooled regression model is excluded. On the other hand, as there is evidence of correlation between the

[34] In partial adjustment model (PAM), the smaller the value of speed of adjustment (θ), the faster the demand is reaching the long-run equilibrium level (Q^*), and the smaller the difference between short and long term elasticities.

error term and other explanatory variables, the Random Effect model is also rejected. Hence, the Fixed Effect model is the most suitable specification of bus demand model based on the ranges of our data.

One advantage of using the Fixed Effect model in this research is that it controls all unobserved variables that may affect bus use and are variant across areas. There are also other unobserved or unmeasured characteristics (unobserved heterogeneity) which may affect, in some extent, bus patronage and we are not aware of. The FE model is able to control such effects.

Although there is a risk of losing too many degree of freedom to account for different areas when using the FE model, our panel data structure has a longer (T), number of observation over time, and a smaller (N), number of group (regional area) which reduces the risk.

- Motoring costs and car ownership per capita variables are not significant

Any time series or panel data regression depends on the variations of the explanatory variable to estimate predicted values for the dependent variable. However the variable of motoring costs shows little variations over the years. It also has low correlation with bus demand over the period of study. Therefore, no significant effect on bus demand was observed. And hence it was rejected by all models during the estimation process.

Car ownership is highly correlated with one of the explanatory variable (income) whilst disaggregated time series are only available since 1992, causing much shorter time span of this series. Thus, it was not surprising that it was always dropped (due to correlation with income variable) during the model estimation process.

- Deregulation dummy variable

The coefficient of the deregulation policy dummy variable is always found significant and has a negative sign. This indicates that this variable significantly captures the negative impacts of deregulation policy on local bus demand. For example, a coefficient of -0.046 is estimated for this variable as show in Table 5-4. The transformed (unlogged) figure (= 0.955) implies that demand level after bus deregulation is 95.5% of its level before the policy was implemented.

5.8.4 Concluding remark on basic model estimations

The primary aim of this chapter is to estimate a forecasting demand model, which thereafter will be used to predict various scenarios in the local bus travel market to evaluate the longer impacts of deregulation policy. At this stage, we may choose the best estimated model based on the overall test statistics. However, the statistics reported in Table 5-4 may be invalid, as the presence of non-spherical errors or stationarity of the variables have not been investigated yet. As mentioned earlier, these are basic panel models and should be considered as a starting point for our model selection procedure rather than as final models. Given that, the final choice should be made after investigating the error structure in the estimated models. We will focus on fixed-effects model as our previous analysis confirmed the fixed effect in our model.

6. Advanced Model Estimation

6.1 Demand Model

6.1.1 Introduction

There are obviously several other issues in panel modelling that go further than basic coefficient estimation or heterogeneity control. In the current estimation procedure we will examine the issue of non-spherical errors, if any are detected, as they will pose a clear violation of standard OLS assumptions about error structure. Consequently, the interpretation of these models would be invalid, as error structure may bias these estimates (Beck and Katz, 1996). Accordingly, we re-estimated the models using proper estimators that correct this matter appropriately. This clearly improves the coefficient and standard error estimates.

Let us consider the following simplified equation from which our basic model was estimated:

Equation 6-1

$$y_{it} = \beta X_{it} + \varepsilon_{it}$$

where y_{it} is the dependent variable, X_{it} is a vector of the independent variables, β is the coefficient vector, i = 1,…, n is the number of units (area) and t = 1,…, T is the number of observations for unit i. Let us focus here on ε_{it} , which denotes the error term. In ordinary least squares (OLS) regression, the error processes are assumed to have the same variance (homoscedasticity) and are independent of each other (uncorrelated). Only under such an error structure can the OLS be the best linear unbiased estimator (BLUE) (see Baltagi, 2011).

However, pooled time series cross-sectional data generally have complex error structures that violate OLS assumptions. This data commonly suffers from a variety of non-spherical error components, including heteroscedasticity, serial correlation, and cross-sectional correlation. Serial or autocorrelation means that the error term of one year is correlated with that of past (or future) years, within a single unit (area). Contemporaneous correlation (or cross-section dependency), on the other hand, denotes correlation across units (areas) for a specific year. Finally, heteroscedasticity applies in cases when error variations across units (areas) are not constant.

If these problematic error structures are detected and are not appropriately corrected, then the estimated standard errors are inefficient and are possibly biased (see, for example, Hsiao, 2003; Baltagi, 2011). Yet, this does not extend to the estimated model's parameters, which are still consistent. Thus, statistical inference may be affected by such an inefficient but consistent estimate. Baltagi (2011, p. 223) stated that

> " unbiased and consistent, but their standard errors as computed by standard regression packages are biased and inconsistent and lead to misleading inference."

6.1.2 Testing the presence of non-spherical error process

Now, we will apply the proper tests to detect the presence of non-spherical error structure, if any, and then re-estimate the model using a proper estimator to address this matter. Serial correlation is most common when the time dimension (T) of the panel is relatively large. Contemporaneous (error) correlation or cross-sectional dependence has recently received increased attention in studies of panel data estimators (Reed and Ye, 2007). This type of non-spherical error arises from some time-variant factors that affect most units (areas) at the same time. In pooled cross-section time-series data (or panel data), there is a great chance that errors are cross-sectionally dependent (or contemporaneously correlated across units). The presence of group heteroscedasticity is also a possibility.

Three different tests developed or modified to handle panel models were applied to detect the presence of non-spherical error structure. First, following Greene (2003, p. 323), groupwise heteroscedasticity is tested using a modified Wald test applied to the residuals of the fixed effect regression model. Our preferred estimation method, fixed effect (FE) is used to estimate the prior models' presumed homoscedasticity (no heteroscedasticity). To verify such a prior presumption, the null hypothesis of homoscedasticity should be accepted.

In the context of the data utilised in this research, there are many advantages of the test such as:

- The ability to test for groupwise heteroscedasticity in pooled cross-section time-series data (or panel data).
- The test is applicable after the estimation of the fixed effect regression model; fixed effect exist in our data.
- In the sense of small sample properties, the test has high power in the context of fixed effect, with large (T) and small (N) panels; this is similar to the structure of the utilised panel. In fact, we applied a test, implemented by Christopher Baum (2001) in Stata, which has one modification to Greene's formulae to handle an unbalanced panel dataset.

Second, based on Equation 7.76 in Wooldridge (2002, p. 176), we applied the test that David Drukker implemented in Stata to check for the presence of serial correlation in the errors of the panel data models estimated in earlier steps. The test's null hypothesis states that there is no serial correlation. Drukker (2003), based on simulation evidence, proved that the test has good power properties.

Finally, to test for cross-sectional dependence in the residual of the estimated fixed effect regression models, we used the test proposed by Greene (2003, p. 601) and amended by Baum (2011) which calculates the Breusch-Pagan statistic. In the OLS regression, the errors are assumed to be independent from each other. However, with pooled cross-section time-series data (or panel data), there is a great chance that the errors are cross-sectionally dependent (or contemporaneously correlated across units).

Based on the results of the tests applied on the static version of the model, all models suffer from two types of non-spherical errors (both serial and contemporaneous correlation). The positive aspect is that there should be no concerns of groupwise heteroscedasticity in any model (although it was barely rejected when London was included).

The presence of serial correlation justifies the inclusion of a lagged dependent variable (LDV) as one way to remove (or reduce) serial correlation[35]. Fortunately, the inclusion of LDV is simply equivalent to the dynamic model, which is considered in our analysis based on theoretical backgrounds.

Table 6-1 Results of tests applied on residuals of the dynamic model, estimated using fixed effect regression, to detect any non-spherical error structure.

Tests	Panel including London area		Panel excluding London area	
	Statistics	p-value	statistics	p-value
1) Wooldridge test for auto-correlation in panel data[1]	9.16	0.039	2.56	0.036
2) Modified Wald test for groupwise heteroscedasticity in fixed effect regression model[2]	6.13	0.294	2.56	0.635
3) Breusch-Pagan LM test (cross-section dependency or contemporaneous correlation across panels)[3]	10.06	0.435	6.56	0.363
Conclusion	Serial correlation only		Serial correlation only	

(1) H_0: no first-order autocorrelation. (2) H_0: no heteroscedasticity (homoscedasticity). (3) H_0: assume cross-sectional independence.

Moving to the dynamic version of the model, the main finding given by the test statistics presented in Table 6-1 is that the contemporaneous correlation across panels disappears when both LDV and time trend are added as explanatory variables of bus demand[36].

[35] It was suggested that when including the LDV in the equation, the error term will usually be serially independent (see, for example, Beck and Katz, 1996). Thus, the inclusion of LDV is justified theoretically to seek a dynamic specification and statistically to reduce the serial correlation.

To conclude, we examined the presence of any non-spherical error process in our models using the related tests capable of handling unbalanced panel datasets. Solely serial correlation is detected in our preferred estimated models. Therefore, all conventional OLS estimators employed in our estimation procedure are invalid. The OLS method assumes the errors are independent and homoscedastic. Part of these assumptions is violated. Given that, alternative estimators are able to correct the AR(1) process and, in most models, cross-section dependency is required.

6.1.3 The choice of estimator

An estimation procedure correcting solely for serial correlation is less problematic compared to a similar procedure that allows for serial and contemporaneous correlation simultaneously[37]; the latter has been the subject of heated debate between researchers regarding which estimator should be selected when estimating a panel model (see 6.2.3.1). The former may be performed by adopting one of two approaches.

One approach is to include a lagged dependent variable with a conventional OLS estimator. The other approach is to use an estimator that allows for an AR(1) structure in the errors; theoretically, there are no prior conditions to choose between available estimators. The first approach, advocated by Beck and Katz (1996), has been tested earlier (equivalent to the dynamic specification) but failed to correct for such an error process. Therefore, the second approach will be considered by choosing estimator(s) fitting panel (cross-sectional time-series) models where the disturbance follows a first-order autoregressive process. Available estimators include a panel data first-order autoregression estimator (xtregar) that implements the techniques derived from c and Wu (1999), the generalised least squares with AR(1) process (GLS-AR1) and the panel corrected standard error with AR(1) process (PCSE-AR1). It should be noted that the former estimator (xtregar) does not correct for cross-sectional correlation or heteroscedasticity. The main advantage of these estimators is that they permit the use of the fixed effect method while allowing for AR(1) disturbance correction.

[36] But when the time trend variable is not included, there is no change to the conclusion drawn from the static model. A possible interpretation of these results is that panel regression analysis using various areas from the same country is expected to be influenced by similar factors (e.g. policies or economic factors) at particular times. If these effects are not modelled using theory (due to lack of data) or a time dummy (e.g. time trend), then contemporaneous correlation of errors across areas is expected. Roodman (2006) and Reed and Ye (2011) noted that contemporaneous correlation is considerably reduced, but not necessarily removed, when time period fixed effects (which have a similar role to a time trend) are specified in the model.

[37] The error process of the fare model, which will be explained in 6.2.3, shows both types. In that chapter we will discuss the implications of the choice of estimator.

The choice of estimation strategy – OLS over GLS or PCSE – in the presence of only serial correlation is not discussed in detail in the literature. In other words, no specific criteria can be applied to choose between these estimation methods. Therefore, in an attempt to exhaust all possibilities of different parameters' estimates, we decided to apply all of them. Only then may we choose, based on the most plausible results.

6.1.4 Estimation Results

6.1.4.1 Introduction

Based on the results of related tests, we found that the dynamic versions of the model suffer from serial correlation. Therefore, in this section, we re-estimate our earlier models using more advanced estimators, other than standard OLS for panel data that are able to treat the detected non-spherical errors; serial correlation. Again, the estimation strategy requires us to re-apply the same regression models twice; once using panel "A", which includes London, and the second using panel "B", that excludes London.

We will present the results of the dynamic models with AR(1) errors only (with model specification 2, which includes the time-trend variable). The reason is that the dynamic models using specification 1 (which excludes the time trend) still suffer from contemporaneous correlation, even after using advanced estimators accounting for such error structure. The same applies to all static models, regardless of the specifications used. The analysis of these models are moved to the technical appendix.

6.1.4.2 Dynamic models with AR(1) errors - FGLS and PCSE estimators

Two possible alternative estimators are considered. The first estimator is the Panel Corrected Standard Errors (PCSEs) that uses a modified version of ordinary least squares (OLS) that can handle a first-order autoregressive process. In fact, the estimator provides OLS estimates of the coefficients when no autocorrelation is presented, but produces Prais-Winsten regression estimates once autocorrelation is specified; for details see Kmenta (1997, p. 121). The second alternative estimator employs a specific form of generalized least squares (GLS) widely used to account for the issue of first-order autoregressive structure in the error process; namely the feasible generalised least squares (FGLS). In both estimators, regional dummies are included to account for the fixed area effects in the estimated model[38]. These two estimators are more advanced than OLS-AR1 (xtregar) in that both are able to

[38] Again, a dummy for the Shires was dropped as this region is set as a reference for other areas and to avoid perfect collinearity between the regional dummies.

correct for all three types of non-spherical error problems when needed. Only the versions of these estimators, which account for AR(1) error structure, will be considered here.

6.1.4.3 Panel A: including London

The estimation results are shown in Table 6-2. All parameters of the model using the above estimators are very significant at the 1% level and have the expected signs. The R-squared for PCSE is very high (.997); however, no similar goodness of fit results can be obtained for the FGLS.

The estimates of the FGLS and PCSE are identical; the p-values are slightly different. Again, the estimated elasticities are acceptable (although long-run income elasticity is large in absolute). It should be noted that the PCSE corrects for cross-section dependency by default, whereas this is optional in the FGLS. Still, as the considered model imposes no such problem in the error terms, we can see the identical results of these estimators. This also confirms the results of the Breusch-Pagan LM test of independence in the lower part of Table 6-2, which shows the absence of cross-section dependency.

Table 6-2 The dynamic demand model used specification 2 [includes time trend] and panel dataset A [includes London] – using FGLS-AR(1) and PCSE-AR(1) estimators with fixed effect.

Variables	GLS (AR1)			PCSE (AR1)		
	Coeff.	p-value	LR Elasticity	Coeff.	p-value	LR Elasticity
$Ln(Q_{t-1})$	0.842	0.000		0.842	0.000	
Ln(S)	0.179	0.001	1.14	0.180	0.002	1.14
Ln(I)	-0.343	0.005	-2.18	-0.343	0.006	-2.17
Ln(F)	-0.114	0.000	-0.72	-0.114	0.002	-0.72
DD	-0.071	0.000		-0.071	0.000	
TT	0.009	0.000		0.009	0.001	
London DV	0.054	0.088		0.054	0.037	
Mets DV	0.004	0.869		0.004	0.839	
Scot DV	-0.016	0.601		-0.016	0.582	
Wales DV	-0.037	0.004		-0.037	0.005	
Constant	3.066	0.004		3.067	0.005	
R^2				0.997		
Number of obs.	130			130		
No. of groups	5			5		
Rho (ρ)	0.141			0.142		
Modified Wald test*	7.20	0.206				
BP LM test**	12.19	0.273				

* Testing groupwise heteroscedasticity. ** Testing contemporaneous correlation. Note: AIC and BIC information criteria and likelihood-ratio tests are not available if an AR1 autocorrelation structure was specified at estimation

Also, Table 6-2 presents the test statistics of the Modified Wald test for groupwise heteroscedasticity and the Breusch-Pagan LM test of independence (contemporaneous correlation). These tests are applied to re-examine the structure of the error terms of the model after it was re-estimated using the

FGLS. The null hypothesis is accepted in both tests, which shows no such problems exist in the error term. Moreover, the magnitude of the common autoregressive parameters (ρ) estimated by the FGLS and PCSE is very small (.141 and .142, respectively), which indicates that the serial correlation is well treated by these estimators.

In conclusion, the FGLS and PCSE estimators give a very low value for the AR(1) coefficient, which indicates the removal of serial correlation. In this case, the choice is between the FGLS and PCSE. As both have produced identical results, this confirms their consistency and makes the choice of either estimator without any concern.

6.1.4.4 Panel B: excluding London

The same estimation procedure steps have been repeated but this time using the panel dataset after excluding London. Table 6-3 shows the estimation results of both estimators. All parameters of the model using the above estimators are very significant at 1% and have the expected signs, with the exception of the service variable parameter, which is significant at 5%. The estimates of the FGLS and PCSE are identical

The estimated elasticities for the service and fare variables seem lower than conventional figures (e.g. Dargay and Hanley (1999)). The opposite conclusion is drawn for income elasticity. The overall fit of the model is very good. The R-squared, available for PCSE only, is very high (.998). The lower part of Table 6-3 presents the test statistics of the modified Wald test (groupwise heteroscedasticity) and the Breusch-Pagan LM test of independence (contemporaneous correlation). These tests are applied to re-confirm the absence of such a problematic structure in the error terms of the model estimated by the FGLS. The null hypothesis is rejected in both tests, which implies an absence of these problems. Furthermore, the magnitude of the common autoregressive parameters (ρ) estimated by the FGLS and PCSE is very small (.141 and .142, respectively). This suggests the serial correlation has been removed.

In summary, only the FGLS and PCSE estimators give a very low value for the AR(1) coefficient, which indicates the removal of the serial correlation. As both have produced identical results, this means there are no concerns regarding the choice of either estimator.

Table 6-3 The dynamic demand model used specification 2 [includes time trend] and panel dataset B [excludes London] – using FGLS-AR(1) and PCSE-AR(1) estimators with fixed effect.

Variables	GLS (AR1)			PCSE (AR1)		
	Coeff.	p-value	LR Elasticity	Coeff.	p-value	LR Elasticity
$Ln(Q_{t-1})$	0.630	0.000		0.630	0.000	

Ln(S)	0.133	0.032	0.36	0.133	0.039	0.36
Ln(I)	-0.629	0.000	-1.70	-0.629	0.000	-1.70
Ln(F)	-0.124	0.000	-0.34	-0.124	0.001	-0.34
DD	-0.048	0.000		-0.048	0.002	
TT	0.011	0.000		0.011	0.000	
Mets DV	0.247	0.001		0.247	0.000	
Scot DV	0.190	0.007		0.190	0.004	
Wales DV	-0.026	0.042		-0.026	0.046	
R^2				0.998		
Number of obs.	101			101		
Number of groups	4			4		
Rho (ρ)	0.140			0.140		
Modified Wald test	2.17	0.704				
BP LM test**	7.73	0.259				

* Testing groupwise heteroscedasticity ** Testing contemporaneous correlation. Note: AIC and BIC information criteria and likelihood-ratio tests are not available if the AR1 autocorrelation structure was specified at estimation

6.1.4.5 Conclusion on dynamic model estimation results

The estimation procedure correcting for non-spherical errors in the dynamic model has resulted in very significant estimates for the models used in panel A or B. These models differ slightly according to the structure of the panel dataset utilised (inclusion of London or not). But only one should be selected in which its forecast of demands will be used in our cost-benefits analysis. The choice between two models is explained in the next section.

6.1.5 Model choice

In summary, two alternative bus demand models, out of many various specifications, fit the data very well that may be used in our cost-benefit calculations. Both models are properly specified, very significant, and their error terms do not suffer from any non-spherical errors. This section will compare these dynamic models, then discuss the choice of the most appropriate one for this research analysis. Table 6-4 presents the estimation results of these dynamic models.

Table 6-4 Alternative dynamic models of local bus demand.

	Model 1: **Panel A (including London)** PCSE-Fixed Effect			Model 2: **Panel B (excluding London)** PCSE-Fixed Effect		
Variables	Coeff.	p-value	LR Elasticity	Coeff.	p-value	LR Elasticity
$Ln(Q_{t-1})$	0.842	0.000		0.630	0.000	
Ln(S)	0.180	0.002	1.14	0.133	0.039	0.36
Ln(I)	-0.343	0.006	-2.17	-0.629	0.000	-1.70
Ln(F)	-0.114	0.002	-0.72	-0.124	0.001	-0.34
Deregulation dummy	-0.071	0.000		-0.048	0.002	
Time trend	0.009	0.001		0.011	0.000	

London DV	0.054	0.037		
Mets DV	0.004	0.839	0.247	0.000
Scot DV	-0.016	0.582	0.190	0.004
Wales DV	-0.037	0.005	-0.026	0.046
R^2	0.997		0.998	
Number of obs.	130		101	
Number of groups	5		4	
Rho (ρ)	0.142		0.140	

In terms of the calculated elasticities, model 1 is closer to the short and long-term "conventional" values, except for long-term income elasticity, which seems high. Model 2 has lower than expected long-term elasticities for service and fare, but lower elasticity for income. The clear distinction between the estimated short- and long-term elasticities confirms the importance of including the dynamic process in our demand model.

Overall, the estimated fare elasticities seem low; but still fall in the range reported in the literature[39]. There is evidence that, in absolute terms, the fare elasticity is falling over time (the same thing applies to service elasticity). This may be explained by growing number of the concessionary fare payers - as explained below[40].

Data on concessionary passenger journeys are available since 2007/8 from Department for Transport - Bus Statistics. The data indicates that the number of concessionary passenger journeys is about one third of total passenger journeys, see Table 6-5. Those on free fares are unaffected by fare changes and hence this will pull down the market fare elasticity (in absolute terms). Note if the market elasticity is -0.4, the non fare payers have a value of 0 and constitute one third of the market, this might suggest that the adult fare payers have an elasticity of-0.6. Thus, the fare elasticity of fare payers is larger than elasticity estimated in this research. However, the focus of this research is on the aggregate elasticity which represents the impacts of "average fares" (total revenue paid by passenger excluding the concessionary fare reimbursement by trip).

Other attempt to pick up this circumstance in the models developed in this research (e.g. differentiate between free travellers, in the form of passengers on concessionary fares, and fare paying passenger)

[39] For example, Dargay and Hanly (1999) in their report to the Department of the Environment, Transport and Regions on "bus fare elasticities" have reported a low short-term fare elasticity of (-0.13) related to the low fare level in which this elasticity was calculated.

[40] In case of service, it may be explained by the growing market where services are provided for social needs. Since deregulation, two sub markets have been emerged. The most part of the market was run by commercial services, but smaller part of the market was commercially unviable and subsidised services were provided for social needs. However, the number of subsidised bus KM increased over the years as some operators stopped running commercial services in some routes which had to be replaced by subsidised services. These services are not expected to stimulate demand as it run for social need in very low demand routes.

is constrained by the data availability (the number of concessionary trips are available for recent years only whilst the developed models are based on time span extend back to 1980). However, we attempted to include dummy variables that represent the years when concessionary fare scheme was reformed but none of these dummies had statistically significant coefficients indicating that these dummies do not have any additional explanatory power.

Table 6-5 Concessionary passenger journeys as a percentage of total passenger journeys (%).

Year	**London**	**English Mets**	**English Shires**	**Scotland**	**Wales**	**Great Britain**
2007/08	*31*	*34*	*30*	*30*	*41*	***32***
2008/09	*31*	*35*	*33*	*32*	*42*	***33***
2009/10	*32*	*35*	*36*	*33*	*43*	***34***
2010/11	*32*	*36*	*36*	*34*	*43*	***34***

Source: Department for Transport - Bus Statistics, Table BUS0105 (http://www.dft.gov.uk/statistics/series/buses/)

Wheat and Toner (2010) estimated fare elasticities lower than that calculated by Dargay and Hanly (1999)[41]

> "The results differ from those of Dargay and Hanly when the magnitude of the elasticity estimates are compared ... in all cases the revised estimates are lower than those previously estimated."

They explained the difference by the falling fare elasticity over time as follows

> "This perhaps indicates why our results in the previous sections differ from those of Dargay and Hanly; their sample covered the earlier years and so they found a higher fare elasticity. In our sample, the later years have a very low fare elasticity which impacts downwards on a time invariant estimate of the fare elasticity."

Another reason of low fare elasticity estimated in this research is that a longer panel is used (longer time span) compared to previous studies. Wheat and Toner (2010) concluded that
"As the sample length is increased so the fare elasticity and R-squared (measure of model fit) falls. This supports our finding of a falling whole market fare elasticity over time."

[41] Both studies analysed STATS100A data via DfT commission. Dargay and Hanly (1999) had a sample length of 10 years (1987/88 to 1996/97) whilst Wheat and Toner (2010) had extended sample of 18 years (1989/90 to 2006/07).

Table 6-6 Illustration, by Wheat and Toner (2010), of falling elasticities as longer sample periods are used.

Sample start		**1990**	**1990**	**1990**	**1990**	**1990**	**1990**	**1990**	**1990**	**1990**	**1990**	**1990**
Sample End		**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
Fare	SR	-0.57	-0.56	-0.52	-0.46	-0.4	-0.36	-0.34	-0.32	-0.26	-0.19	-0.18
Fare	LR	-0.76	-0.74	-0.69	-0.61	-0.59	-0.57	-0.56	-0.53	-0.47	-0.37	-0.38
Service	SR	0.54	0.55	0.55	0.52	0.49	0.43	0.41	0.36	0.32	0.28	0.27
Service	LR	0.71	0.73	0.72	0.7	0.73	0.69	0.68	0.6	0.57	0.56	0.58

Source: Table 4.6 in Wheat and Toner (2010)

Finally it is worth noting that these empirically estimated elasticities are heavily reliant on the employed data, model specification and spatial aggregation (Balcombe *et al.*, 2004). Abrate *et al.* (2009), among others, emphasised this point and it is very relevant to quote their comments here

> "As remarked in Oum (1989), one of the most striking features of the transportation literature is the wide variety of demand models proposed, which is mostly linked to the choice of aggregation level of the data and to the choice of functional form. Indeed, differences in types of data and in functional specifications are likely to affect empirical results with relevant policy implications, such as elasticity values and traffic forecasts."

This point was also highlighted by Dargay and Hanly (2002)

> "A most striking feature of the reviews is the variation in the elasticities obtained in the individual studies, which is not surprising given the differences in data and methodology used and circumstances considered."

as well as by Dargay and Hanly (1999)

> "There is substantial variation in the estimated elasticities, dependent on the data and fare measures used, the model specification and the level of aggregation. This is to be expected in any empirical study, and all statistical results are surrounded by a degree of uncertainty."

The parameter of lagged dependent variable (LDV) is always significant. This parameter has important implications on the pace of response in demand for changes in its determinants; in other words, how long it will be until these changes will take full effect. The parameter is closer to one than zero, which indicates that the reactions of bus users to changes to main bus demand determinants are slow but build up over the years. This also illustrates the importance of studying the impacts of any changes in these determinantes, e.g. due to policy reforms, not only in the short term but, more importantly, in the longer time horizon, as this is the period in which the full impacts of interventions occur.

The inclusion of London in our panel dataset seems to have the greatest effect on the LDV parameter. This parameter is higher when London is included, which reflects slower demand response to changes in London than in the rest of the country; where demand is more sensitive to changes.[42]

The specified deregulation dummy captures the effects of deregulation policy on demand. The policy has negative impacts on bus patronage. In model 2, the deregulation dummy variable indicates a 4.7% reduction in demand in the short run, and a 12.2% reduction in demand in the long run. These percentages are calculated by taking the exponential value of the deregulation dummy parameter, as the demand (the dependent variable) is in a logarithmic form[43].

Overall, we may employ any of the two models with no theoretical or statistical concerns. However, the model behaves differently when London is included and should be treated with caution[44]. Excluding London may also be justified for comparison purposes, a competitive tendering policy to provide local bus services that apply to London, in contrast to a deregulation policy that is implemented in the rest of the country. In fact, a comparison between the two policies applied simultaneously in GB is intended as part of our cost-benefits analysis.

Also, we used models to forecast demand for year 2010/11, and model 2 (excludes London) is found superior. Therefore, the demand model for London using only time series data are required.

6.1.6 London's time series model

The nature of collected data for London allows for time series analysis rather than panel analysis (as carried in the previous analysis). Many models (using various combinations of possible independent variables as explained earlier) are found to be very significant. Yet, these models are estimated using the simple OLS method, which requires some strict assumptions and need to be tested to ensure that no violations occurred.

The most important violation of these assumptions is the presence of serial correlation (auto-correlation). Regularly, a regression analysis using time series data would give "super-significant"

[42] The coefficient of the lagged dependent variable (0.842) suggests a relatively slow adjustment; 99% of adjustment takes around 27 years (Ln(1-0.99)/Ln(0.842)) – a long adjustment period. When London is excluded from the panel dataset, a relatively faster adjustment is estimated, with 99% of the adjustment occurring within 10 years (Ln (1 - 0.99)/ Ln (0.630)).

[43] In the short run, the level of demand after the implementation policy is 95.3% of the level of pre-deregulation [Exp(-0.048) *100], which indicates a reduction of 4.7% due to deregulation impacts; the percentage in the long run is 87.8% [Exp(-0.048/(1-0.630))] or a reduction of 12.2% due to deregulation impacts.

[44] A similar conclusion of different model behaviour that led to the exclusion of London from the panel dataset is drawn by Toner *et. al* (2010) in their estimation of a cost model. Toner *et. al* (2010) stated that "We used the non-London dataset ... there was some evidence that the models including London behaved differently."

results caused by serial correlation rather than the true relationship between variables. Yet, the estimate is still unbiased despite the incorrect standard errors. In this case, the residuals are predictable rather than random "white noise" (Enders, 2005). Thus, we need to test our models against the presence of serial correlation, and if present, we need to use an estimation technique other than simple OLS that accounts for such an issue.

In fact, the presence of serial correlation is confirmed in the initially estimated models using conventional tests for autocorrelation, namely the most commonly used tests of Durbin Watson (DW) and the Breusch-Godfrey tests.

6.1.6.1 The Cochrane-Orcutt and Prais-Winsten estimators

An alternative estimation technique, to the conventional OLS method that account for the serial correlation issue and estimates correct standard errors is the Cochrane-Orcutt (1949) estimator. The Prais-Winsten (1954) estimator is an alternative that usually gives similar estimation results. The latter is superior to the former, since the former loses some degree of freedom by dropping the first observation when estimating the transformed equation, while the latter does not. In small sample datasets like the one we use, this can be a significant advantage (Stata Corporation, 2009, p. 240). Both estimators use the generalized least squares (GLS) method to estimate the coefficients. For further theoretical details on the two methods see Davidson and MacKinnon (1993). Table 6-7 illustrates the most robust estimated time series model for London.

Table 6-7 Dynamic time-series model for bus demand in London, Prais-Winsten AR(1) regression.

Variable	Coef.	p-values
Ln(Q_{t-1})	0.534	0.000
Ln(S)	0.316	0.055
Ln(I)	-0.448	0.088
Ln(F)	-0.434	0.001
Ln (Motoring costs)	0.472	0.020
Dummy for privatisation process*	-0.064	0.035
Time trend	0.020	0.010
Constant	2.667	0.323
R^2	0.990	
R^2 (Adj.)	0.987	
Number of obs.	30	
Durbin-Watson d-statistic (transformed)	1.838	
Rho	.165	

*Starts from 1991 onwards.

As can be noticed, the estimated parameter for the motoring costs variable and a dummy for the privatisation process in London are significant and explain some variations in the bus demand.

6.1.7 Shortages of our models/modelling approach

It is well recognised that our modelling approach is an attempt to fully exploit the transport data available to this research (the longer time span of the data built up over time compared to previous studies) as well as the recently developed or updated estimation procedures (in particular, extension of time series methods to include panel data analysis). Yet, there are unavoidable deficiencies of our modelling approach related to the type of transport data available.

For example, it is clearly acknowledged that the above estimation procedure assumes that all factors which may effects the bus demand are fully specified in the estimated models, while they are not. These models included bus fares, service levels and income as explanatory variables but do not take account of any measures of car ownership and costs. In the meantime, inclusion of these variables in any models is problematic. Such deficiencies are common in local bus demand studies[45] (Balcombe *et al.*, 2004).

Disaggregated data on car ownership at regional levels were not published before 1992. More importantly, even if such data are available, inclusion of this variable is statistically problematic as it causes a collinearity problem with the income variable (based on data available after 1992). On the other hand, the cost of a rival mode is also statistically problematic. The cost of a private car, the only rival mode, is almost constant over the period of study and shows smaller variations than needed in regression analysis.

Furthermore, to accurately capture the dynamic processes in bus demand, longer transport time series are required. In this regard, it is of interest to quote from the TRL's practical guide that

> "There is an increasing amount of evidence on the dynamic processes that underpin public transport demand but knowledge remains limited. In part, this is due to the limited availability of consistent data sets that cover long time periods." (Balcombe, *et al.*, 2004)

The collection of official data for the local bus industry should be more disaggregated on a smaller scale. Some variables suffer from the high aggregation level of the collected data, for example, the number of bus kilometres, and thus, their quality is questionable. Thus, data are collected at area level, and including detailed information on fare types, network structure/length, and service frequency would be very useful. Also, the use of personal disposal income in this research is constrained by the aggregate nature of the available data since 1980 as provided by the Office for National Statistics

[45] e.g. Dargay and Hanly (1999 and 2002).

(ONS). Based on comprehensive discussion on the availability of more disaggregated data, the ONS strongly warns of using disaggregated data (only available since the early 1990s) with other historical personal income data, as there is a major change in definition which significantly affects the consistency of combining these different sources of income data.

6.2 The Fare Model

6.2.1 Introduction

In order to evaluate the long term impacts of the bus deregulation policy against the basic counterfactual scenario (what would have happened under the abolished regulated regime), both quantities (demand) and prices (fares) will be the key inputs in the cost-benefit methodology. So far, we have estimated a forecasting demand model that can predict demand under this basic counterfactual, whilst the fare may simply be extrapolated based on its historical trend.

However, there is another counterfactual scenario that need to be taken into account based on the arguments of Glaister (1991) and Romilly (2001). For instance, Romilly stated that

> "It can be argued that it is the reduction in subsidy, rather than the lack of competition, which caused fares to increase. If this is the case, then the evaluation of deregulation should allow for the effects of subsidy reduction."

Thus, a separate fare-forecasting model that explicitly includes the effects of subsidy changes is needed. The model will be used to forecast fares assuming the subsidy would have not been reduced and would continue to follow its historical level[46].

6.2.2 Model specification

The bus fare variations can be explained by two principal variables, costs and subsidy. Lower costs give operators greater margins to set their fare level; typically this will encourage lower fares to be set by operators. Conversely, higher subsidies provided by the central government or local authority would lead to lower bus fares. Subsidies can be further divided into two main components; Public Transport Support (PTS) and Concessionary Fare Reimbursements (CFR).

There is a third type of subsidy called Bus Service Operator Grants (BSOG) or Fuel Duty Rebate (FDR). This will not be included in the model as the operators' cost is calculated net of fuel duty reimbursement and hence is not included in their cost calculations.

[46] Extrapolating the inputs under the counterfactual scenario is highlighted in Chapter 8

The initial model specification is as follows:

Equation 6-2

$$Ln(F_{it}) = \propto \ + \beta Ln(C_{it}) + \gamma Ln(PTS_{it}) + \delta Ln(CFR_{it}) + \varepsilon_{it}$$

where:
F_{it} = Revenue from passengers excluding Concessionary Fare Reimbursements per trip (£ per trip, real);
C_{it} = Cost per vehicle kilometres (£ per vkm, real);
PTS_{it} = Public Transport Support per vehicle kilometres (£ per vkm, real);
CFR_{it} = Concessionary Fare Reimbursement per vehicle kilometres (£ per vkm, real);
ε_{it} = Error term

No deregulation policy dummy can be used as the availability of cost data starts from the mid-1980s. The inclusion of a time trend variable will be tested. Also, both the static and dynamic versions of the model will be investigated. In the latter case, a lagged dependent variable will be used in the RHS of the model equation.

6.2.3 Model Estimation

A fare model estimated based on the best data available. The data were collected from different sources (mainly from various versions of the DfT's Public Transport Bulletin Statistics). The disaggregated nature of the data by regional areas allows for estimating the panel model.

After several trials using different combinations, a few robust models were estimated. As the methodology here is broadly similar to the one detailed for the demand model section, we will be very brief when we explain the estimation process.

The corresponding tests have confirmed the superiority of the fixed effect method over the random effect or pooled methods; thus, the latter will be neglected. However, the error process in the estimated fare models shows serial and contemporaneous correlation simultaneously (see Table 6-8), which may have some implications on the choice of estimator as detailed in the next section.

Table 6-8 Results of tests applied on residuals of the dynamic model, estimated using fixed effect regression to detect any non-spherical error structure. Panel excluding London area.

Tests	statistics	p-value
1) Wooldridge test for autocorrelation in panel data[1]	11.70	0.042
2) Modified Wald test for groupwise heteroscedasticity[2]	4.42	0.352
3) BP LM test of cross-section dependency[3]	12.63	0.049
Conclusion	Both serial correlation and cross-section dependency	

(1) H_0: no first-order autocorrelation. (2) H_0: no heteroscedasticity (homoscedasticity). (3) Breusch-Pagan LM test of cross-section dependency or contemporaneous correlation across panels; H_0: assume cross-sectional independence.

6.2.3.1 The choice of estimator

Unlike the demand model, the error process in the estimated fare models shows serial and contemporaneous correlation simultaneously. This is to be expected in empirical work but is, nevertheless, problematic. A Monte Carlo Evaluation tackled this issue in some detail in a seminal study by Reed and Ye (2007), who comment on this particular issue that

> "It is likely that both of these are present in many empirical applications. This is a problem, because most common panel data estimators are unable to simultaneously handle both serial correlation and cross-sectional dependence."

They also added elsewhere, in their paper "which panel data estimator should I use?", that:

> "All of this creates a confusing situation for researchers using panel data in which both serial correlation and cross-sectional dependence may be present. On the one hand, there is a plethora of panel data estimators available from statistical software packages like EViews, LIMDEP, RATS, SAS, Stata, TSP, and others. On the other hand, the finite sample performances of these estimators are not well known. At the end of the day, it is not clear which estimator one should use in a given research situation."

Indeed this creates a dilemma and one should be careful with the choice of the proper estimator. One widely used proposed solution in empirical work is to use the feasible generalised least squares (FGLS) estimator. This estimation approach was developed by Parks (1967). Hundreds of papers in the literature have cited Parks (1967). The estimator is both consistent and asymptotically efficient. Nevertheless, to obtain accurate estimates of the parameters, the FGLS (Parks) estimator may be implemented only when the number of time periods (T) is larger than the number of cross-sectional units (N), T>N. This condition does not pose any problem as this is already the case in our employed panel dataset structure. On the other hand, in finite samples, the FGLS (Parks) estimator is criticised by Beck and Katz (1995) for producing unreliable standard error estimates. This criticism opens the door for finding an alternative estimator that may perform better in finite samples.

The only alternative estimator that accounts for both cross-sectional and serial correlation is the panel-corrected standard error (PCSE) estimator. The two-step estimator proposed by Beck and Katz (1995) themselves is argued to produce reliable standard error without any loss in its efficiency compared to its FGLS counterpart. Therefore, the PCSE estimator has become very popular in recent research.

Still, the advantages of Beck and Katz's PCSE estimator over Park's FGLS estimator, in the presence of cross-sectional and serial correlation, do not hold in some circumstances; see Chen *et al*. (2009).

Given the difficulty of choosing between the two estimators, we rely heavily on the work by Reed and Ye (2011).[47] One of the main findings of their experiments is that performance of estimators varies based on the criteria being used. The researcher is facing a trade-off between the estimator's efficiency and the accuracy of its estimated confidence intervals, as no estimator performs well in both criteria. Thus, they recommend the use of the FGLS (Parks) estimator if $T/N \geq 1.5$ when efficiency is the primary concern. Whereas, Beck and Katz's (1995) PCSE estimator is recommended if constructing accurate confidence intervals, and a low autoregressive coefficient (ρ), less than 0.3, is more important.

Now we need to convey these recommendations to this study. The FGLS (Parks) estimator is very attractive in terms of efficiency, as the condition that $T/N \geq 1.5$ is applicable to the utilised panel dataset. Yet, it is not unreasonable to use the PCSE estimator because it is also recommended on the basis of constructing accurate confident intervals and a low autoregressive coefficient (ρ). We therefore estimate the fare model using the Feasible Generalised Linear Squares (FGLS) estimator as well as the panel-corrected standard errors (PCSE) estimator. This should obtain efficient estimates and reliable standard errors in the presence of cross-sectional and serial correlations in the disturbances. The results of these estimators will be compared later. By doing so, we assure that the estimated parameters are not incorrectly reported as being significant.

6.2.3.2 Dynamic Specification

To ensure consistency with the demand model, the fare model is estimated using the panel that excludes London. Also, we will focus on the results of the advanced estimator, namely Panel Corrected Standard Error (PCSE)[48] with fixed effect included in the model specification, rather than the OLS counterparts, as spherical-error is indicated by the corresponding tests that the OLS does not account for.

The preferred model specification is as follows:

Equation 6-3

$$Ln(F_{it}) = \propto + \beta_1 \, \mathrm{Ln}(F_{it}) + \beta_2 \, LnC_{it} + \beta_3 \, Ln(PTS_{it} + CFR_{it}) + \beta_4 \, TT_t + \beta_5 \, RDV_i + \varepsilon_{it}$$

[47] The attractiveness of Reed and Ye's (2011) study to this research is that their analysis focuses on evaluating the performance of various panel data estimators in the presence of both serial and cross-sectional correlations. Additionally, it emphasises fixed effects models where the employed panel data have N < 100 and T=10-25. It also draws its set of panel data estimators mainly implemented in a Stata statistical software package. All these conditions applied to our analysis.

[48] The alternative FGLS estimator gives identical results.

Where:
F_{it} = Cost per vehicle kilometres
F_{it-1} = Lagged dependent variable
C_{it} = Cost per vehicle kilometres
PTS_{it} = Public Transport Support per vehicle kilometres
CFR_{it} = Concessionary Fare Reimbursement per vehicle kilometres
TT_t = Linear time trend, t=1,2,..etc.
RDV_i = Regional dummy variables.
ε_{it} = Error term

Table 6-9 shows the results. It can be observed that both subsidy components have to be combined in a single variable to estimate a significant model.

Table 6-9 Dynamic model results using the PCSE estimator that includes fixed effect.

Variables	**Panel excluding London*** PCSE (AR1)- Fixed		
	Coeff.	p-value	LR Elasticity
Ln(lagged fare)	0.591	0.000	
Ln(cost per VKM)	0.189	0.03	0.466
Ln(SUB per VKM)*	-.180	0.000	-0.442
TT	0.009	0.000	
Mets DV	-0.107	0.002	
Scot DV	-0.109	0.000	
Wales DV	-0.048	0.036	
Constant	-0.450	0.000	
R2	0.977		
Number of obs.	89		
Number of groups	4		
Rho	0.130		

* Preferred model. **SUB = combining both type of subsidies (CFR & PTS) per VKM in a single variable.

6.2.3.3 London Model

As the time series model is estimated using the Prais-Winsten estimator[49] to account for serial correlation detected in the preliminary step, the cost variable was found to be insignificant and dropped from the model equation, see Table 6-10.

Table 6-10 Estimation results of the time series fare model for London, using the Prais-Winsten estimator.

Variables	Preferred model		
	Coeff.	p-value	LR Elasticity

[49] The Prais-Winsten estimator is highlighted in 1.1.6.1.

Ln(lagged fare)	0.690	0.000	
Ln(CFR per VKM)	-0.262707	0.033	-0.85018
Ln(PTS per VKM)	-0.012932	0.024	-0.04185
TT	-0.004929	0.027	
Constant	-0.429749	0.000	
Adj. R2	0.831		
Number of obs.	24		
DW (transformed)	1.8489		
Rho	0.08667		

6.3 The Cost Model

6.3.1 Introduction

6.3.1.1 Why modelling bus costs

Bearing in mind that the aim of this research is to evaluate the long-term impacts of deregulation policy, one of the premises made by the authors of the White Paper in 1984 to advocate deregulation of the local bus industry was that it would substantially reduce costs (see Beesley and Glaister (1985a)). Thus, it is necessary to understand the cost structure of the local bus market in GB in order to determine to what extent the policy has achieved its objective [and to what extent this should be (purely) attributed to the observed policy or to other external factor(s)]. This need was stressed by Berechman (1983) as follows

> "Regulatory and pricing policies, which are introduced to enhance efficiency and quality, by and large fail to do so and, in fact, are viewed as having destructive effect on the provision of services. It is, therefore, most important to understand the economic structure of bus transport, so that the effect of public policies can be evaluated."

Also, there is a strong argument by White (1990) and Mackie *et al.* (1995) emphasising that a great part of cost reductions accompanying the implementation of the bus deregulation policy was caused by exogenous (external) factors. White (1990) stressed that the high unemployment rate and diesel prices in the late 1980s played a major role in the observed cost reductions. Hence, the fall in costs should be attributed to these factors rather than solely to the deregulation policy. White argued that

> "... part of the reduction in unit operating costs was due to the fall in unit fuel costs and the lower earnings of staff. The former is wholly exogenous to deregulation. The second is associated with deregulation, but only to the extent that changes in the bus industry enabled it

> to take advantage of changes in the labour market caused by other factors (such as high unemployment)".

Determining a counterfactual scenario (what would have happened in the absence of policy intervention) through the application of a cost model is necessary to evaluate how the observed policy has impacted this side. A cost model would be developed to assess the extension of pre-deregulation trends in wage rates and staff productivity and to isolate the impact of variable fuel prices.

Regarding the above-mentioned issues, the operating cost per bus kilometre rose considerably in the second decade since deregulating the market, between 1995/6 and 2005/6 (DfT,2006c). This has been parallel with the rapid growth in wage rates and fuel prices (CIT, 2007; Competition Commission, 2011).

This, on the one hand, supports White's argument (larger part of reductions caused wholly or partly by factors exogenous to deregulation). On the other hand, it raises some doubts about the success of the deregulation policy in achieving one of its main long term objectives: to enhance the productivity and quality of bus services. Berechman (1983) defines poor public transport as "produced inefficiently, and requires increasing subsidies".

This raised some concerns among experts in the field and stimulated some investigation of the main sources of cost increases. The recent study by the TAS carried out for the Commission for Integrated Transport (CIT, 2007) has highlighted this point that

> "Above inflation cost increases in the bus industry have been of some concern for a few years. Operators are seeing decreasing profit margins, local authorities are faced with further deregistration of services and increasing tender prices, while the passenger faces more frequent and significant fare increases."

Yet, the cost level is still about 30% below the pre-deregulation level. Also, the increasing trends in costs and subsidies observed outside London were also reported within London where a different regulatory system was adopted.

Accordingly, our cost analysis would seek to investigate this issue (as much as the published data allows for) in an attempt to isolate the impacts of these exogenous factors from the pure policy impacts. In order to fully isolate the different impacts (and to be able to give clearer suggestions of future policy options for the bus services), it is important to model the compound and interrelated factors that govern the operating costs of bus services in GB.

Given that a cost model utilising all available data and incorporating every possible factor is developed

1. To assess the extension of pre-deregulation trends in wage rates and productivity and;

2. To isolate the impact of changes in fuel prices.

6.3.1.2 Trends by area

As Figure 6-1 shows, a clear decline in unit costs can be observed throughout the country since the mid-1980s, starting concurrently with the policy interventions and continuing until the mid-1990s, after which there were some increases. Sharper increases have followed in recent years. These above-inflation cost increases have been of some concern as we suggested earlier. Comparing the regulated area of London to other deregulated areas, a similar trend is observed, although the increases have been more severe in London.

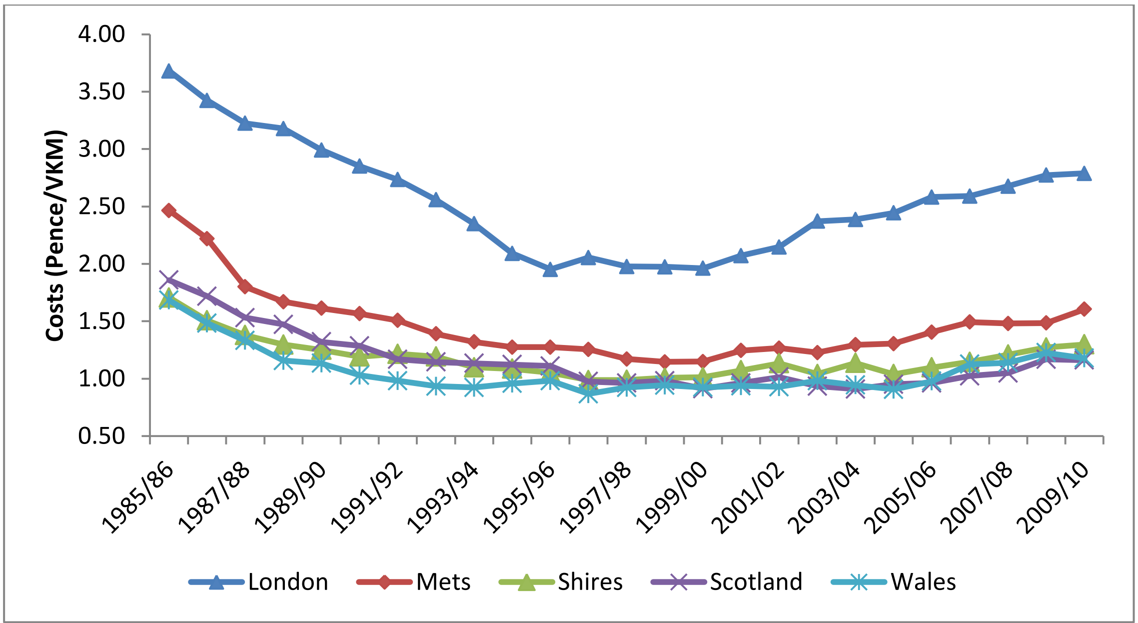


Figure 6-1 Trends in cost per vehicle kilometres in different areas of the country since deregulation, 2009/10 prices.

Source: Public Transport Statistics Bulletin (various years).

Yet, there are some variations between regions as higher cost reductions were observed during the first decade in larger cities (English Metropolitan areas and London) than in rural areas, as illustrated in Figure 6-2. This was caused mainly by the larger potential capacity to reduce cost in large cities as the trends started from a higher base level[50] (refer to Figure 6-1 again). A smaller, but very significant percentage of cost reductions was observed elsewhere in the country. However, the largest increases during the second decade have been also observed in the largest areas.

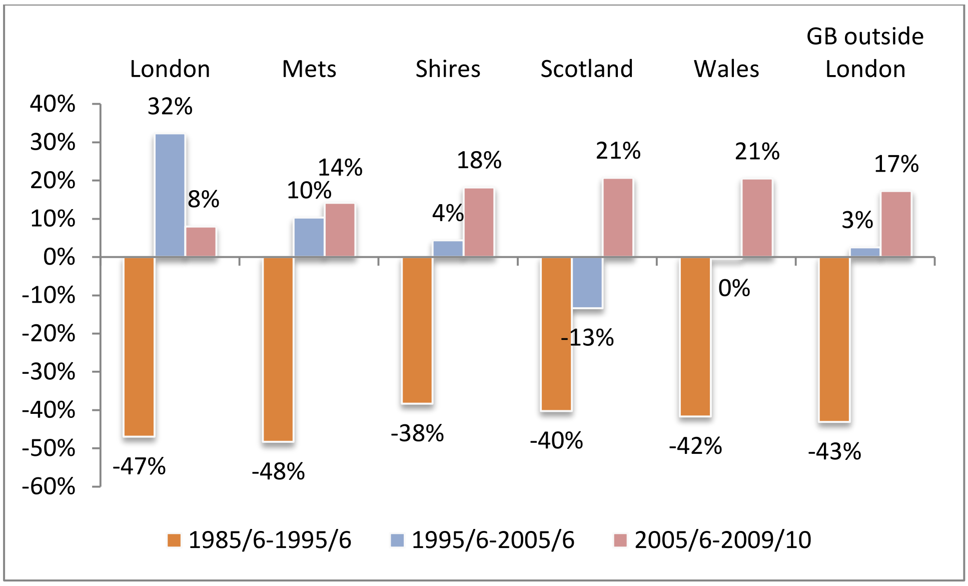


Figure 6-2. Percentage change in costs in different areas of the country.
Source: author's calculations.

Taking the entire period since the policy interventions, the percentage change in cost per vehicle kilometres across areas is around -30%, as predicted by the White Paper in 1984. This would indicate clear success of the deregulation policy if the observed reductions were attributed to it. Again, the extent to which fuel prices and labour rents in the greater general market have contributed to that reductions in costs needs to be investigated.

The opposite conclusion is drawn when the trend in cost per passenger trip is considered[51] (see Figure 6-3). In fact, this cost increased in all deregulated areas as the sharp drop in total number of bus trips offset any gains in total cost reductions. Conversely, a positive outcome was observed in London, which adopted a competitive tendering policy. Bus cost per passenger trip has maintained the same reduction (of 30%) as that which occurred in the cost per vehicle-km.

[50] Generally, higher costs per vehicle kilometres are always observed in large cities. These costs are driven by the longer period of demand peak and low speed and delay caused by traffic congestion in these areas, which require extra services to maintain acceptable frequency.
[51] As passenger trips were declining over the period, while VKM was increasing overall.

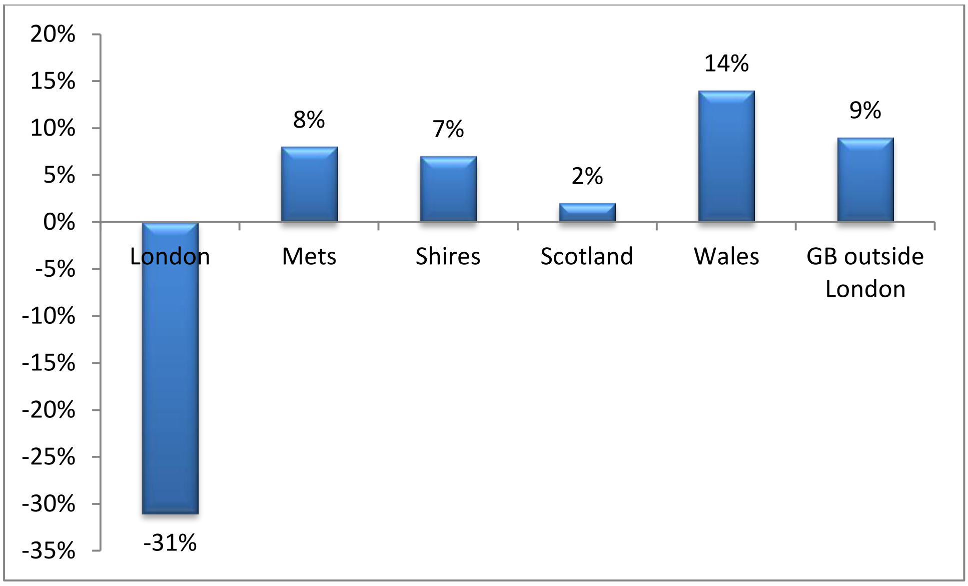


Figure 6-3 Percentage change in costs per passenger trip in different areas of the country since policy changes (1985/6-2009/10).

6.3.1.3 Source of reduction

Based on the above discussion, and as detailed in the literature review, it is very clear that the decline in wages and fuel prices along with increasing staff productivity (through efficient working practices and reduced number of administration and maintenance staff) are the larger factors that cause of such reductions in operating costs.

Wages and staff productivity, in particular, are the most influential components of cost structure in the local bus industry in GB. Labour costs account for about 70% of total costs (CIT, 2007). Thus, it is not surprising that variations in labour costs significantly shaped the trend in operating costs. The bus industry was and still is a heavily “labour-intensive” industry (see Figure 6-4 and Figure 6-5).

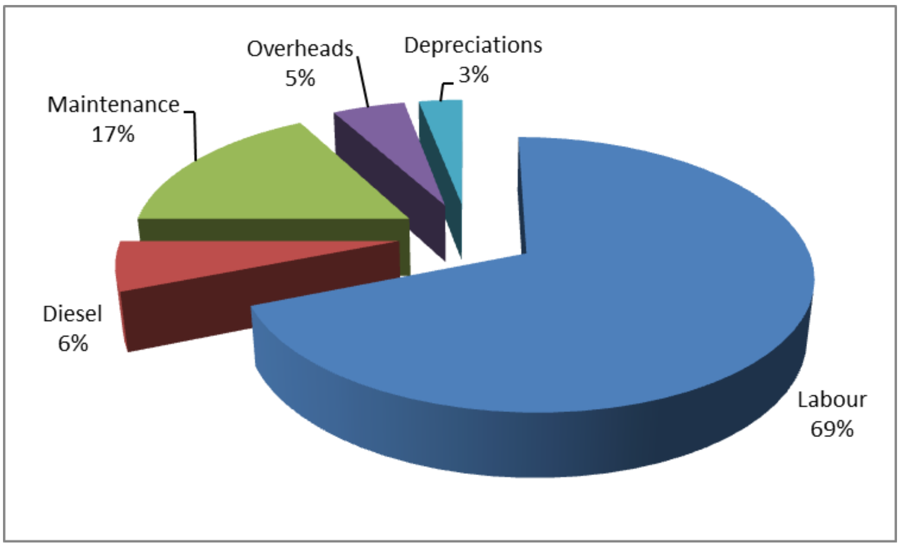


Figure 6-4 Bus cost structure in 1978, National Bus Company (NBC).

Source – National Bus Company Annual Report for 1978.

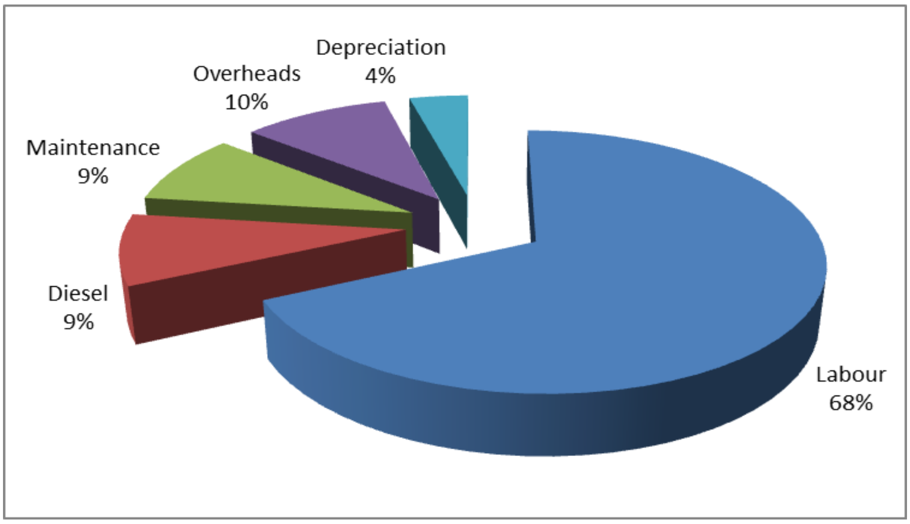


Figure 6-5 Bus cost structure, 2006.

Source: Bus Industry Monitor 2006.

In fact, the local bus is the most labour-intensive transport mode in the UK, as can be seen in Figure 6-6.

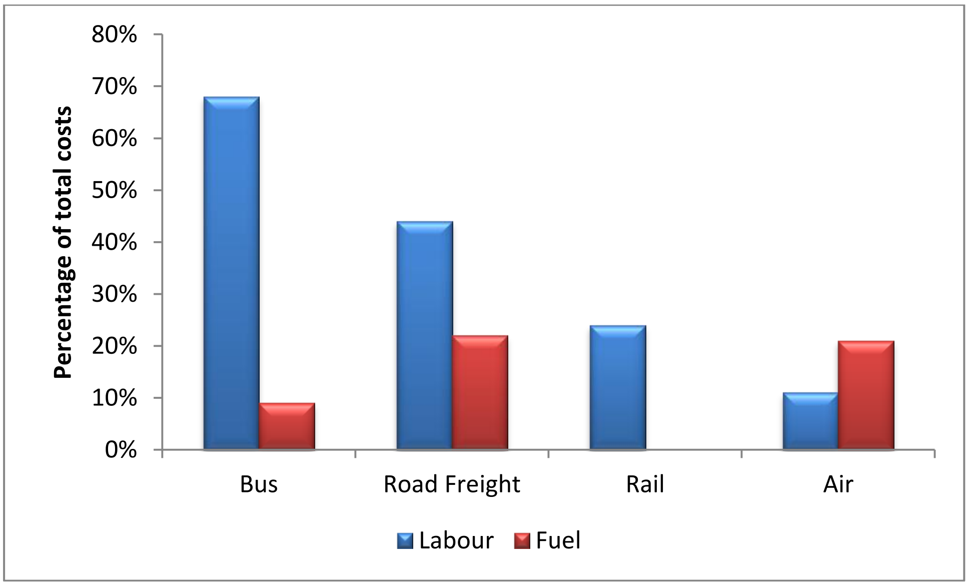


Figure 6-6 Main Cost Components (labour and fuel) by mode.

Source CIT (2007)

Another significant factor that fluctuated during the deregulation era that also influences operating costs is diesel prices; 80% of total operating costs are governed by these two cost components (labour and fuel).

Logically, total outputs (total vehicle kilometres operated) also contributes to total cost, as cost proportionally increases as the total vehicle kilometres run increases. Similarly, congestion (or delay) would affect cost; that's why a higher level of cost per kilometre is reported in the metropolitan areas and London than in the English shires and in Wales. Fleet structure is another factor considered as the use of mini- and midi-buses after deregulation has frequently been reported in the literature as one of the reasons for the decline in costs (e.g. Romilly (2001)).

6.3.1.3.1 Is competition or privatisation the reason for such reductions?

Another interesting observation is that privatisation first took place in the English shires as a result of the NBC subsidiaries sale between 1986 and 1988. However, besides Scotland, the shires experienced the lowest cost reductions among other areas between 1985/86 and 1988/89. Thus, the observed reduction observed in the deregulated areas might be attributed to competition (which was reported to be higher in the larger urban areas) rather than privatisation.

This argument raised in the literature, see Vickers and Yarrow (1995), concurs with the observed trend in ownership concentration. At the beginning of the deregulation era a substantial number of small bus firms were operating in the local bus market, and this allowed for competition, or threats of it. But as ownership moved towards more market concentration in a handful of large companies, through mergers and acquisitions, this reduced competition in the market and consequently operating costs, which decreased substantially after being relatively high during the early period, as such reduction was an essential factor for surviving competition (or threat of it).

Table 6-11 Reductions in cost per vehicle kilometres as observed in the early period just after deregulation (£/VKM; real).

	London	**Mets**	**Shires**	**Scotland**	**Wales**	**GB out.**
1985/86	3.68	2.47	1.71	1.86	1.68	1.96
1988/89	3.18	1.67	1.30	1.47	1.16	1.41
% Change	-14%	-32%	-24%	-21%	-31%	-28%

Source: Author calculations based on data extracted from various DfT publications.

Still, we disagree with this argument given the observed trend in Scotland. In this area, in particular, privatisation was delayed until the 1989 Transport Act (in Scotland), while the highest competition level was reported there before privatisation took place. However, Scotland during this period showed the least cost reductions among different areas of the country outside London (see Table 6-11). Privatisation, as an essential and integrated part of the deregulation policy package, has contributed to improved labour productivity by allowing for efficient working practices and applying pressure on wage levels in the industry. A policy maker needs a combination of competition and private ownership to minimise costs.

6.3.2 Data

Data from several published sources (mainly the Department of Transport) were combined with some data supplied by bus operators, taken from the Bus Industry Monitor report (TAS, 2007)).

As a result of the growing confidentiality of data, limited consistent data published by the Department of Transport are summarised in Table 6-12.

Table 6-12 Related variable data published by the DfT.

Variable	Area-disaggregation	Aggregate data	Comments & notes
Cost (dependent variable)	Yes	Yes	
Vehicle-kilometres operated (VKM)	Yes	Yes	Total aggregate VKM or disaggregated by commercialised vs. subsidised VKM.
Bus Age	Only since 2005	Since 1992/3	Does not date back to 1985.
Vehicle stock	Since 2005	Yes	The only consistent data published by the DfT are available for specific years rather than the whole period of assessment. The data also suffers from: - Missing disaggregation by vehicle type (mini- or midi-buses – single – double decker) or at least single vs. double-decker). - No separate number of coaches before 1997/8 back to 1985/6.
Staff employed by bus and coach operators	No	Yes	Job title since 1985 disaggregated to maintenance, administration and all platforms that since then have been mainly drivers. However, no area disaggregation, and mixed with coach industry.
Gross weekly earnings, # of hrs per week, and earning per hour.	No	Yes	No area disaggregation, and mixed with coach industry
Diesel prices			DfT data, collected in a specific month of the year (April), and excluding duty but including tax, can be used.
Investment/capital costs			New buses registered can be an indicator of investment/capital costs.

The DfT denied a request to access the Stat100 dataset for reasons of confidentiality. However, some useful data extracted from the Stat100 dataset are published by the Bus Industry Monitor Report. Most of the key data are summarised in Table 6-13.

Table 6-13 Summary of key data extracted from the Bus Industry Monitor Report (TAS, 2007).

Variable	Area-disaggregation	Aggregate data	Comments & notes

Seat-km	Since 96	Since 87	
Avg. bus size	Since 96	Since 87	
Average bus load	No	Since 1990	London vs. GB outside London.
Costs per supported VKM	Since 87	Since 87	
Bus investment	Since 1996	Since 1990	Bus and coach investment (mainly new vehicle purchase)
Fleet age	Since 1997	Since 1997	
Productivity: Staff numbers per PSV owned	No	Yes	
Productivity: km run per employee	No	Yes	

PSV= Public Service Vehicle

As is clear from the above tables, in spite of numerous data collected from various sources, there still are some deficiencies, including a general lack of disaggregation or consistency of available data for the period of the study.

Ideally, disaggregation of data for every variable by area type would be desirable as this would allow for panel analysis. Also, it can be noticed that for a few variables, particularly earnings and staffing numbers, data classified under coach and local bus industry (the data are mixed for both industries) have had to be employed in the absence of a reliable method to separate them.

It worth bearing in mind that although earning level is reported for driver staff, this actually accounts for the majority of staff (about 75%) employed in the industry. A similar argument was made by White (1990). In 2007/8, the number of driver staff was 132,000 out of a total of 174,000 (DfT, 2009).

Given that a time series cost model for all of Great Britain, excluding London, will be estimated along with another model for London only, the first model will adequately serve the research objective (focusing on the deregulation policy applied only outside London). The latter will allow for a comparison between the effects of contrasted policies applied outside London (deregulation) with that applied within London (competitive tendering) on the operating cost of bus services.

In their latest extensive cost modelling work applying econometric techniques to the DfT's Stat100a database, Toner *et al.* (2010) concluded that "there was some evidence that the models including London behaved differently (as might be expected)". Thus, their final model was based on data excluding London.

6.3.3 Methodology

6.3.3.1 Model specification

The two largest and most influential "variable" cost components are drivers' wages and diesel prices (OFT, 2010). Based on the direct operator survey and consultation process, the CC found these two components have the largest impacts among other factors. Our calculation, based on TAS's (2007) figures for bus cost breakdown, shows that these components account for at least 70% of total costs.

Although data on other cost components in the local bus industry in GB are unavailable or inconsistent, as shown in Table 6-12 and Table 6-13, the available data on labour and diesel prices should allow for legitimate analysis and modelling work. This view is in line with the one raised by the TAS consultants[52], who have monitored the bus industry since 1991.

TAS comments on this issue that, "As in past years, there is insufficient data in published accounts on operating costs presented in a uniform fashion to attempt any meaningful analysis." However, TAS added that

> "The one exception is employment and labour costs, where statutory requirements guarantee uniformity of presentation. Since labour costs account for an average of around 60 percent of operating costs across the companies surveyed, it may fairly be presumed that variations in unit labour costs account for an element of performance variation."

6.3.3.2 Model Estimation

The nature of the collected data allows for time series analysis (like the one performed to estimate London's models) rather than panel analysis (as carried out for demand and fare models for Great Britain outside London). Various combinations of possible independent variables, as explained in the previous section, are found to be very significant. Yet, these models are estimated using the simple OLS method, which requires some strict assumptions and need to be tested to ensure that no violations occur. Thus, a similar estimation approach to that explained in 6.1.6 (London's time series demand model) is adopted here.

6.3.3.3 Estimation Results

After many combinations were tested and post-estimated tests were used, and consequently alternative estimation methods correcting for serial correlation in time series models were used, few models gave significant results. In the following paragraphs, only significant models will be highlighted.

[52] Publisher of Bus Industry Monitor (BIM).

The estimated "basic" model defines total cost as a function of input and output prices; wage (earnings per week), fuel (Diesel) price, VKM (commercial only) and time trend, see Table 6-14. Model 2 is superior to the basic model in terms of capturing the effect of total employee number on costs; it also shows a higher adjusted R-squared. Models 3 and 4 are similar to model 2 but use specific job title (non-platform staff only or administrative staff only) instead of total staff, and give similar significant results.

Although the added variable (number of staff) has improved our model, it still fails to capture the change in productivity per staff member. Thus, number of staff per vehicle is added to the model to capture the change in productivity of bus employees. Indeed, this model gives very significant results and higher R-squared (see model 5). In this latter model, total VKM was found to be more significant than the commercial counterpart.

When using disaggregated data for the productivity variable, only administrative staff per PSV gives robust results (see model 6). Finally, model 7 employs the average bus size to see its effects on total costs. Although the model gives significant results, it fails to include any significant result for the productivity variable.

In addition, we attempt to improve the variable that proxies "network size" by using seat-KM as a variable that combines the capacity and journey length, instead of VKM. However, the estimation results were found to be insignificant. Adding capital cost and fleet age were also found to be insignificant and do not improve our cost model. This is a similar finding to that of Toner *et al.* (2010). Therefore, the decision to omit these variables from our regression analysis is justified.

Table 6-14 Estimation results of cost models using the Prais-Winsten estimator.

Variables	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6		Model 7	
	Coeff.	Sig	Coeff.	Sig	Coeff.	Sig	Coeff.	Sig	Coeff.	Sig	Coeff.	Sig	Coeff.	Sig
Ln(Total VKM)									1.138	0.001	1.108	0.001	1.273	0.001
Ln(Commercial-VKM)	0.555	0.006	0.685	0.001	0.689	0.001	0.766	0.000						
Ln(Diesel prices)	0.147	0.025	0.199	0.006	0.143	0.014	0.127	0.025	0.144	0.014	0.096	0.073	0.158	0.009
Ln(Earnings/week)	1.148	0.000	0.841	0.003	0.637	0.020	0.915	0.000	0.799	0.008	1.015	0.000	0.598	0.079
Ln(Total staff no.)			0.512	0.071										
Non-platform staff					0.359	0.023								
Administrative staff							0.216	0.017						
Total staff per PSV									0.775	0.019				
Admin. staff per PSV											0.256	0.007		
Avg. bus size													1.467	0.017
Time trend	-0.026	0.000	-0.027	0.000	-0.015	0.006	-0.020	0.000	-0.023	0.000	-0.021	0.000	-0.021	0.000
Constant	-3.225	0.150	-5.132	0.034	-2.692	0.152	-4.091	0.041	-6.340	0.059	-6.368	0.045	-11.61	0.008
Adjusted R^2	0.912		0.927		0.931		0.936		0.961		0.966		0.966	
DW (transformed)	2.442		2.469		2.424		2.635		2.086		2.165		2.399	
Number of obs.	21		21		21		21		22		22		22	

6.3.3.4 Preferred cost model

Now we need to decide which model would best serve the research objective. Our decision should be based on statistical indicators (adjusted R-squared and p-values in particular) as well as best model specification (the variables we are most interested in). Model 6 is superior in terms of both statistical tests and model specification.

However, it can be argued that staff productivity as defined in this model by number of staff per Public Service Vehicle (PSV) is problematic. The relationship between this variable and the total cost (the dependent variable) is linear only if the number of staff per PSV is larger than one. But overall, when considering the portion of the curve when the number of staff per PSV is less than 1, the relationship is in fact a non-linear parabolic[53], see Figure 6-7. In this case, parabolic transformations should be used in the model equation, by simply adding a squared or quadratic term of the variable to the right-hand side of the equation. However, it is suggested that vehicle kilometres per member of staff or per PSV would better model the productivity variable.

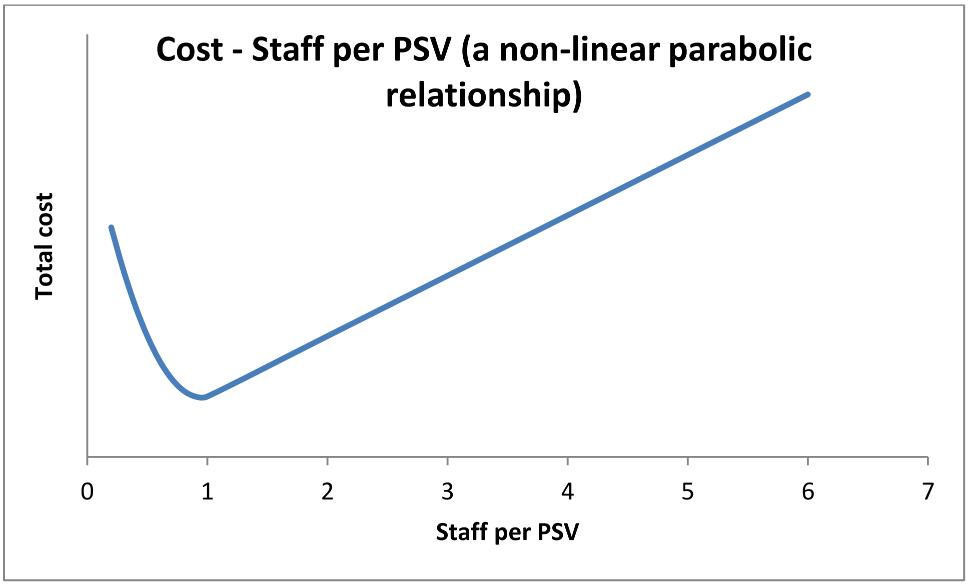


Figure 6-7 A non-linear parabolic relationship between total cost and staff per PSV (hypothetical relationship).

The new model estimation results using total vehicle kilometres per staff as a productivity variable is shown in Table 6-15.

[53] When number of staff is less than PSV, then there will be some vehicles that cannot be utilised. To operate a bus, at least one employee (a driver) is needed.

Table 6-15 Estimation results of cost models using VKM per staff as the productivity variable, the Prais-Winsten estimator.

Variables	**Model 8***		**Model 9**		**Model 10**	
	Coeff.	Sig	Coeff.	Sig	Coeff.	Sig
Total VKM	1.272	0.000	1.366	0.001	1.121	0.001
Diesel	0.259	0.000	0.254	0.000	0.187	0.001
Labour earnings per week	0.746	0.007	0.716	0.001	0.425	0.044
Productivity variable:						
-VKM per total no. of staff	-0.387	0.001				
-VKM per platform staff			-0.589	0.005		
-VKM per non-platform staff					-0.291	0.001
Time trend	-0.023	0.000	-0.035	0.000	-0.013	0.010
Constant	0.626	0.780	0.667	0.784	1.691	0.504
Tests:						
Overall R-squared	0.982		0.994		0.998	
Adjusted R-squared	0.976		0.992		0.998	
DW (transformed)	1.830		1.966		1.719	
Number of obs.	22		22		22	

*Preferred model

The equation of model 8 includes total kilometres run per staff. Models 9 and 10 are identical to model 8 but use disaggregated staff data; platform and non-platform staff, respectively.

Our preferred model is model 8, as kilometres run per "total" staff is the most comprehensive variable. The model defines cost as

Equation 6-4
Total cost = f (labour wage, diesel prices, staff productivity, total output and time trend)

Where
Labour wage = earnings per week (£/week)
Diesel prices = Total price per litre as in April each year, including VAT but excluding duty (pence/litre).
Staff productivity = Total vehicle kilometres run per staff (km/staff).
Network size = Total number of vehicle-kilometres run each year (km).
Time trend = Linear time trend, T=1,2,.. etc.

We believe the preferred model is robust and adequate for this research objective for many reasons. First, technically, our regressions show that all variables are very significant and have the expected signs. The overall model has very high R-squared, and the serial correlation problem is well treated. Second, the most important factors that heavily control bus costs in GB, as reported in the literature, are specified in the preferred model. Staff productivity, labour rents, and fuel prices are repeatedly mentioned in the literature as the main sources of cost reductions (they cumulatively account for at least 70% of total costs). Vehicle kilometres, which are also specified in the model have a proportional relationship with total costs. Finally, the time trend variable, which is found to be very significant, should control for other unobserved factors. This model is a version of the Cobb-Douglas functional form.

The results of the preferred model, as shown in Table 1-13 (model 8), suggest the following equation:

Equation 6-5

TC= Constant + 1.272 (Vehicle kilometres) + 0.259 (Diesel price) + 0.746 (Labour earnings per week) – 0.387 (Total VKM per staff) – 0.023 (time trend).

This is a natural logarithm function, as all variables are in natural logarithm form. Thus, elasticities for vehicle kilometres, diesel prices, labour rents and labour productivity are given by the coefficients estimated above.

With respect to the elasticities, defined as the effect on total costs as a result of change in one explanatory variable at a time, the highest elasticity of total cost is with respect to vehicle kilometres, of 0.894 (1.272 – 0.387). This can be interpreted as that a 10% increase in VKM will cause total costs to increase by 8.94%, holding other variables constant.

Given that, the way the operators reacted to the increase in costs in recent years by cutting total vehicle kilometres run is logical. More accurately, the provision of commercially operated services has dropped since its peak in the 1990s, although such services were slightly boosted by the provision of a free concessionary scheme for elderly people in England in 2006/7 as bus operators started to compete for the extra journeys carried by this age category by extending the area their network covered or increasing service frequency. During the same period, supported bus services, driven by social necessity, increased substantially as local transport authorities had to substitute such declines in services in the commercial section of the market. This, in turn, resulted in significant shrinkage in the commercially operated sector of the bus market in the deregulated areas (outside London). In their analysis of the market (the Bus Industry Monitor), TAS (2007) noted that: “Our analysis shows that the proportion of mileage run commercially was at its lowest level since deregulation in 2004/05 in the English Shires, Scotland and Wales.” Between 2001/01 and 2005/06, TAS observed a 16.4% fall in service provisions in PTE areas.

The elasticity of 0.895 (1.272 - 0.387) suggests a slight economies of scale with respect to vehicle kms. But can this be relied on? Despite limitations of our data and degree of spatial aggregation, it is worth performing a significance test to check that the elasticity is significantly different from 1.

Thus, a Wald test was performed on the null hypothesis that the sum of coefficients of vehicle kms variable in the model is equal to 1. The test result rejects the null indicating that there are slight economies of scale.

Now, we need to set this finding in the context of the literature. There was a common assumption that there is constant returns to scale with respect to operator's size in the British bus industry, based on early cost studies such as Lee and Steedman (1970) and Nash (1982). However, it was recognised that although there is no advantage of operator size in terms of significant cost savings but the larger operators have some advantages in terms of marketing and services co-ordination (Nash, 1982).

More recent studies concluded that there already economies of scale (increasing return to scale) but for small operators only which expected to diminish (become constant) as operator's size increases. However, these studies had not agreed on specific limit of this boundary. Preston (1999) found that small operator (up to 50 buses) are enjoying increasing return to scale whilst this benefit would disappear as the size reachs around 100 buses whilst Berechman (1993) suggested a range between 100 and 500 buses as the optimal operator's size in which increasing return to scale is expected. Cowie and Asenova (1999) found that smaller firms operating fewer than 200 buses experience increasing return to scale. However, Toner *et al.* (2010) carried out a more up-to-date analysis and found that there are economies of scale for "all operators" and "large operators", but constant returns to scale for "small operators".

For the European bus industry, there are some empirical evidences (e.g. Kerstens, 1999, Matas and Raymond 1998 and Viton, 1997) that suggest a U-shaped average cost function where smaller operators enjoying increasing returns to scale, which become constant and then decreasing as operators' size increases (Gagnepain et al., 2011)

It can be noted that there is some degree of uncertainty over economies of scale (or at least over the size of operations that exhibits increasing returns to scale). Unfortunately there is high degree of aggregation in our data (and there is no distinction between operator sizes). Given these concerns about data quality made above, it would be difficult to draw definitive conclusions but there does seem to be slight economies of scale in British bus industry outside London. This should be revisited if better cost data can be obtained. This finding is in agreement with the conclusion made by Toner *et al.* (2010) for "all operators".

Indicating significant but still inelastic impacts, the total cost elasticities with respect to staff costs and staff productivity are 0.746 and -0.387, respectively. Although less elastic compared to vehicle kilometres, employee-related factors have significant impacts on costs, as illustrated by the corresponding elasticities that are close to unity. The smallest elasticity figure of 0.259 is estimated with respect to diesel prices; still, this indicates fuel prices play an important role in total costs. The negative value of the time trend variable indicates that total costs of operating bus services is decreasing, although slightly, when considering the whole period of study.
A similar model was estimated using time series data representing London only, see Table 6-16. The model' equation can be expressed as follows

Equation 6-6
Total costs = - 0.48 + 0.1947798 (vehicle kilometres) + 0.1352012 * (diesel prices) + 0.622 * (total wages) - 0.168 (1994 dummy) + 0.213 (2002 dummy).

Table 6-16 Estimation results of cost model for London, using VKM per staff as the productivity variable, the Prais-Winsten estimator.

Variables	Coeff.	Sig
Total VKM	0.195	0.109
Diesel	0.135	0.031
Total wages[1]	0.622	0.000
Year 1994 dummy[2]	-0.168	0.000
Year 2002 dummy[3]	0.213	0.000
Constant	0.480	0.692
Tests:		
Adjusted R^2	0.999	
DW (original)	1.611	
DW (transformed)	1.819	
Number of obs.	22	

[1]Equals labour earning per week multiplied by total staff employed. [2] Captures the complete privatisation and tendering process. [3]Captures the beginning of the extensive improvement of the London bus service in parallel with the road-pricing scheme and the Mayor's plan (GLA, 2001).

6.3.4 Conclusion

Determining to what extent any bus transport policy has achieved its objective [and to what extent this should be (purely) attributed to the observed policy or to other external factor(s)] recalls the need to have a better understanding of the bus structure in order to evaluate it.

The estimated model shows that labour costs and productivity are the major factors that govern the total cost of operating local bus services in GB. Fuel prices have less influence, although it is still significant. This is in line with the fact that labour and fuel costs account for almost 80%

of total costs. A detailed breakdown of the cost structure carried by TAS (2007) shows that labour costs and diesel prices accounted for 68% and 9% of total costs, respectively.

The recent observation of the above inflation increases in total costs parallel to the observed growing trends in these variables has important implications. This, on one hand, supports White's (1990) argument that the larger part of reductions following the mid-1980s changes were caused by wholly or partly exogenous factors to deregulation. On the other hand, this raised some concerns (if the observed trends continued in future) regarding the quality and sustainability of operated services.

A study by TAS carried out for the Commission for Integrated Transport (CIT, 2007) has highlighted this point:

> "Above inflation cost increases in the bus industry have been of some concern for a few years. Operators are seeing decreasing profit margins, local authorities are faced with further deregistration of services and increasing tender prices, while the passenger faces more frequent and significant fare increases."

Indeed, our model confirms that "further deregistration of services" would be the expected main operators' strategy to face this increasing trend in total cost. The model estimated the highest total cost elasticity with respect to total vehicle mileage, and hence, deregistration of the less profitable bus routes would significantly reduce total costs. Local transport authorities found themselves obliged to consider these routes as socially necessary and cover them by tendering services. This in turn, required a higher subsidy level and caused the recent sharp reverse in the subsidy trend.

The most positive picture of the deregulation outputs occurred in the costs and subsidy sides. But if the recent sharp growing trends continue in the future, this will shed light on the success of the deregulation policy in achieving one of its main objectives, enhancing the productivity and quality of bus services, given the Berechman's (1983) definition of poor public transport as "produced inefficiently, and requires increasing subsidies".

A sharp conclusion on the success of deregulation policy can only be achieved through a wider cost-benefit analysis. Therefore, our final conclusion will only be made after undertaking this analysis in an upcoming chapter. Determining the counterfactual (what would have happened in the absence of the policy intervention) through the application of a cost model is necessary to evaluate how the observed policy has impacted this side. The estimated cost model will be used to assess the extension of the pre-deregulation trends in wage rates and productivity and to isolate the impact of variable fuel prices.

The main limitations of the estimated model are the aggregate nature and relatively small sample size of time-series data (up to 25 years). It can be argued that these two limitations would only allow for estimating an aggregate model and may lead to the exclusion of some variable(s). The suitability of the aggregate model for our analysis is not arguable as we are evaluating policy impact over a very large area (the whole of Britain outside London). Yet, disaggregated datasets, if available to this research, would add extra credits to our analysis.

However, the latest extensive cost modelling work using the DfT's Stat100a database and other data from TAS, by Toner *et al.* (2010), was only be able to estimate a model based on very few variables. Their preferred model, based on the whole 1,653 observations (panel data extracted from the DfT's Stat100a over an eight-year period), specifies vehicle kilometres, passenger journeys, adjusted number of fleet size and time trend as the only explanatory variables of total bus costs. Furthermore, even after expanding their data sample by merging another dataset from TAS that includes the input price (labour costs and capital costs) and fleet age variables, none of these added variables were significantly estimated. Thus, it is believed that expanding the data sample (for example if it would be possible to get access to the DfT's classified Stat100 dataset) would not significantly change our modelling conclusion/results.

6.4 The structure of the model system

A necessary condition for consistent estimation is identification (see Green (2003) for in depth detail). However, Kennedy (2003, p.193) noted that

> "Not all simultaneous equations systems suffer from the simultaneous equation estimation bias. A recursive system is one in which there is unidirectional dependency among the endogenous variables"

Kennedy also added that

> "In system of simultaneous equations, all endogenous variables are random variables – a change in any disturbance term changes all the endogenous variables since they are determined simultaneously, an exception is a recursive system" (Kennedy, 2003, pp.180)

We could write the structure of the model system that estimated in this chapter as follows

Demand (Q) = f (Fare, Service, Income, Deregulation dummy, Time trend, $Q_{t-1,}$ and error term) (1)

Fare (F) = f (Total cost per VKM, Subsidies per vkm, Time trend, F_{t-1}, and error term) (2)

Total cost = f (VKM, Wages, Fuel, VKM per staff, Time trend, and error term) (3)

which here happens to be recursive, because "Fare" variable appears in the equation for "Demand" but the "Demand" does not appear in the equation for "Fare", similarly is the relationship between "Fare" and "Total cost", see . There are no "feedback loop" relationships between the endogenous variables. Because this system is recursive, it is identified and we could estimate these three equations separately via OLS. For a more detailed discussion of recursive systems, see Kmenta (1997, 719–720) and (Kennedy, 2003, pp. 193).

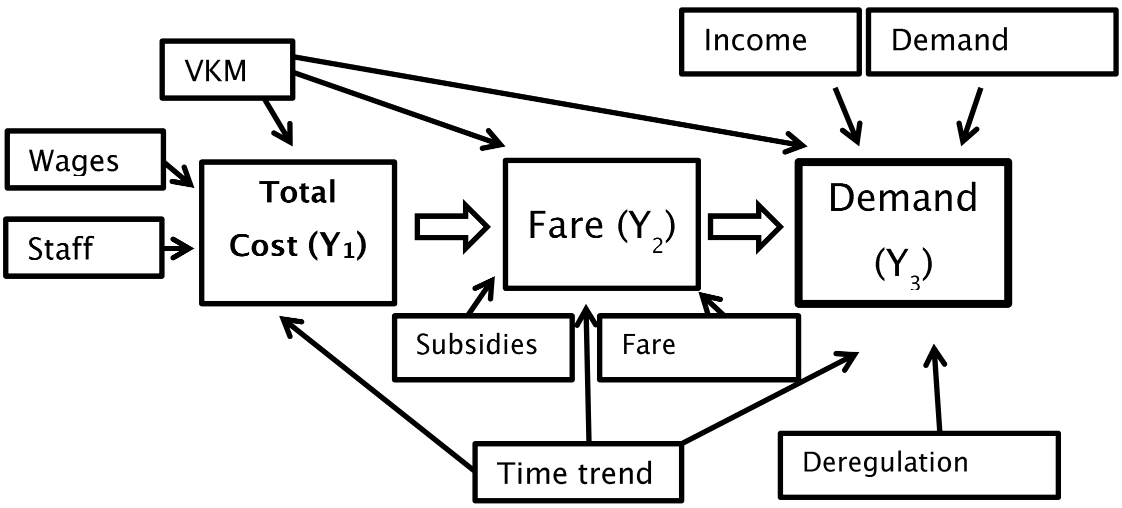


Figure 6-8Illustration of the structure of the model system – recursive.

7. Cointegration and error correction approach

7.1 Introduction

The estimated partial adjustment model (PAM) is statistically significant. However, the estimation approach is criticised for paying no attention to the danger of getting spurious regression (Granger and Newbold, 1974) as a result of employing non-stationary data (Phillips, 1986; Baltagi, 2008). In the context of transport data sets for Great Britain, previous researchers have referred to the presence of non-stationary process in these series (Romilly, 2001).

The latest advancement in the analysis of time series and panel data in the last two decades have shed light on the issues of non-stationarity. Researchers frequently ignored the crucial problem of spurious regression that emerges from the analysis of non-stationary data sets. This is either because they underestimate the seriousness of that problem or due to the lack of the proper treatments (Lin and Brannigan, 2003).

If the variables are proved to be non-stationary, then there are two possible solutions. First, check whether the variables are bonded in a cointegrated relationship. Otherwise, the regression should be re-estimated using an alternative model specification (error correction), see Figure 7-1.

The cointegration approach, which will be explained in detail in section 7.5, is a somewhat recent approach to the analysis of non-stationary variables. It can be employed to model a relationship between variables of interest regardless of a non-stationary process in their time-series data as long as there is a long run equilibrium to connect them.

In case the variables are not cointegrated, then we have to re-estimate the model using the error correction specification. Dargay and Hanly (1999) explained the superiority of the Error Correction Model (ECM) over PAM when utilising non-stationary series as:

> “Another problem with the Partial Adjustment Model occurs if the dependent variable is non-stationary, which is usually the case with economic series that continually increase (or decrease) over time. If this is the case, the estimates obtained may be inconsistent and the standard significance tests misleading. This is not a problem with the Error Correction model, since the dependent variable is in differenced form, and thus generally stationary”.

Another advantage of ECM is how the dynamics behaviour employed in this model specification. The ECM includes more lagged forms as the lagged independent variables are specified along with the lagged dependent variable. This implies that the short and long run impacts of the independent variables are distinctively represented[54] in the model equation (Dargay and Hanly, 1999). In contrast, the dynamics in PAM is embodied by a lagged dependent variable. While this may capture the dynamic behaviour in the model, sometimes a more complicated model structure is needed.

Accordingly, further investigation on whether or not the non-stationarity process is warranted in our data and to determine the degree of integration, is important. If this is the case, we should test the presence of a cointegration relationship between our variables that should deal with such potential problems. In this case, ECM would still be a superior model for capturing the dynamic behaviour. Consequently, if the possibility of estimating ECM is permitted, its results will be compared with that of PAM to determine how robust the estimates are.

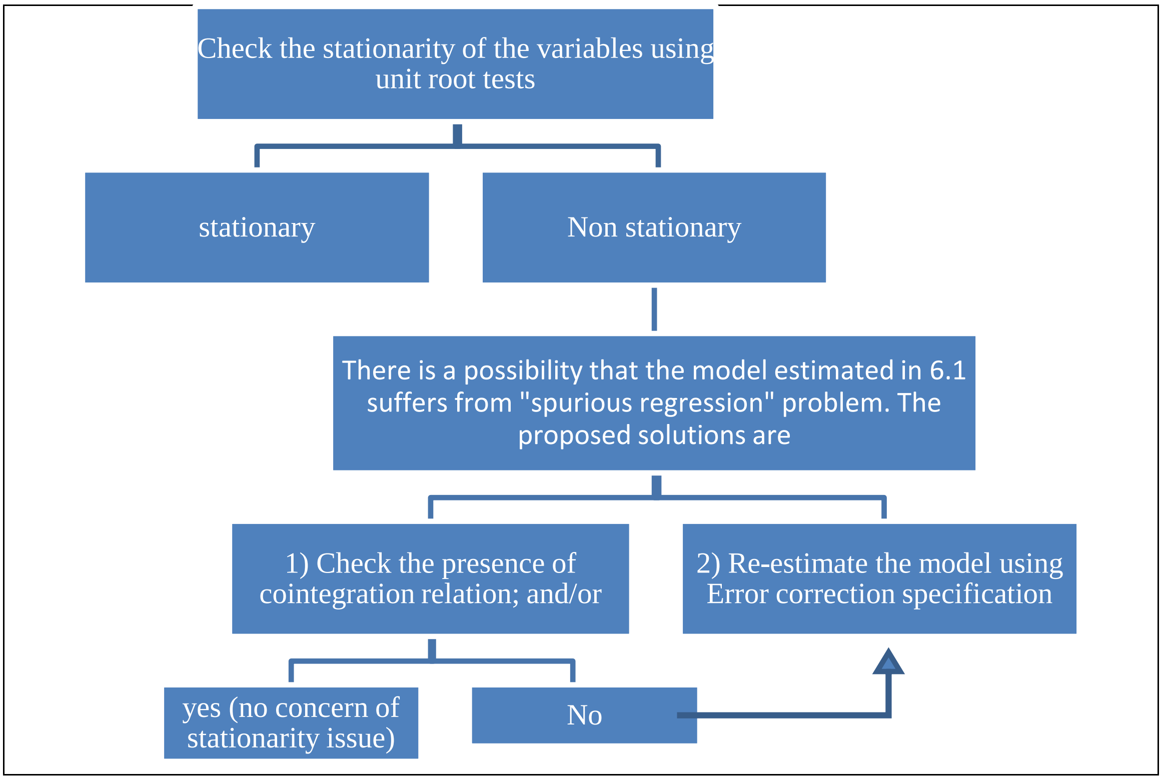


Figure 7-1 Methodological approach of this chapter

In this chapter, the adopted approach starts first with the concepts of spurious regression and non-stationarity. Then, proceeds to review the most suitable unit root tests and applies them to our variables. Also, the concept of cointegration is explained before the presence of cointegration relationship is tested using various cointegration tests. Finally, the implied error correction model will

[54] In PAM, the long run impact of any variables is proportionally related to the short run impacts, determined by the coefficient of LDV. Thus, the proportion is the same for all independent variables.

be estimated using the Engle and Granger two step and the alternative single equation estimation procedures.

In the TRL's *The Demand for Public Transport: A practical guide*, it was recommended that further work on the possibility of more than one cointegrating relationship should be investigated whenever the cointegration/error correction model approach is considered (Balcombe *et al*., 2004, p44). This can only be carried out by the Johansen estimation procedure rather than the two procedures mentioned earlier. However, the Johansen estimation procedure is more complex as it consumes larger degrees of freedom and needs larger number of observations to estimate a robust model. Moreover, there is some identification difficulty associated with this procedure, as described by Romilly (2001): "it may be very difficult to detect some of the multiple cointegration relationships often detected by the JML [Johansen maximum likelihood] method, particularly where economic theory has nothing specific to say about the coefficient values in the cointegrating vector". There is also a major drawback of this procedure related to the type of data set employed. The procedure is applicable to time series, however, whether it can be extended to include panel data sets utilised in this research is unknown. Thus, the Johansen procedure will be employed to explore the number of cointegrating relationships and estimate the error correction model, using time series (analysis at region-levels) rather than panel data sets.

7.2 Spurious regression

We need to shed light on the concept of stationarity and the spurious regression problem before moving on to explain the concept and cointegration. So far we have followed the classical theory that assumes that all variables are stationary, that is, they have constant means and variances regardless of their evolution over time. Thus, bus demand, fares, service, and income variables are assumed to be stationary. Nonetheless such classical assumptions may be violated by the employed data. Based on previous research that has employed similar data to this research, time series of transport variables are expected to be non-stationary (Dargay and Hanley, 1999; Romilly, 2001).

OLS regression method using non-stationary variables may significantly overestimate the t-ratios and the adjusted R-square; this is known as the problem of spurious regression. These limitations would affect the associated test statistics and for this reason their usefulness becomes questionable.

A common guideline widely followed to examine if the problem of spurious regression exists is to check whether the t-statistics is high and combined with a very low Durbin–Watson (DW) statistic, even lower than the R-square estimated using the standard OLS method. In this case the non-stationarity of the variables is most probably the cause and the model suffers from a spurious regression problem. As these conditions do not apply here, we may conclude our regressions are not spurious.

Another more formal and consistent approach to examine the possibility of spurious regression is to test the stationarity of the variables using unit root tests, as will be explained in the next section. To theoretically explain the spurious regression, we will follow the analytic proof of Phillips (1986). Consider the following equations:

Equation 7-1

$$y_t = y_{t-1} + \varepsilon_t$$

$$x_t = x_{t-1} + e_t$$

Where the variables y_t and x_t are non-stationary time series and independent from each other. Consider now the simple regression of the two variables:

Equation 7-2

$$y_t = \beta x_t + \varepsilon_t$$

Where β is a coefficient that can be estimated by OLS regression. According to the previous definitions, as sample size increases, β should equal or be very close to zero (or alternatively its t-statistic be insignificant) indicating no relationship between the two variables, y and x. However, if (in Equation 7-2):

(a) the estimated β does not converge to zero; and

(b) the t-statistic diverges to (+) infinity, where the null hypothesis tested here is β=0.

Then the model suffers from spurious regression. The consequences as described by Lin and Brannigan (2003) are

> "an overestimated R^2, biased coefficients, and unreliable significance tests for parameter estimations since both t and f values generated from the regression do not follow the normal t and f distributions."

7.3 Non-stationary – Integration, *I*(d)

It is important to understand the concept of stationarity and integration and how these can be investigated. By stationarity, we mean that both the variances and the means of the time series are invariant over time and it is integrated of order 0, denoted as *I*(0)[55]. If the series lacks any of these properties, then it is non-stationary and integrated in higher number, for example *I*(1) or *I*(2). That means the series can deviate away from its mean (does not have a constant mean). A series contains a

[55] The order of integration is usually defined as *I*(d) process, where *d* is a number of differencing to turn a time series into a stationary one.

single unit root when it is integrated of order 1, or *I*(1) and can be represented by a simple autoregressive AR (1) model as follows:

Equation 7-3

$$y_t = y_{t-1} + u_t$$

Nevertheless, u_t is still a stationary process. In contrast, stationary time series takes the following general form:

Equation 7-4

$$y_t = \rho y_{t-1} + u_t$$

Where the absolute value of the parameter ρ is less than one, (ρ <1), and u_t is stationary and has zero mean.

The majority of time series are non-stationary but emerge to be integrated of order 1 and contain a single unit root. As referred to earlier, the main problem emerges when analysing integrated (or non-stationary) time series is the high possibility of obtaining a spurious regression problem. The best remedy for that is to find a cointegration relationship which can be redefined, now, as a stationary linear combinations of two or more time series integrated at the same order *I*(1). This remedy approach, cointegration, will be covered later after verifying that the variables are non-stationary but integrated at the same order.

7.4 Panel Unit Root Test

7.4.1 Underlying methodologies of panel unit roots

The "time series" unit root tests are well-established and widely used in empirical research, counterpart tests for unit roots in panel datasets are a recent and developing field (Baltagi, 2009). Also, these tests allow for exploration of case by case (or series by series). However, a broad range of techniques for unit roots, or non-stationarity, tests have been advanced for panel datasets in the last decade. For instance the tests developed by Levin *et al.* (2002), Harris and Tzavalis (1999), Breitung (2000), Im, Pesaran and Shin (2003), Hadri (2000), and Choi's (2001) fisher-type tests. The main stimulator of such advancement was the increasing availability of time series data for broad range of cross-section dimension, rather than for longer period of time.

Breitung and Pesaran (2008) classified panel tests into two broad categories based on their approaches of dealing with cross-dependence across the units (time series) that make up the panel. The first category, called first generation and which includes the entire tests mentioned earlier, treat the issue of cross-dependence by assuming that cross section data are independently distributed. The focus is more on the problem of nonstandard asymptotics of conventional unit root tests for individual time series.

The second category, or generation, relaxes the hypothesis of cross- section independence and treats the limitation of the first generation by orthogonalising the individual (cross-section) before applying the DF test (Breitung and Das 2005), but assume weak correlation across the cross-sectional dimension of the panel. The second generation of panel tests can be further divided into two major approaches, the covariance restrictions approach developed by Chang (2002, 2004), and the factor structure approach adopted mainly by Choi (2002) and Pesaran (2003 and 2007), Phillips and Sul (2003), Bai and Ng (2004), and Moon and Perron (2004), among others (see Baltagi, 2008; Barbieri, 2006a).

In our case, we may use the panel unit root tests which hypothesise cross-section independence of panel data as they are well established and most practical methods (Barbieri, 2006a). Still, the hypothesis of cross-section independent panel has recently been questioned in the literature. Banerjee *et al*. (2004) warns that the panel unit root tests in the presence of cross-sectional dependence will be biased towards the alternative hypothesis. Thus, applying a test belonging to the second generation, which treats this issue in parallel to the first-generation test, is desirable in order to account for this argument[56]; the presence of the cross-section independency in the variables.

7.4.2 First generation of panel unit root test

The most widely used panel unit root test in recent research include the test developed by Levin *et al.* (2002) or (LLC), Im, Pesaran and Shin (2003) or (IPS), and Fisher-Type test based on ADF (Maddala and Wu, 1999) and PP-test (Choi, 2001).

In our case, the main disadvantage of LLC method is its inability to handle unbalanced panel data. Thus, the method cannot be applied to test the stationarity of our variables, unlike the IPS and Fisher-type methods, which are applicable for both balance and unbalanced panel data. In a comparison between the Fisher and IPS tests, Choi (2001) concludes that the Fisher test is superior to the IPS test as it has an improved finite sample power. This conclusion is in line with Maddala and Wu (1999) and Maddala *et al*. (2000) who conclude that the Fisher test is superior to both the IPS and LLC tests (Baltagi, 2008). Thus, in the next section we apply the Fisher-type unit root test.

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[56] In fact the adopted approach in this research has developed and advanced step by step based on the empirical test results as can be seen later.

7.4.2.1 Fisher type tests

The Fisher-type unit root tests are based on an approach which was first developed by Fisher (1932). The Fisher approach combines the p-values from individual unit root tests for each i cross section's series to estimate a common test statistic. The test was further developed in the context of testing the existence of unit root process in panel datasets by Maddala and Wu (1999) and Choi (2001).The structure of the test can be expressed as:

Equation 7-5

$$\Delta y_{it} = \alpha_{0\mathrm{i}} + \alpha_{1\mathrm{i}} t + \emptyset_i y_{i,t-1} + \sum_{j=1}^{p} \beta_i \Delta y_{i,t-1} + \varepsilon_{it}$$

Where Δy is the first difference of the tested variable, α_0 is a constant or individual effect, $\alpha_1 t$ is a time trend term, and i indexes individuals and t indexes time. The parameter of the lagged variable (ϕ) is unrestricted and variable for each individual constructing the panel. To deal with potential serial correlation in error term, a number (ρ) of lagged difference is introduced in the equation.

The overall p-value of the Fisher-type test can be determined by:

$$p = -2 \sum_{i=1}^{N} \ln p_i$$

Where ρ_i is the individual-specific p-value from unit root test carried out for each individual series. The tested null hypothesis is that each individual series contains a unit root process. The alternative assumes that one or more individual series are stationary. The advantages of this test are that it relaxes the assumption of the common autoregressive parameter and allows for individually specific ones.

7.4.2.1.1 The test's empirical results

Two forms of the test are used, namely the one that conducts the ADF unit root test on each individual time series as well as the alternative which employs the PP test. We also considered two options for the deterministic components, intercept only and both intercept and time trend. Furthermore, we apply the tests using multiple lag lengths, from 0 to 3, as the test procedure using the STATA statistical package (version 11) does not allow for variable lag length for each individual series (restricted to be common for all time series included in the panel).

The test gives four test statistics based on four different methods, suggested by Choi (2001). These methods are used to combine the p-values which are initially determined for each individual series in the panel. The most suitable one in the context of our panel data structures is the inverse normal Z statistic. Choi (2001) recommends the use of this particular statistic in practice as it gives the best balance of test's size and power. Table 7-1 reports the inverse normal Z statistics of the Fisher test using ADF regression.

Table 7-1 Fisher test (ADF), Inverse normal Z statistics.

Lag length/Variable	Intercept Only		Intercept & Trend	
	Statistics	p-value	Statistics	p-value
Lag=0				
Ln Q	-4.430	0.000	-3.219	0.001
Ln S	-3.255	0.001	-2.618	0.004
Ln F	0.223	0.588	0.217	0.586
Lag=1				
Ln Q	-8.564	0.000	-8.975	0.000
Ln S	-5.524	0.000	-7.727	0.000
Ln F	0.148	0.559	0.016	0.506
Lag=2				
Ln Q	-0.527	0.299	-0.612	0.270
Ln S	-0.208	0.418	-0.426	0.335
Ln F	-0.127	0.449	-0.823	0.205
Lag=3				
Ln Q	-0.527	0.299	-1.713	0.043
Ln S	0.090	0.536	0.221	0.587
Ln F	-2.286	0.011	-3.996	0.000

H_0: All individual time series contain unit roots, H_1: Fraction of time series are stationary.

The results indicate that for demand and service variables the null hypothesis that every individual series in the panel contains unit root can be strongly rejected when no or one lag is included. The conclusion is the same whether the trend is added to the intercept as exogenous variable or not. This is not the case when longer lag lengths are considered.

For the fare variable, the null hypothesis cannot be rejected even if up to two lags is included. The null for the fare variable can only be rejected when three lags are used in the ADF regressions. The results clearly show that the test is sensitive to the lag length included in the ADF regressions. The conclusion varies as the considered lag lengths change. This supports the use of the Fisher-type test but based on Phillips–Perron (PP) regressions rather than ADF. The results are given in Table 7-2.

The Fisher-type panel unit root employing Phillips–Perron (PP) regressions gives very consistent conclusions regardless of the lag lengths considered. For all lag lengths and options of deterministic components, we can strongly (at 1% confidence level) reject the null hypothesis in favour of the alternative hypothesis which states that the fraction of individual series in panel is stationary, for both demand and service variables. However, the opposite applies for fare variable.

Overall, the test's null hypothesis can be rejected for the demand and service variables and can be concluded that our data is stationary. But, the is not the case for the fare variable which proved to be non-stationary.

Table 7-2 Fisher test (PP), Inverse normal Z statistics.

Lag length/Variable	Intercept Only		Intercept & Trend	
	Statistics	p-value	statistics	p-value
Lag=0				
Ln Q	-4.429	0.000	-3.2195	0.001
Ln VKM/head	-3.255	0.001	-2.6185	0.004
Ln F	0.223	0.588	0.2166	0.586
Lag=1				
Ln Q	-4.870	0.0000	-3.8260	0.000
Ln VKM/head	-3.5302	0.0002	-3.0900	0.001
Ln F	0.1524	0.5606	0.0477	0.519
Lag=2				
Ln Q	-4.974	0.000	-4.116	0.000
Ln VKM/head	-3.498	0.000	-3.191	0.001
Ln F	0.057	0.523	-0.081	0.468
Lag=3				
Ln Q	-5.012	0.000	-4.291	0.000
Ln VKM/head	-3.382	0.000	-3.093	0.001
Ln F	-0.021	0.492	-0.158	0.437

H_0: All individual time series contain unit roots, H_1: Fraction of time series are stationary.

7.4.3 Second generation of panel unit root tests

The second generation of panel unit root tests follow two main approaches. The first is the covariance restrictions approach which employs instrumental variable methods or the bootstrap technique to account for any cross-sectional dependency in the panel data (Barbieri, 2006a). The approach was first proposed by Chang (2002, 2004) which requires no or minor limitations on the matrix of residual covariance. The second approach is more widely applied and depends on the factor structure approach to treat any distortion to the size of the panel unit roots tests caused by the cross-section dependency (Barbieri, 2006a). The latter approach includes the works done by Bai and Ng (2002, 2004), Pesaran (2003), Moon and Perron (2004), and Choi (2006) among others.

The test developed by Pesaran (2003 and 2007), denoted as CADF, is applied to check whether or not cross-section dependence exists in our panel data, as it may distort the size of the Fisher tests. The CADF test is chosen among others as its practical procedure is well established and can handle unbalanced panel data.

7.4.3.1 Pesaran's (2003 and 2007) Test

The test developed by Pesaran (2003 and 2007) is based on an approach which allows for cross-section dependence by averaging the lagged values of the cross-sectional units and their first differences and then fitting these values in augmented DF regressions. It is denoted as CADF because it employs a cross-sectionally augmented Dickey–Fuller test. To briefly review the theoretical background of the test let us consider the following heterogeneous model using panel data:

Equation 7-6

$$\Delta y_{it} = (1-\emptyset_i)\mu_i + \emptyset_i y_{i,t-1} + u_{it}$$

The error term (u_{it}) has a one-factor structure as follows:

$$u_{it} = \gamma_i f_t + \varepsilon_{it}$$

Where f_t is the unobserved common effect and ε_{it} is the idiosyncratic error of each individual series (Pesaran, 2003). The equation of CADF regression, which allows for cross section dependency, is:

Equation 7-7

$$\Delta y_{it} = \alpha_{\mathrm{i}} + \emptyset y_{i,t-1} + d_0\bar{y}_{t-1} + d_1\Delta\bar{y}_t + \varepsilon_{it}$$

Where $\bar{y}_t$ is the mean of all cross-sectional observation (N) at time t. The inclusion of the averaged lagged values for each cross-section (i) as well as its first difference allows for cross-sectional dependence by the means of a factor structure (Baltagi, 2008).

So far the case of serial correlation in the error term has not been considered. To do so the regression should be augmented not only by adding a number of lagged first differences of y_{it}, as in the univariate time series case, but also for $\bar{y}_t$ as follows:

Equation 7-8

$$\Delta y_{it} = \alpha_{\mathrm{i}} + \emptyset y_{i,t-1} + d_0\bar{y}_{t-1} + \sum_{\mathrm{j=0}}^{\mathrm{p}} a_{j+1}\Delta\bar{y}_{t-j} + \sum_{\mathrm{k=1}}^{\mathrm{p}} b_k\Delta\bar{y}_{i,t-k} + \varepsilon_{it}$$

The overall test result, the CIPS statistic, is in fact an average of the individual cross-sectional ADF t-statistics ($CADF_i$) obtained from running a regression for each i unit, similar to the technique of the IPS test. The Pesaran approach also gives a truncated version of the IPS test which contains first and second order moments that overcomes the problem of moment calculation (Lewandowski, 2007). The Pesaran (2003) test also incorporates the cross-sectionally demeaning procedure, as described earlier for IPS test, to mitigate the impact of cross sectional dependence on the test statistics.

Similar to the earlier tests, all individual series are non-stationary under the null hypothesis, while the alternative is that some of the individual series are stationary. Pesaran (2003) gives the critical values of the test statistic, (t-bar), as well as Z[t-bar]. The latter is similar to its counterpart in the IPS test.

7.4.3.1.1 The test's empirical results

The Pesaran (2003) panel unit root test, which accounts for cross-sectional dependence, is applied to all three variables. The demeaning procedure, which extracts the cross-sectional average, is considered. As our panel data is unbalanced, the estimated test statistics is the standardised Z[t-bar] statistic. The extreme t-values are truncated by defaults in the test. The test results under two categories of determinist components and augmented by different lag lengths are given in Table 7-3.

Table 7-3 Pesaran's (CADF) panel unit root test, the inverse normal Z statistics.

Lag Length/ variable	Intercept Only			Intercept & Trend		
	Statistics		p-value	Statistics		p-value
	t-bar	Z[t-bar]		t-bar	Z[t-bar]	
Lag=0						
Ln Q	-1.820	-0.124	0.451	-1.914	0.853	0.803
Ln VKM/head	-1.643	0.241	0.595	-2.428	0.253	0.400
Ln F	*	-0.181	0.428	*	0.464	0.679
Lag=1						
Ln Q	-3.342	-3.261	0.001	-4.168	-3.995	0.000
Ln VKM/head	-2.022	-0.540	0.295	-4.326	-4.335	0.000
Ln F	*	0.198	0.579	*	1.069	0.857
Lag=2						
Ln Q	-2.305	-1.123	0.131	-3.024	-1.536	0.062
Ln VKM/head	-1.273	1.004	0.842	-2.983	1.447	0.074
Ln F	*	-0.582	0.280	*	0.117	0.547
Lag=3						
Ln Q	-2.481	-1.487	0.069	-2.545	-0.505	0.307
Ln VKM/head	-1.530	0.474	0.682	-2.691	-0.819	0.206
Ln F	*	-2.317	0.010	*	-0.487	0.313

*In case of unbalanced panels, only standarized Z[t-bar] statistics can be computed.

The test results show variations with the lag lengths and the options of the determinist components considered in the ADF regressions. Let's focus on the option of deterministic components that includes the time trend, as the individual time series analysis showed clear time trends in almost all series.

When no lag is considered, this implies that no serial correlation exists in the variables; the null hypothesis cannot be rejected for all tested variables. The null hypothesis, which states that every individual series in the panel contain unit root, is confirmed. The same conclusion emerges when length lag of three is selected.

For demand and service variables only, the null hypothesis is strongly rejected when one lag is included, and to a lesser extent when two lags is considered, whilst the Pesaran test statistics are far from rejection regions for the fare variable for both lag lengths.

Given the test sensitivity to the chosen lag lengths, as illustrated in Table 7-3, we need to choose the most appropriate lag length in order to get a clearer conclusion on the stationarity of our variables based on Pesaran's CADF test. The number of lagged values, the degree of augmentation, can be selected based on information criterion such AIC and SIC. However, this method is used for time series rather than panel datasets. Another method suggests number of lags equal the number of observation collected per year (e.g. 4 for quarterly collected data). As our data are annual, this method suggests lag length equals 1. We can strongly (at 1% confidence level) reject the null hypothesis in favour of the alternative that fractions of individual series in a panel are stationary, for both demand and service variables. However, the opposite applies for the fare variable. This conclusion is similar to that suggested by the fisher type test[57].

7.4.4 Summary and conclusion based on the results of panel unit root tests

The results of unit root tests indicate that there is at least one non-stationary variable. Thus, there is a possibility that estimates from PAMs suffer from "spurious regression" problem. The proposed sulotions are:

- To check the presence of cointegration relation; and/or
- To re-estimate the model using an error correction specification

7.5 The concept of cointegration

In the last two decades the concept of cointegration became a major applied methodology in time series analysis, as a treatment of non-stationarity issues and/or to examine the existence of the long-run relationship between the considered variables. The methodology, and the associated tests, has been recently extended to the field of panel data analysis. The latter is still rapidly developing while the former is relatively well established since its introduction in the early 1980s by Granger (1981).

In general, the presence of non-stationary process in one or more time series is problematic as any linear relationship between these series will be non-stationary too. The series will move randomly and

[57] Also, frequently used in the literature, Newey and West (1994) give general formulas for calculating the appropriate lag length as $4(T/100)^{2/9}$. Our panel variables have an average time span about $\overline{T} = 28$. Based on Newey and West's (1994) formula the appropriate lag length should be equal to approximately three. Given that, we can conclude that all tested variables are non-stationary and contain unit roots.

may move away from each other. In addition, the non-stationary relationship will be integrated in the same order of the time series with the highest integration degree. For instance, if three time series with degree of integration equals zero, one, and two (or I(0), I(1), and I(2)) respectively, then a linear relationship that combines the three series will be integrated of order two, I(2).

Therefore, a regression of an explained variable on one or more non-stationary, explanatory variables may suffer from a problem of spurious regression. However, if a long-run equilibrium relationship between the regressed variables is expected, then the problem can be remedied by adopting a cointegration approach. Two or more non-stationary variables can have a stationary relationship if and only if there is a long-run equilibrium state between them (Granger, 1981).

The unique case of cointegration relationships was first discovered by Granger (1981). Under this specific case, the linear relationship between integrated variables is stationary or integrated of order zero, I(0), and hence it is a mean reverting. The differences between the variables are cancelled out as the long run equilibrium state is retained. To state the matter differently, the cointegrated variables may drift away from each other in the short run, but in the long run they are moving together. The difference occurred in the short-run is temporary and will be corrected over time in order to maintain the equilibrium relationship. Based on that, the error term of such a relationship should be a white noise. In practice, the long-run equilibrium can be a product of economic factors or change in policy to maintain desired conditions.

To explain the cointegration relationship theoretically, let us consider a simple relationship between two non-stationary variables but integrated at the same order $I(1)$:

$$y_t = \beta x_t + z_t$$

where z_t is the unexplained part of the relationship or the error term. If the two variables are cointegrated, the error tem is stationary, $I(0)$, and has a constant mean. The error term can be obtained by the following regression model:

$$z_t = y_t - \beta x_t$$

The two series can drift away from each other but only temporarily, as a response to shock for example. However, the cointegration relationship will limit such divergence and close the gap in the long run. Thus, error term (z_t) is stationary in such a relationship regardless of the non-stationary process in the variables, and can be interpreted as a measure of deviation from equilibrium. Furthermore, the relationship is at equilibrium state when the term (βx) is equal to zero.

Given that, it can be noted that the rationale behind the cointegration tests is to examine the stationarity of its error term. In fact this concept is the basis of all cointegration tests created by Engle and Granger (1987), Phillips and Ouliaris (1990) and Johansen (1991, 1995). In other words, the idea is to find out a linear combinations of variables whose movement eliminates the stochastic trend and creates an aggregate common stationary movement, I(0).

The previous equation can be expanded to accommodate more variables as follows:

$$Z_t = Y_t - \sum_{p=1}^{k} \beta_p X_{pt}$$

Where k is the total number of explanatory variables. In this case, there can be more than one cointegration relationship, and theoretically, as many as (k-1) cointegration relationships can occur.

The main advantage of cointegration regression, of non-stationary but cointegrated variables, is the treatment of the spurious regression. Another advantage of using cointegrated regression is that the least squares estimator can efficiently be used to accurately estimate the regression parameters.

7.6 Cointegration tests

The results of unit root tests allow us to move to the second step to investigate the existence of cointegration relationship using panel cointegration test.

7.6.1 Cointegration tests: the two major approaches

In practice, nearly all cointegration tests, for time series or panel data, are based on two main approaches to investigate the presence of a long-run equilibrium (cointegration) relationship; the two-step Engle-Granger (1987) test and Johansen's (1991, 1995) test. The two approaches will be reviewed briefly before moving on to explain the most suitable cointegrating panel test for our panel data.

7.6.1.1 Engle-Granger (1987) approach

The Engle-Granger (1987) approach is widely used in practice as most residual-based cointegration tests are built on its concepts. The DF test for unit root, explained earlier, forms the basis of the Engle-Granger (1987) approach. Therefore, it is sometimes referred to as the EGDF cointegration test. It is also known as the two-step Engle-Granger (1987) test, as the procedure includes a regression analysis followed by an ADF unit root test on the residual.

The E-G test assumes a relationship between multiple time-series variables as expressed in the following regression model:

$$Y_t = \beta X_t + ut$$

Where x_t is a vector of k explanatory variable ($x_1, x_2, \ldots, x_k$). The error term, or the residual, u_t, should be stationary, $I(0)$, in order for the variable y to be cointegrated with the vector (X). If not, the regression analysis will suffer from the problem of spurious regression. Hence, the rationale behind the E-G approach is to test the stationarity of the residual (u_t).

Carry out a regression analysis of the previous model using the ordinary least square (OLS) method to obtain the parameter (β) and the residual (u_t). The residual can be re-represented in the regression equation as:

$$\hat{u}_t = Y_t - \hat{\beta} X_t$$

where $\hat{\beta}$ is the estimated parameter using the OLS regression. A first-degree autoregressive AR (1) model of the residual ($\hat{u}_t$), as in the form tested by the DF test, should be estimated as follows[58]:

$$\hat{u}_t = \theta \hat{u}_{t-1} + \varepsilon_t$$

Given that the DF test examines for a unit root under the null hypothesis, H_0: $\theta = 1$ versus the alternative of stationarity of the series, H_1: $\theta < 1$, if the test's null hypothesis is accepted, then the variables are not cointegrated. On the other hand, if the test rejects the hypothesis of the residual's non-stationarity process, then the presence of the cointegration relationship is confirmed.

Alternatively, the augmented version of the DF test may be used instead of the basic DF test. The alternative augmented version is preferred since it accounts for the serial correlation problem, which commonly appears in the time series analysis, and which the basic DF test fails to treat. Thus, the equation in step two becomes:

$$\Delta \hat{u}_t = \emptyset \hat{u}_{t-1} + \sum_{i=1}^{p-1} \gamma_i \Delta \hat{u}_{t-1} + \varepsilon_t$$

One issue should be noted here. The critical values of the basic DF or ADF test cannot be used to interpret the results from the EGDF cointegration test. Instead, critical values given by Engle and Yoo (1987), Phillips and Perron (1988), or Phillips and Ouliaris (1990) should be used.

7.6.1.2 Johansen's (1988, 1991, and 1995) approach

Another approach widely used in empirical research to identify the existence of cointegrating relationship is the one developed by Johansen (1991, 1995). Johansen's cointegration procedure is more appropriate than the E-G procedure when dealing with a model in a multivariate framework. In this case, the expected multiple cointegrating relationships can be incorporated into a vector

[58] In order to apply the basic DF unit root test, with no deterministic trend, on this AR (1) model.

autoregressive (VAR) model, while all variables are assumed to be endogenous. Unlike the E–G test, the non-stationary variables should not be restricted to the same integration order, *I*(d). However, it requires a larger data size as it is based on the VAR model, in contrast to the E-G method, which can be consistently estimated using OLS regression.

After inspection of that the variables are non-stationary, the approach employs the Johansen (1988) Maximum Likelihood (ML) method to examine the presence of the cointegration relationship between the variables. Unlike the E-G approach, the Johansen ML approach is able to specify the (r) number of cointegrating relationships (or cointegrating vectors) in the multivariate model. The maximum possible number of cointegrating relationship is (k-1), where k represents the total number of variables incorporated in the model.

The test for cointegration in the Johansen procedure is similar to the ADF test, but a VAR model is employed to extend the analysis to a multivariate framework. Consider a VAR model:

$$Y_t = AY_{t-1} + u_t$$

The equation can be re-written as:

$$\Delta Y_t = (A - I)Y_{t-1} + u_t$$

Assumes $\pi = (A - I)$, then:

$$\Delta Y_t = \pi Y_{t-1} + u_t$$

Where Y_t and u_t are vectors of (k*1) size; k is number of included variables; and A and I are (k*k) parameters and identity matrix respectively.

The number of cointegrating vectors (r) represents the rank of π matrix. When π is composed of all zeros, then the rank of the matrix (r) will be zero. Thus we can conclude that all of the variables (Ys) are non-stationary and contain unit root processes, and hence they are not cointegrated.

The Johansen procedure is based on testing the π matrix, which consists of long-run coefficients. Two matrices of coefficients are estimated by this approach. The first matrix represents a set of coefficients that capture the long run equilibrium (β), the other matrix of coefficients capture the speed of adjustment (α).

The relation between π and the two matrices can be expressed by:

$$\pi = \alpha\beta$$

Two tests are incorporated in the procedure to examine the cointegration which may produce, to some extent, different results. The assessment of the π matrix is the basis of these tests. The tests either employ trace or eigenvalue of the stochastic matrix (π). Consequently, the results are used to specify the number of cointegration vectors (r). Based on the rank of π (r), an error correction model can be determined.

The two tests, trace and eigenvalue, can be expressed in the following two equations;

$$J_{trace} = -T \sum_{i=r+1}^{k} \ln(1 - \hat{\lambda}_i)$$

$$J_{max} = -T \ln(1 - \hat{\lambda}_{r+1})$$

Where T is the number of observations over time and λi (hat) is the calculated eigenvalue from the matrix (π).

The two tests differ on their tested hypotheses. In the trace test, the null is that there is r or less cointegrating relations versus the alternative which assumes that there are k relations, which implicitly means that the series are stationary. The maximum eigenvalue test, on the other hand assumes r cointegrating relations in the null hypothesis versus the alternative of r +1 cointegrating relations. After the two statistics are determined, trace and maximum eigenvalue, they are compared to corresponding critical values.

There are three main advantages of the Johansen Maximum Likelihood cointegration approach over the two stage Engle-Granger approach. First, there would be no endogeneity problem as the Johansen approach is based on the VAR rather than the OLS method. Secondly, unlike the E-G approach, the matrix of cointegrating vectors (β) can be restricted and tested under restrictions to see whether it is significantly different from zero or is equal to one. Finally, after estimating the Error Correction Model (ECM), the concept of causality can be tested using the Granger Causality test. As the significance of lag terms in the ECM are jointly examined, the direction of causality between the dependent variable and independent variables can be determined.

However, the Johansen Maximum Likelihood cointegration approach is not without problems. As more than one cointegration vector can be identified, the same number of specifications of the Error Correction Model would result; this may be considered an advantage. However, the choice between these potential specifications of ECM is problematic, as any of the possible solutions would pose problems. Also, the two tests, trace or maximum eigenvalue based, employed in the procedure to determine the number of cointegrating relationships may give different results. Finally, as stated earlier, it requires a large sample size as it is based on the VAR model rather than the OLS method.

7.6.2 Panel cointegration test

We need to examine whether bus demand, fare, service level, and income variables are cointegrated using a proper cointegration test. If such a relationship exists, it means that there is a long-run equilibrium relationship between our variables so that deviations from the equilibrium are mean reverting.

The test of cointegration has been a growing field in recent years particularly for panel data. The panel cointegration tests are developed based on two main approaches: residual-based and maximum-likelihood-based as outlined above. The first approach includes residual-based tests developed by Kao (1999), McCoskey and Kao (1999), and Pedroni (2004). On the other hand, the tests proposed by Larsson *et al*. (2001) and Groen and Kleibergen (2003) are among other tests based on the approach of maximum-likelihood.

Similar to the first generation of panel unit root test, the residual-based cointegration tests have an assumption that the panel is cross-sectionally independent. Banerjee *et al*. (2004) argue that cross-section dependency, if it exists, may cause distortions to the test statistics. In the same context, Gengenbach *et al*. (2006) illustrated that if the assumption of cross-section independency is violated, the residual-based tests may be divergent.

To overcome this issue, panel cointegration tests have advanced in recent years allowing for the case where the cross-sectional dependency is presented. As a response to the defect of previous tests, Westerlund (2007) presents an alternative approach of panel cointegration testing based on the concept of the error correction model. The basic premise of the test is that if there is a presence of error correction for individual series in the panel or for the whole panel, then the cointegration relationship is warranted.

Barbieri (2006b) in her extensive reviews of panel cointegration tests concluded, in the same context as Banerjee *et al*. (2004), that “It is important to recall that in the cointegration test framework, tests are based on severe restrictions”. The Westerlund test indeed relaxes these restrictions, or at least the most controversial ones. Another appropriate test is the one developed by Gengenbach *et al*. (2006), which is based on a common factor approach.

However, both tests require larger datasets than the one available in the current research. Our panel dataset has a very small cross-sectional dimension (N=4 or 5) whilst the Westerlund (2007) test was developed for panels with larger N. Thus, it is doubtful if the test results could be considered evidence of no cointegration[59].

As the application of panel cointegration test is problematic we will rely on the alternative common approach to investigate the presence of a long-run equilibrium relationship (cointegration); using cointegration tests for individual time series. Given that, the relationship can only be investigated by an area by area analysis[60].

7.6.3 The alternative approach: Cointegration test for time series (Area-by-area analysis)

More deeper and detailed analysis on area-by-area level, using an Engle and Granger (1987) residual-based cointegration test and Johansen system-based cointegration test for individual areas, may result in a clear conclusion.

In our approach, we start to apply the EG approach to investigate the presence of long-run equilibrium between the variables. This is followed by performing the Johansen test to firstly confirm the EG results and secondly to identify the number of these relationships that exist since the EG test lacks the ability to do so.

The EG test is referred to as the residual-based test as it applies the ADF unit root test on the residual obtained from OLS regression in the preceding step, and is the basis of all residual-based panel cointegration tests. The Johansen test, on the other hand, is known as the system-based cointegration test as it employs the Johansen (1988) maximum likelihood (ML) procedure. The two conventional types of the Johansen test are applied in our analysis. The first employs the trace statistics, whereas the alternative uses the maximum eigenvalue statistics. A third type of test procedure is employed to verify the results of the two former types.

7.6.3.1 Comments on the results of EG and Johansen cointegration tests.

The residual-based Engle-Granger (1987) test and the system-based Johansen (1988) test are used here to investigate for the presence of long run equilibrium (cointegration relationship) between the

[59] This comment is based on communication with Dr Damiaan Persyn, the first author of the paper published in stata journal to explain the Westerlund test using STATA routine, see Persyn and Westerlund (2008). Also, Prof. Joakim Westerlund, who developed the test, has been contacted and he commented that “The main problem here I guess is that the power is increasing in N, which means that if you have small N, then your test is likely to suffer from low power, making it difficult to reject the null even if it's false.”

[60] “With T=4 or 5, it is preferable to test for cointegration of the four individual series, instead of panel cointegration tests. The panel tests simply are not developed for such small N (N should be, say, at least 15-20). With such small N it would be more interesting to consider the individual series anyway.

variables considered in the bus demand models for each individual area. Combining the outcomes of both tests, our analysis resulted in an uncertain conclusion for Scotland, Wales, and London. The former test indicates that the variables are cointegrated for all individual areas. Although this confirms the conclusion for Metropolitan areas and Shires, the Johansen (1988) test implies opposite conclusions for Scotland, Wales, and London.

A review of empirical researches involved similar analysis shows that such conflicting results of these tests are common. Various studies that carried out both residual-based and system-based cointegration tests reported inconsistent p-value results from the two considered tests (e.g. Gregory *et al*., 2004; Pesavento, 2004; Basher and Elsamadisy (2012)).

One way to overcome the contradictory results from the EG and Johansen tests is to adopt alternative tests such as Error-Correction-based tests proposed by Boswijk (1994) or the similar test developed by Banerjee *et al*. (1998). However, this may also create another dilemma of which cointegration test should be used.

This dilemma was best described by Bayer and Hanck (2009):

> This regularly forces the applied researcher to select from the test decisions of the various applicable procedures. This choice is difficult because, as discussed in e.g. Elliott *et al*. (2005), there exists no uniformly most powerful test, even asymptotically. Often one test rejects the null hypothesis whereas another test does not, making it unclear how to interpret test outcomes then. More generally speaking, the p-values of different tests are typically not perfectly correlated (Gregory *et al*., 2004).

Fortunately, Bayer and Hanck (2009 and 2013) have developed a new procedure that combines the results of multiple tests and gives a single joint test-statistic.

7.6.4 Bayer-Hanck Test (Combining Cointegration Tests)

The Bayer-Hanck cointegration test produces a joint test-statistic for the null hypothesis of no-cointegration based on four individual cointegration tests. The produced joint test-statistic includes results from two Error-Correction-based tests; namely tests developed by Boswijk (1994) and Banerjee *et al*. (1998), besides the commonly used tests of Engle-Granger and Johansen (maximum eigenvalue). For a detailed explanation see Bayer and Hanck (2009). In addition, the test outputs include another combined statistic based on Engle-Granger and Johansen (maximum eigenvalue) alone as well as results of each single test reported separately.

7.6.4.1 Empirical results

The long term cointegration relationship is confirmed, the no cointegration null hypotheses are rejected in the two joint statistics of Bayer-Hanck Test, as shown in Table 7-4. The test output based on the joint result of the Engle-Granger and Johansen procedures exceeds the 5% critical value of the test. The same conclusion is obtained by the second joint test-statistic, based on four individual cointegration tests this time.

Table 7-4 Fisher Type Test statistics of Bayer-Hanck (2009) test for cointegration, separate for each of the five regions of GB, lag=1.

Underlying tests	**Fisher Type Test statistics of Bayer-Hanck (2009) test**				
	English Mets	English Shires	Scotland	Wales	London
1- Combined result of EG and Johansen tests[1]	25.57*	55.997*	15.224*	20.649*	16.458*
2- Combined result of (EG, Johansen, Banerjee, and Boswijk) tests[2]	43.35*	121.856*	44.051*	131.173*	20.510*

[1] 5% critical value is 10.637. [2] 5% critical value is 20.486. *Significant at 5% level and rejects the null hypothesis of "no cointegration".

7.7 Concluding remarks on the results of cointegration tests

Our analysis resulted in the same conclusion from the residual-based test of Engle-Granger (1987) and the system-based test of Johansen (1988) only for some areas, with contradictory results for the rest. These tests are used here to investigate for the presence of long run equilibrium (cointegration relationship) between the variables considered in the bus demand models for each individual area. This does not create a clear-cut conclusion.

Fortunately, Bayer and Hanck (2009) have developed a new procedure that combines the results of multiple tests, including Engle-Granger and Johansen procedures, to give a single joint test-statistic. The Bayer-Hanck procedure also produces test statistics from two other cointegration tests performed separately, specifically, the Error-Correction-based tests proposed by Boswijk (1994) and Banerjee *et al*. (1998). All different outputs of the test reject the null hypothesis of no cointegration.

Therefore, we may conclude that the presence of a cointegration relationship in our model is confirmed in every individual area considered in the analysis. Consequently, when using panel data comprised of all these areas we might be sure that the same long-run relationship exists. Thus, we may proceed further in our analysis (the cointegration/error correction approach) and estimate the local bus demand model under the error correction specification.

More importantly, this has very important implication on the partial adjustment model estimated in 6.1. In this special case, cointegration relationship, as stated by Stock (1987), the fundamental assumptions of OLS estimator are not violated regardless of the non-stationarity of the individual time series. And hence, the estimator is both consistent and efficient. Given that, we may also conclude that the partial adjustment model estimated earlier does not suffer from spurious regression as long as the cointegration relationship is confirmed.

7.8 Error Correction Model Estimation

7.8.1 Introduction

In addition to the treatment of non-stationary issues, the main advantage of the error correction model (ECM) is the ability to specify and include both short and long run equilibrium relationships in one equation. It also allows for the direct estimation of the speed of correction or the pace by which the dependent variable moves back towards the long-run equilibrium after any shock caused by a change in one or more of the independent variables.

The basic formula of the ECM for two variables is as follows

Equation 7-9

$$\Delta y_t = \alpha\, \Delta x_t + \gamma\, EC_{t-1} + e_t$$

where

$$EC_{t-1} = (y_{t-1} - \beta x_{t-1})$$

where y and x are the dependent and independent variables, respectively; Δ is the first difference term; and EC_{t-1} is the error correction term that captures the deviations from the long-term equilibrium relationship. In addition, γ is the feedback effect[61] which measures the speed of correction to the deviations from equilibrium in the last period (t-1).

The model explicitly captures the short-run adjustment while maintaining the information from the long-run relationship. Hence, it provides direct estimates and easy interpretations of the short run impacts of change in x on y (the term Δx_t), the long-run impacts (EC_{t-1}), and the speed of error correction (periods required for y to revert to long-run equilibrium after a deviation caused by a change in x, through the parameter γ).

[61] Equivalent to the adjustment coefficient in PAM, (1-θ).

Thus, it can be concluded that x has "contemporaneous" or short-run effects on y if the coefficient α of the first difference of x (or Δx) is statistically significant. Similarly, x has long-run effects if the coefficient β of the lagged value of x (or x_{t-1}) is statistically significant. Meanwhile, the periods by which the long-term effect is fully occurred are determined by the parameter γ (Bannerjee *et al.*, 1993).

Another advantage of ECM is that the model can be simply estimated with OLS regression as all terms in the ECM are stationary. The EC_{t-1} term is simply the residual of the cointegrated long-term relationship between y and x; thus, it is undoubtedly stationary. The other term (Δx) is simply a first difference of the series; consequently, the integrated series becomes stationary after differencing.

This equation is well-known as an error-correction model, as the EC_{t-1} term has meaning only if the system deviates from its long term equilibrium. If the speed of the adjustment coefficient (γ) has a unity value (-1), it can be said that the system has an immediate adjustment. In this case, a static model would be an appropriate specification to model the relationship. On the other hand, when the coefficient is not significantly different from zero, then there will be no correction adjustment to deviations from the long-run equilibrium. Thus, the speed of adjustment coefficient has a value that ranges between these extreme limits[62].

The previous model can be extended to include more than two time series (or variables). In this case, the model specification can be expressed as follows

Equation 7-10

$$\Delta y_t = \alpha_1 \Delta x_{1t} + \alpha_2 \Delta x_{2t} + \ldots + \alpha_n \Delta x_{nt} + \gamma(y_{t-1} - \beta_1 x_{1t-1} - \beta_2 x_{2t-1} - \ldots - \beta_n x_{nt-1}) + e_t$$

where x_1, x_2..,x_n are the n independent variables which have effects on the dependent variable.

It is worth noting that the concept of cointegration is always connected with error-correction mechanisms in the literature, based on the Granger Representation Theorem (GRT), where the estimation of the ECM can only be possible if the existence of a cointegration relationship between the non-stationary variables is confirmed. However, other researchers believe the ECM is applicable for both non-stationary and stationary series (Keele and De Boef, 2004). Therefore, the use of the ECM should be based on theoretical backgrounds, even if a cointegration relationship does not exist between the series. According to Keele and De Boef (2004), "When theory dictates there might be different long and short term effects, then error correction may be the appropriate model."

[62] Asche (1997) commented on these restricted limits that "This is because the adjustment will be monotonic only in this interval, and all other values induce excessive costs."

The conclusion based on our pre-estimation tests—namely, unit root and cointegration tests—confirms that our variables are both integrated and cointegrated and, hence, the estimation of the ECM is appropriate to model the demand for bus use in Great Britain, given the range of the utilised data. Moreover, theoretical argumentation also confirms that our explanatory variables have two clear different short- and long-run effects on the dependent variable. Accordingly, the ECM methodology is applicable to our variables.

The ECM might suitably serve the objective of this research. We are interested in capturing the long run dynamics of bus demand behaviour to evaluate the long-term impacts of deregulation policy. The short-run relationship would also help understand the instant reaction of demand to changes in fare, service, and income variables.[63]

7.8.2 Estimation methods

Three different procedures can be used to estimate the ECM: the Engle–Granger two-step procedure, the single-equation ECM, and Johansen's maximum-likelihood (ML) method. In empirical works, several error correction models have been estimated using the Engle–Granger two-step method. A fewer number of studies have employed the single-equation ECM, and even fewer have adopted Johansen's ML system estimator (vector ECM). Although these procedures are different, they all share the same theoretical strategy: The series are bounded together in the long run, while the short-run behaviour is governed by how far the relationship is currently deviated from the long-run equilibrium (Keele and De Boef, 2004). A brief discussion of these methodologies follows.

7.8.2.1 The Engle–Granger two-step procedure

Among these different estimation approaches, the Engle–Granger (EG) method has been the most extensively applied procedure since it was presented by Engle and Granger (1987). To explain the EG two-step procedure, let's start with the simple model of two integrated I(1) series as follows:

Equation 7-11

$$y_t = \beta x_t + u_t$$

Using the OLS method, the previous equation is estimated in the first step.[64] The stationarity of the residual from the regression equation in step one is then verified using the ADF or PP. In practice, the residual can be estimated as:

[63] Beck (2008) warns that "almost all the work associated with this approach is for single time series data rather than TSCS data. Currently this must be marked as an area for further study."

[64] It should be borne in mind that any inferences on the estimated parameters at this step are not valid as the objective of this estimation step is only to approximate the parameter values (Brooks, 2008, p. 350). Unlike in the final model equation obtained after step two, the variables involved in the first step are still non-stationary—

Equation 7-12

$$\hat{u}_t = y_t - \beta x_t$$

If the residual is found to be a stationary I(0), this will confirm the presence of a linear combination (or a cointegrated relationship) between the integrated I(1) variables. Thus, Equation 7-11 is a "cointegrating regression".

Finally, the lagged residual term ($\hat{u}_{t-1}$) enters the error correction specification as a long run equilibrium relationship while the differenced variables (Δx_t) are interpreted as a short run relationship as follows:

Equation 7-13

$$\Delta y_t = \alpha\, \Delta x_t + \gamma\, \hat{u}_{t-1} + e_t$$

Despite its name, the EG method consists of three main steps rather than two.

After the final step, we are sure all series in this regression are stationary and there are no other types of misspecification (Brooks, 2008, p. 342). Thus, it is only now possible to make inferences about the estimated parameters in the last regression (Equation 7-13).

In Equation 7-13, α_1 approximates the short–run effects of explanatory variable x on the dependent variable y (and, as stated earlier, the long term effect represented by β). γ is the adjustment coefficient which approximates the pace at which y adjusts back to the long-run equilibrium after a deviation due to a change in x. Therefore, the model combines both the static long-run relationship and the dynamic short-run behaviour explicitly in the final equation.

If the autocorrelation is an issue, then the ECM can be extended to involve a larger lag order as follows:

Equation 7-14

$$\Delta y_t = \sum_{i=0}^{n} \alpha_{i+1} \Delta x_{t-i} + \gamma\, \hat{u}_{t-1} + e_t$$

where n is the optimum lag number.

However, the EG two-step procedure does have its limitations. First, the unit root and cointegration tests employed in the procedure might suffer from a lack of power as discussed in earlier sections. Second, and more importantly, any estimation bias from the first step is carried forward in the estimate of the final equation in the second step.

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that is, it might suffer from "spurious regression problem" where t-statistics of the estimated parameters, or even R^2, are unreliable. However, we should not worry about these statistics now.

7.8.2.2 Single-equation error correction model

The single-equation ECM is merely a re-presentation of an autoregressive distributed lag (ADL) model (Banerjee *et al.*, 1993). De Boef (2001) described this similarity as "It [ECM] requires no restrictions on the ADL so that the same information is available from the ADL as from the ECM representation". As the ADL is the most general model applied to almost all types of time series data, the single-equation ECM is also applicable to both stationary and integrated time series. Thus, the stationarity of the data, and similarly the cointegrated relationship between the variable, is not a constraint here, unlike the EG technique.

The starting point for illustrating the basics of the single-equation technique is the ADL model. Following Keele and De Boef (2004), single-equation ECM can be driven from a simple ADL (1,1) model, as follows:

Equation 7-15

$$y_t = \alpha_0 + \alpha_1 y_{t-1} + \beta_0 x_t + \beta_1 x_{t-1} + u_t$$

To get the first difference of y, the term y_{t-1} is subtracted from both sides of the equation to create:

Equation 7-16

$$\Delta y_t = \alpha_0 + (\alpha_1 - 1) y_{t-1} + \beta_0 x_t + \beta_1 x_{t-1} + u_t$$

Then the term $\beta_0 x_{t-1}$ is added and subtracted from the right-hand side of the equation:

Equation 7-17

$$\Delta y_t = \alpha_0 + (\alpha_1 - 1) y_{t-1} + \beta_0 \Delta x_t + (\beta_0 + \beta_1) x_{t-1} + u_t$$

or

$$\Delta y_t = \alpha_0 + \beta_0 \Delta x_t + (\alpha_1 - 1)\left[y_{t-1} - \frac{(\beta_0 + \beta_1)}{(\alpha_1 - 1)} x_{t-1} \right] + e_t$$

Although the models specified under the ADL form do not give any direct or indirect indication of the system's speed of adjustment to any deviation (or disequilibrium) caused by changes in the explanatory variables, the coefficient (γ) under the ECM specification does give a direct approximation. As in EG method, the term (γ) is called the error correction rate or speed of adjustment coefficient. It should also be noted that, as (γ) = (α_1 -1), its sign should always be negative.

Given that the term ($y_{t-1} – x_{t-1}$) represents the gap between the dependent and independent variables, when this term equals zero, it indicates that the system is currently at its long-run equilibrium state. Otherwise, any value not equal to zero (positive or negative) will determine the extent to which the system is away from this equilibrium.

7.8.2.3 Johansen's maximum likelihood (ML) procedure

Johansen's technique for estimating the ECM is based on the vector autoregressive (VAR) model. It is a system-based approach rather than the simpler single equation-based counterparts (both previously described procedures are classified under the latter approach). This gives Johansen's procedure an advantage in cases where the number of variables of interest is more than two as there is a chance that the number of cointegration relationships might be more than one (multiple cointegrating vectors) and only the Johansen method can identify them. However, this also makes the Johansen method more complex. Given that, it is appropriate here to illustrate the Johansen method using a simplified illustration. Following Utkulu (1997), consider the following VAR model consisting of k variables:

Equation 7-18

$$Y_t = \sum_{i=1}^{p} A_i Y_{t-i} + E_t$$

where Y_t is a vector of k variables (or k x 1 matrix), A_i is an k x k coefficient matrix, and p is the optimum lag number in the VAR model. E_t is a vector of white noise errors. If exogenous variables need to be included to control for the deterministic trend or dummy variables, then the model specification becomes:

Equation 7-19

$$Y_t = \sum_{i=1}^{p} A_i Y_{t-i} + \delta D_t + E_t$$

where is D_t a vector of n exogenous variables which represent the deterministic trend or dummy variables (such as a constant term, a time trend, or policy dummies) and δ is a k x n matrix of coefficients for these exogenous variables.

The previous VAR model can also be rewritten in the form of a vector error correction model (VECM):

Equation 7-20

$$\Delta Y_t = \sum_{i=1}^{p-1} \Gamma_i Y_{t-i} + \Pi Y_{t-p} + \delta D_t + E_t$$

where:

$\Gamma_i = -I_k + \sum_{j=1}^{i} A_j$; $\Pi = -I_k + \sum_{j=1}^{p} A_j$

and I_k denotes a k x 1 identity (or unit) matrix. The intuition behind the Johansen approach to test for cointegration, and consequently EC specification, is to determine the rank of the Π matrix, r, as Π is considered a matrix of the long-run coefficient (Brooks, 2008, p. 350).

Therefore, the Π matrix is the most important term in the previous equation and requires further explanation. In fact, this matrix is a product of two matrices, α and β, and can be rewritten as:

$$\Pi = \alpha.\beta$$

where α is a (k * r) matrix and is often indicated as the adjustment (or the feedback) matrix while β is also a (k * r) matrix, referred to as the cointegrating matrix. In any system of possibly k cointegrated variables, there is at most r = k-1 cointegrating vectors. r indicates the rank of cointegration in the Johansen test. The Johansen procedure allows us to determine the number of cointegrating vectors or rank of cointegration which contributes to a better and more efficient estimation of the ECM (Demetrescu *et al.*, 2008).

The Johansen procedure is sensitive to lag order used in the VECM, for this reason it is important to determine the optimum lag length (Nielsen, 2001). This can be done by using the lag which minimises the information criteria (Brooks, 2008, p. 350).

The Johansen procedure is undoubtedly superior to the single-equation approach in terms of statistical properties of the model as well as the size and power of the associated (Johansen) test for cointegration. Yet the different theories underlying these procedures make a direct comparison between them inappropriate. Charemza and Deadman (1992, p. 201) suggest that the different approaches must be perceived as complementary and not as substitutes for each other. This view is shared by Utkulu (1997), who suggested that Johansen's system-based approach should be treated as a verification of the single-equation methods. The same author identified the shortcomings of the Johansen method, particularly with a small sample size or when more than a single cointegrating vector is estimated; both of these conditions applied to our data, as will be shown later.

7.8.3 Empirical results

As previously discussed, the ECM can be estimated using three different techniques: the EG two-step procedure, the single-equation ECM procedure, and Johansen's system approach. As more lags and differences are involved in the ECM procedure, this estimation approach requires a larger sample size than the partial adjustment model (PAM). Thus, a panel dataset including London had to be used to increase the total number of observations. The ECM estimation results based on the single-equation error-correction procedure and Johansen's system approach have been found to be insignificant. Thus, the ECM estimation results based on the EG two-step procedure are discussed in the next section.

7.8.3.1 The Engle–Granger two-step procedure

In this section, the ECM for bus demand was estimated using the EG two-step method (Engle and Granger, 1987). One advantage of employing this procedure is that the ordinary least squares (OLS) estimator can be used to estimate the model's parameters, despite the fact that the relationship modelled using the ECM is nonlinear (Asche, 1997).

The final model can be specified as follows:

Equation 7-21

$$\Delta \mathrm{y_t} = \alpha\, \Delta \mathrm{x_t} + \gamma\, \hat{\mathrm{u}}_{t-1} + e_t$$

or

$$\Delta Ln(Q_t) = \alpha_1 \Delta Ln(S_t) + \alpha_2 \Delta Ln(F_t) + \alpha_3 \Delta Ln(I_t) + \gamma\, [Ln(Q_{t-1}) - \beta_1 Ln(S_{t-1}) - \beta_2 Ln(F_{t-1}) - \beta_3 Ln(I_{t-1})]$$

The error term should be stationary I(0) only if the integrated variables are also cointegrated, according to the EG theorem. Otherwise, $\hat{\mathrm{u}}_t$ will still be a non-stationary process. Therefore, in the first step of the EG procedure, the long term relationship should be estimated first and the stationarity of its residual should be tested.

The long term relationship is modelled using a static regression with the variables in their levels as:

Equation 7-22

$$\mathrm{Ln(Q_t)} = \beta_1 \mathrm{Ln(S_t)} + \beta_2 \mathrm{Ln(F_t)} + \beta_3 \mathrm{Ln(I_t)} + \beta_4 (\text{Deregulation dummy}) + \beta_5 (\text{time trend}) + \mathrm{u_t}$$

to estimate the residuals in practice, we need to re-write the equation in the following form:

Equation 7-23

$$\hat{\mathrm{u}}_t = \mathrm{Ln(Q_t)} - \beta_1 \mathrm{Ln(S_t)} - \beta_2 \mathrm{Ln(F_t)} - \beta_3 \mathrm{Ln(I_t)} - \beta_4 (\text{Deregulation dummy}) - \beta_5 (\text{time trend})$$

If the residuals $\hat{\mathrm{u}}_t$ are found to be stationary, then we can be sure there exists a cointegrating relationship between the variables. Hence, the ECM specification is warranted.

The outputs of step 1 of the EG approach, or the static long run relationship, reveal a robust estimate. Table 7-5 summarises the results of step 1 of the EG method. All coefficients are statistically significant at the 1% level of significance and have the expected signs.

Theoretically, rather than statistically, the service variable should have the expected positive sign whereas income and fare are expected to have the opposite signs. Nonetheless, Engle and Granger proved that, although these estimates using OLS are super consistent, theoretical inference still does not apply at this first stage (Asche, 1997). Thus, inferences of the results should only be possible after the final stage.

Next, the estimated residuals $\hat{u}_t$ from the first step should be tested by any standard unit root test. Following Dargay and Hanly (1999), the estimated residuals $\hat{u}_t$ from the first step have been tested by the ADF test for each individual area in the panel. The outputs show that the residuals are stationary[65]. Based on the last results, the analysis can proceed to the second step.

In the second step of the EG two-step method, a lag of the residual term obtained from the first step is used to employ the error-correction mechanism in the final model, along with first difference of each variable.

The final equation of the ECM is:

Equation 7-24

$$\Delta Ln(Q_t) = \alpha_1 \Delta Ln(S_{t-1}) + \alpha_2 \Delta Ln(F_{t-1}) + \alpha_3 \Delta Ln(I_{t-1}) + \gamma \hat{u}_{t-1} + e_t$$

where e_t is an error term. The coefficient γ of the lagged residual term ($\hat{u}_{t-1}$) determines the presence of an error-correction mechanism in the previous equation. Thus, it should have a negative sign while its magnitude ranges between 0 and 1.

The results of the second step of the EG method revealed $-1 < \gamma < 0$, as displayed in Table 7-6. Looking solely at this value, we can indicate the proper specification of the ECM. Yet the significances of the estimated parameters are accepted at 10% only, particularly for the income variable and lagged residual term $\hat{u}_{t-1}$, while the values of R^2 are relatively low compared to the estimated PAM.

Table 7-5 Results of step 1 in the Engle-Granger procedure

Variable	Coefficient	t	p-value
$Ln(S_t)$	1.069	9.14	0.00
$Ln(I_t)$	-1.779	-6.27	0.00
$Ln(F_t)$	-0.403	-5.11	0.00
DD	-0.220	-7.07	0.00
TT	0.033	5.12	0.00
Londondv	0.596	10.22	0.00
Metsdv	0.288	4.89	0.00
Scotdv	0.031	0.41	0.68
Walesdv	-0.180	-6.18	0.00
Constant	16.297	6.8	0.00

Number of obs = 131, F(9,121) = 745.74, Prob > F = 0.000,
R-squared = 0.9823, Adj R-squared = 0.9810

[65] Again, due to space limitations, are moved to a technical appendix.

Table 7-6 Results of step 2 in the Engle-Granger procedure

Variable	Coefficient	t	p-value
$\Delta Ln(S_t)$	0.268	3.08	0.00
$\Delta Ln(I_t)$	-0.521	-2.71	0.01
$\Delta Ln(F_t)$	-0.309	-6.30	0.00
EC_{t-1}	-0.088	-2.25	0.03
Londondv	0.024	2.83	0.01
Metsdv	-0.006	-0.66	0.51
Scotdv	-0.004	-0.43	0.67
Walesdv	-0.008	-0.92	0.36
Constant	-0.001	-0.13	0.90

Number of obs = 126, F(8, 117) = 12.50, Prob > F = 0.000
R-squared = 0.461, Adj R-squared = 0.424

Using larger lag lengths

In the short run context, the shock in one or more explanatory variables might have gradual effects on the dependent variable rather than the instant change computed by the end of the first year. Considering this point, lags of the first difference of these variables should be included to allow for such gradual effects. The estimated model can then be written as:

Equation 7-25

$$\Delta Ln(Q_t) = \alpha_0 + \sum_{i=1}^{p} \delta_{1i}\Delta Ln(S_{t-i}) + \sum_{i=1}^{p} \delta_{2i}\Delta Ln(F_{t-i}) + \sum_{i=1}^{p} \delta_{3i}\Delta Ln(I_{t-i}) + \alpha_1\hat{z}_{t-1} + e_t$$

where p is lag length. The size of p should be chosen carefully. As a rule of thumb, Enders (1995, p. 313) suggests that three years is an appropriate length to allows for the system's dynamics. Up to three lags were incorporated into the previous equation, which left the results unchanged. Thus, it can be concluded that larger lag lengths (larger than 1) do not seem to add in much information or result in a better model estimate.

In conclusion, the ECM estimated by the EG two-step procedure has significant statistics and reasonable elasticities. However, the limits of the EG procedure, as previously discussed, encourage a re-estimation of the ECM using a better estimation technique—namely, the single-equation error correction procedure and Johansen's system approach.

Table 7-7 Short and long run elasticities drawn from ECM, estimated by the EG procedure.

	Specification includes time trend		Specification excludes time trend	
	Short-term	Long-term	Short-term	Long-term
Service	.268	1.069	.259	.895
Income	-.521	-1.779	-.495	-.375*
Fare	-.309	-0.403	-.317	-.488

*Long term elasticities smaller than the short counterpart are common under error correction specification (see OXERA, 2003, for example).

The outputs in Table 7-5 and Table 7-6 suggest the following equation (written in the common error-correction form):

Equation 7-26

$$\Delta Ln(Q_t) = 0.268\,\Delta Ln(S_t) - 0.309\,\Delta Ln(F_t) - 0.521\,\Delta Ln(I_t) - 0.088\,\hat{u}_{t-1} + e_t$$

where

$$\hat{u}_{t-1} = Ln(Q_{t-1}) - [16.297 + 1.069\,Ln(S_{t-1}) - 0.403\,Ln(F_{t-1}) - 1.779\,Ln(I_{t-1}) - 0.22\,\text{DD} + 0.033\,\text{TT}]$$

where DD is a deregulation dummy and TT denotes the time trend variable.

7.8.4 Final conclusion on ECM estimation

The ECM estimation in this chapter is motivated by the need for an alternative empirical methodology; besides the PAM, to forecast the local bus demand under the counterfactual scenarios. The main objective is to re-estimate the bus demand function using an approach able to handle the dynamic behaviour in a more advanced way.

There are only few previous assessments for the bus demand model which employed the cointegration and ECM approaches in an attempt to estimate the short and long-run relationships (Dargay and Hanly, 1999; Romilly, 2001).[66] In the first study, they employed similar explanatory variables (bus fare, service, and income) in the ECM which was estimated by the EG two-step procedure; other alternative procedures such as the single-equation ECM or Johansen's procedure were not used. Whereas in the second, the analysis was based on a pure time series analysis rather than utilising the advantages of panel data. Thus, the finite-sample properties of this estimate are uncertain.

It is very clear that, although employing the concept of cointegration and the error-correction mechanisms in the model has many advantages as previously detailed, this is not a straight forward process.

The best estimated ECM, in turn, suggests that all the explanatory variables are significant in the long run as well as in the short run. The size of the speed of adjustment coefficient (-0.088) suggests a slow adjustment rate in the system to any shocks in the explanatory variables. In other words, the bus demand level is adjusting back to its long term equilibrium level, but only 8.8% of the gap will be filled in the first year.

[66] Wheat and Toner (2010) estimated ECM but have not reported the estimation results.

Table 7-8 Comparison of the estimated bus demand elasticities based on error correction models

Model	Service		Income		Fare	
	SR	LR	SR	LR	SR	LR
Our model	0.27	1.07	-0.52	-1.78	-0.31	-0.40
Dargay & Hanly (1999)*	-0.07	0.36	0.27	-0.64	-0.49	-0.88
Romilly (2001)	-0.11	0.30	0.23	0.61	-0.38	-1.03
Recommended values**	0.38	0.9	-	-0.5 to -1.0	0.38	0.9

* see Table B.3.1 in this source. **As suggested by Balcombe *et al.* (2004).

For comparison, the elasticities estimated from the ECM reported in the two previous studies are given in Table 7-8. Our model estimated short and long service elasticities close to the recommended values—closer than the other models. The income elasticities are clearly higher than others (in absolute terms). Regarding fare elasticities, the short run value is very reasonable and close to the recommended values whereas the long run value is smaller than what was recommended. Table 7-8 clearly highlights the differences between these studies with respect to the various estimated elasticities. These differences show the sensitivity of the ECM and can be attributed to differences in the employed datasets[67] and model specification.

There are some findings that are based on cointegration and the ECM approach. The results of the time series and panel analysis using unit root and cointegration tests provide evidence that the variables included in the local bus demand model are integrated (non-stationary) but bounded together in the long run (by a cointegration relationship). Furthermore, Balcombe *et al.* (2004, p. 43) suggested further work when cointegration and the ECM approach are considered. They suggested determining the number of cointegrating relationships in the model whenever there are more than two variables considered. This point is tackled and the results suggest the presence of only a single cointegrating relationship between the considered variables.[68]

Another finding is that the error-correction mechanism seems to exist in the demand function. A robust ECM is estimated using the EG two-step estimation procedure. Thus, the estimated ECM will be compared with PAM and the chosen model will be used in forecasting the counterfactual scenarios.

[67] For example, Dargay and Hanly's (1999) model is estimated for panel data collected for GB whereas the model in Romilly (2001) is estimated using time series data for GB excluding London.
[68] Initially, the analysis suggested two cointegrating relationships, but the model estimation procedure suggests that only a single relationship is found to be significant. A larger sample size is required in future work to further investigate this issue.

7.8.5 Model choice: PAM or ECM

Now we need to choose between the models estimated by the partial adjustment and error-correction specifications. Table 7-9 and Table 7-10 offer some useful comparisons of the two modelling approaches. As the significant estimate of ECM is only possible when the panel dataset including London is used, it will be compared with PAM estimates using the same dataset (for comparison purposes only; see column 1 in Table 7-9). Overall the two approaches give roughly similar elasticities for service and income variables, although fare elasticities are different. This indicates that alternative model specifications do not differ much. The R^2 is much higher in PAM compared to that associated with ECM. Although the alternative model specifications differ in defining the dependent variable (one in level and the other in first difference), the PAM is in fact an unrestricted version of the ECM.[69] Another way to compare between these models is to look at the model selection criteria. Both AIC and BIC suggest no preference of any model as both models share almost similar figures.

The TRL's practical guide justifies the use of PAM over ECM in a relatively small sample as "error correction models can be more data intensive and hence partial adjustment models are often used where time series data sets are limited in duration." (Balcombe *et al.*, 2004, p. 43)

Furthermore, Wheat and Toner (2010) compared the ECM and PAM and preferred the use of the latter based on the fact that:

> "The simplicity of the PAM however has the advantage that it is parsimonious relative to the ECM. Further, given that we are considering yearly data in this application, it is unlikely that the ECM provides a sufficient superior description of the data vis-à-vis the extra parameters that need to estimated."

In addition, there is a practical advantage of the estimated PAM that makes it possible to isolate London from the rest of GB[70]. This will enable us to compare the two regulatory regimes adopted in these areas. Therefore, we will choose and rely on the PAM[71] in the subsequent chapters.

Table 7-9 Short and long run elasticities drawn from PAM, estimated by the PCSE estimator

	Panel A (including London)	
	Short-term	Long-term
Service	0.180	1.137

[69] I am very thankful for professor Jean-Yves Pitarakis (University of Southampton) for commenting on how to compare PAM and ECM: "Partial adjustment models are just a variant of the ECM. In a crude way one could still compare their r-squares. You might worry about what's going on if they are drastically different. An alternative model comparison could be based on either the AIC or BIC model selection criteria."

[70] ECM requires larger sample size and London's data had to be merged with other areas of GB.

[71] As we decided earlier, we will use the PAM which was estimated using a panel dataset excluding London.

Income	-0.343	-2.175
Fare	-0.114	-0.720
Speed of adjustment (θ)*	0.842	
The adjustment coefficient (1-θ)**	(0.158)	
R-squared	0.997	
AIC	-566.6	
BIC	-544.4	

The dataset used is panel A (including London). Heterogeneity controlled by Fixed Effect *The higher the value of θ, the slower the speed of adjustment (longer periods are required to reach equilibrium). **Equivalent to the feedback effect (γ) in the Error Correction Model specification.

Table 7-10 Short and long run elasticities drawn from ECM, estimated by the EG procedure

	Panel A (including London)*	
	Short-term	Long-term
Service	.268	1.069
Income	-.521	-1.779
Fare	-.309	-0.403
The feedback effect (γ)**	0.088	
Adjusted R-squared	0.448	
AIC	-565.4	
BIC	-543.2	

The dataset used is panel A (including London). Heterogeneity controlled by Fixed Effect. *Results of the model based on panel dataset excluding London are insignificant and omitted, as ECM specification consumes a larger number of observations than PAM, where a larger number of observations is required. **Equivalent to adjustment coefficient (1-θ) in the partial adjustment specification.

8. Extrapolation of Key Input Variables under the Counterfactual Scenarios

The main objective of this chapter is to extrapolate the values of key inputs under the counterfactual scenarios. These input values along with the estimated parameters (elasticities) will shape the counterfactual scenarios. Most of these input variables will be used in the cost model to forecast the total costs under the "counterfactual" scenario—namely, the continuation of the regulated regime. The second counterfactual scenario considered in this research, "replaced subsidy", assumes the industry is deregulated and privatised, but with "no" subsidy reduction. Under this scenario, only fares will be affected (lower levels) which in turn will affect demand, with no impacts on any other variables (Romilly, 2001). As the impacts of subsidy are explicitly incorporated in the fare model which was estimated for that purpose, extrapolated values of the subsidy variable will be substituted in the model to forecast fares. Table 8-1 summarises which input variables need to be extrapolated and which will be forecasted using the corresponding model under each scenario.

Table 8-1 Input variables under counterfactual scenarios

Counterfactual scenario	Extrapolated input variable	Forecasting model	Notes
1- The "counterfactual" scenario (continuation of the regulated regime*).	Staff number Wages VKM	Cost Model	Diesel prices will be used as actually observed.
	Subsidy	Fare Model	Cost values, as forecasted by the cost model, will be feedback as input in the fare model
	VKM (as used as input in the cost model above)	Demand Model	Fare values, as forecasted by the fare model, will be feedback as input in the demand model. Values of personal income variable will be used as actually observed.
2- The "replaced subsidy" scenario (policy reforms with "no" subsidy reduction)**	Subsidy (is counterfactual as in the previous scenario)	Fare Model	Cost values will be used as actually observed.
		Demand Model	Fare values as forecasted by the fare model will be feedback in the demand model. Values of all input variables (other than fares) are as actually observed.

No extrapolation of some input variables (income, population, diesel prices, and motoring costs) as their values are used as actually observed. *The reference scenario. **Very similar to the actual scenario, deregulation or competitive tendering and privatisation, but with no subsidy reduction which will only affect fare directly and demand indirectly (through higher fares), but with no effects on costs; a similar scenario considered by Romilly (2001).

8.1 Forecasting Methods

Time series forecasting models, in contrast to causal models, are appropriate in the case of univariate forecasting or where we have little theoretical knowledge about the factors (explanatory variables) that shape the trend of the forecasted variable. The forecast process in the time series models is built on the past historical observations of the examined variable (or time series) assuming the continuation of the same influencing factors (at the same level of effect) in the future, as in the past. The patterns observed in the historical data (trend, seasonality, and/or cycles) are captured and then extrapolated into the future (Chatfield, 2002).

Time series forecasting models are considered for two reasons. First, given our theoretical (or counterfactual) assumption that the pattern observed in our time series data in the pre-deregulation era would continue after deregulation, then the time series model should be an appropriate approach in this case. However, the underlying assumption becomes more unsubstantiated the longer the time horizon is forecasted. This is not limited to time series methods. Any forecasting procedure would involve some assumptions and, consequently, the uncertainty level would increase as the length of the period needs to be forecasted increases, regardless of the type of method employed in the forecast. It should be noted that, generally speaking, the longer the forecasting period is stretched into the future, the less accurate the forecasts become. Second, the time series model is usually preferred over the causal model in an "out-of-sample" forecast (Chatfield, 2002). Nevertheless, the causal model will be used in a later (or complementary) step to perform a "within-sample" forecast[72] of some dependent variables (bus demand, fares, and cost).

8.1.1 Time series forecasting models

The most general and sophisticated time series models for forecasting are the autoregressive integrated moving average models, typically denoted as ARIMA (p, d, q).[73] This method, developed by Box and Jenkins (1970), forecasts the variable (time series) based on its historical

[72] It should be noted that the input variables are forecasted (in this chapter beyond 1985/6 based on historical data before that year). Thus, this is an "out of sample" forecast. However, these values will be used as inputs in the cost, fare, and demand models which are estimated based on actual data up to year 2000/10. Therefore, these "causal" models will be used for "within the sample" forecasts of cost, fares, and demand.

[73] Where p is the number of autoregressive terms, d is the number of nonseasonal differences, and q is the number of lagged forecast errors in the prediction equation.

values and stochastic error terms. Four sequential steps are included in Box and Jenkins' methodology for forecasting: (model) identification, (parameters) estimation, diagnostic checking and finally forecasting (for details of the procedure, see Maddala, 1992, p. 542; Chatfield, 2003, p. 65). However, the identification ARIMA models requires a minimum of 50 observations or more (McCleary and Hay, 1980; Tayman *et al.*, 2007).

As it simply forecasts the future based on the past, the time series forecast is reliant on the availability of historical observations. Most data (time series) on variables used in the current research are only available from the 1970s or early 1980s. As the policy change occurred in the mid-1980s, this leaves us with very few annual observations to be used to forecast the counterfactuals.

Therefore, other simpler time series methods for forecasting are suggested here, as these are considered to be much less data consuming than the more sophisticated ARIMA models. Nevertheless, it should be emphasised that these models are no less accurate than the sophisticated ARIMA models. For example, based on an extensive review of time series models for forecasting, Armstrong (1984) concluded from 25 years of research that "sophisticated extrapolation techniques have had a negligible payoff for accuracy in forecasting". Armstrong even recommended the use of simple models over the more sophisticated counterparts: "Meanwhile, simple methods and the combination of forecasts are recommended."

Simpler time series methods for forecasting include moving averages, smoothing techniques, or Holt's linear exponential smoothing (Chatfield, 2002). These methods forecast future values of any time series by extrapolating the historical level, trend, and seasonality components observed in the series into the future, assuming the continuation of these patterns. Due to space limitation, the detailed calculations to forecast subsidy values using time series forecasting models is moved to a technical appendix.

8.1.2 Concluding remark on time series forecasting methods

Moving average and exponential smoothing are among the most popular time series techniques used for forecasting. The advantage of these methods is that they are easy to evaluate and adjust through adaptive procedures (Yaffee and McGee, 2000). Moving averages can be seen as a filtering step (filtering the white noise error from the time series) rather than as a forecasting model. Exponential smoothing models are better than the moving average in forecasting as they appropriately handle trend and seasonality patterns. In fact, these models take advantage of these patterns by employing them in the forecasting process.

The question here is how well the various methods accurately forecast the future. In addition to determining their forecast accuracy, there is a common procedure used to choose the most appropriate forecasting method for our data. Single exponential smoothing (SES) mostly forecasts better than the naive forecast (forecasted values are the same as the last observation in the series) or the moving averages. Then again, the single exponential smoothing model forecasts well with de-seasonalised data collected on a monthly basis rather than annual data. The latter data are better forecasted using double exponential smoothing (i.e., Holt's methods), especially when the data show a trend pattern (Yaffee and McGee, 2000). Finally, the Holt-Winter method is superior where both trend and seasonality might be involved (Makridakis *et al.*, 2008). As our data are time series collected annually, they have no seasonality pattern, but a clear trend is observed. Therefore, based on the described patterns of the series, the double exponential smoothing or Holt's linear smoothing model should forecast well. These methods were highly sensitive to the assumptions underlying certain parameters.

Given such sensitivity of these time series forecasting models and the contrasting forecasting results obtained, a simpler approach based on trend analysis is recommended to forecast the counterfactual values. The long time period intended to be forecasted under the counterfactual scenario would make any degree of inaccuracy of forecasting assumptions result in a very ambiguous forecast. Trend analysis will help provide good knowledge of the historical movements in the considered time series, which in turn can help predict the counterfactuals.

8.2 Trend analysis

8.2.1 Service level or vehicle kilometres (VKM)

The historical trend in vehicle kilometres (VKM) should help predict their counterfactual values. Figure 8-1 illustrates the actual trends of VKM in GB as a whole, outside London, and within London. A clearer picture is drawn when the observed pre-deregulation trend in each area is forecasted forward (using linear trend line) to predict the counterfactual VKM (expected trend since the mid-1980s), as will be illustrated later in Figure 8-5 and Figure 8-6.

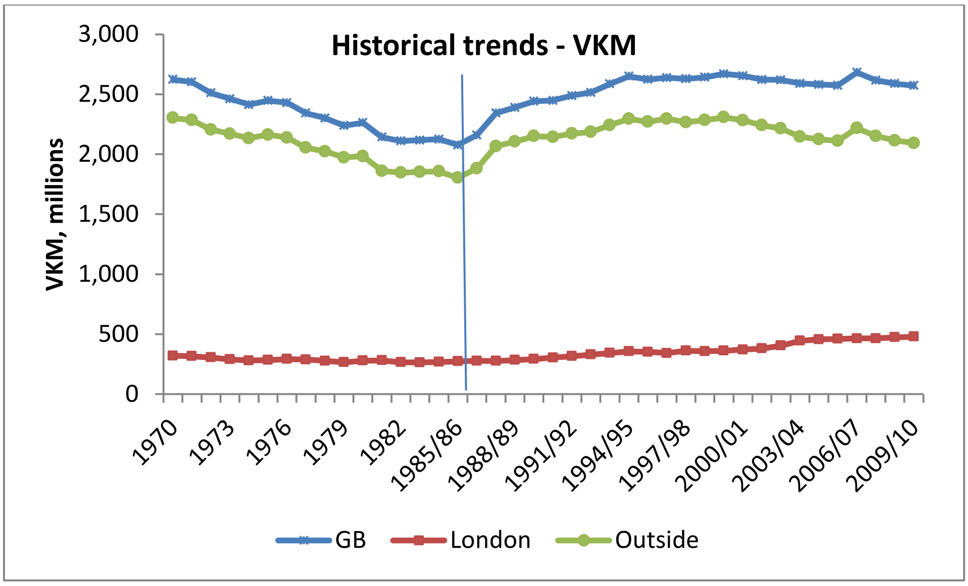

Figure 8-1 Historical trend in vehicle-kilometres in GB

8.2.1.1 Disaggregation into commercial and subsided VKM

Consistent data on service provision divided into commercial services and socially subsided services are available since 1987/8. The market deregulation combined with commercialising and privatising publicly owned bus operators resulted in a sharp increase in commercial VKM from 1987/8 until the mid-1990s, when the trend started to fluctuate around a constant level before declining sharply to a point lower than the 1987/8 level (see Figure 8-2). This clearly indicates the policy's failure to achieve one of its main objectives: to maintain bus service provisions operated on a commercial basis. This conclusion is confirmed by the observed trend in subsidised VKM which increased sharply in recent years (see Figure 8-3). Local authorities were forced to substitute the loss in commercially unviable routes using socially necessary subsidised services.

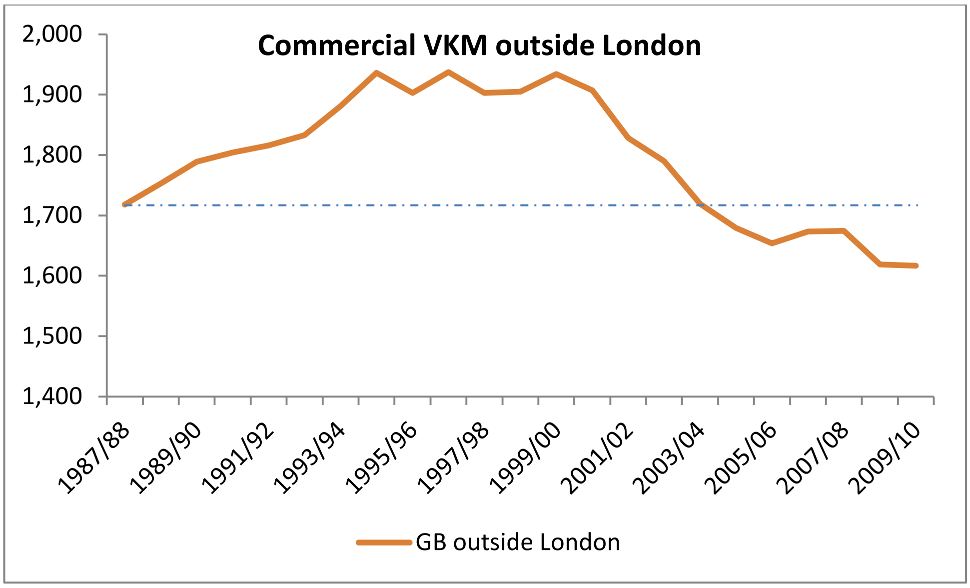

Figure 8-2 Commercial VKM since 1987/88 in GB outside London

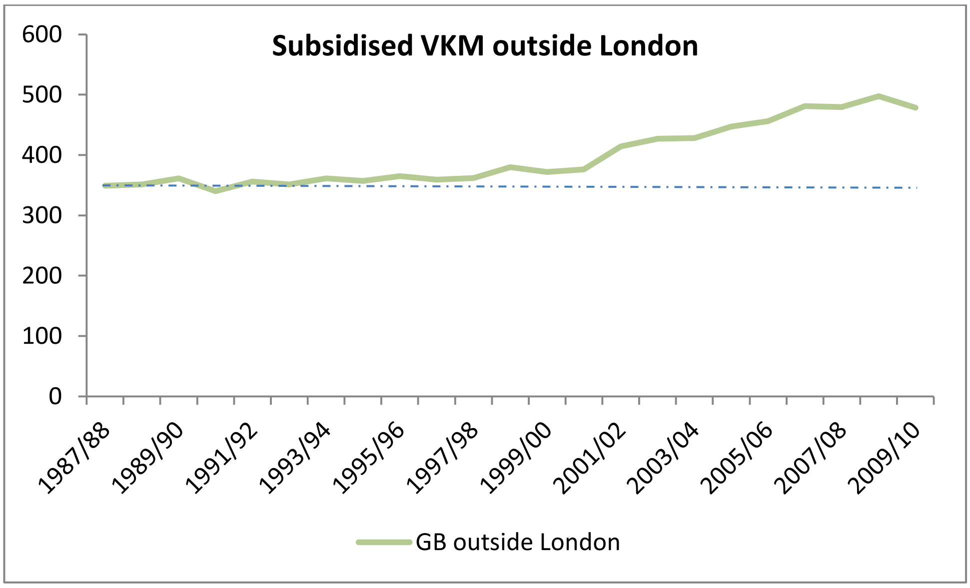

Figure 8-3 Subsidised VKM since 1987/88 in GB outside London

Moreover, similar data disaggregated by area level shows that the greatest increase in subsidised VKM was observed in English shires, where a lower population density makes the service routes less commercially viable (see Figure 8-4). Similar trends, albeit to a lesser extent, are observed in Wales and Scotland. In contrast, the English Metropolitan areas, where the population is highly concentrated, have experienced a slight decrease in subsidised VKM as more viable routes are expected in such areas.

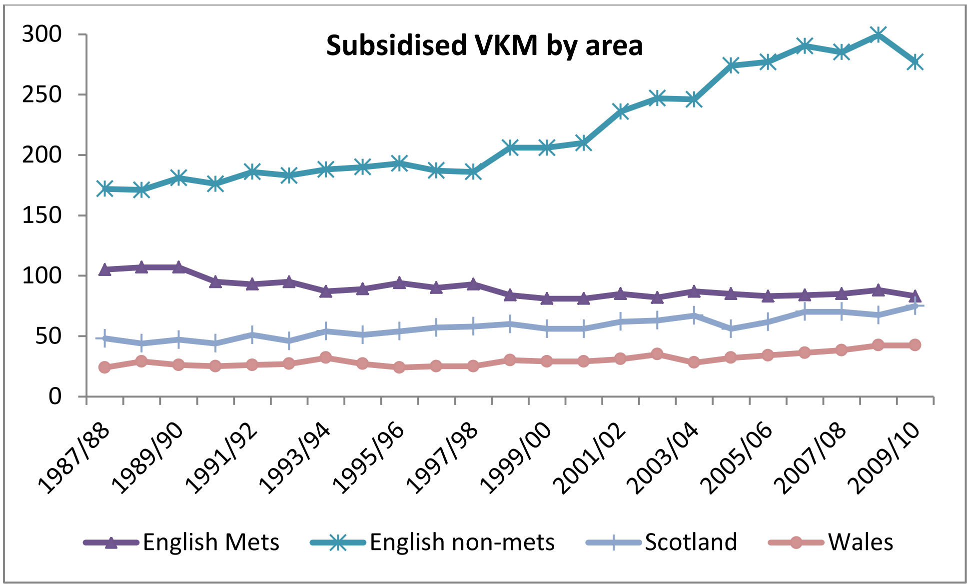

Figure 8-4 Subsidised VKM by area since 1987/88

It can be argued that the previous figures include absolute number and do not account for changes in service provisions. Between 1987/8 and 2007/8, the percentage of the bus market's commercial sector dropped from 83% to 78%. Although not a very significant change, this might cause some concerns given the recent trends in operators deregistering their commercial routes.

8.2.1.2 Counterfactual scenario in service

A linear trend line seems to reasonably fit the data in the pre-deregulation period and should give a very satisfactory forecast as the R-squared factors are very high. Under the counterfactual scenario, sharp steadily declining trends are forecasted in deregulated areas and London—sharper in the former area (see Figure 8-5 and Figure 8-6).

As illustrated in the same figures, it is unarguable that VKM increased sharply, reversing the long term decline trend as a result of the new policies implemented outside London and within. However, these increases in the deregulated area were unsustainable and started to level out after the end of the first decade before declining again in recent years. A better picture in service provisions was drawn in London, where a sustained growing trend has been observed.

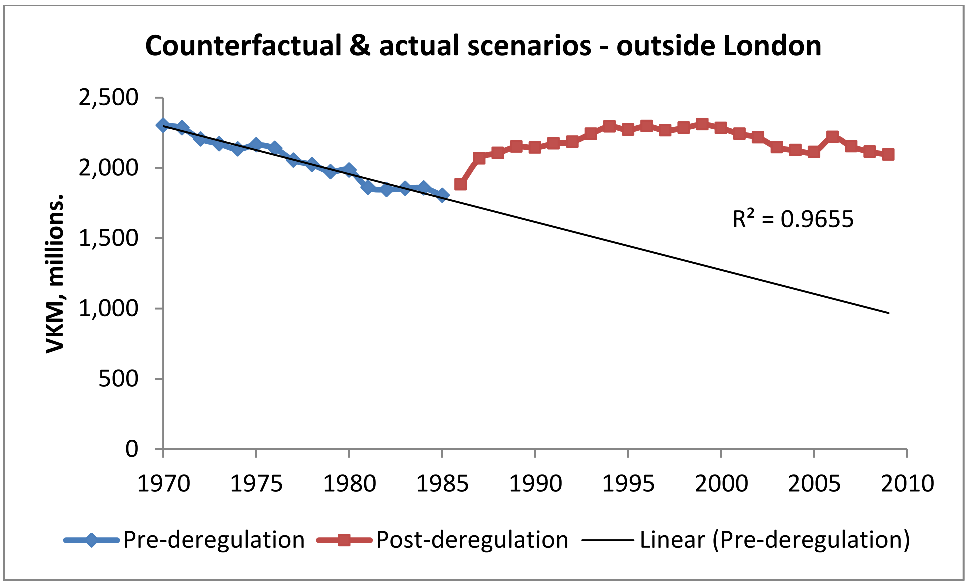

Figure 8-5 Service provision—counterfactual and actual scenario—outside London

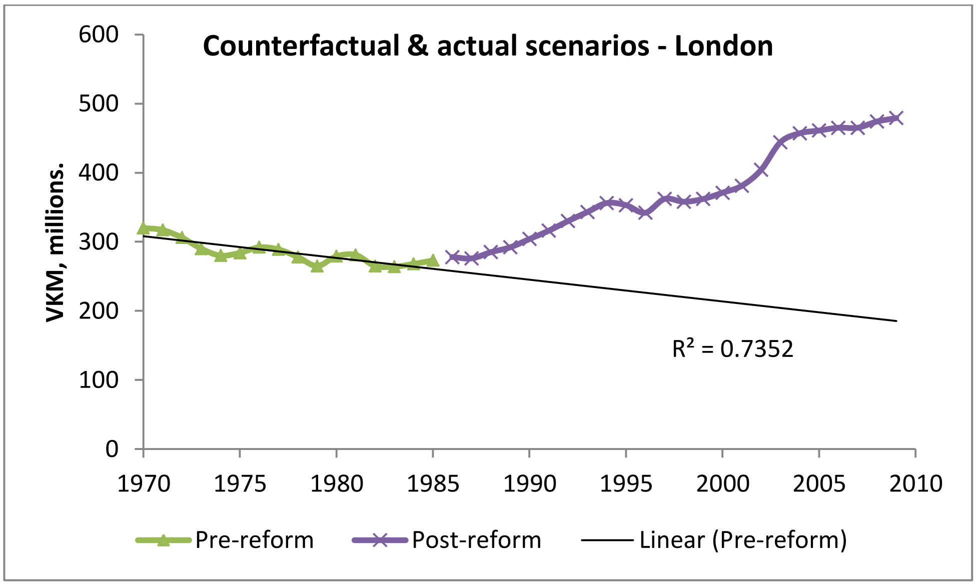

Figure 8-6 Service provisions—counterfactual and actual scenarios—in London

8.2.1.3 Conclusion on the counterfactual VKM

The VKM under the counterfactual scenario can by forecasted by fitting a linear trend line as it reasonably fits the data as shown in Figure 8-5.

8.2.2 Staff employed

A wider look to the historical trends in the number of all staff shows that the trend was declining in the pre-deregulation era, a sign of clear reverse in the trend occurring after deregulation, as shown in Figure 8-7.

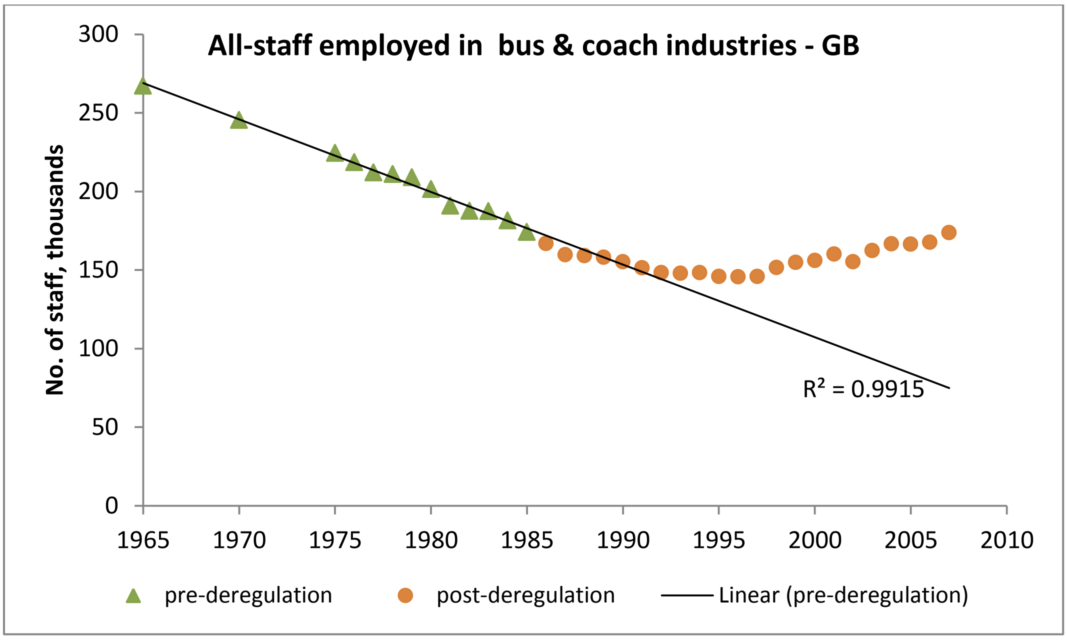

Figure 8-7 Historical trend in number of total staff employed and counterfactual scenario

To predict the counterfactual scenarios, a linear trend line is once again fitted into the data points in the pre-deregulation period as the pattern follows a straight line and the R-squared is extremely high. Hence, it should give a very accurate forecast after deregulation, assuming the counterfactual scenario. Declining trends in the total number of staff would be expected to continue if the old regulated system had been continued.

It should be noted that the only consistent data in staff number, published by the Department for Transport, is the aggregate number of staff employed in the bus and coach industry in GB. Hence, the effects of London's mid-1980s policy change are unclear, as disaggregate figures (number of staff) related to London, if available, are expected to be small and overwhelmed by the figures associated with the other areas of GB. On the contrary, the impacts of the deregulation policy outside of London are expected to be captured when using these data.

London's share is expected to be about 17% of total staff employed in the bus and coach industry in GB (see Table 8-2) based on limited data available for London. The only separate figure available for staff employed in London's bus operations can be found in the 1985 Transport Statistics Great Britain (TSGB), under the category London Bus Limited (LBL) for 1975 to 1984. Unfortunately, it was discontinued since then as the LBL was abolished in parallel with the mid-1980s policy intervention in London and to protect the commercial confidentiality of bus operators.

Table 8-2 Comparison of the number of staff employed in LBL and the broader bus and coach industry, 1975–84

Year	All staff – GB*	All staff – LBL**	%
1975	224.4	34.8	16%
1976	218.5	34.8	16%
1977	212.1	34.9	16%
1978	211.1	34.9	17%
1979	208.9	34.7	17%
1980	201.5	34.5	17%
1981	190.9	34.4	18%
1982	187.7	33.1	18%
1983	187.4	32.4	17%
1984	181.5	31.9	18%

*Staff employed in bus and coach industry. Source: Public Transport Statistics Bulletins (various editions).
**Staff employed in London Bus Limited (LBL). Source: The 1985 Transport Statistics Great Britain (TSGB).

Under the counterfactual scenario, the total number of employed staff can be assumed to follow the declining trend as indicated by the fitted linear trend line, as it reasonably fits the historical data as shown in Figure 8-7. This trend is assumed to represent the deregulated areas as it is overwhelmed by the share associated with staff employed in GB outside London. Thus, London's figure will be assumed to be equal to 17% of the total number,[74] as previously demonstrated.

8.2.3 Staff productivity: total vehicle kilometres per staff

The historical trend in staff productivity measured by vehicle kilometres per staff illustrate that the mid-1980s policy changes in GB, both outside and within London, have little effects on total staff productivity (Figure 8-8). Non-platform staff productivity has strongly improved due to the mid-1980s changes. Nevertheless, the productivity of platform staff, who weigh much more than the non-platform staff, has not improved.

[74] Fitting trend line to historical LBL data and extrapolating the values since the policy changes gives similar results.

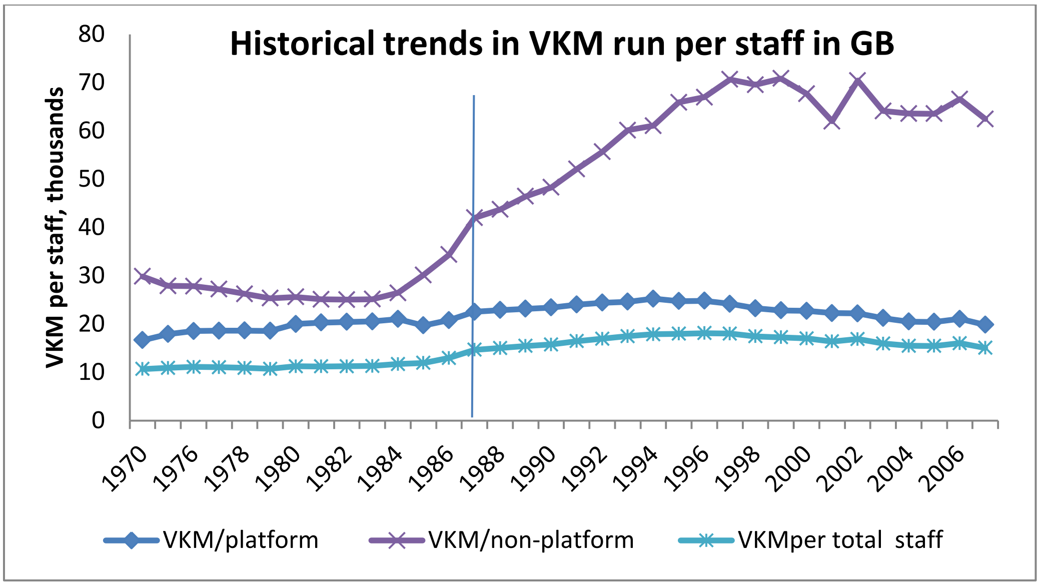

Figure 8-8 Historical trends in staff productivity (VKM per staff)

Under the counterfactual scenario, staff productivity can be very reasonably assumed to be constant (as the 1985/6 level) as almost a flat historical trend of staff productivity, measured by VKM run per total staff, was observed in the years preceding the mid-1980s changes. Otherwise, a linear trend line that fits the historical data and is forecasted further in the future can be a very adequate alternative forecasting method. Figure 8-9 illustrates this alternative forecasting technique (a linear trend line). Based on these results, it can be concluded that the mid-1980s policy changes have brought only slight improvement in staff productivity, if the whole time period is considered. Although a fast-growing trend in staff productivity was observed in the first years following the changes in the mid-1980s, these gains were almost lost during the most recent years.

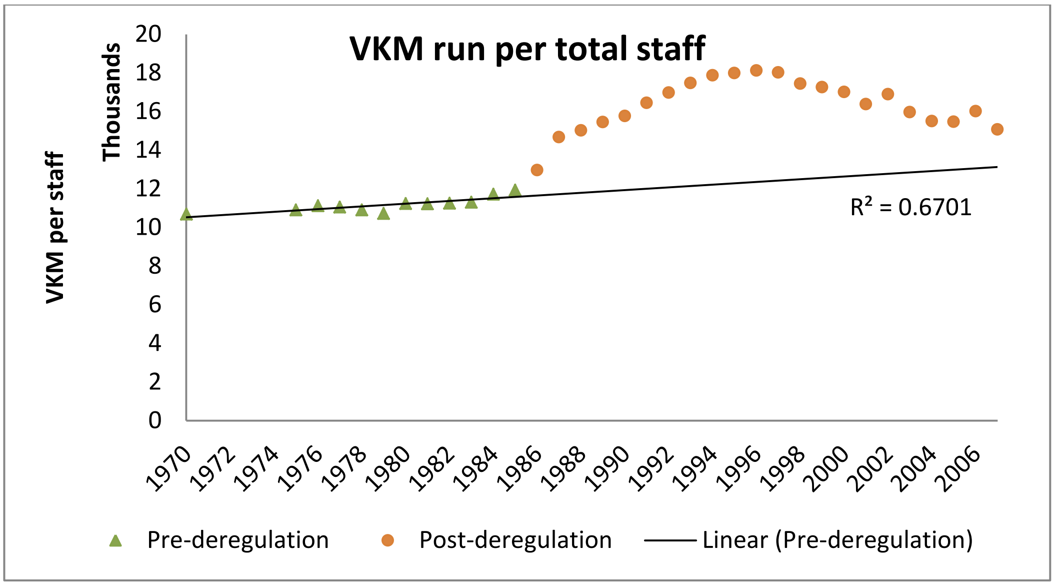

Figure 8-9 Counterfactual and actual scenarios in all staff productivity (VKM run per staff)

The level of staff productivity under the counterfactual scenario can very reasonably be assumed to be constant (1985/6 level) as almost a flat historical trend in staff productivity, measured by VKM run per total staff, was observed in the years preceding the changes in the mid-1980s. Still, a linear trend line that fits the historical data and is forecasted further in the future can be a very adequate forecasting method (see Figure 8-9).

8.2.4 Diesel prices

Historically, diesel prices after duty fluctuated between a flat level and a downward trend, as shown in Figure 8-10. However, diesel prices dropped sharply after the policy implementations in the mid-1980s and did not recover to the same initial level until very recently. The lowest prices ever occurred in the late 1980s and lasted until the end of the 1990s. Given that, White's (1990) argument that cost reductions observed in the late 1980s were partly due to falls in fuel prices is very justified. More importantly, White's argument is not only limited to the short-term period just after deregulation, but should also be extended to include the longer-term period under assessment in this research—namely, from deregulation until 2009/10.

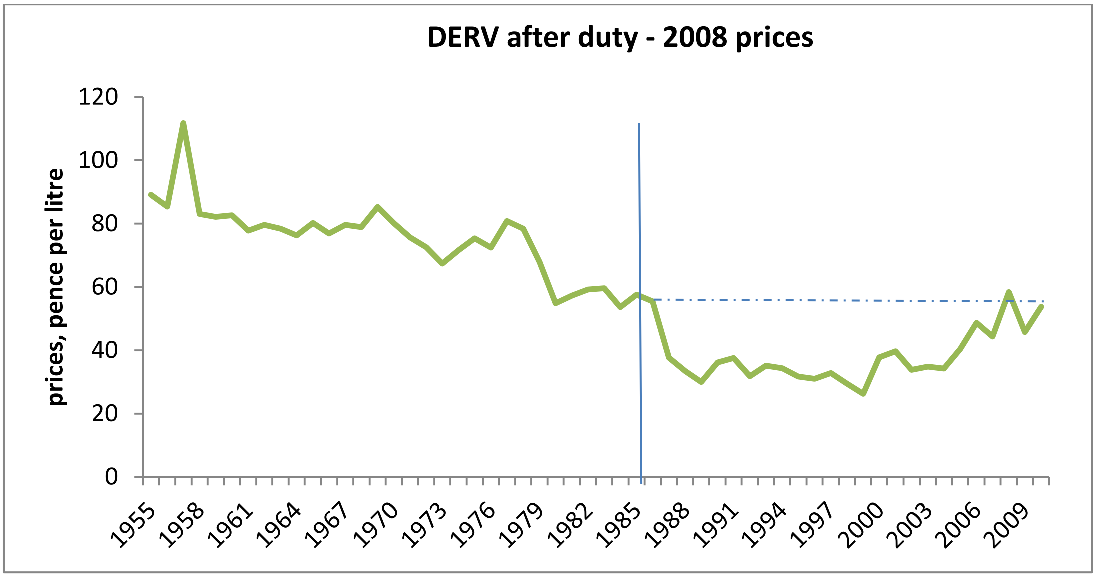

Figure 8-10 Diesel prices after duty as in January each year, 1955-2010. Source: Table 4.1.3 in Energy Price Statistics - Department of Energy and Climate Change. Duty was calculated from Annex C of Quarterly Energy Prices in March 2011, which details duty rates back to 1979.

It is worth noting that, under the counterfactual scenario, the actual data will be used as the fuel prices are determined by external factors and were not completely affected by the adopted bus transport policy. However, diesel prices held constant at the 1985/6 level will be used in separate analyses to isolate the impacts of the price reductions observed after deregulation on bus costs.

8.2.5 Labour rents

Similar to what was observed in diesel prices, it is obvious that labour wages have dropped sharply since the policy implementation in the mid-1980s and did not recover until the mid-2000s (see Figure 8-11). Again, White's (1990) argument that cost reductions observed in the late 1980s were partly due to falls in the wage level, which benefits from the high employment level, is very justified. However, White acknowledges that this should also be partly attributed to deregulation success in providing an environment where labour rents became more competitive and negotiable. A sharp growing trend also emerged in the mid-1990s which can be a source of concern, yet trends in the broader labour market need to be considered to draw a clearer conclusion.

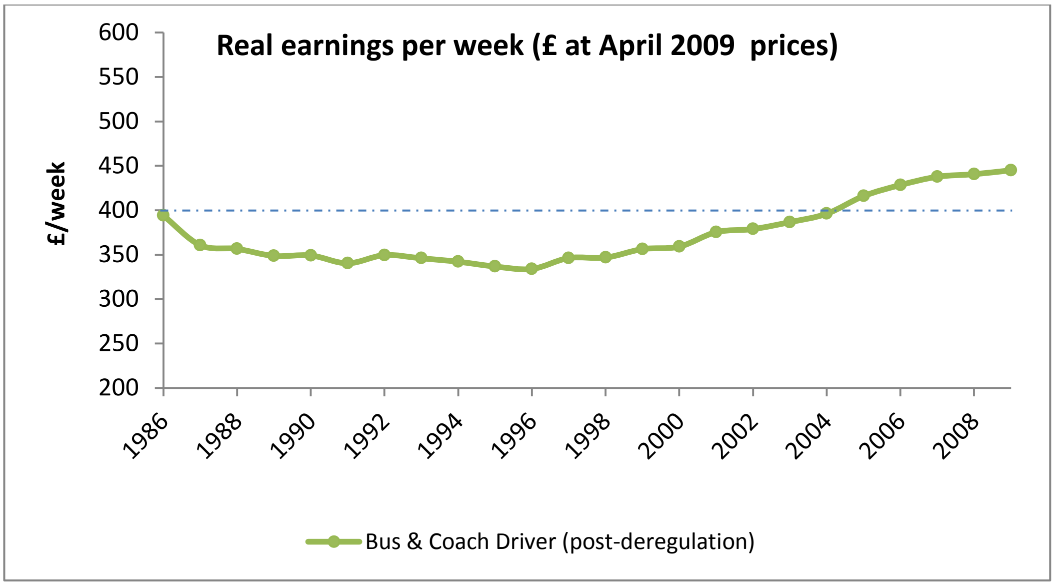

Figure 8-11 Real earnings per week by bus and coach drivers, £ at April 2009 prices

Figure 8-12 gives a wider view of changes in labour wages, including the historical trend and all occupations' earnings per week. Bus and coach drivers' wages were in line with the level earned by all occupations in the pre-deregulation era, although a higher level was observed in the mid-1970s. Therefore, it is not unreasonable to assume that the earning level in the bus industry would follow a similar trend of all occupations earnings under the factual scenario. From the same figure, it can be seen that there has been a clear divergence between the two trends since the implementations of the new policy. The deregulation policy has undoubtedly succeeded in putting great pressure on earning levels in the bus industry.

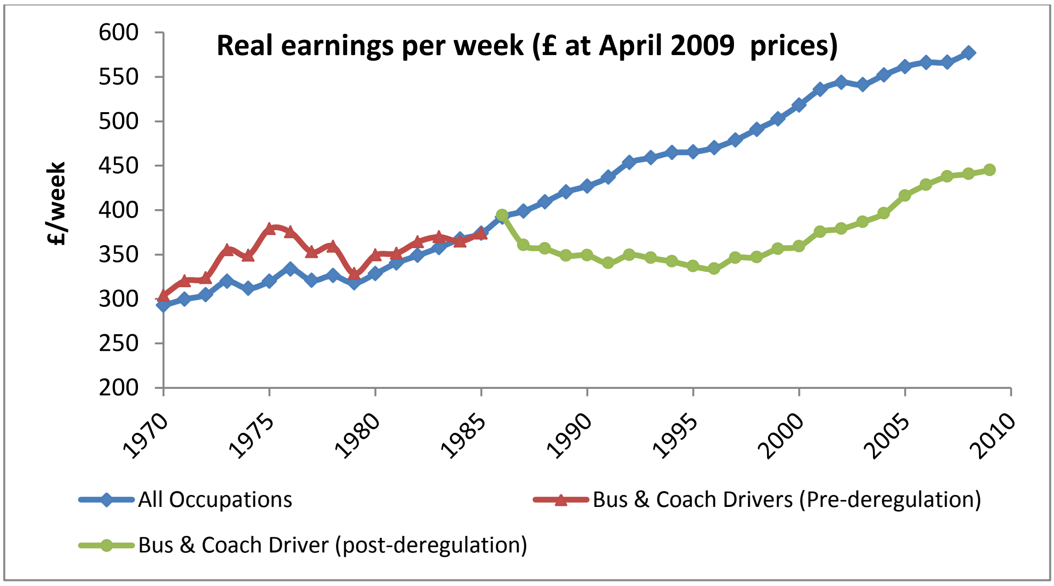

Figure 8-12 Historical trends in real earnings per week, bus and coach drivers versus all occupations, £ at April 2009 prices

Based on the above trend analysis it would be very reasonable to assume that the trend in labour rents, in the absence of the policy intervention in the mid-1980s, would have followed a similar path as that of the all occupations trend.

8.2.6 Subsidy

Bus subsidy data (which consist of two main types: Public Transport Support, PTS, and Concessionary Fare Reimbursement, CFR) warrants a deeper analysis[75] primarily given that one of the research objectives is to isolate its impacts from that caused by the rest of the deregulation policy package. This is driven by Romilly's (2001) argument that the Conservative government's target to cut the public sector borrowing requirement (PSBR) in the early 1980s was the "actual" reason for subsidy reduction and deregulation.[76] Hence, this reduction was caused by a separate and external policy and should be isolated when evaluating the deregulation policy.

After extensive exploration, it is believed that predicting the "counterfactual" subsidy, as well as other inputs, should be based solely on its own historical trend rather than anything else. Theoretically, the definition of "counterfactual" suggests that the effects of every factor prevailed in the past should remain constant when extended to the future assuming "no intervention" or "do nothing".

This is contrary of the method used by Romilly (2001), who made his calculations of counterfactual subsidy based on an "independent" estimate referenced by Hibbs and Bradley (1997) and made by Peter Bottomley in 1995 in a response to the Transport Select Committee. Romilly fitted a simple ARIMA model that produces a PTS figure of up to £2 billion (in 1997 prices) by fitting the pre-deregulation data.

However, there are two main concerns regarding this estimate. First, the principle or method by which Bottomley made his estimate is completely unknown and unjustified in the reference. Second, it clearly overestimates the prediction of "counterfactual", as Romilly mistakenly interpreted subsidy, as defined by Bottomley, to PTS only.

Nonetheless, Bottomley's estimate of "subsidy" is a total of both PTS and CFR in 1994/95 as can be seen here:

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[75] There is a third type of subsidy: Fuel Duty Rebate (became Bus Service Operator Grant). This type is not considered in the analysis as the operator costs are calculated as the net of Fuel Duty Rebate. In addition, there are no consistent data for this variable.

[76] Glaister argues that bus deregulation was about reducing subsidy as part of the retreat of the state.

> “Peter Bottomley told the Transport Select Committee in 1995 that if pre-deregulation rises in subsidy had continued the bill by then would have been £2 billion (an increase from £500 million before 1985). Instead, the industry in 1994/95 received some £700 million.” (Hibbs and Bradley, 1997)

In 1994/95, the PTS figure was only £272 million rather than £700 million. However, the CFR in the same year was £425 million which, in addition to the PTS, made the total subsidy about £700 million. Therefore, it is strongly believed that Romilly’s analysis of the deregulation policy (with replaced subsidy) is upward biased and inaccurate.

Assuming Romilly has correctly interpreted the subsidy figure, it is interesting to compare our simple approach with his estimate using the “maximum likelihood estimation of an AR(4) model, combined with an AR(3) error specification”.

Fitting a linear trend line into the historical data of PTS,[77] starting in 1977, until the last year before the subsidy was reduced[78] predicts a figure of £1.97 billion by 1994/5, as illustrated in Figure 8-13. This is identical to Romilly’s estimate and indicates that a simple approach can forecast the “counterfactual” subsidy as accurately as the more complex forecasting method.

In conclusion, Bottomley’s estimate of the “counterfactual” subsidy (including both PTS and CFR) seems very reasonable, but Romilly’s (2001) subsequent calculations (based on a mistaken interpretation of that estimate) is inaccurate and tremendously overestimated. If used for the longer term, it would severely affect the final conclusion. Therefore, we would predict the counterfactual subsidy based on the conservative assumption given the vital role of the subsidy, particularly its effect on the fare level and consequently the bus demand. Separate estimates of PTS and CFR under the counterfactual will be made before both forecasts are combined and compared with a single forecast of the total subsidy.

[77] The PTS started in 1977/8 after ending the pervious Revenue Support (RS). The reason underlying the exclusion of RS data in the current research is mainly due to the severe change in the definition and collection methodology, making the reliability of the data compared to the PTS very low. The effect of the definitional change on the historical trend is negligible. Romilly used some sort of adjustments to bring the two series together (adjusted the RS upwards). It is believed this would not help achieve a better forecasting of the future.

[78] Recalling Romilly’s argument made earlier, that subsidy reduction is a product of the Conservative government’s target to cut the public sector borrowing requirement (PSBR) in the early 1980s. For example, 1983 experienced the first reduction in PTS, and this was continued in the subsequent years.

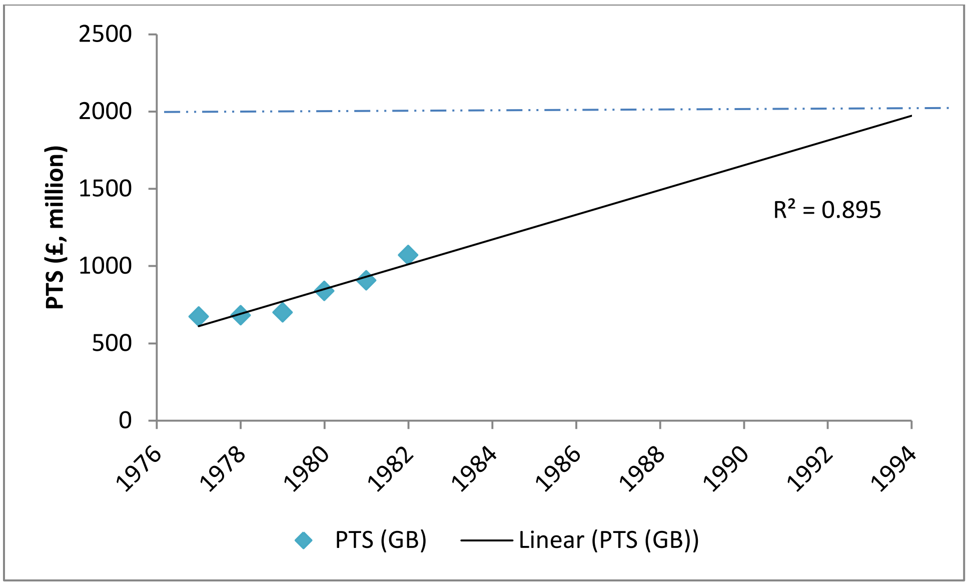

Figure 8-13 Illustration: counterfactual PTS by 1994/5, using linear trend line fitting historical PTS data up to 1982/3. *for simplicity, years are presented in calendar instead of financial years. Hence, 1982 data are for the financial year 1984/5.

8.2.6.1 Public transport support

Figure 8-14 presents the historical trends in Public Transport Support (PTS) in GB as a whole, all areas outside London, and within London. If any conclusion can be drawn from these trends, it should be that the PTS levels have fluctuated sharply over the years, making predicting future trends challenging.

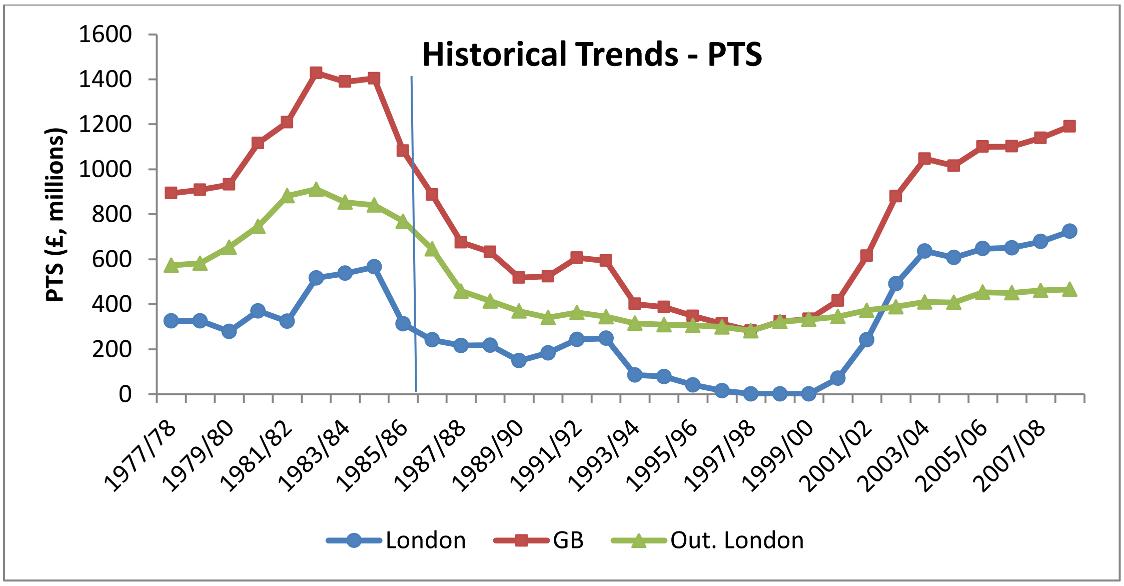

Figure 8-14 Historical trends in Public Transport Support (PTS) in GB

It is interesting to note that the cycle observed in the subsidy trend is related to the political party in control of the national and local governments. In the early 1980s, when the Labour party was in charge of the many local authorities, a high subsidy level was observed. However, the Conservative government adopted a strict fiscal policy from the mid 1980s in response to this. Again, the subsidy increased in parallel to the Labour governments between 1997 and 2010.

A linear trend line might seem to roughly fit the data in the pre-deregulation period and might provide an acceptable forecast; the R-squared is high, as illustrated in Figure 8-15. Under such a counterfactual scenario, a growing trend is forecasted in the areas outside London, and the deregulation policy did very well in halting this growing figure of public support to local buses.

However, it is arguable that a growing trend was expected if the deregulation would have not been implemented. In fact, the trend of PTS was showing signs of a strong turning point even before the D-day. In this case, holding the PTS figure constant at the level of the last year before the policy intervention (1985/6) would be very reasonable, as shown by the horizontal line in Figure 8-15. Under this counterfactual scenario, the deregulation policy has succeeded in maintaining its gains in terms of subsidy reductions that occurred in the first few years after its implementation, although these gains have shrunk since the mid-1990s.

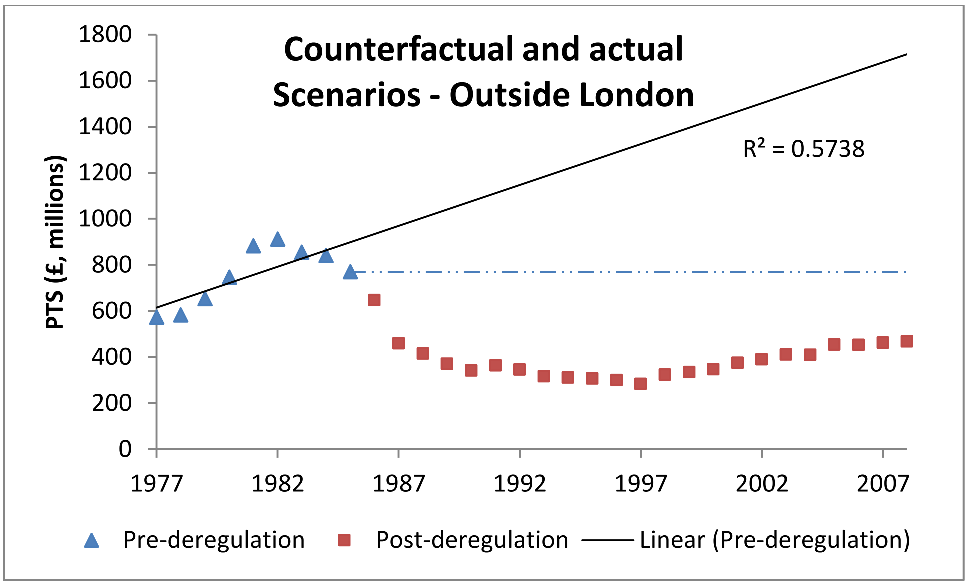

Figure 8-15 Public Transport Support (PTS): Counterfactual and actual scenario—outside London

The picture in London is more dramatic. A linear trend line poorly fits the historical data before the mid-1980s change (see Figure 8-16). This is largely due to the data point that represents the 1985/6 financial year.

Under the London Regional Transport Act 1984, bus services were to be tendered and the responsibility for operating London bus services shifted from the Greater London Council (GLC) to London Regional Transport (LRT), which was controlled by the national government, in June 1984. On 1 April 1985 London Buses Limited (LBL) was established (Wharmby, 2008), and the first round of tendering occurred in the summer of 1985. Accordingly, the financial year 1985/6 should be the first year after the mid-1980s change, whereas the financial year 1984/5 should be the last year before the change.

Considering this fact, a better fit of data resulted as illustrated in Figure 8-17, and the R-squared significantly increased from .30 to .75. Under the modified counterfactual scenario, the new policy adopted in London performed well in reducing the PTS required to run bus services, even after considering its steep growing trend between 2000/1 and 2003/4.

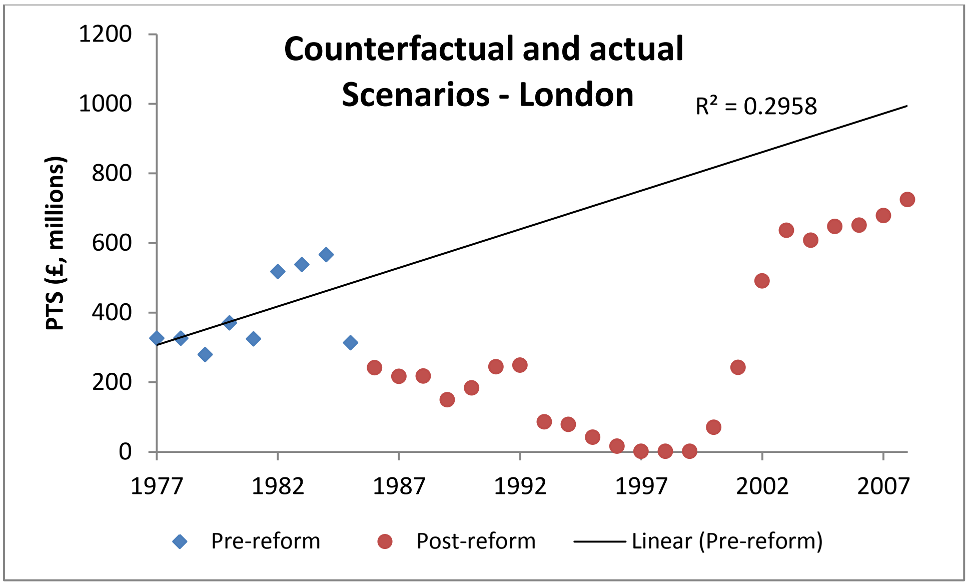

Figure 8-16 PTS—Counterfactual and actual scenarios—London

In conclusion, the counterfactual scenario outside London can either be assumed to be held constant (at the 1985/6 level) or to adopt the approach that fits a linear trend line to the historical data and extend it forward to forecast what would have happened if the regulated system was prolonged. Although it reasonably fits the data (R-squared = .57) as shown in Figure 3-15, the latter method might exaggerate the forecasted figures given that the trend of PTS was showing a sign of a strong turning point even before the D-day. Thus, it is recommended to freeze the PTS figure at the 1985/6 level when considering the counterfactual scenario of PTS outside London.

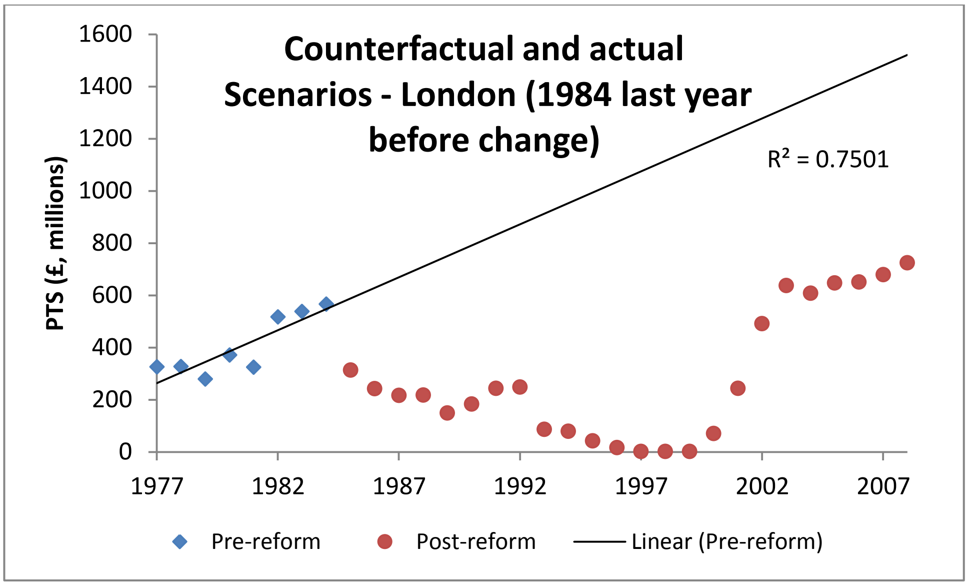

Figure 8-17 PTS—Counterfactual (2) and actual scenarios—London

8.2.6.2 Concessionary fare reimbursement

Not much can be said about the trends in Concessionary Fare Reimbursement (CFR). The observed trends, as illustrated in Figure 8-18, have followed a flat path over the whole period, even before the mid-1980s changes, which have had almost no effect on CFR. The sharp increases since 2006/7 are the only exceptions, but these have been caused by an external factor—namely, the free concessionary scheme for the elderly applied in England. Similar schemes were applied in Wales and Scotland in the early 2000s, but have had very small effects on the trend as results of the small scale of these areas compared to the whole of GB.

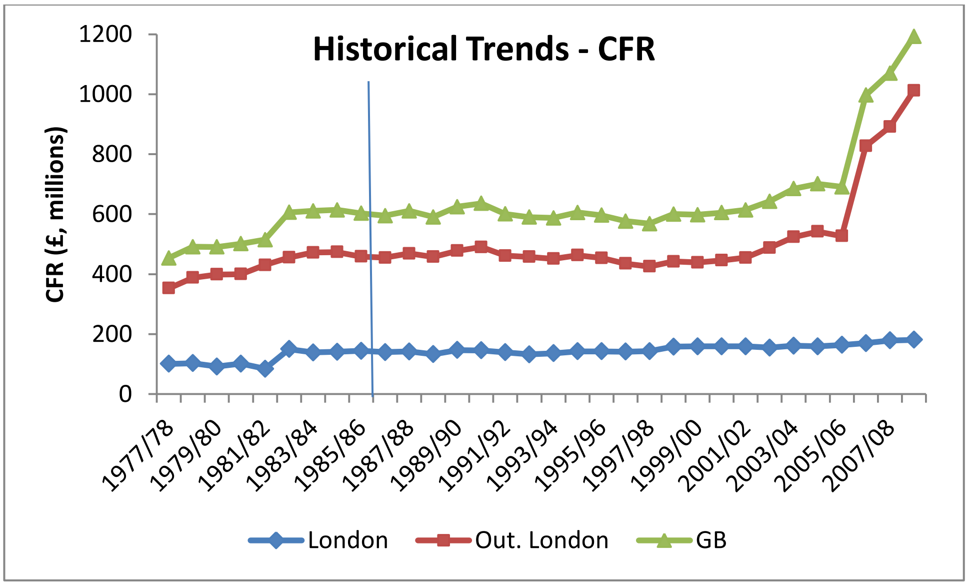

Figure 8-18 Historical trends in Concessionary Fare Reimbursement (CFR) in GB

The CFR is paid to operators based on the general principle that they are "no better and no worse off" from concessionary fares (Baker and White, 2010) to ensure that the benefits go directly to bus users. Thus, the general bus policy adopted would have little or no effect, as illustrated by the flat trends in Figure 8-18.

Under the counterfactual scenario, it would be very reasonable to assume that the CFR trend would have followed the same path as that already observed since 1985/6. As previously indicated, the CFR is paid to bus operators based on the general principle exogenous to the overall regulatory regime. However, following and extending the historical trend is a legitimate assumption for predicting the counterfactual.

A linear trend line seems to reasonably fit the historical data (in the pre-deregulation period) and should give a very satisfactory forecast; in addition, the R-squared data are very high, particularly for GB outside London (see Figure 8-19 and Figure 8-20). However, the significant impact of the free CF is neglected here. Therefore, a simple regression method, which includes a dummy for the introduction of the free concessionary scheme for the elderly, is used to account for this. The results (coefficients) are very significant and consequently used to predict the counterfactual CFR outside London (see Figure 8-21). No effects of the free CF scheme are found in London. Under the counterfactual scenario, moderate growing trends are forecasted in the deregulated area and London, being sharper in London than in the deregulated area (see Figure 8-20 and Figure 8-21).

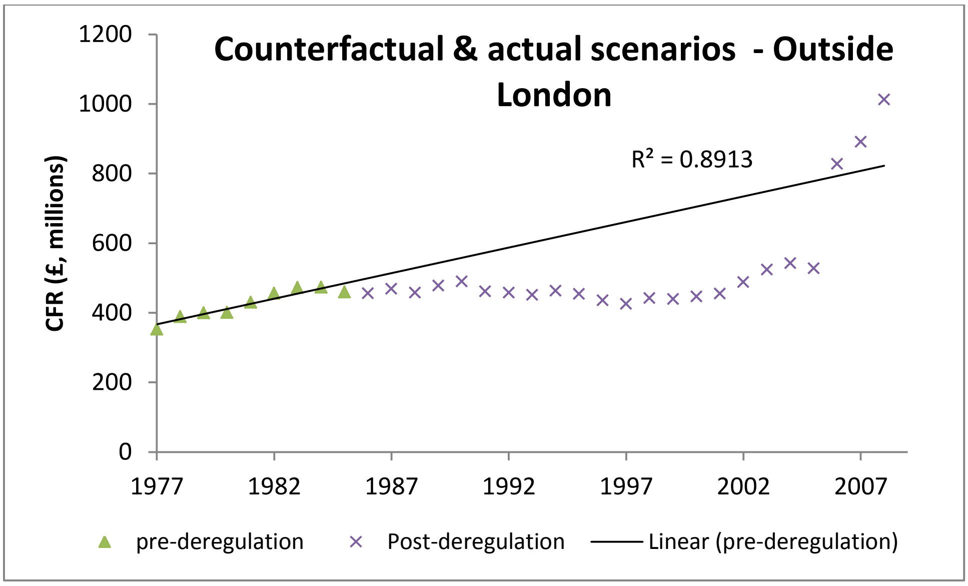

Figure 8-19 CFR—counterfactual and actual scenario—outside London

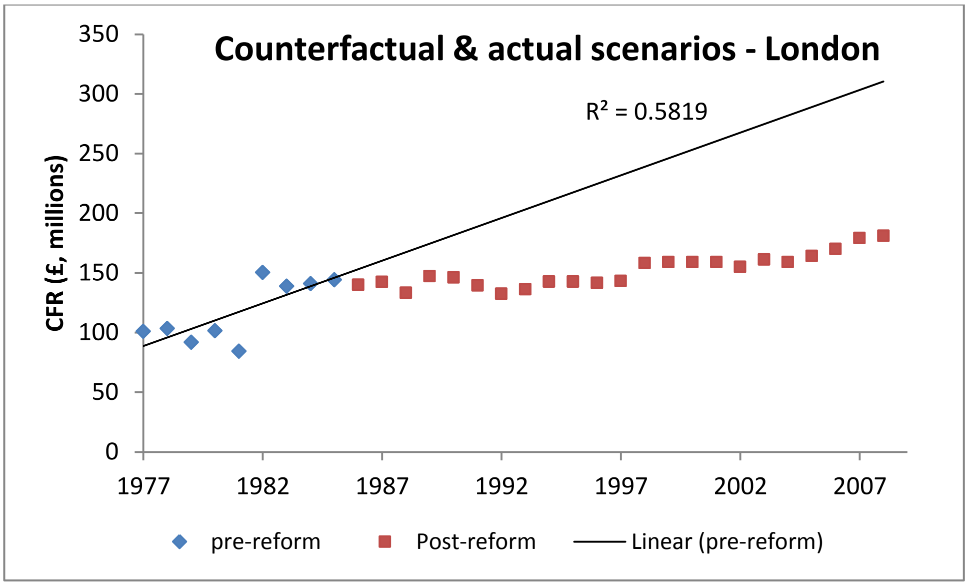

Figure 8-20 CFR—counterfactual and actual scenarios—London

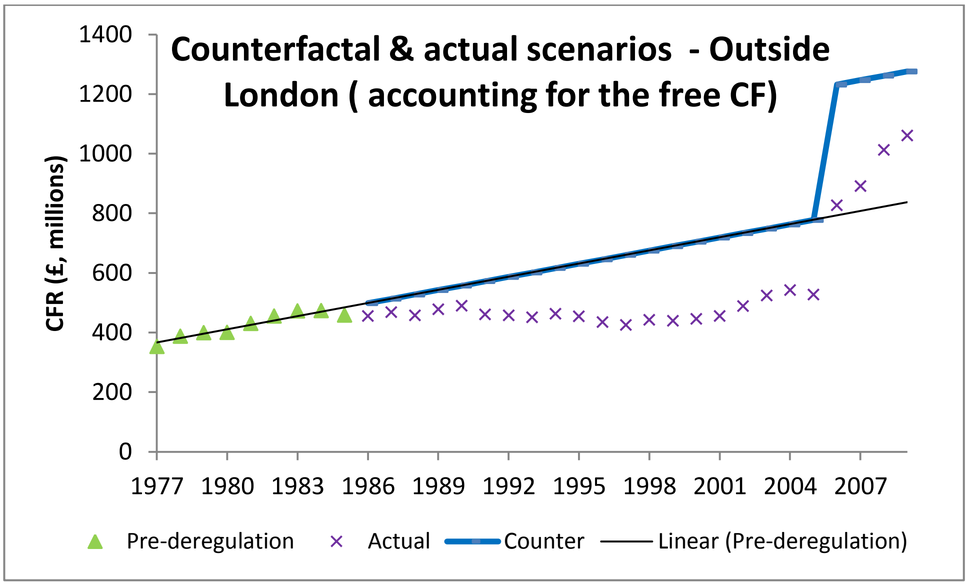

Figure 8-21 CFR—counterfactual and actual scenarios after accounting for the free CF scheme—outside London

8.2.6.3 Total subsidy (SUB)

Total subsidy (SUB), the sum of PTS and CFR, under the counterfactual scenario can be simply assumed to equal the sum of the separate forecasts of the two components. Otherwise, we can use a linear trend line that fits the historical data of SUB and extend it further. In fact, both methods give identical forecasts.

8.3 Overall conclusion

Predicting the counterfactual precisely—namely, what would have happened if there was no bus policy intervention in the mid-1980s—is not an easy task. However, it would be very reasonable to assume that the input variable trend would have followed the same path as that already observed in the past. Thus, the future (counterfactual here) is predicted by the past.

After extensive exploration, it is believed that predicting the "counterfactual" inputs should be based solely on their own historical trends rather than anything else. Theoretically, the definition of "counterfactual" suggests that the effects of every factor that prevailed in the past should remain constant when extended into the future assuming "no intervention" or "do nothing".

The trend analysis performed in this chapter demonstrated that, on many occasions, extending the historical trend in the future proved to be a legitimate assumption when predicting the counterfactual values of input variables (a trend line always fits the historical data reasonably with high R-squared). On the other hand, assuming that the counterfactual values of input variables are "constant" at the level of the last year before policy intervention (1985/6) often proved to be justified.

The two assumptions, trending and constant variables, will be adopted in the cost-benefit analysis. The estimate of two boundaries based on two counterfactual assumptions would include the following advantages:

- It would be more reasonable to specify two limits instead of estimating a single exact figure that is argued to quantify the impacts of counterfactual scenario.
- The estimated limits might account for any other unconsidered assumptions, as the two estimated figures can be assumed as upper and lower limits that include the results of any other assumptions. We might also take the average of the two estimates as a middle point.
- Long-term forecasting would raise many concerns and an estimate based on boundaries instead of exact figures would be more accurate and practical.

A summary of the input variable assumptions under counterfactual scenarios is presented in Table 8-3.

Table 8-3 Summary of input variable assumptions under counterfactual scenarios

Variable	Assumptions	Notes
VKM	can be assumed as either:	

	- constant (1985/6 level) or; - fitting a linear trend line as it reasonably fits the data.	
Staff	can be assumed as either: - constant (1985/6 level) or; - fitting a linear trend line as it reasonably fits the data.	- For London, the number of staff is assumed to equal 17% of total staff employed in the bus and coach industry in GB. This was based on limited data available for London. No percentage is assumed for outside London as the GB figure is overwhelmed by staff employed in GB outside London operators. Therefore it should broadly reflect the changes in staff outside London. - Note: The available data combine the bus and coach industries. Separating them is not possible. However, the majority of staff are employed by local bus operators. - Disaggregate figures for staff (namely platform, maintenance, administrative and non-platform staff) were considered but excluded during the modelling process.
Staff productivity	can be assumed as either: - constant (1985/6 level) or; - fitting a linear trend line as it reasonably fits the data.	- To build the variable "VKM per staff", the assumptions used for staff and VKM as explained in the text were applied here. - Disaggregate figures for staff (namely platform, maintenance, administrative and non-platform staff) were also tested, but excluded during the modelling process.
Diesel prices	As actual	Excluding duties but including VAT. Refer to April of each year
Labour wages (earning per week)	can be assumed as either: - constant (1985/6 level) or; - reasonably, the trend in labour rents, in the absence of the policy intervention in the mid-1980s, would have followed a similar path to that of the all occupations trend.	- Bus and coach drivers' wages are used as a proxy for this variable. This is also the variable used in the DfT publications. - Bus and coach drivers' wages were in line with levels earned by all occupations in the pre-deregulation era. Therefore, it is reasonable to assume that the earning level in the bus industry would have followed similar trends as for all occupation earnings under the counterfactual scenario.
Total wages (used for London Only)	can be assumed as either: - constant (1985/6 level) or; - trending (see notes)	This variable was constructed and used for London only, as earning per week was not found significant. It simply equals the number of total staff

		multiplied by labour wages (earning per week); the assumptions used for these two variables as explained in the text were applied here.
Public Transport Support (PTS)	can be assumed as either: - constant (1985/6 level) or; - fitting a linear trend line as it acceptably fits the data.	For GB outside London, although it acceptably fits the data (R-squared = .57), the forecasting method by fitting the historic trend might exaggerate the forecasted figures given that the trend of PTS was showing a sign of a strong turning point even before the D-day. Thus, it might be more reasonable to freeze the PTS figure at the 1985/6 level when considering the counterfactual scenario of PTS outside London (and neglect the trending assumption). However, to consider all possible scenarios, a trending option was included in our calculations. The picture in London is more dramatic, as the linear trend line poorly fits the historical data before the mid-1980s change. This is largely due to the data point that represents the 1985/6 financial year. Under the London Regional Transport Act 1984, bus services were to be tendered and the responsibility for operating London bus services shifted from the Greater London Council (GLC) to London Regional Transport (LRT) in June 1984. On 1 April 1985 London Buses Limited (LBL) was established (Wharmby, 2008), and the first round of tendering occurred in the summer of 1985. Accordingly, the financial year 1985/6 should be the first year after the mid-1980s change, whereas the financial year 1984/5 should be the last year before the change. After considering this fact, as illustrated in Figure 8-17, the R-squared factor significantly increased from .30 to .75. *Only for this variable, 1984 was assumed to be the last year before the change when calculating the trending assumption in London.
Concessionary Fare Reimbursements (CFR)	should be assumed as: - constant (1985/6 level) However, for consistency with other input variables it will be also assumed as	For GB outside London, it will be very reasonable to assume that the CFR trend would have followed the same path as that already observed since 1985/6. As indicated earlier, the CFR is paid to the

	- fitting a linear trend line	bus operator based on general principle exogenous to the overall regulatory regime. For London, the historical trend was almost flat, with a break between 1981 and 1982 when the CFR figure jumped but levelled off once again.
Total Subsidy (SUB)	can be assumed as either: - constant (1985/6 level) or; - fitting a linear trend line	Consisting of Public Transport Support (PTS) and Concessionary Fare reimbursement (CFR)
Income and population	as actual	The proxy available since 1980 is the UK GDHI normalised by the UK population figure.
Cost, Fares, Demand	are based on their model outputs where the assumptions used for inputs variables are as explained above	For costs outside London, the time trend is omitted, as it captures the deregulation impacts given the data year range which is only available since the mid-1980s. Otherwise, it was used when applicable (fare and demand models outside London – demand model only for London) When applicable, dummy variables are always omitted when calculating the counterfactuals

9. Constructing the counterfactual scenarios

9.1 Introduction

In this chapter, the counterfactual costs, fares, and demands are forecasted by substituting the extrapolated values of some input variables into the developed forecasting models. The coefficients (or elasticities) of the forecasting models along with the input values will shape the counterfactuals.

The coefficients (or elasticities) of the forecasting models are estimated during the modelling process based on actual data and will remain the same when used in the forecasts. However, the input values for the subsidy variable are now different, and these values in particular will shape the two counterfactuals scenarios. In this chapter, the actual scenario will be used as the reference case for comparison purposes only. The final comparison will be based on welfare changes using a cost-benefit analysis where the first "counterfactual" scenario will be the "base case" or "reference scenario".

It should be noted that costs, fares, and demands under the counterfactual scenario are estimated twice using two different assumptions made based on the input variables (constant vs. trend, as detailed in Chapter 8). The resultant two trends can be used as estimates of the lower and upper boundaries of the dependent variable under the counterfactual scenario. For simplicity, we will refer to the counterfactual estimate that assumes input variables are held constant at their 1985/6 values as the "constant assumption" whereas the alternative counterfactual estimate that assumes input variables are trending in a similar manner as historically observed will be denoted as the "trending assumption". For space limitations, all detailed calculations carried out in this chapter are included in a technical appendix.

In each following subsections, the forecasting model used will be highlighted, and then the forecast results will be outlined and compared to the actually observed trend. The deregulated area in GB outside London is separated from London due to the contrasting bus policy applied in these areas. All model specifications are Partial Adjustment Model (PAM).

9.2 The "counterfactual" scenario: prolongation of the regulatory regime

The counterfactual scenario refers to the prolongation of the regulatory system or no policy intervention scenario, as detailed in the methodology chapter. A summary of the input variable assumptions under the counterfactual scenario is presented in Table 9-1. All the dummy variables specified in the models to capture issues related to or brought about by the policy interventions, in London or the deregulated areas, should be omitted when calculating this counterfactual.

Table 9-1 Summary of input variable assumptions under the "counterfactual" or "prolonged regulatory regime" scenario

Variable	Assumptions	Notes
Staff number, wages, vehicle kilometres (VKM), and total subsidy (SUB).	can be assumed as either: - constant at the 1985/6 level, or - trending: fitting a linear trend line as it reasonably fits the data.	Total subsidy = Public Transport Support (PTS) + Concessionary Fare Reimbursements (CFR) * Total subsidy per vehicle kilometres (SUB per VKM) is calculated by dividing the two variables (SUB & VKM).
Diesel prices, Income and population	As actual	External variables, not affected by the bus policy.
Costs, fares and demand	Are based on their forecasting model outputs where the assumptions used for inputs variables are as explained above.	

9.2.1 Total and unit costs under the counterfactual

9.2.1.1 The deregulated area in GB outside London

The cost model used to forecast total costs (TC) in the deregulated area of GB outside London is based on time-series datasets. The model equation is estimated as follows:

Equation 9-1

Ln(Total Cost) = 0.626 + 1.272* Ln(Vehicle kilometres) + 0.259* Ln(Diesel price) + 0.746* Ln(Labour earning per week) - 0.387* Ln(Total VKM per staff) - 0.023*(time trend).

where total VKM per staff is used as a proxy of staff productivity. In order to calculate counterfactual costs, any dummy variables in relation to the policy intervention (deregulation) should be omitted. However, as the data of bus cost is not available before the year 1985/6 and only data since then are used, no dummy was needed to capture the introduction of the deregulation policy during the modelling process. However, the time trend variable is related to the deregulation policy (in this model as well as the upcoming fare model) and should be omitted when the counterfactual is calculated. This is because the data range, as previously explained, covers the period since deregulation only. Thus, the time trend here controls the downward cost trend[79] that dominates the period since the mid-1980s to around 2000.

The "counterfactual" total costs (TC) and unit costs (per VKM), as forecasted by the model, are compared to the actually observed as demonstrated in Figure 9-1 and Figure 9-2.

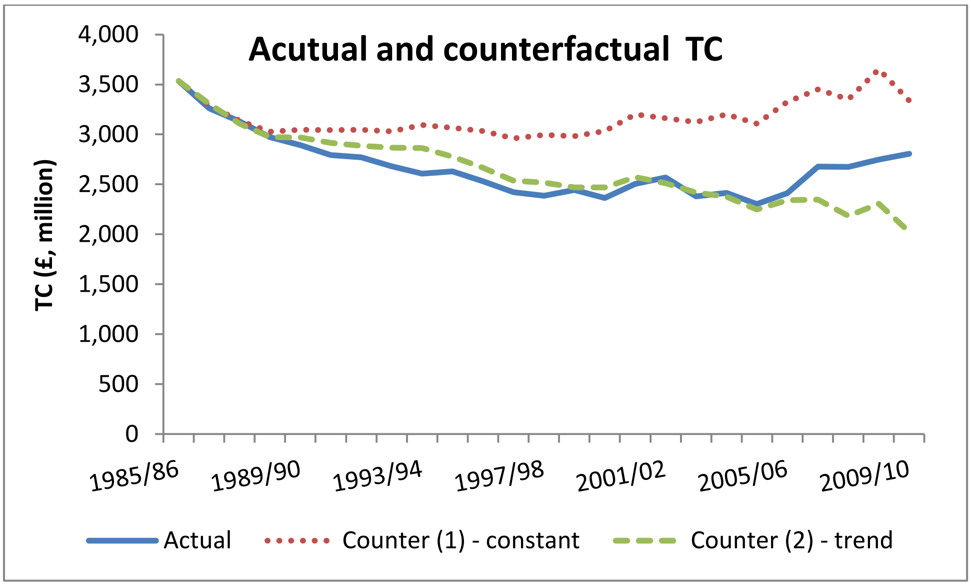

Figure 9-1 Comparison of the actual and counterfactual scenario in TC in GB outside London

After initial declines identical to the actual trend, the counterfactual total cost would have been expected to either slightly increase or decrease based on the assumption made (constant or trend), but why? If input variables are assumed to be held constant at the 1985/6 level (except, of course, the diesel prices, which are set by factors external to the bus industry), then changes in TC can be wholly attributed to the changes in diesel prices as observed over the period. On the other hand, logically, the model predicted lower values in TC if the historical trends in the explanatory variables are assumed to continue, on course, after 1985/6. In this case, staff productivity and labour rents would have been expected to increase (to a lesser extent for the former) and network coverage would shrink, following their historical trends. The result is fewer bus services run by fewer staff (who earn higher wages, but are more productive) and, accordingly, a declining trend in total costs. The intensity of this decline is increased or reduced by changes in diesel prices.

The two trends can be used as estimates of the lower and upper boundaries of the "total costs" predicted under the "counterfactual" scenario. When compared to the actual trend, it can be

[79] Indicates impacts of deregulation on total costs = exp(-0.023) = 0.977 ≈ -2.33% p.a.

noted that the deregulation policy has not succeeded in terms of reducing the total costs of bus services than what would have been expected under one version of the counterfactual. The trend in actual TC is between the two forecasted boundaries, although closer to the lowest estimate of TC. Yet the total cost is not the best indicator to consider. Instead, a comparison based on unit cost (or cost per vehicle kilometres) should provide a sharper conclusion.

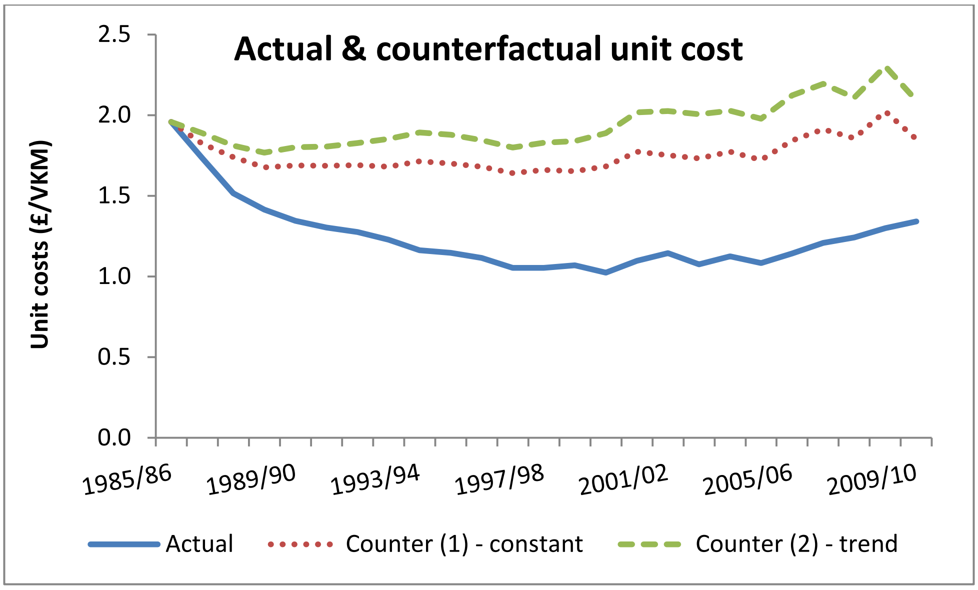

Figure 9-2 Comparison of actual and counterfactual scenario in cost per VKM in GB outside London

Now, after using unit cost instead of total cost, as shown in Figure 9-2, there is not much difference between the two counterfactual trends. In fact, the highest estimate of counterfactual unit costs is given under the “trending assumption” which before provided the lowest TC (here the forecasts assume the continuation of the historical decline in VKM leading to total cost divided over smaller denominators each year, whereas the TC is divided by a constant denominator under the “constant assumption”). Overall, the counterfactual unit costs would have expected to remain at a constant level, fluctuating around £2 per VKM. However, in comparison to the actually observed trend, this is a much higher figure than the £1 per VKM actually observed in the late 1990s after deregulating the bus industry (but this figure was not maintained over a long period).

The deregulation policy has had positive impacts on operating costs in the short and medium terms in particular, mainly as a result of improved staff productivity but also due to a reduction of labour rents. However, in the longer run, in parallel with recent increases in labour wages and diesel prices (which returned to the 1985/6 level), these gains start to diminish. This observation sheds light on the importance of long-term policy evaluation, as contrasted outcomes are observed as we keep tracking the policy outcomes over the years (this remark is more obvious in London, as we will see in the upcoming section). Hence, new lessons can be drawn, clearly different than that drawn from the short or medium term evaluations.

9.2.1.2 London

The forecasting cost model used for London is based on time-series datasets. The chosen model was estimated as follows:

Equation 9-2

$$\text{Ln(Total Cost)} = 0.480 + 0.195 * \text{Ln(Vehicle kilometres)} + 0.135 * \text{Ln(Diesel price)} + 0.622 * \text{Ln(Labour earning per week * Total staff no.)} - 0.168*(\text{1994-dummy variable}) + 0.213*(\text{2002-dummy variable})$$

where the 1994 dummy variable (1994/5-present)[80] captures the completion of the processes of "privatising" the bus operations and of "tendering" the bus routes whereas the 2002 dummy variable (2002/3-present)[81] captures the process of expanding the bus network services in London according to the Mayor's transport strategy and for the preparation for the Congestion Charging (CC) scheme (GLA, 2001).

In order to calculate the counterfactual costs, any dummy variables in relation to a policy intervention should be omitted. Hence, only the previously explained 1994 dummy variable is omitted when forecasting the counterfactual TC, as the 2002 dummy is not related to the policy reform and caused by external policy. The "counterfactual" total costs as forecasted by the model are compared to the actually observed values in Figure 9-3.

[80] Its coefficient indicates a one-off decrease in total costs = exp(-0.168) = 0.845 ≈ 15.5%.
[81] Its coefficient indicates a one-off increase in total costs = exp(0.213) = 1.237 ≈ 23.7%.

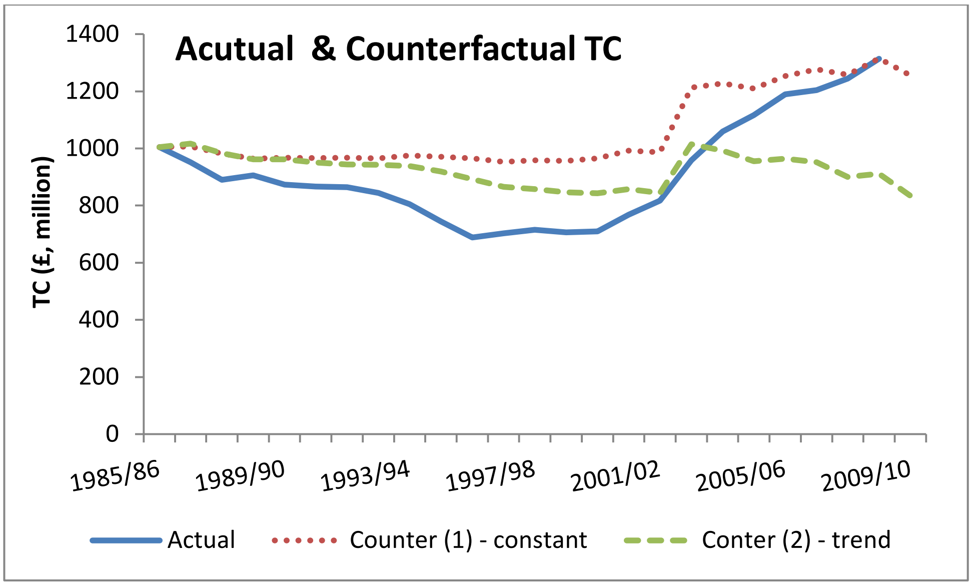

Figure 9-3 Comparison of actual and counterfactual scenarios in TC in London

Figure 9-3 shows that, if the regulatory system would have continued with no policy intervention, the TC would have been expected to remain at a flat level under the "constant assumption" until the early 2000. On the other hand, it could have followed a slight and consistent declining trend under the "trending assumption" (values of input variables follow their historical trends).

Under both assumptions, the level of counterfactual TC would have been higher than what was actually observed until the early 2000s. The policy reform in the mid-1980s succeeded in bringing "total" costs down in the short and mid-term. However, all the gains of lower costs have been lost in subsequent years.

In the longer run, very sharp increases resulted in TC much higher than its starting level in 1985/6 and even higher than what would have been expected in the absence of policy intervention. This again sheds light on contrasting outcomes of policy change between the short and long term and consequently the importance of continuous evaluation in different time horizons.

Again, we should look at the unit cost (or cost per vehicle kilometres) as this should give a more accurate picture of changes in costs. This indicator accounts for the change in the bus network size. As illustrated in Figure 9-4, the trend in actual costs per VKM has shown a similar pattern as its corresponding TC trend in Figure 9-3. However, the sharp increases in the long run as observed in the latter are now less steep. As a result, the gains in cost reductions since the policy intervention are only partially lost by the end of the period. The level of unit costs at the end of the period is still much lower than the 1985/6 level. This is mainly due to the extra observed VKM run after the policy change, allowing for the spreading of the total costs over more services. The level of actual costs per VKM is also much less than what would have been expected under the prolonged regulatory system (counterfactual), although the gap between the actual and counterfactual has started to close recently. No extra VKM would have been run under the counterfactual (constant assumption) or even a shrink in network size would have been expected (trending assumption) following the historical declining trend in VKM (thus, the cost per VKM under the latter assumption became higher than under the former).

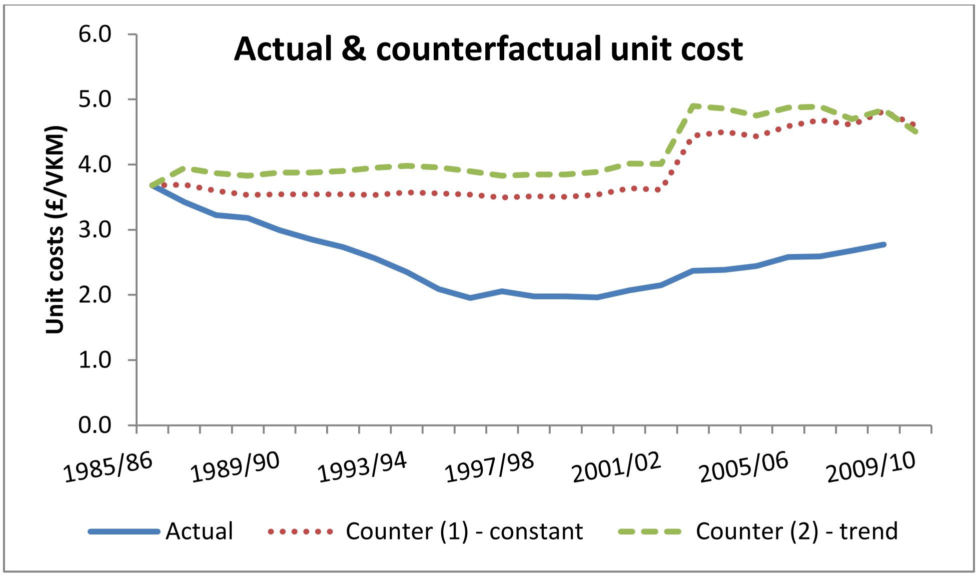

Figure 9-4 Comparison of actual and counterfactual scenario in cost per VKM in London. In the counterfactual scenario, both cost and VKM are the forecasted counterfactual values.

9.2.2 Fare level under the counterfactual

The fare is defined in this research as passenger receipts per journey, excluding CFR. We believe that this is the best possible indicator of the real fare level as actually perceived by bus users.

9.2.2.1 The deregulated area in GB outside London

The forecasting fare model used for the deregulated area of GB outside London was estimated based on panel datasets consisting of multiple time series data collected from various regions of the country (similar to region classification used in the DfT publication). The estimated model equation is:

Equation 9-3
Ln(Fare) = -0.450 + 0.591 * Ln(Lagged fare value) + 0.190 * Ln(Cost per VKM) - 0.180 * Ln(Subsidy per VKM) + 0.009* (time trend)

As explained in section 6.2.3, two types of subsidies (PTS and CFR) are combined in the single variable (SUB). To allow for a change in network size, both are divided by VKM. The model specification is dynamic (PAM) as the lagged value of the dependent variable (fare) appears in the RHS of the model equation. Again, all variables are in natural log forms (except the time trend). No dummy variables in relation to the policy intervention are specified; hence, no variable should be omitted when calculating the counterfactual fares, except the time trend variable. This variable is related to the deregulation policy[82] because the data range, as previously explained, covers the period since deregulation only. Thus, the time trend here controls the upward trend in fare dominating the period since the mid-1980s.

Figure 9-5 draws the counterfactual trends in fares as predicted by the fare model under the counterfactual scenario and compares it to the actual one. Counterfactual fares would have been expected to follow a flat trend under the "constant assumption". Otherwise, counterfactual trends in fares could have followed a slightly declining trend based on the "trend assumption".

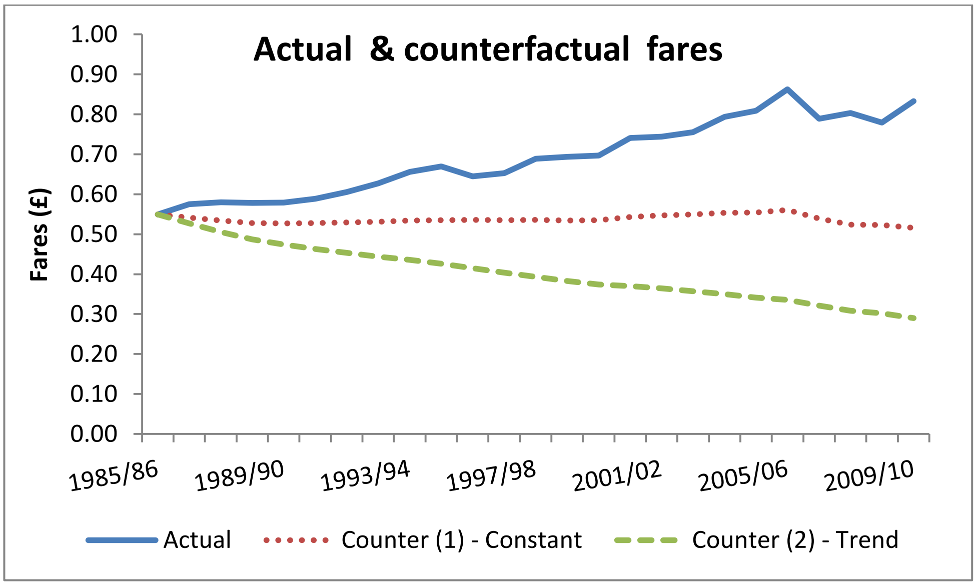

Figure 9-5 Comparison of fares under actual and counterfactual scenarios in GB outside London

Again, the two trends can be used as estimates of the lower and upper boundaries of fares under the counterfactual scenario. Given that, it can be argued that the deregulation policy in the best

[82] Indicates impacts of deregulation on fares = exp(0.009) = 1.009 ≈ 0.9% p.a.

case brought small disbenefits to bus users in terms of fare level and in the worst case produced a consistent series of fare increases and hence disbenefits to bus users.

9.2.2.2 London

The London forecasting fare model used is estimated based on time series datasets. The model equation is as follows:

Equation 9-4

Ln(Fare) = -0.430 + 0.691 * (Lagged fare value) - 0.260 * Ln(CFR per VKM) – 0.013 * Ln (PTS per VKM) – 0.005 * (Time trend)

Similar to the corresponding model used for the deregulated area, the two types of subsidies (PTS and CFR) are combined into a single variable. To allow for changes in the network size, both are divided by VKM. However, unlike the previous model, the cost variable is found to be insignificant and dropped from London's fare model (low explanatory power).

No dummy variables in relation to the policy intervention are specified, but the time trend variable is associated with the policy reform. Hence, no variable should be omitted except the time trend[83] when calculating the counterfactual fares.

As indicated in Figure 9-6, the trends in fares as predicted by the model under the counterfactual scenario would have always been expected to be lower than the actual trend. In the best case scenario, the actual fares will be equal to those forecasted under the "constant assumption" on one or two occasions. Any changes in counterfactual fares are entirely caused by changes in subsidy variables.

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[83] Indicates impacts of policy reform in London on fares = exp(0.005) = 1.005 ≈ 0.5% p.a.

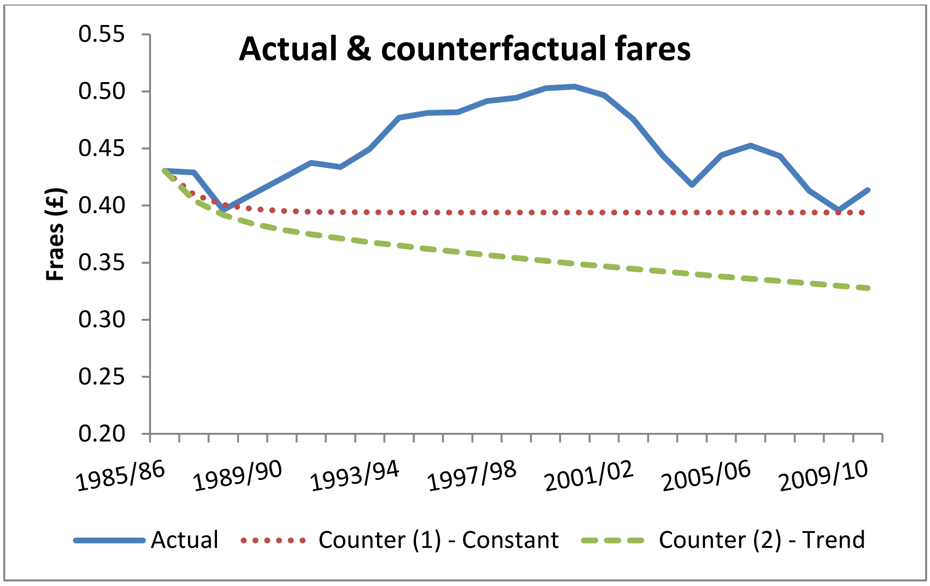

Figure 9-6 Trends in fares under actual and counterfactual scenarios in London

Following the same argument again, the two trends can be used as estimates of the lower and upper boundaries of fares under the counterfactual scenario. Thus, it can be claimed that policy intervention in London in the best case brought no additional benefits to bus users in terms of fare level. However, it held the fare level constant in the mid-1980s, regardless of the fluctuations experienced over the years.

9.2.3 The bus demand under the counterfactual scenario

9.2.3.1 The deregulated area in GB outside London

The forecasting demand model, as detailed in the previous chapter, is used to forecast the counterfactual bus demand in the deregulated area of GB outside London. The model is based on panel datasets consisting of multiple time series data from various regions of GB. The model equation is estimated as follows:

Equation 9-5

Ln(Demand) = 6.807+ 0.630 * Ln(Lagged demand value) + 0.133 * Ln(VKM per capita) - 0.629 * Ln(Income) - 0.124 * Ln(Fare) - 0.048 * (Deregulation Dummy) + 0.011 * (Time trend)

where VKM per capita is used as a proxy of service level and total general domestic household income (GDHI) per capita is used as an indicator of disposable personal income. The deregulation dummy variable[84] is used to capture the effects of the policy change. The model specification is dynamic (PAM). When calculating the counterfactual demand the deregulation dummy variable should be omitted. However, as the data range extends back before 1985/6, the time trend variable is not related to the deregulation policy and should be used in the

[84] Indicates a one-off decrease in demand = exp(-0.048) = 0.953 ≈ - 4.7%.

counterfactual calculation. The “counterfactual” demand (or trip per capita) as forecasted by the model is compared to the actually observed values in Figure 9-7.

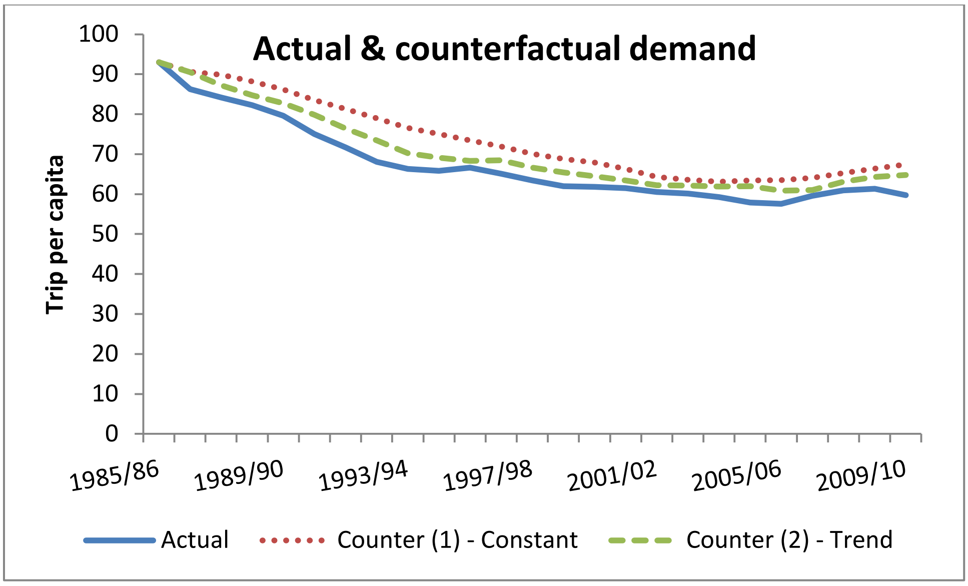

Figure 9-7 Comparison of demand under actual and counterfactual scenarios in GB outside London

As illustrated in Figure 9-7, the trends in demand under the counterfactual scenario are higher, regardless of the assumption made for the input variables (constant vs. trend). Based on these results, we can argue that policy intervention (bus deregulation) has an adverse effect on the level of bus demand. Consequently, these will affect the consumers and operator surplus, which will be calculated in a later step. Yet much of the observed decline in demand would have happened anyway, as the counterfactual trends suggest.

9.2.3.2 London

The forecasting demand model used for London was estimated based on time series datasets, where the model equation is estimated as follows:

Equation 9-6

Ln(Demand) = 2.667 + 0.534 * Ln(Lagged demand value) + 0.316 * Ln(VKM per capita) - 0.4484 * Ln(Income) - 0.434 * Ln(Fare) + 0.472 * Ln(Motoring Costs) - 0.064 * (1991 Dummy) + 0.020 * (Time trend)

This model specification is similar to the corresponding model used for the deregulated area, except for two variables. The first is the dummy variable[85] that starts in year 1991/2, which is used as the middle year to capture the privatisation process between the late 1980s and mid-1990s. The second is the index of motoring costs variable (which was found to be insignificant

[85] Its coefficient indicates a one-off decrease in demand = exp(-0.064) = 0.938 ≈ - 6.2%.

outside London). The latter variable should separately capture the effect of car ownership, unlike in the corresponding model for the deregulated area, where the effects are combined with income in a single variable. Therefore, the elasticity of income is less here. The elasticities of service and fare seem identical to the classic figures reported in the literature, in both the short and long run.

No dummy for an introduction of a policy change is used (or found to be significant), mainly because the policy change was applied more gradually in London in contrast to the sudden change that occurred outside it (Big Bang). A dummy variable capturing the "privatisation" process is used, as previously indicated.

In the calculations of counterfactuals, the time trend variable will be used as it captures the effects before and after policy changes, as detailed in the previous section. The year 1991 dummy variable specified in the model is in relation to the policy intervention; hence, it should be omitted when calculating the counterfactual. Figure 9-8 compares the "counterfactual" fares, as forecasted by the model, with those actually observed.

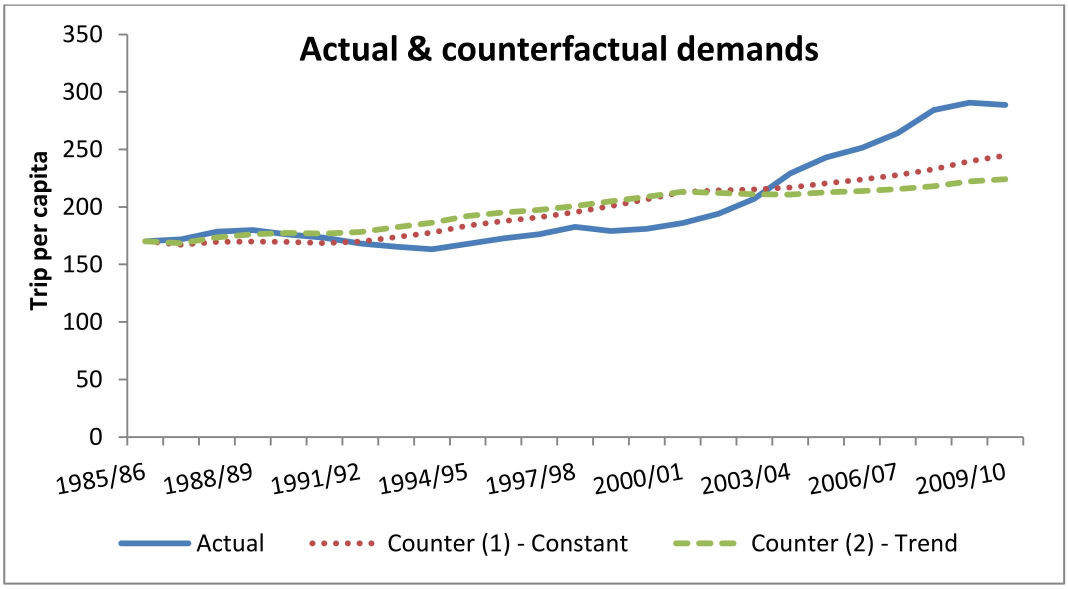

Figure 9-8 Comparison of demand under actual and counterfactual scenarios in London

The trends in demand under the counterfactual scenario (based on constant and trend assumptions) had been trending close to each other up to the early 2000s. This is very similar to those actually observed since the policy intervention in London. However, the trends started to diverge over the time, with very sharp increases in actual demand. These trends suggest that the policy intervention in London has positive impacts on the level of bus demand, most obviously in recent years. However, part of the recent demand increases would have happened anyway, as suggested by the counterfactual demand trends.

Two observations are worth further comments. First, why are the trends almost flat and identical at the beginning of the period (up to the early 2000s)? Second, why did a clear trend divergence (specifically by the actual trend) suddenly occur starting in the early 2000s?

The explanations of the former (identical flat trends up to early 2000s) are somewhat similar to those put for the trends in deregulated areas, which can be explained by the following:

- The effects of fare and service variables, which have similar elasticities with respect to demand, cancel each other out under each scenario. Both variables followed similar trends: increasing in the actual, constant under the first counterfactual "constant assumption", and declining under the latter "trend assumption".
- Consequently, the effects of income (and motoring costs) on demand became the main driver of observed trends in all scenarios. The size of both variable elasticities with respect to demand was almost identical, although with opposite signs: -.45 and +.47, respectively. A trend of income shows that personal income increased rapidly until the early 2000s, which should have led to less favourable conditions for using buses, given the negative sign of the income elasticity. In the meantime, the upward trend in motoring costs dominated this period, leading to more favourable conditions of bus uses, given its positive elasticity. Thus, to some extent, the impacts of the income and motoring costs cancel each other out.

With respect to the second observation, a clear divergence of the actual trend from the counterfactuals can be explained by the turning points in the trends of both service and fare variables. The "actual" service level has increased while fare has decreased since the early 2000s and in parallel to the sharp increases observed in the actual demand trend. Such movement occurred despite the decline in motoring costs observed during the same period.

In conclusion, the forecast results suggest that the bus policy intervention in London has positively affected the bus demand, although part of this would have happened anyway. However, these impacts have been postponed for more than a decade due to gradual implications of the new bus policy in London. The processes of the "privatisation" of bus operations and "tendering" the bus routes were not completed before the mid 1990s. However, it can be argued that the positive impacts can to a certain degree be attributed to the targets set in the London Mayor's transport strategy (GLA, 2001), which was subsequently adopted by the

TfL and DfT, to increase bus use and quality.[86] However, this would not be possible without the tools provided by the new policy in London. The competitive tendering regime allowed private operators to provide efficient services whilst maintaining the authority of planning and controlling in the hands of the Mayor of London. This allowed for such targets to be achievable.

It can also be seen that the two assumptions made to forecast the input variables have a minor effect on the final forecasts of the "counterfactual" demand. However, this is not the case for bus fares or, consequently, consumer or producer surplus, which will be calculated in a later step.

9.3 The "replaced subsidy" scenario: policy reforms with no subsidy reduction

The principal hypothesis under this scenario is that the change in subsidy would affect fares which would consequently affect demand, while all other key variables remain unaffected (or as actually observed). Using "counterfactual" subsidy values as predicted in chapter 8 instead of the observed reduced subsidy values, the forecast of fare using its model will be lower than what was actually observed. Consequently, when such lower fares are used as input in the demand model, higher levels of bus demand are expected. These forecasted results allow us to build the "replaced subsidy" scenario.

The summary of input variable assumptions under this counterfactual scenario—namely, the "replaced subsidy"—is presented in Table 9-2. The dummy variables in relation to the policy intervention, if any, should be used, and no variable should be omitted when calculating the considered counterfactual fares or demand.

Table 9-2 Summary of input variable assumptions under the "replaced subsidy" scenario

Variable	Assumptions	Notes
Total Subsidy (SUB)	can be assumed as either: - constant (1985/6 level) or - fitting a linear trend line as it reasonably fits the data.	Total subsidy = Public Transport Support (PTS) + Concessionary Fare Reimbursements (CFR)
Vehicle kilometres (VKM)	As actual	
Total Subsidy per Vehicle kilometres (SUB per VKM)	By dividing the two elements above. As SUB is assumed to be either constant or trending, these	

[86] One might argue that from 2000 onwards a new policy regime has been operating in London.

	assumptions will be extended to this variable (SUB per VKM).	
Diesel prices, Income, motoring costs and population	As actual	External variables
Costs	As actual	No need to be forecasted using the estimated cost model, as no effect of subsidy on costs.
Fares and demand	Are based on their model outputs where the assumptions used for input variables are as previously explained.	

9.3.1 Fare level under the counterfactual scenario

9.3.1.1 The deregulated area in GB outside London

Again, the fare model equation is:

Equation 9-7

Fare = -0.450 + 0.591 * Ln(Lagged fare value) + 0.190 * Ln(Cost per VKM) - 0.180 * Ln(Subsidy per VKM) + 0.009* (time trend).

No variable should be omitted when calculating the considered counterfactual demand.

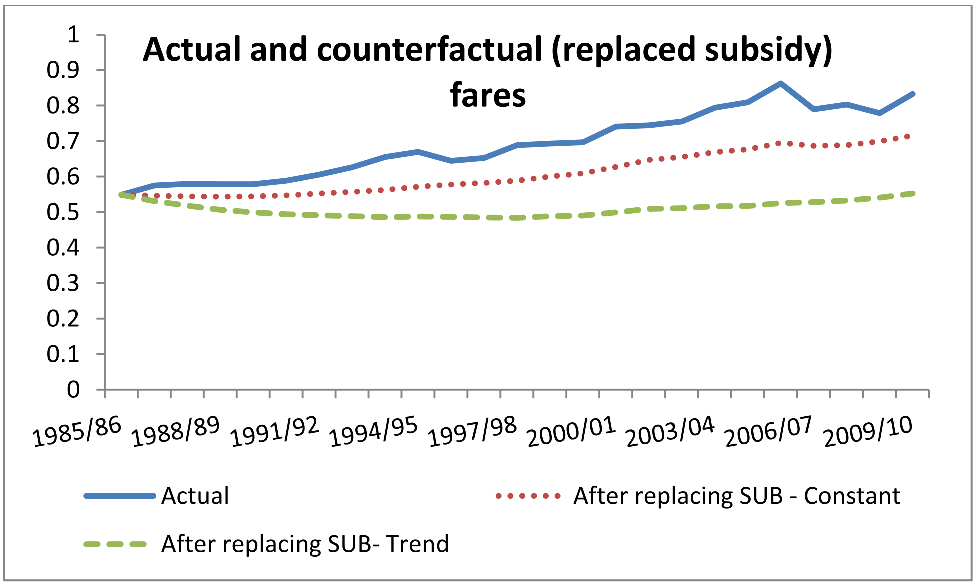

Figure 9-9 Comparison of actual (deregulation) and counterfactual (replaced subsidy) fares

Figure 9-9 draws the counterfactual trends in fares as predicted by the fare model under the "replaced subsidy" scenario and compares it to the actual one. Under the "constant assumption", counterfactual fares would have been expected to follow an upward trend similar to (but less steep than) the actual trend. Otherwise, counterfactual trends in fares could have followed a flat trend based on the "trend assumption". The difference between the actual and counterfactual trends is entirely caused by the replaced subsidies, where higher subsidies are expected under counterfactuals.

Therefore, it can be argued that, if the deregulation policy had not been accompanied by another "external" monetary policy, as argued by some authors, the fares would have been expected to be lower than what was actually observed. This would have brought about additional benefits to bus users in terms of lower fare levels.

9.3.1.2 London

The London forecasting fare model is estimated based on time series datasets. The model equation is as follows:

Equation 9-8

Ln(Fare) = -0.430 + 0.691 * (Lagged fare value) - 0.260 * Ln(CFR per VKM) – 0.013 * Ln (PTS per VKM) – 0.005 * (Time trend).

Unlike the corresponding model used for the deregulated area, the two types of subsidies (PTS and CFR) are separated in two variables. To allow for a change in the network size, both are divided by VKM. In addition, the effect of the cost variable on the fare level is found to be insignificant in London. No variable should be omitted when calculating the counterfactual demand. Figure 9-10 compares the fares under the "replaced subsidy" scenario, as forecasted by the model, with those actually observed.

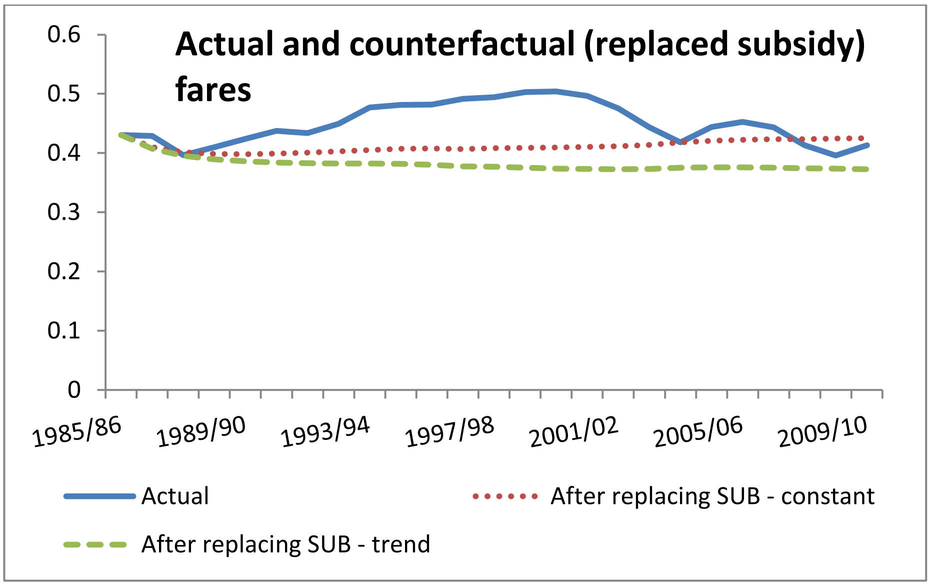

Figure 9-10 Actual versus the counterfactual (replaced subsidy) fares

As can be seen in Figure 9-10, the trends in fares as predicted by the model under the counterfactual scenario would have been expected to be almost constant and lower than the actual trend. The divergence between actual and counterfactual trends continued until 2003/4, resulting in a clear gap. This was caused by the sharp reductions in “actual” subsidies leading to higher “actual” fares as reflected in the actual fare trend. However, this gap has started to close since the early 2000s and completely closed by the end of the period. This again can be largely attributed to sharp increases in “actual” subsidies.

Yet the overall difference between actual and counterfactual fares is small, unlike what was observed in GB outside London. The maximum difference observed was only £0.10. Fares in London have been less sensitive to subsidy changes as they are set by the transport authority, which considers many factors before deciding the fare level; in deregulated areas, this is left to market forces. In addition, London’s fares started from a lower base compared to those outside it.

Bus services in London are generally heavily subsidised, which might explain the low fare level that is usually maintained. Nevertheless, London operators received zero subsidies in terms of Public Transport Support between 1997/8 and 1999/00, and the fares increased by less than £0.10 from the year with the highest subsidy, 1984/5. In conclusion, subsidy reductions in London have smaller impacts on fares and consequently on the benefits to bus users.

9.3.2 The bus demand under the counterfactual

9.3.2.1 The deregulated area in GB outside London

The forecasting demand model is again used to forecast the counterfactual bus demand in the deregulated area of GB outside London. The model is based on panel datasets and estimated as follows:

Equation 9-9

Ln(Demand) = 6.807 + 0.630 * Ln(Lagged demand value) + 0.133 * Ln(VKM per capita) - 0.629 * Ln(Income) - 0.124 * Ln(Fare) - 0.048 * (Deregulation Dummy) + 0.011 * (Time trend).

No variable should be omitted when calculating the counterfactual demand.

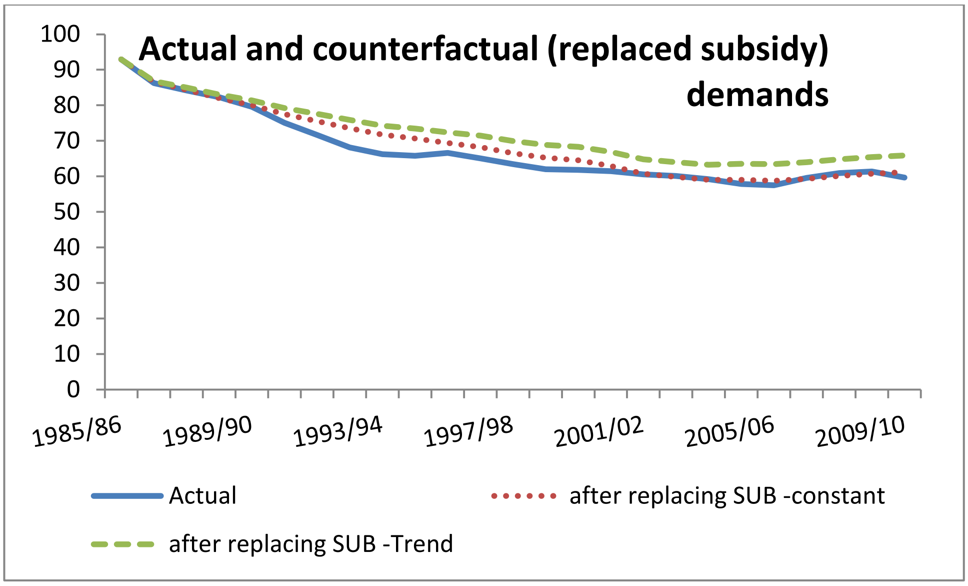

Figure 9-11 Comparison of demand under actual and counterfactual scenarios in GB outside London

The trends in demand under the counterfactual scenario are slightly higher than the actual, as illustrated in Figure 9-11. This is anticipated as a lower fare due to a higher subsidy would stimulate further demand.

9.3.2.2 London

The forecasting demand model used for London was estimated based on time series datasets where the model equation is estimated as follows:

Equation 9-10

Ln(Demand) = 2.667 + 0.534 * Ln(Lagged demand value) + 0.316 * Ln(VKM per capita) - 0.448 * Ln(Income) - 0.434 * Ln(Fare) + 0.472 * Ln(Motoring Costs) - 0.064 * (1991 Dummy) + 0.020 * (Time trend)

In the calculations of counterfactuals, no variable should be omitted. Figure 9-12 graphs the actual and counterfactual scenarios in demands.

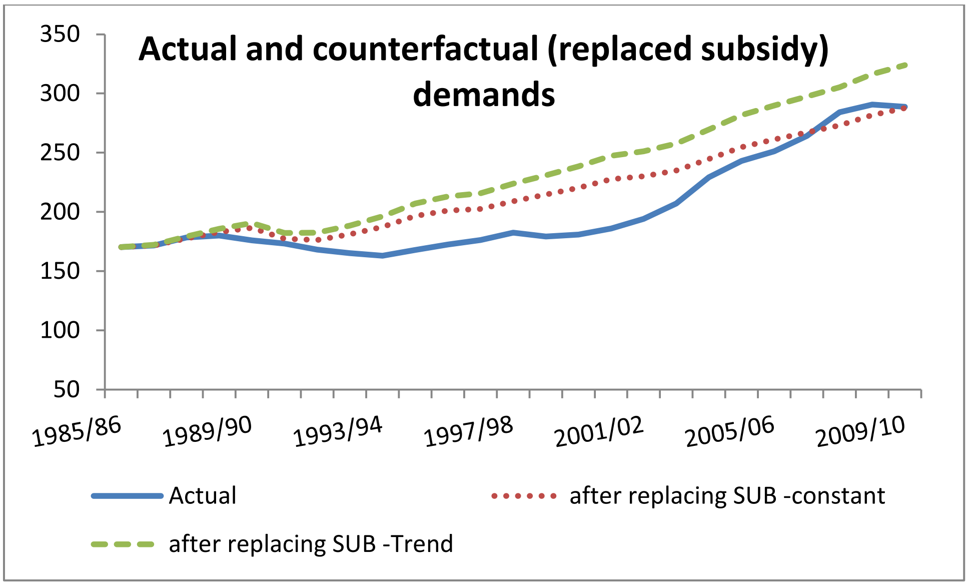

Figure 9-12 Comparison of demand under actual and counterfactual scenarios in London

The counterfactual demand, after replacing the lost subsidy, is clearly higher than the actual trend from the mid 1990s until the early 2000s, whereas they are very close at the beginning and end of the period. This result is logical as the "actual" subsidy observed in London was very low in the former period, resulting in higher fares during the same period. The patterns observed in Figure 9-12 mirror the same patterns observed in the corresponding fare trends as detailed in 4.3.1.2. Thus, the divergence of the actual trend from the counterfactuals is explained by the corresponding changes in fares.

Overall, these trends suggest that subsidy reductions in London had some negative impacts on the level of bus demand—most obviously between the mid-1990s and the early 2000s. However, the recent increases in "actual" subsidies have erased these impacts.

It can also be seen that the two assumptions made to forecast the subsidy input variable have small but very significant effects on the final forecasts of "counterfactual" demands, for GB outside London in particular. This is also the case for bus fares which consequently affect consumer or operator surplus, which will be calculated in a later step.

10. Welfare Analysis

10.1 Introduction

Most answers to the questions raised in this research (and in the literature review) can be addressed by performing a wider cost-benefit analysis of the policy reforms. However, such an analysis is not without some constraints or limitations. Even so, it is believed that our analysis assumptions are fairly cautious. In this chapter, welfare changes for key members/groups in the bus market are calculated. The total welfare change in the bus industry is largely dependent on changes in consumer and producer surpluses. The government and bus labourers (workers) are also directly affected by the changes in the bus industry and, as such, are included in the analysis.

Our measure of welfare changes for the main groups can be summarised by the following equations:

Equation 10-1

$$\Delta W_{t,bu} = \Delta CS_t \qquad (for\ bus\ users)$$

Equation 10-2

$$\Delta W_{t,bo} = \Delta TR_t + \Delta SUB_t - \Delta TC_t \qquad (for\ bus\ operators)$$

Equation 10-3

$$\Delta W_{t,g} = -\Delta SUB_t * \mathrm{DWEA}_t \qquad (for\ the\ goverment\ and\ taxpayers)$$

Equation 10-4

$$\Delta W_{t,bw} = \Delta TC_{due\ to\ change\ in\ wages} \qquad (for\ bus\ workers)$$

Thus, the overall welfare changes is

Equation 10-5

$$\Delta W_{t,\ overall} = \Delta W_{t,bu} + \Delta W_{t,bo} + \Delta W_{t,g} + \Delta W_{t,bw}$$

where W = welfare, CS = consumer surplus calculated using the rule of half (RoH), TR = total revenue, TC = total costs, SUB = total subsidies, DWEA = deadweight efficiency adjustment (or the shadow price of public funds equals 1.2), and t = year (1,2,..,T). Δ refers to the difference between the actual outcome and the counterfactual. The calculations based on previous equations are repeated for each year over the period of evaluation, 1986/7 to 2009/10, as well as during the first or second decade since the policy reforms.

The change in subsidy and labour wages as included in the previous equations are worth further attention. These are transfers in benefit rather than economic gains or losses. Furthermore, subsidy impacts need to be isolated as they can be caused by external fiscal policy rather than the bus policy reforms. In addition, we need to compare the policy reform in GB outside London with the alternative and simultaneous regulatory reform that occurred within London.

The following sections discuss our welfare results for each group, with a focus on bus users (consumers) and operators (producers) in particular, before the overall welfare change is estimated as explained in the previous equations.

The calculations of welfare changes are given as Net Present Values (NPV), discounted using the Treasury's Green Book 3.5% discount rate. All values are expressed in 2008/9 prices. The "counterfactual" scenario (prolonged regulatory system) is used as the "reference scenario". Again, due to space limitations, the detailed calculations are presented in the technical appendix.

10.2 Change in Consumer Surplus (ΔCS)

In order to calculate the change in consumer surplus, the trapezoidal area (under the demand curve and between the two fare levels) should be determined. This area can be calculated using the rule of half (RoH), given the number of bus trips and fare values under the actual and counterfactual scenarios, as detailed in 4.3.3.1. The counterfactual bus fares and trips are estimated using the forecasting models, as detailed in 9.2.2 and 9.2.3.

The calculated welfare for each year represents either a gain or loss as a result of movement from a demand and price combination to another new combination (or equilibrium). Whether this movement is on the demand curve or between two old and new curves (due to demand curve shift), the associated welfare change can still be calculated by the RoH. CS is calculated for each year as follows:

Equation 10-6

$$\Delta\, CS_t = \frac{1}{2}\,(F_{1t} - F_{2t})\,(Q_{1t} + Q_{2t})$$

where F_1 = counterfactual fares, Q_1 = counterfactual demand, F_2 = actual fares, Q_2 = actual demand, and t = year (1,2,..,T).

10.2.1 Consumer surplus calculations in GB outside London

10.2.1.1 Change in CS due to deregulation policy

This section determines how the deregulation policy in the local bus industry has affected the consumer surplus, comparing the results to what would have happened if the previous regulated system had been continued (the "counterfactual" scenario). As shown in Table 10-1 part a, the change in consumer surplus (CS) expressed as NPV (net present value) over the whole period, 1986/7 to 2009/10, is -£24 billion, which is equivalent to -£1 billion per annum on average. The negative sign indicates that this figure represents a loss in CS as a result of deregulation. The loss in CS is associated with deregulation impacts which caused demand losses. The CS calculations are performed using forecasts of passenger trips and fares based on the “constant assumption”, which is comparable to one of the scenarios used by Mackie and Preston (1996) and Romilly (2001).

Now we need to consider the alternative possibility: the “trend assumption”. The new CS calculations estimate a welfare loss of £-16.3 billion, equivalent to £-679 million per annum on average, over the entire period from 1986/7 to 2009/10.

In summary, the bus users are the clear losers of the policy reform (deregulation) in GB outside London. Overall, their loss ranges between £24 billion (calculated under the “constant assumption”) and £16.3 billion (under the “trend assumption”). Moreover, the largest losses in consumer losses were calculated during the first few after deregulation (see Table 10-1 part a), see year by year analysis illustrated in Figure 10-2.

10.2.1.2 Replaced subsidy scenario: the missing welfare gains due to subsidy reductions

It is also of research interest to determine how the bus industry would have performed if the subsidy had not been reduced. The welfare change for bus users should now be recalculated using the forecasts of passenger trips and bus fares after replacing the reduced subsidy (the “replaced subsidy” scenario). Under this scenario, the lower fares (caused by the replaced subsidy) would lead to higher demands and consequently should lead to better welfare changes compared to what is calculated in 5.2.1.1. In other words, the deregulation package as actually observed would have resulted in “better” welfare than what was calculated if the subsidy since 1985/6:

- was held constant at that year’s level (constant assumption); or
- kept increasing following its historical trend before the policy reform (trend assumption).

This is a “missing” welfare gain due to the subsidy reductions accompanying the policy reforms in the mid-1980s, as illustrated in Figure 10-1.

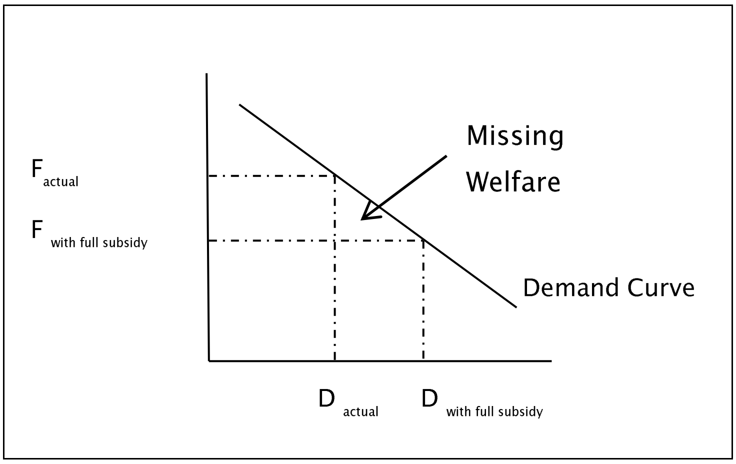

Figure 10-1 Illustration of missing welfare due to subsidy reductions

Between 1986/7 and 2009/10, there was a reduction in the subsidy outside London by £5,929 to £17,152 million in present value (depending on assumptions used to forecast the counterfactual subsidy; constant vs. trend). Our results show that, if the subsidy had not been reduced and held constant, then the consumer loss would have shrank to £15,560 million due to deregulation whilst the result based on the "trend assumption" would have shown a positive figure (gains of £7,358 million; see Table 10-1 part b). The results indicate that there is a "missing" welfare gain to bus users of about between £8 billion and £24 billion, caused by subsidy reductions alone (see the last row of Table 10-1).

Although the reduced subsidy caused some "missing welfare gain" to bus service consumers, a "missing welfare loss" to the government (or transport authority as well as taxpayer) also occurred, as it is the body which would have to provide the subsidy, see also 10.3.1.2. If one assumes a shadow price of public funds of around 1.2 (after Dodgson and Topham, 1987) then there are deadweight efficiency gains from this reduced expenditure of around £1,186 to £3,430 million outside London. It can be noted that "missing welfare gain" (consumer losses due to subsidy reductions) are larger than the associated deadweight efficiency gains.

Table 10-1 Welfare changes of bus users due to policy change (deregulation), £ million at 2008/9 prices

The scenario compared to the "counterfactual" scenariol[1]	Constant[2]			Trend[2]		
	Since reform 1986/7-2009/10	1st decade 1986/7-1995/6	2nd decade 1996/7-2005/6	**Since reform 1986/7-2009/10**	1st decade 1986/7-1995/6	2nd decade 1996/7-2005/6
A. the actual scenario: ΔCS - Due to deregulation package (includes subsidy reductions)	**-24,044 (-1,002 p.a.)**	-11,741	-9,006	**-16,299 (-679 p.a.)**	-7,086	-6,647

B. the "replaced subsidy" scenario: ΔCS - Due to deregulation package (excludes subsidy reductions)	**-15,560 (-648 p.a.)**	-8,190	-5,049	**7,358 (307 p.a.)**	1,669	4,680
Missing welfare gains due to subsidy reductions = B – A	**8,484 (353 p.a.)**	*3,551*	*3,957*	***23,657*** **(998 p.a.)**	*8,755*	*11,450*

Discounted by 3.5% as suggested by the Treasury's Green Book (Treasury, 2003). [1]The "counterfactual" scenario which is a forecast of how the industry would have performed under the regulatory system. [2]Assumption used to forecast the counterfactual scenarios.

The analysis so far raises the following question: Would an alternative regulatory policy have done better? This will be investigated in the next section.

10.2.2 The alternative policy: consumer surplus calculations in London

An alternative regulatory policy—namely, competitive tendering—was applied in London in parallel with the implementations of the deregulation policy in the rest of the country. Based on the "constant assumption", it can be said that the London policy reform caused a welfare "gain" of £399 million to bus users, compared to a welfare "loss" of £24,044 million calculated in the deregulated areas. A welfare gain of £451 million is forecasted under the "trend assumption", compared to a corresponding loss of £16,299 million in the deregulated area. Table 10-2 summarises the change in consumer surplus calculated after the policy reforms in London. It can be concluded that London experience is beneficial to bus consumers in contrast to the deregulation policy.

Assuming the subsidy had not been reduced, welfare "gains" of £2,363 to £4,348 million (based on forecast assumptions) are calculated for London, compared to welfare "loss" of £15,560 million in the deregulated areas under constant assumption (but welfare gain of £7,358 million under the trend assumption). These figures suggest that competitive tendering system, as applied in London but without subsidy reductions, would increase consumer surplus compared to the regulatory system or deregulation policy. This conclusion also supports the case for the bus subsidy.

Table 10-2 Welfare changes of bus users due to policy change (competitive tendering) in London, £ million at 2008/9 prices.

The scenario compared to the "counterfactual" scenariol[1]	Constant[2]			Trend[2]		
	Since reform 1986/7-2009/10	1st decade 1986/7-1995/6	2nd decade 1996/7-2005/6	**Since reform 1986/7-2009/10**	1st decade 1986/7-1995/6	2nd decade 1996/7-2005/6

A. the actual scenario: ∆CS - Due to reform package (includes subsidy reductions)	**399 (17 p.a.)**	0	-340	**451 (19 p.a.)**	-386	-273
B. the "replaced subsidy" scenario: ∆CS - Due to reform package (excludes subsidy reductions)	**2,363 (98 p.a.)**	811	886	**4,348 (181 p.a.)**	707	1,943
Missing welfare gains due to subsidy reductions = B – A	**1,964 (82 p.a.)**	811	1,226	**3,897 (162 p.a.)**	1,093	2,216

Discounted by 3.5% as suggested by the Treasury Green Book (HMT, 2003). [1]The counterfactual scenario which is a forecast of how the industry would have performed under the regulatory system. [2]Assumption used to forecast the counterfactual scenarios.

10.3 Change in Producer Surplus (∆PS)

In this section, the impacts of the mid 1980s bus policy reforms in GB on "bus operators" are analysed. Our measure of welfare changes for producer surplus can be summarised by the following equation:

Equation 10-7

$$\Delta PS_t = \Delta TR_t + \Delta SUB_t - \Delta TC_t$$

where PS = producer surplus, TR = total revenue, SUB = total subsidies, t = year (1,2,..,T), and TC = total costs. ∆ refers to the difference between the actual outcome and the counterfactual.

10.3.1 Producer welfare calculations in GB outside London

10.3.1.1 Change in total costs (∆TC)

As presented in Table 10-3, the results show that the deregulation policy brought welfare gains to bus operators in terms of reduced total costs (TC). Over the entire period, 1986/7 to 2009/10, a saving to operators of £7,305 million is calculated under the "constant assumption". However, a negligible difference exists between the deregulation and regulation if the TC in the latter is forecasted based on the "trend assumption".[87]

One aspect of deregulation that is implicitly included but does not "explicitly" appear in previous TC calculations is that the size of service network, which was shrinking since the 1950s but expanded just after the policy implementation. Therefore, some savings in unit costs (costs per VKM) were spent by operators in running extra bus kilometres. However, these extra VKM might (or should) be

[87] Under the "trend assumption", counterfactual VKM is assumed to shrink following the observed historical trend. Thus, forecasted total costs are also shrinking.

considered as an essential outcome of the deregulation policy, as the quantity regulation is released and competition (or the threat of it) is introduced under such a policy. At the end of the day, the calculations of change in operator's welfare should be based on the "total" costs spent rather than unit costs (White, 1990). Any extra VKM operated should result in improved service quality (higher frequency or network expansion); hence, extra demand would be stimulated. Consequently, this would be reflected in higher operators' revenue (which will be calculated in an upcoming section). Otherwise, these extra VKM are an unnecessary loss to operators (in terms of wasteful competition or unviable services). In addition, using the total (not unit) costs in our calculations will allow for any savings due to change in fleet size or vehicle size mix (e.g., proportion of mini and midi buses).

Table 10-3 Summary of changes in total operating costs (TC) outside London 1986/7-2009/10 (£, million) at 2008/9 prices

Welfare change to bus operators	**Constant**[1]			**Trend**[1]		
	Since reform 1986/7-2009/10	1st decade 1986/7-1995/6	2nd decade 1996/7-2005/6	**Since reform 1986/7-2009/10**	1st decade 1986/7-1995/6	2nd decade 1996/7-2005/6
Change in total operating costs (ΔTC) due to policy reform	**-7,305**	-1,968	-4,002	**-83***	-826	-193

Discounted by 3.5% as suggested by the Treasury Green Book (HMT, 2003). *Counterfactual total costs under the trend assumption are expected to reduce substantially similar to what was actually observed but for different reasons, due to the forecasted shrinkage in network size (or total VKM). [1]Assumption used to forecast the counterfactual scenarios.

10.3.1.2 Transfer in benefits

White (1990) stressed two issues when conducting a welfare analysis: the concept of transfer effects as "it is important to distinguish transfer effects from economic gains or losses" and the impacts of external factors to the bus industry as "not all cost changes during this period were due to deregulation"—in particular, cost changes due to diesel prices, which are also a transfer effect but not within the industry (from petroleum companies to bus operators). Another transfer in benefits occurred from bus operators to the government or taxpayer (through subsidy reductions).

Changes in diesel prices:

We need here to consider White's (1990) argument that diesel prices (which dropped below the mid-1980s level, until the late 2000s) are set by external factors to the bus industry; hence, if there are benefits from this variable, it should not be attributed to the bus policy impacts. However, there is a simple way to isolate the impacts of diesel prices by forecasting the counterfactual using "actual" prices. Thus, "actual" diesel prices, instead of forecasted prices, are incorporated as inputs into the cost model to forecast the costs under the counterfactual scenario. This will avoid any favourable bias to deregulation when compared to the counterfactual (regulated system). Both scenarios are thus based on the same value of fuel prices,[88] meaning there are no "transfer" in benefits.

Still, we might be interested to calculate the decrease in total costs due to this variable separately, as this is "at the expense of other sectors or the economy" (Mackie and Preston, 1996). Based on our calculations, there is a savings of £5,934 million in TC over the period of study associated with the observed reductions in diesel prices alone. This is estimated using the forecasting cost model, where diesel prices are assumed to be constant at April 1985 prices over the entire period (see Table 10-4).

Table 10-4 Changes in total operating costs (TC) due to diesel prices outside London 1985/6-2009/10 (£, million) at 2008/9 prices

	Change in TC		
	Since reform 1986/7-2009/10	1st decade 1986/7-1995/6	2nd decade 1996/7-2005/6
Isolating the impacts of change in diesel prices[1] [transfer of benefits from other sectors to bus operators]	**-5,934**	-3,773	-2,269

Discounted by 3.5% as suggested by the Treasury Green Book (HMT, 2003). [1]Forecasted using the cost model assuming actual values for all explanatory variables except labour wages, where diesel prices are assumed to be constant at the April 1985 level over the entire period since the policy reform.

Changes in labour wages:

There is another argument regarding the "transfer" in benefits, and this time will affect our evaluation of the policy reform impacts. A substantial part of the calculated reductions in TC is caused by the lower wage rates in the bus industry observed since deregulation. This is in reality associated with the new negotiated practices as the deregulated market permitted wage negotiations. Operators have gained from the lower labour wages, but workers now suffer from less attractive working conditions. Therefore, we will explicitly estimate this "transfer" in benefit from employees. However, we will keep it as benefits[89] to the bus operators from the deregulation while using it elsewhere as a loss to bus workers.

Table 10-5 shows that forecasts of changes to operators' costs of £-483 million to £-8,638 (under the "constant" and "trend" assumptions, respectively) were due to lower wages alone. Under the latter

[88] White (1990) also adopted a different approach as his methodology has not considered a counterfactual scenario. Instead he considered ex ante versus ex post (simply, the year 1989/90 was compared to the last year before deregulation [1985/6]).

[89] The lower wages are clearly a product of the new policy which provided the ground for wage negotiations (Heseltine and Silcock, 1990). Threat of competition due to RSL removal and subsidy reductions forced operators to keep costs as low as possible. Labour costs are the largest component of TC, more than 50%, and logically any savings in costs would be at the expense of labour (TAS, 2007).

assumption, weekly earnings in the bus industry were assumed to continue following a similar trend to that for "all occupations".

Table 10-5 Summary of changes in total operating costs (TC) due to changes in labour wages outside London 1986/7-2009/10 (£, million) at 2008/9 prices

Transferred benefits from bus labour (to operators)	Constant[1]			Trend[1]		
	Since reform 1986/7-2009/10	1st decade 1986/7-1995/6	2nd decade 1996/7-2005/6	**Since reform 1986/7-2009/10**	1st decade 1986/7-1995/6	2nd decade 1996/7-2005/6
Isolating the impacts of change in labour wages	**-483**	-1,008	-286	**-8,638**	-3,655	-4,218

* Discounted by 3.5% as suggested by the Treasury Green Book (HMT, 2003). [1]Forecasted using the cost model assuming actual values for all explanatory variables except labour wages, where wages are assumed to be either constant at the April 1985 level over the entire period since the policy reform (constant assumption) or trending similarly to what was actually observed in trend of "all occupation" weekly earnings (trend assumption).

Subsidy:

Subsidy is another "transfer" in benefits—this time from bus operators to the government. The bus operators have lost some support over the period, equalling £5,928 and £17,152 million, depending on the forecast assumptions. This is equivalent to -£274 and -£715 million per annum. Therefore, the reduced subsidy is assumed to be a loss to operators but a gain to the government. Table 10-6 summarises the changes in bus subsidies given the considered scenarios.

Table 10-6 Summary of changes in subsidies (ΔSUB) outside London 1986/7-2009/10 (£, million) at 2008/9 prices

Change in subsidy[1]	Constant assumption[2]			Trend assumption[2]		
	Since reform 1986/7-2009/10	1st decade 1986/7-1995/6	2nd decade 1996/7-2005/6	**Since reform 1986/7-2009/10**	1st decade 1986/7-1995/6	2nd decade 1996/7-2005/6
ΔCFR	***181***	*40*	*57*	***-2,779***	*-802*	*-1,407*
ΔPTS	***-6,109***	*-3,112*	*-2,432*	***-14,373***	*-5,724*	*-6,375*
Total (ΔSUB)	***-5,928***	*-3,071*	*-2,376*	***-17,152***	*-6,526*	*-7,782*

All figures are discounted by 3.5% as suggested by the Treasury Green Book (HMT, 2003). [1]The actual scenario is deregulation with subsidy reduction. The counterfactual is "prolonged regulatory system". [2]Assumption used to forecast the counterfactual scenarios.

10.3.1.3 Change in passenger revenues

By passenger revenues we mean the revenue received by operators from fares as actually paid by users (thus, excluding CFR). The calculations show that bus operators in the deregulated market have enjoyed welfare gains of £4,473 to £12,517 million (depending on the forecast assumption) as a result of revenue increases compared to the "counterfactual" scenario. It can be noted that fare increases after deregulation have offset any revenue losses due to demand decreases.

Interestingly, if the subsidy had not been reduced since the 1980s, then operators' revenues from passengers would have not been higher. Higher subsidies would have resulted in lower fares, in association with small increases in demand, but not enough to maintain the same revenue calculated for the actual scenario. Table 10-7 summarises the changes in passenger revenues given the considered scenarios.

Table 10-7 Summary of changes in Passenger Revenues (ΔTR) outside London 1986/7-2009/10 (£, million) at 2008/9 prices

The scenario compared to the "counterfactual" scenario[1]	Constant assumption[2]			Trend assumption[2]		
	Since reform 1986/7-2009/10	1st decade 1986/7-1995/6	2nd decade 1996/7-2005/6	**Since reform 1986/7-2009/10**	1st decade 1986/7-1995/6	2nd decade 1996/7-2005/6
Actual	**4,473**	549	2,606	**12,517**	3,436	6,306
Replaced subsidy[3]	**1,231**	-478	993	**5,490**	1,110	2,881

All figures are discounted by 3.5% as suggested by the Treasury Green Book (HMT, 2003). [1]Counterfactual is a forecast of how the industry would have performed under the "prolonged regulatory system". [2]Assumption used to forecast the counterfactual scenarios. [3]Fares are calculated using the forecasting fare model assuming actual values for all explanatory variables except the subsidy variable, where the subsidy is assumed to be either constant at the April 1985 price over the entire period since the policy reform (constant assumption) or increasing following its historical trend (trend assumption). The forecasted fares are then fed into the forecasting demand model to calculate the demand.

10.3.1.4 Conclusion on change in producer surplus outside London

Bus operators have clearly benefited from the higher fare under the deregulated market to increase their revenues. Deregulation has also set the grounds for labour wage negotiations; hence, operators have benefited from such practices to reduce their operating costs. However, these savings are offset by some other aspects. First, operators have to run extra bus mileage to maintain an acceptable service level to prevent large demand losses due to fare increases or to deter competition (or threat of it) in the deregulated market. Second, subsidy reductions observed in parallel to the mid-1980s reform have substantially offset their gains. Table 10-8 summarises the total welfare change for bus operators due to deregulation outside London over the period 1986/7 to 2009/10.

Overall, bus operators have experienced welfare gains over the whole period of £5,849 million compared to the counterfactual (regulatory system), if the latter is forecasted based on the "constant assumption". However, a welfare loss of £-4,552 million is expected if the input variables used to forecast the counterfactual assumed to follow their historical trends before the policy reform (i.e., the "trend assumption"). This loss is entirely caused by the reduced subsidy to operators.

In the case that subsidy reductions are assumed to be caused by independent fiscal policy, rather than as a part of the deregulation package, then deregulation has strongly benefited bus operators. Compared to the old regulatory system, the new policy has brought welfare gains of £5,573 to £8,536 million, depending on the forecast assumptions.

Table 10-8 Summary of overall welfare change for bus operator (ΔPS) due to deregulation outside London 1986/7-2009/10 (£, million)

The scenario compared to the "counterfactual" scenario[1]	Entry	Constant assumption[2]			Trend assumption[2]		
		Since reform 1986/7-2009/10	1st decade 1986/7-1995/6	2nd decade 1996/7-2005/6	**Since reform 1986/7-2009/10**	1st decade 1986/7-1995/6	2nd decade 1996/7-2005/6
1. Actual: Deregulation as actually observed (including the observed subsidy reductions)	ΔTC (-)	-7,305 (-304)	-1,968	-4,002	-83 (-3)	-826	-193
	ΔTR (+)	4,473 (186)	549	2,606	12,517 (522)	3,436	6,306
	ΔSUB (+)	*-5,928 (-247)*	*-3,071*	*-2,376*	*-17,152 (-715)*	*-6,526*	*-7,782*
	Net benefits[3]	**5,849 (244)**	-554	4,232	**-4,552 (-190)**	-2,264	-1,283
2. Replaced Subsidy: If bus industry is deregulated but subsidy have not been reduced	ΔTC (-)	-7,305 (-304)	-1,968	-4,002	-83 (-3)	-826	-193
	ΔTR (+)	1,231 (51)	-478	993	5,490 (229)	1,110	2,881
	ΔSUB (+)	0	0	0	0	0	0
	Net benefits[3]	**8,536 (365)**	1,490	4,995	**5,573 (232)**	1,935	3,074

Discounted by 3.5% as suggested by the Treasury Green Book (HMT, 2003). [1]Counterfactual is a forecast of how the industry would have performed under the regulatory system. [2]Assumption used to forecast the counterfactual scenarios. [3]Net benefits for bus operators =Δ revenue + Δ total subsidy - Δ total cost.

10.3.2 The London alternative

The alternative policy applied in London has shown negative impacts on operators, in contrast to bus users, largely due to the reduced subsidy. If the impact of the reduced subsidy is isolated, then bus operators in London have gained over the whole period. Table 10-9 summarises the total welfare change for bus operator due to policy reform in London over the period from 1986/7 to 2009/10.

Table 10-9 Summary of overall welfare change for bus operator (ΔPS) due to competitive tendering in London 1986/7-2009/10 (£, million) at 2008/9 prices

The scenario compared to the counterfactual[1]	Entry	Constant assumption[2]			Trend assumption[2]		
		Since reform 1986/7-2009/10	1st decade 1986/7-1995/6	2nd decade 1996/7-2005/6	**Since reform 1986/7-2009/10**	1st decade 1986/7-1995/6	2nd decade 1996/7-2005/6
1. Actual: Competitive tendering as actually observed (including the observed subsidy reductions)	ΔTC (-)*	-2,266 (-99)	-1,029	-1,194	-641 (-28)	-865	-243
	ΔTR (+)	1,250 (52)	382	527	2,025 (84)	436	963
	ΔSUB (+)	-4,825 (-201)	-3,281	-1,820	-13,556 (-565)	-5,559	-6,248
	Net benefits[3]	**-1,309 (-55)**	-1,870	-99	**-10,890 (-454)**	-4,258	-5,042
2. Replaced Subsidy: If bus policy is reformed but subsidy has not been reduced	ΔTC (-)*	-2,266 (-99)	-1,029	-1,194	-641 (-28)	-865	-243
	ΔTR (+)	1,150 (48)	288	516	1,817 (76)	303	903
	ΔSUB (+)	0	0	0	0	0	0
	Net benefits[3]	**3,416 (142)**	1,317	1,710	**2,458 (102)**	1,168	1,146

Discounted by 3.5% as suggested by the Treasury Green Book (HMT, 2003). [1]Counterfactual is a forecast of how the industry would have performed under the regulatory system. [2]Assumption used to forecast the counterfactual scenarios. [3]Net benefits for bus operators = Δ revenue + Δ total subsidy - Δ total cost *Cost data for 2009/10 in London is missing and not included in the calculations.

10.4 Welfare change for government and other affected sectors

Our calculations, as summarised in Table 10-10, show that the government, or taxpayer, seems to be the clear winner due to the mid-1980s policy reforms. Its welfare gains outside London range between £5,929 and £17,152 million, while similar figures calculated in London range between £4,825 and £13,556 million. These benefits are a result of the reduced subsidy levels paid by the government to bus operators since the policy reforms. If subsidy reductions are assumed to be caused by external fiscal policy, then there are no direct impacts[90] of the bus policy reforms on the government. In

[90] That can be quantified in a "monetary term". Still, the government might benefit from deregulation of the industry by shifting the responsibility of planning the services. However, this is controversial as the inability to coordinate and plan bus services serving the overall government's objectives (e.g., environmental and safety objectives) can be considered a loss.

contrast, bus workers are the clear losers. The welfare change to bus workers is not affected by changes in subsidy

Table 10-10 Summary of welfare change to other sector of the economy and the government due to the bus policy reforms both London and outside London 1986/7-2009/10 (£, million) at 2008/9 prices

Group	Entry	Outside London		London	
		Constant assumption[1]	Trend assumption[1]	Constant assumption[1]	Trend assumption[1]
Bus labour (employee)	Reduces Labour wages (-)	-483 (-20 p.a.)	-8,638 (-360 p.a.)	-470* (-20 p.a.)	-2,820* (-123 p.a.)
Government[2]	Reduced subsidy (+)	5,929 (247 p.a.)	17,152 (715 p.a.)	4,825 (201 p.a.)	13,556 (565 p.a.)
Deadweight efficiency (to society as a whole)[2,3]	Reduced subsidy (+)	1,186 (49)	3,430 (143)	965 (40)	2,711 (113)

Discounted by 3.5% as suggested by the Treasury Green Book (HMT, 2003). Due to space limitations, welfare changes during the first or second decade are omitted. [1]Assumption used to forecast the counterfactual scenario. [2]These benefits appear when comparing actual and counterfactual scenarios but are not applicable when the "replaced subsidy" scenario is compared to the counterfactual, as no subsidy reduction would occur. [3]If one assumes a shadow price of public funds of around 1.2 (after Dodgson and Topham, 1987), then there are deadweight efficiency gains from the reduced expenditure to overall society. *This estimate of labour wages is based on weekly earnings of bus and coach drivers in GB, but earnings in London are expectedly higher; thus, this estimate should be interpreted with caution.

10.5 Overall welfare change of the society

Our welfare analysis calculated changes in welfare due to bus policy reforms in GB (outside and within London). The analysis compared what was actually observed with the "do-nothing" or "counterfactual" scenario; another scenario concerning the level of subsidy (i.e., the "replaced subsidy".) was also considered. The forecasts of these scenarios were based on three econometric models for London and the rest of the country separately, in which the impacts of the subsidy were determined and possibly isolated. In addition to the demand models, we also developed forecasting models of operating costs and fares that permit a more detailed counterfactual analysis, such as the impact of reductions in subsidy, fuel prices, and labour wages. The main purpose for using the fare model is to separate the impacts of subsidy changes from those caused by the bus regulatory reforms. The cost modelling also permitted an analysis of the extent to which the observed reductions in operating cost should be attributed to reductions in input prices (particularly wages and fuel). These models are estimated with reference to elasticity values derived straight from actual bus data.

Results of overall welfare change to society as a whole are presented in Table 10-12. The analysis shows that outside London the results are sensitive to the assumptions made concerning the counterfactual. Thus, Table 10-11 shows the final results after averaging the figures given by the constant and trend assumptions.

Table 10-11 Summary of cost and benefits of British bus policy reforms [including or excluding the impacts of subsidy reductions] in GB, 1986/7 -2009/10 (£, million) at 2008/9 prices

	Inclusion of subsidy reductions[1] (as part of the bus policy reforms)?	Outside London (deregulation)			Within London (competitive tendering)		
		Since reform 1986/7-2009/10	1st decade 1986/7-1995/6	2nd decade 1996/7-2005/6	**Since reform 1986/7-2009/10**	1st decade 1986/7-1995/6	2nd decade 1996/7-2005/6
Consumer surplus (bus user)	Included	**-20,172**	-9,414	-7,826	**425**	-193	-307
	Excluded	**-4,101**	-3,261	-185	**3,356**	759	1,415
Producer surplus (bus operator)	Included	**649**	-1,409	1475	**-6,100**	-3,064	-2,571
	Excluded	**7,055**	1,713	4,035	**2,937**	1,243	1,428
Bus workers	Both	**-4,561**	-2,332	-2,252	**-1,645**	-723	-820
Government (or transport authority)	Included	**11,541**	4,799	5,079	**9,191**	4,420	4,034
	Excluded	**0**	0	0	**0**	0	0
Deadweight efficiency gains from reduced subsidy	Included	**2,308**	960	1,016	**1,838**	884	807
	Excluded	**0**	0	0	**0**	0	0
Overall welfare change to society as a whole	Included	**-10,235**	-7,397	-2,508	**3,709**	1,324	1,143
	Excluded	**-1,607**	-3,880	1,598	**4,648**	1,279	2,023

The research findings indicate that there is net welfare gain in London, but welfare loss in GB outside London. Remarkably, the welfare loss outside London occurred during the first decade after deregulation whilst there was small loss in the second decade (or even a slight gain when the impact of subsidy reduction is excluded). We found some relatively strong evidence that bus deregulation supressed demand in the long run. As a result, we found that consumers suffered substantial losses of benefit in GB outside London. These losses were partially offset by gains to the producer[91] and government, but enforced by losses to bus workers, so that society seems to have not benefitted

[91] Through reductions in operating costs and increases in operator revenues (see Table 10-8).

overall. Thus, the producers and government have emerged as the clear winners from deregulation at the expense of bus consumers and workers.

In London, although there are losses to producers and at a lesser scale to bus workers, large subsidy savings are calculated as benefits to the government (and as deadweight efficiency gains to the society) that offset all previous losses, consumers have also gained. The result is a welfare increase for society as a whole.

A closer look at the pattern of welfare changes (year by year), as illustrated in Figure 10-2, suggests that outside London:

- Government (and taxpayer) is the clear and constant winner from deregulation.
- Bus users are the main and constant loser from deregulation as their consumer surplus constantly decreases.
- Bus operators were losing up to 1997/8 when they have started to benefit from the deregulated industry. At the beginning of the period their loss as a result of subsidy reductions was larger than can be cushioned by the increases in passenger revenues or decreases in total costs. However, in the long run, their welfares figure became positive as their revenues have been increasing persistently whilst reductions in subsidy started to fading over time. Nonetheless, operating costs started to increase recently which brought their welfare down since 2006/7.
- Bus workers are another loser from deregulation, however, in the long run their welfare improved as the wage rate started to increase (in year 2009/10 the first welfare gain to workers is calculated).
- The society as a whole had been losing, particularly in the first decade after deregulation (up to year 1995/6). This finding which is supported by the conclusion drawn from the examination of the trends of the main indicators of local bus services, as detailed in section 3.4, suggests that the deregulation impacts persisted for a decade until 1995/6 and started to diminish since then. A finding that is also remarkably consistent with another empirical finding, the Partial Adjustment Model also suggests 10 years as the period when the deregulation policy (as well as other explanatory variables) completed 99% of its impacts on demand.

  But smaller welfare losses were calculated since then (became neutral or close to zero at the end of the period). We may call this era as a "controlled" deregulation as it was in parallel to the first elected "labour" government since deregulation who showed intention to re-regulate the industry[92].

[92] Some "soft" policy interventions (or "light" re-regulation) started by the 2000 Transport act followed by the "free" concessionary fare schemes and the Local Transport Act 2008.

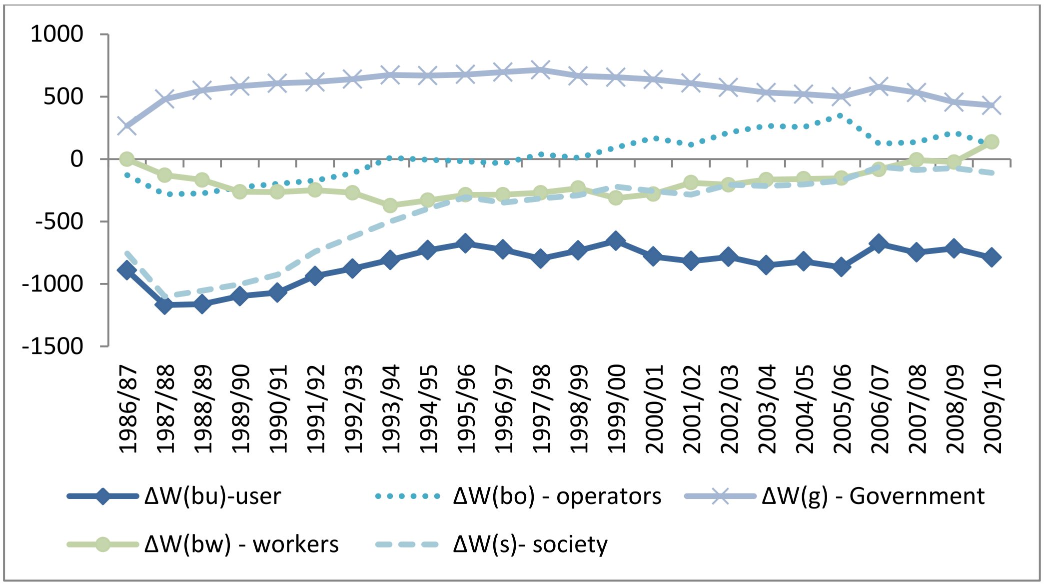

Figure 10-2 Illustration of pattern of welfare changes (year by year) outside London - after averaging the figures given by the constant and trend assumptions.

Similar year by year analysis for London, as demonstrated in Figure 10-3 indicates that

- Again, the government (and taxpayer) is the clear and constant gainers from the policy reform, although fewer gains calculated since early 2000s when subsidy reached high level in London.
- Bus users are temporarily lost from the reform, mainly from the early 1990s until the early 2000s, and since then large gains to users are calculated.
- Competitive tendering regime seems less profitable to bus operators (compared to the deregulated market). Operators are the main and constant loser from the reform in London, however, much smaller loss calculated since the early 2000s as subsidy increased in spite of the simultaneous increases of their costs. Their revenue from bus users seems not to benefit much from the high increases in demand as the fare levels kept low in London (and possibly due to the high use of discounted fares through travel passes).
- Bus workers are slightly disbenefited from the reform in London but still better than their situation in the deregulated areas.
- Unlike the rest of the country, the society as a whole has always been gaining in London.
- Overall, it can be seen from Figure 10-3 that the welfares of the key groups have dramatically changed from early 2000 onwards. Earlier, in 1993/4 or 1994/5, another sudden change in the trends is noticeable.

  These observations (as well as the trends of the main indicators of local bus services examined in section 3.4) suggest that the impacts of London's regime can be categorised under three periods[93]. The first, lasted up to the early 1990s when the bus network was gradually tendered to public and private firms (competitive tendering era). Second, since the mid 1990s up to the early 2000s, the impacts of the complete privatisation of the publicly owned operators are evident (privatisation era). Third, since the early 2000s onwards, the impacts of the Mayor's plan of service improvement in London.

[93] The trend in unit costs in London clearly illustrates these periods (Figure 3-4) as well as trends in demand and fares (Figure 3-9and Figure 3-5), and to a lesser extent the trend in service level (Figure 3-7).

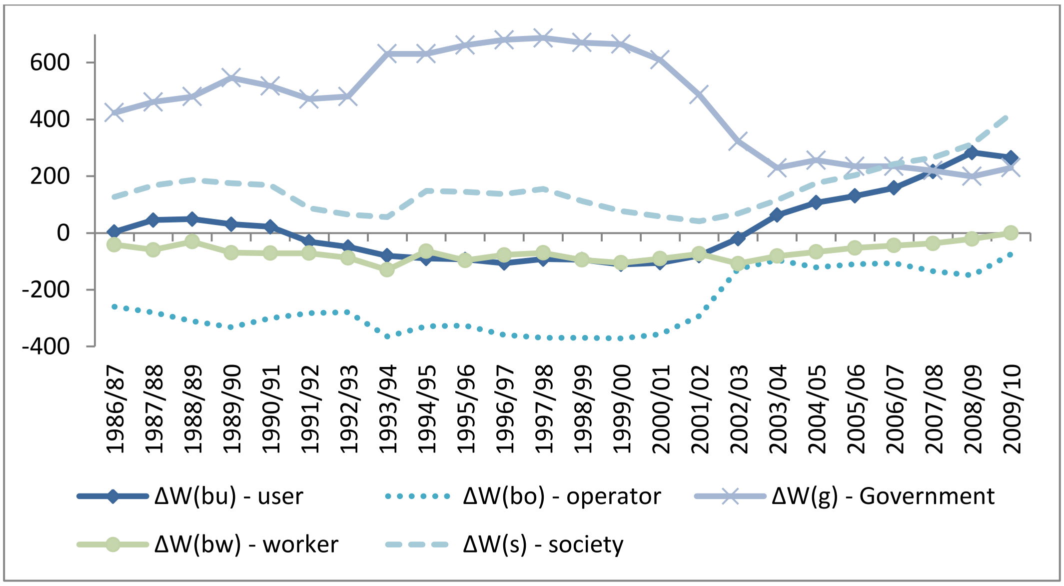

Figure 10-3 Illustration of pattern of welfare changes (year by year) in London - after averaging the figures given by the constant and trend assumptions.

Thus far, the observed subsidy reductions are assumed to be internally caused by the policy reforms in GB. Yet what if such reductions are externally caused by a parallel and separate fiscal policy? The welfare result for London remains positive and for GB outside London remains negative. However, a smaller loss was calculated during the first decade of the deregulation outside London whilst the second decade showed welfare gains.

In London, both consumer and producer surpluses remain positive; however, there are no benefits to the government or deadweight efficiency gains as impacts of subsidy reductions are isolated under the considered scenario. The result is a welfare increase for society as a whole, larger than that calculated before isolating the impacts of subsidy reductions. The bus subsidy in London seems to benefit both consumers and producers.

In the deregulated market, the consumer surplus remains negative but the producer welfare gain substantially increased and emerged as the clear winner. The bus subsidy seems to have positive impact on the deregulated market (seeming to benefit consumers and producers as well as society as a whole) but its reduction since the market was deregulated was not solely responsible for the calculated welfare loss outside London. In London, the competitive tendered market produced positive welfare change in London regardless of the impacts of subsidy changes.

In conclusion, the current welfare analysis clearly suggests that:

- The "alternative" competitive tendering policy, as applied in London, would increase per capita welfare gains to the society as a whole (compared to both the old regulatory system and the deregulated market, with or without subsidy reductions);
- The deregulation regime seems to harm bus users, but less impact is expected if the subsidy has not been reduced. In contrast, the competitive tendering regime increases per capita welfare gains to bus consumers more than the deregulation;
- The deregulation policy seems to benefit producers more than the competitive tendering does;
- Increasing the current subsidy level seems to increase the welfare of consumers, producers, and society as a whole in the deregulated market as well as the competitive tendered market; and
- Although the policy reforms in the mid 1980s are governing the local bus industry in GB outside London (and to a lesser extent in London), there are lighter re-regulations started to impact the industry since the early 2000s

Table 10-12 Summary of cost and benefits of British bus policy reforms [including or excluding the impacts of subsidy reductions] in GB, 1986/7 -2009/10 (£, million) at 2008/9 prices

Welfare change	Inclusion of subsidy reductions[1] (as part of the bus policy reforms)?	Outside London (deregulation)						Within London (competitive tendering)					
		Constant assumption[2]			Trend assumption[2]			Constant assumption[2]			Trend assumption[2]		
		Since reform 1986/7-2009/10	1st decade 1986/7-1995/6	2nd decade 1996/7-2005/6	**Since reform 1986/7-2009/10**	1st decade 1986/7-1995/6	2nd decade 1996/7-2005/6	**Since reform 1986/7-2009/10**	1st decade 1986/7-1995/6	2nd decade 1996/7-2005/6	**Since reform 1986/7-2009/10**	1st decade 1986/7-1995/6	2nd decade 1996/7-2005/6
Consumer surplus (bus user)	Included	-24,044 (-1,002)	-11,741	-9,006	-16,599 (-679)	-7,086	-6,647	399 (17)	0	-340	451 (19 p.a.)	-386	-273
	Excluded	-15,560 (-648	-8,190	-5,049	7,358 (307)	1,669	4,680	2,363 (98)	811	886	4,348 (181)	707	1,943
Producer surplus (bus operator)	Included	5,849 (244)	-554	4,232	-4,552 (-190)	-2,264	-1,283	-1,309 (-55)	-1,870	-99	-10,890 (-454)	-4,258	-5,042
	Excluded	8,536 (365)	1,490	4,995	5,573 (232)	1,935	3,074	3,416 (142)	1,317	1,710	2,458 (102)	1,168	1,146
Bus labour (employee)	Both	-483 (-20)	-1,008	-286	-8,638 (-360)	-3,655	-4,218	-470 (-20)	-393	-217	-2,820 (-123)	-1,052	-1,422
Government (or transport authority)	Included	5,929 (247)	3,071	2,376	17,152 (715)	6,526	7,782	4,825 (201)	3,281	1,820	13,556 (565)	5,559	6,248
	Excluded	0	0	0	0	0	0	0	0	0	0	0	0
Deadweight efficiency gains from reduced subsidy	Included	1,186 (49)	614	475	3,430 (143)	1,305	1,556	965 (40)	656	364	2,711 (113)	1,112	1,250
	Excluded	0	0	0	0	0	0	0	0	0	0	0	0
Overall welfare change to society as a whole	Included	-11,563	-9,618	-2,209	-8,907	-5,174	-2,810	4,410	1,674	1,528	3,008	975	761
	Excluded	-7,507	-7,708	-340	4,293	-51	3,536	5,309	1,735	2,379	3,986	823	1,667

Discounted by 3.5% as suggested by the Treasury's Green Book (Treasury, 2003). [1] Inclusion of subsidy appears when comparing actual and counterfactual scenarios, but it is excluded when "the replaced subsidy" scenario is considered and compared to the counterfactual, as no subsidy reduction would occur. [2] Assumption used to forecast the counterfactual scenario.

11. Conclusions and Recommendations

11.1 Introduction

In this concluding chapter we will summarise the empirical findings from the application of the econometric models (chapter 6) and from the key results of the trend analysis (Actual versus counterfactual trends – chapter 9) and the welfare analysis (chapter 10). We will then discuss some policy implications of the research findings and outline the research limitations and prospect for future areas of research, before making a final remark.

11.2 Key results from the econometric models

11.2.1 The Demand Model

11.2.1.1 The Partial Adjustment Model

- we find some relatively strong evidence that bus deregulation supressed demand in the long run by around 12.2%

When the demand model(s) for the deregulated areas are estimated, the coefficient of deregulation policy dummy variable[94] is always found significant and has a negative sign. This indicates that this variable significantly captures the negative impacts of deregulation policy on local bus demand. A coefficient of (-0.048) is estimated for PAM. The transformed (unlogged) figure (= 0.953) implies that demand level after bus deregulation is 95.3% of its level before the policy was implemented. Thus, the bus deregulation supressed demand in the short run by 4.7% and in the long run by around 12.2%.[95]

- relatively slow adjustment (long adjustment periods) of bus demand in response to change in explanatory variables

The coefficient of the lagged dependent variable (0.630) suggests a relatively slow adjustment, with 99% of the adjustment occurring in 10 years[96] – suggesting relatively long adjustment periods [the fare model suggests 9 years].

- **Lower fare and service elasticities**

[94] Suggesting a long term effect of the deregulation policy as this dummy variable is operational throughout the period, 1986/7 to 2009/10.
[95] The coefficient of the lagged dependent variable is 0.63. Thus, the short term impact equals [EXP (-0.048) = 0.953 = -4.7%] and the long term impact equals [EXP (-0.048/(1-0.63)) = 0.878 = -12.2%].
[96] Calculated as [Ln (1 - 0.99)/ Ln (0.630) = 9.967].

The estimated demand model suggests slightly smaller (absolute) service and fare elasticities than conventional figures suggested by Dargay and Hanly (1999, 2002). Nevertheless, the estimated elasticities are in the general range found in the literature (including the work of Dargay and Hanly). Wheat and Toner (2010) updated the work of Dargay and Hanly and reached similar conclusion regarding fare elasticity stating that "We also find evidence that, at the level of the whole bus market, the short run and long run fare elasticity is falling over time." They justify this difference as

> "This is because there has been an increase over time in the proportion of passengers which pay fixed or zero fare. These passengers will have no reaction to changes in the fare level given they pay an unrelated charge (or none at all)."

Similar justification applies to this research as the fare variable is defined as the "average" costs of traveling per trip which includes concessionary and non-concessionary trips. In regards to service level, there is some evidence (Headicar, 1989; Evans, 1990) that bus operators temporarily run extra bus miles only to increase market share and/or deter potential entrants in the deregulated areas until they have competitive advantage (and sometimes duplicate services in areas which observed some sort of competition) rather than to increase frequency where needed in benefit to bus users and therefore attract further demand.

- There is heterogeneity in the panel (area-specific unobserved effects) and the Fixed Effect method is the most suitable specification to control for it

In addition to the standard pooled regression, Fixed and Random Effect methods are used during the model estimation process in order to investigate the issue of panel heterogeneity. There are strong evidences, both statistically and theoretically, that confirm the presence of fixed (area) effects in the panel data sets.[97] Thus, the Fixed Effect method is the most suitable specification of bus demand model to control heterogeneity based on the ranges of our data.

11.2.1.2 Alternative method - cointegration and the ECM approach

There are also some findings based on cointegration and the ECM approach. The results of the time series and panel analysis using unit root and cointegration tests provide evidence that the variables included in the local bus demand model are integrated (non-stationary) but bounded together in the long run (by a cointegration relationship). Furthermore, Balcombe *et al.* (2004, p. 44) suggested further work when cointegration and the ECM approach are considered. They suggested determining the number of cointegrating relationships in the model whenever there are more than two variables considered. This point is tackled and the results suggest the

[97] There are unobserved or unmeasured characteristics (unobserved heterogeneity) variant across areas which may affect, in some extent, bus patronage that we are not aware of or do not have suitable data o model it. The FE model is able to control such effects.

presence of only a single cointegrating relationship between the considered variables.[98] Another finding is that the error-correction mechanism seems to exist in the demand function. A robust ECM is estimated using the EG two-step estimation procedure.

11.2.2 Cost and Fare Models

The equation of the cost model for areas outside London specifies the time trend as an explanatory variable which is related to the deregulation policy as it is operational throughout the period, 1986/7 to 2009/10. The coefficient of time trend variable (= -0.023) indicates impacts of deregulation on total costs equals (-2.33% p.a.).[99]

An alternative cost model estimated for London specifies two dummy variables:

- the 1994 dummy variable (1994/5-present) which captures the completion of the processes of “privatising” the bus operations and of “competitively tendering” the bus routes. Its coefficient indicates a one-off decrease in total costs = exp(-0.168) = 0.845 ≈ -15.5%.

- the 2002 dummy variable (2002/3-present) captures the process of expanding the bus network services in London according to the Mayor’s plan and for the preparation for the Congestion Charging (CC) scheme. Its coefficient indicates a one-off increase in total costs = exp(0.213) = 1.237 ≈ +23.7%.

As in the cost model, the time trend variable specified in the fare model for the deregulated areas is related to the deregulation policy. The coefficient of the time trend variable indicates the impact of deregulation on fares = exp(0.009) = 1.009 ≈ 0.9% p.a. An alternative fare model was estimated for London, where the coefficient of the time trend variable indicates impact of the policy reform in London on fares = exp(0.005) = 1.005 ≈ 0.5% p.a.

11.3 Key results from trend analysis (Actual versus counterfactual trend)

- **Bus deregulation policy have caused further losses in demand**

As illustrated in Figure 9-7, there is a gap between the actual and counterfactual demand trends in GB outside London, between of 5 to 10%; the levels of demand under the counterfactual

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[98] Initially, the analysis suggested two cointegrating relationships, but the model estimation procedure suggests that only a single relationship is found to be significant. A larger sample size (longer time series) is required in future work to further investigate this issue.

[99] exp(-0.023) = 0.977 ≈ -2.33% p.a.

scenario are always higher. Thus, we can again argue that bus deregulation policy has an adverse effect on the level of bus demand (as also suggested by the deregulation dummy specified in the demand model).

But are the subsidy reductions that accompanied the deregulation policy partially or fully responsible for such demand losses? The levels of demand under the counterfactual scenario remain slightly higher than that under the "replaced subsidy" scenario[100], see Figure 9-11, which indicates that the subsidy reductions are only partially responsible for this gap[101].

On the other hand, much of the actual decline in demand observed since the mid 1980s would have happened anyway, as the counterfactual trend in demand is also declining[102].

- **Recent slowdown of demand decline that was actually observed in the deregulated areas would have been expected anyway**

The forecasts of the counterfactual have shown that the historical decline in demand would have been expected to level out by mid-2000s, and even to increase by 2006/7 and forwards in parallel to the local and national free concessionary fare schemes (introduced in London in 2006/7 and 2008/9 respectively). Another factor of this deceleration is the dampening personal income increases in recent years[103].

- **The competitive tendering regime in London has boosted demand in the long term only**

As demonstrated in Figure 9-8, the trend in demand under the counterfactual scenario suggest no effects by the competitive tendering regime on the demand up to the early 1990s when the process of dividing and privatising the publicly owned London Bus Limited (LBL) was started. This process caused minor decline in demand but actual and counterfactual trends continued to move in parallel. However, these trends started to diverge since the early 2000s, with very sharp increases in actual demand trend. This might suggest that the policy intervention in London has had positive impacts on the level of bus demand in the long term. However, this may also be attributed to the expansion of the bus network services in London according to the Mayor's transport strategy (GLA, 2001).

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[100] The scenario which isolates the impacts of subsidy reductions by hypothesising that subsidy has not been reduced.
[101] Differs from year to year but can be stated that subsidy reduction is responsible for 32% of the gap in average.
[102] The factors that caused the long term historical declining trend, since the 1950s, would have continued to have the same adverse impacts. In 2009/10, the "actual" demand was 36% lower than its level at 1985/6 whilst the "counterfactual" demand was only 29% lower.
[103] The estimated demand elasticity with respect to income variable is very high, see Table 6-9.

Again, what if the subsidy has not been reduced? The levels of demand under the counterfactual scenario become always lower than that under the “replaced subsidy” scenario, see Figure 9-12. Thus, the subsidy reduction is “fully” responsible of the loss in demand in London, particularly in the 1990s when subsidy reduced dramatically.

- **Deregulation policy caused consistent series of fare increases, in disbenefits of bus users**

Figure 9-5 shows that the counterfactual fares would have been expected to be lower than what was actually observed. Given that, it can be argued that fares are higher under the deregulated industry than the regulated regime. Even when isolating the impacts of subsidy reductions, the fares remain higher under the deregulated market[104].

- **The competitive tendering regime has minor effects on fares**

As shown in Figure 9-6, it can be claimed that policy intervention in London brought no additional benefits to bus users in terms of lower fare levels. However, it held the fare level constant at the mid-1980s level. Although fares increased during the 1990s, in parallel to substantial reductions in total subsidies, they decreased again in the 2000s. Thus, when isolating the impacts of subsidy reductions, there is no difference between the fare level under the competitively tendered and regulated markets.

- **Both bus policy interventions have reduced unit costs in the short to medium terms, but was not maintained in the long term**

Overall, the counterfactual unit costs outside London would have expected to remain at a constant level, fluctuating around £2 per VKM (at 2008/9 prices), see Figure 9-2. However, this is a much higher figure than the £1 per VKM observed in the late 1990s after deregulating the bus industry (but this figure was not maintained in the long term). In London, the same patterns in unit costs are observed as outside London.

11.4 Key results from welfare analysis

The key findings of the research are identified by the results of the cost-benefit analysis (CBA) outlined in chapter 10. The CBA calculated the changes in welfare, of key parties in the industry, due to the bus policy reforms in both GB outside London and within London. The analysis compared what was actually observed with the “do-nothing” or “counterfactual” scenario - what would have happened in absence of policy interventions. Another scenario concerning the impacts of level of subsidy is also considered. The main findings are as follows

[104] Differs from year to year but can be stated that fares are still higher by about 20% in average.

1. **The deregulation policy (competition "in" the market) reduced the society's welfare. In contrast, the alternative competitive tendering regime (competition "for" the market) as applied in London increased the society's welfare.**

We find that consumers suffered substantial losses of benefit in Great Britain outside London, by £20bn at 2008/9 prices over the period between 1986/7 to 2009/10. This is in line with the empirical finding that bus deregulation supressed demand in the long run (by around 12.2% as indicated by the policy dummy variable specified in the demand model). These losses were partially offset by the calculated producer gains of £0.6bn (through reductions in operating costs and higher revenues), gains to the Government of £11.6bn (through reduction in subsidy level), and deadweight efficiency gains of £2.3bn (from the reduced subsidy assuming 1.2 shadow price). However, substantial losses to bus workers of £4.6bn are calculated so that society seems to lose overall by £10.2bn.

In contrast, gains to consumers (£0.4bn) are calculated in London. But producers emerged as clear losers by a large figure of £6.1bn, bus workers was also lost (£1.6bn). However, substantial reductions in subsidy resulted in large gains to the (£11bn, of which £1.8bn as deadweight efficiency gains). However, the result is a welfare increase for the society as a whole in London (£3.7bn). Another interesting observation is that, only in London, the consumer surplus became positive (gain) in the long run (since year 2003/4 onwards).

In conclusion, deregulation has failed to increase overall societal benefits and, in fact, the opposite has occurred. Yet, when each group in the industry is considered alone, the policy has resulted in mixture of winner and losers. The government emerged as the clear gainer and in the long run the operators have gained too (interestingly in line with the increasing market concentration in few large operators). But this was at the expense of bus users and labour. Simply, the deregulation policy package has shifted the burdens (of operating bus services) from the Government to the private sector. It should be noted, however, looking at year by year welfare changes suggests that the adverse impacts of the deregulation on the overall welfare started to reduce after the first decade (but user's welfare continued to deteriorate). In contrast, the competitive tendering regime London increased welfare gains to society as a whole.

2. **What if the observed reductions in subsidy are caused by external monetary policy rather than as a part of the policy reforms?**

In this case, the analysis shows that the previously net welfare decreases outside London remains even when the impacts of subsidy reductions are excluded. By contrast, welfare increases are found in London irrespective of whether these impacts are included or excluded, refer to Table 10-11. Under both regulatory regimes (deregulation and competitive tendering) the subsidy seems to benefit bus users and producers. The Government is not the winner anymore as it is the body that would pay these higher subsidy levels.

3. Overall conclusion

Overall, we find that bus reforms in London have been more welfare enhancing than the reforms in Great Britain outside London, where deregulation led to substantial welfare losses, in the first decade of the reforms (1986/7 to 1995/6) in particular. From the second decade onwards there are smaller losses.

11.5 Policy Implications

11.5.1 Has deregulation been a successful policy?

The answer may be controversial as it depends on the Conservative Government's intention/objective when it deregulated the market in the mid1980s. Glaister (1991) argues that bus deregulation was about reducing subsidy as part of the retreat of the state:

> "the prime motivation for the policy was actually to change things on the supply side in order to meet global requirements for subsidy reduction whilst minimising damage to passengers through fare increases and service reductions."

In this case, the deregulation has succeeded in operating buses at lower subsidies and costs through the private sector. However, it failed in "minimising damage to passengers" as there are significant fare increases and demand falls attributed to impacts of the deregulation policy, thus, there are substantial consumer losses calculated as shown by the CBA results.

Moreover, the 1984 "Buses" White Paper argued that "Competition provides the opportunity for lower fares, new services, and more passengers". But the deregulation has failed to stimulate competition and consequently reduce fares and halt patronage decline, in fact, it did the opposite with respect to fares and patronage. It is true that deregulation has not been attributed by service reductions in the short to medium term. However, this is not the case in the long term as substantial reductions in commercial vehicle kilometres were observed. As a result, the bus market became increasingly dependent on the socially subsided services[105], competitively tendered route operated for social needs.

This argument is consistent with that concluded by a parallel investigation by the OFT (Office Fair Trade) and CC (Competition Committee). The OFT initially, in March 2009, announced that it had some concerns that "limited competition between bus operators tends to result in higher prices and lower quality, for bus users." (OFT, 2009, p5). Later, in August 2009, the OFT decided to refer the local bus services market, in the GB outside London, to the CC for a market investigation based on their conclusions that

> “The evidence presented earlier indicates that local markets are concentrated at a variety of levels, that new entry is limited and that incumbent operators may exploit these features to charge higher prices and offer poorer service.” (OFT, 2009, p60).
>
> and;
>
> “Deregulated bus markets are characterised by what economists call 'competition in the market'. Based on our findings, we suggest that in many local bus markets this seems to have broken down and been replaced by much weaker competition and, in some examples, virtually no competition at all.” (OFT, 2009, p61).

The final report by the CC, concluding their extensive investigation, confirmed these concerns and found that deregulated services and the associated “competition in the market” as unworkable:

> “We found that competition in the supply of local bus services is not effective in those local markets where head-to-head competition does not exist, and hence that there are adverse effects on competition (AECs).” (Competition Commission, 2011, p1).

The welfare analysis carried out in this research confirms the argument of a deregulation failure as it shows that although the policy resulted in a mix of welfare gains and losses to the key groups in the industry, overall, there are negative effects on the bus user’s welfare as well on the wider society’s welfare. Producers (operators) gained from deregulation in the long run, but instead of investing their gain to improve the service quality, it was wasted (in the short/medium run) on extra unproductive vehicle kilometres and to acquire larger market share. In addition, operator’s gains came at the costs of bus employees who suffered from lower wages and

[105] Between 1999/00 and 2008/9, the percentage of the commercial bus kilometres dropped from 84% to 76%. Local authorities had to replace these cuts through subsidised (tendered) services (source: extracted from various DfT’s statistics bulletins) .

deteriorated working standards. Also, there are signs that operators deferred investments in services (TAS, 2007). Moreover, it remains doubtful if operator gains would persist in the future given the recent increase in industry's wages and fuel prices[106]. Adding to that the current Government plan to cut or reform operator subsidy (Bus Service Operator Grant - BSOG) and to reduce local funds (HC, 2011). The government emerged as the clearest winner as their financial support was reduced and the burden of service planning and provisions were shifted to the private sector (operators).

There is also an interesting remark here that is worth further attention. How has the deregulation policy succeeded in reducing costs, at least in the short to medium term, whilst it failed to produce competitive markets? The 1984 White Paper's main arguments were that first the deregulation would produce completive markets, and second the emerged competition would reduce the costs. This question may be restated, which part of the deregulation package is responsible for these particular outcomes?

It can be argued that "privatisation and commercialisation" of the bus operators has brought the effectiveness of the private sector which triggered these cost reductions. In the meantime, "deregulation" [defined here as the removal of service operating licence] and the associated "competition in the market" failed to deliver real competition due to the market concentration of a few large operators.

In the previous chapter we answered this question by arguing that whilst the isolation of "subsidy reduction" impacts from the rest of the deregulation package is possible, "privatisation" is an integral part to "deregulation", building on similar hypothesis by Romilly (2001) and others. Now, based on the previous remark, this issue may be worth further investigation in future works. As noted before, the massive changes brought by the deregulation package and the nature of the "Big Bang" implementation of this package made the evaluation very difficult (but not impossible).

11.5.2 Should there be further regulatory change?

Whilst our welfare analysis suggests that the deregulation policy has adverse impacts on the society's welfare; it also suggests that the "alternative" competitive tendering policy as applied in London would increase society's welfare. London experience has the same positive impacts

[106] These two factors in particular have significantly contributed in the calculated operator's gains as these prices went below their mid-1980s for about two decades.

of deregulation whilst retaining the advantages of coordinated and integrated services run by multiple operators, tendered at route level.

In the longer run, the outcomes of London's competitive regime have even improved, in term of service and fares levels; and as a result its high bus use growth is exceptional in the UK. Our welfare calculations show that the consumer surplus in London has been positive since 2003/4.[107] Although these longer run improvements required higher subsidy, remarkably, the system was adequately operated at "zero" subsidy for four consecutive years in the mid 1990s.

All OFT concerns (of lack of competition, rises in fares, and falls in demand) were raised exclusively in the deregulated market in GB outside London as the OFT inspected the situation in the competitive tendering market in London but it did not detect any issues of concern. Bus users in London benefit from discounted, integrated and simply structured fares valid over a comprehensive network coverage, regardless of which operators were running these routes. The use of travel cards (Oyster smartcard and other passes) is dominant with minor use of cash fares (White, 2009). The government's 2000 Ten Year Transport Plan (DETR, 2000) which set a target of an increase of England's bus use by 10% by 2010/11 (above the base year level) had been achieved by London alone whilst it failed elsewhere[108].

In London only, the wider role of buses was achieved. "Social exclusion" was reduced as "mobility" of users increased; particularly the elderly, the disabled, and people with shopping trolley or child buggy who benefited from full conversion to low-floor bus design and comprehensive network coverage (White, 2009). It can be argued that its impacts on the "environment" and "climate change" are better than deregulation as more users are riding buses and such a sustainable system is aiding economic activities (Mackie *et al.,* 2012). Such role of buses has not been achieved in the deregulated areas outside the capital, with some exceptions in a few small urban cities such as Brighton and Oxford (DfT, 2006a). Yet these exceptional cases are small cities patterned by unique characteristics[109] that do not exist elsewhere in the country. These patterns allowed for sufficient funds through Local Transport Plan (LTP) bids; favourably received by local authorities based on their successful progress in implementing particular schemes (e.g. bus priority or park and rides).

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[107] The main reason of the delay in witnessing the positive impacts of the policy reform in London may be attributed to the gradual process of implementing these policy changes.
[108] Between 2000/1 and 2010/11, the bus used increased in London by 65% whilst declined in the deregulated area by 4% (source: driven from Table BUS0103 in Annual Bus Statistics: Great Britain 2011/12) .
[109] "They are all freestanding historic small cities with a fairly dense and compact centre containing substantial employment and major tourist attractions." (Knowles and Abrantes, 2008, p103).

Balcombe *et al*. (2004); stated that

> "The concerns of policy makers and planners now are less with the problems of maintaining public transport, on which the mobility of a sizeable minority of people depends, but with increasing its attractiveness to car users".

This is not the case in GB outside London as the local bus industry is still struggling, particularly in large conurbations, and a large share of its base (users) has been lost. On the other hand, this is exactly the case in London. In the long run, sharp increases in demand, partially from former or would be car users, are apparent. Thus, some policy intervention, to a greater or lesser extent, in GB outside London in the Metropolitan areas in particular, seems unavoidable.

The CC report specified four features of local bus industries that restrain any effective head-to-head competition (or competition "for" the market) and which limit the effectiveness of potential competition and new entry. These features are

1. the presence of high degree of market concentration (the bulk of the services run by few large operators;
2. barriers to entry and expansion;
3. customer behaviour in deciding which bus to catch (tend to jump in the first bus arrive); and
4. operator behaviour (tend to avoid competing in other "Core Territories") causes "geographic market segregation".

All these features in local bus services support the use of competition "for" the market over the alternative (competition "in" the market). This is also supporting our finding, built on our welfare analysis, that the alternative policy of competitive tendering and the associated competition in the market as applied in London is favoured over deregulation.

Then, the question is why has London's model has not been extended or copied elsewhere? Another question is why deregulation is still active, irrespective to its failure in "minimising damage to passengers"? An answer is given by Knowles and Abrantes (2008, p103) that

> "It is clear, however, that the government is not prepared to finance London-style fare subsidies and frequency increases elsewhere; deregulation has been retained because of proven cost savings to the Exchequer, even though in the long run it could generate higher costs due to increased congestion and carbon emissions, and more demand for road-building and maintenance.".

This answer may support the Glaister (1991) and Hibbs and Bradley (1997) argument that the Thatcher's government intention to deregulate the industry was a result of an overall public policy to reduce public expenditure and the deregulation regime is the best way to achieve this target (operating services at the lowest public fund possible).

There were some alternative measures proposed by the Labour Governments (1997-2010). The first initiative, Statutory Quality Partnership (SQP) and Quality Contracts (QC), introduced through the 2000 Transport Act has "practically" failed[110] and thus were followed by another initiative through the Local Transport Act 2008. However, for the latter initiative is also doubted that it would tackle the industry problem, in the large conurbations in particular. For example, Preston (2010) concluded that "There are concerns that the Local Transport Act [2008] will be as ineffective in promoting Quality Contracts as the 2000 Transport Act and a series of remedial measures will be needed." Among others, the concerns include that it could take a long time to complete the contracting process[111] or the contracts could be sabotaged by incumbent operator [such as "operators to propose pre emptive Quality Partnerships" or "an existing operator, having lost a Quality Contract, withdraws vehicles and staff (the so called scorched earth policy)."].

After three years of its introduction, the independent transport consultants TAS commented on the consequences of the 2008 Act that "Difficulties in the complex relationships between local authorities and bus operators remain" and concluded that ".. one suspects that the history of the latest piece of transport legislation will be no more glorious than its immediate predecessor [2000 Transport Act]." (TAS, 2010, p147). TAS also referred to the gap between what was initially suggested in the preceding White Paper (and the parallel Eddington's transport report) and with that introduced in the Act. Indeed, the proposal was substantially altered during the approval process in the Parliament "as a result of intensive lobbying by both the industry and the local authority sector." (Knowles and Abrantes, 2008).

An example showing the reluctance of policy makers, DfT declared recently their intention to block any QC from a new fund, the Better Bus Area (BBA) fund. This decision has ignored the

[110] "The North Sheffield SQP signed in autumn 2007 is the only SQP [in England] in the seven years since they became permissible under the 2000 Transport Act because of the difficulty in persuading private bus operators to sign statutory agreements" (Knowles and Abrantes, 2008)
[111] This was proven in practice. In November 2009, first Quality Contract was proposed in West Yorkshire and ITA meeting, initial plans approved in June 2012, but Metro (the West Yorkshire PTE) foresees finalising the scheme in 2013, and executing the contract in April 2015. Also, the Association of Bus Operators in West Yorkshire opposed the QC stating that "'Quality contracts will take years to put in place, are completely untried and will cost millions of pounds". Source: Bus and Coach Professional Magazine, 29 June 2012, http://www.busandcoach.com (accessed in 2/1/2013).

recent calls by Commons Transport Committee and ITAs for eligibility of QC of the new fund[112].

Unless a proper regulatory change is considered, the continuation of successive government's policy failures, the recent growing trends in costs and subsidies, and the recent financial concerns would have adverse impacts on local bus industry outside London. It is expected to suffer from further decline instead of stimulate demand and cause a modal shift from private cars.

11.5.3 Has the era of deregulation ended?

We found that many of the outcomes of the bus deregulation policy observed in the short and medium term have been reversed in the longer term, as detailed in section 3.4. Trends in key variables such as costs and subsidies have been reversed, substantially increasing after a period of decline. The downward trends in service (VKM) and, to a lesser extent, patronage have also been reversed.

Based on visual examination of long-term trends**,** it can be argued that the impacts of deregulation have persisted for about a decade but no longer deliver. The mid- to late 1990s seem to have been a turning point for many key trends. What we have observed since then is a new era of 'controlled' deregulation, characterised by light re-regulation introduced by Labour governments through the Transport Acts of 2000 and 2008, as well as concessionary fares schemes.

A further outcome is also remarkably consistent with another empirical finding, the chosen Partial Adjustment Models (demand and fare models). According to these, 10 and 9 years are proposed, respectively, as the period when the changes in explanatory variables, including the deregulation dummy variable specified in the demand model, completed 99% of their impacts. Similarly, our (year by year) welfare analysis shows that deregulation was welfare negative for a decade (until 1995/6), but turned almost neutral (slightly negative) thereafter.

[112] Also, "David Brown, pteg's lead director on bus issues, said the DfT's proposals discriminated against transport authorities who decided a QC was the best way to improve bus services". Source: transportxtra, Issue 605, 14 Sep 2012 http://www.transportxtra.com/magazines/local_transport_today/news/?id=32110

11.6 Research limitations and prospect for future works

The current research is subject to certain limitations that should be taken into account in future work, notably in the methodology employed. Attempts to include other variables, particularly car ownership and motoring costs, were unsuccessful for outside London. The main reason was statistical, namely the high multi-correlation between the former variable and the income variable included in the model equation, while the time series of the latter variable showed very small variations over the years. Also, disaggregated data by geographical regions before the year 1992 are impossible to obtain, which makes the inclusion of the car ownership variable in the panel model very difficult, leading to insignificant parameter estimates.

Further research should also widen the welfare analysis to consider other impacts on the environment. We found that the scarcity of environmental time series data since the mid-1980s was the main obstacle to including this aspect in our analysis of long-term impacts.

The main impediments to any long-term evaluation are the availability and consistency of time series data for the key variables over the whole period of study, as well as the level of disaggregation of these data, although, at the aggregate level, some transport time series data are available in Great Britain on most key variables. By contrast, it is not possible to obtain disaggregated data in the same manner as at the aggregated level.

The most disaggregated data available consistently since the mid-1980s classify Great Britain into regions (London, English metropolitan areas, the English Shires, Scotland and Wales). Thus, there are some successful stories of deregulation in some small individual cities (as well as failures at similar area level) that cannot be individually analysed but can be included in their higher region level. Thus, we recommend these small cities for case study analysis using appropriate methodology. Unfortunately, this aspiration could not be realised with the methodology applied in the present research and it would not be possible to evaluate longer-term impacts. This study looks at policy impacts at an aggregate level and focuses on the long-term horizon rather than at city level or in the shorter term.

Also, although the time series since deregulation available to this study is twice as long as for similar previous work, this is has proved to be relatively short from the perspective of time series or panel analysis. Robust time series regression analysis requires a large number of observations. Local bus data are collected annually, which makes it difficult to obtain the required number of observations, problems being encountered such as change of collection methodology, missing or not reported years and discontinuity of the series. Although quarterly collected data have become available, they do not go back far enough in time.

In summary, there are two potential areas that can be further investigated and are recommended for future work. First, disaggregate analysis, particularly of small cities that have experienced some success under the deregulation policy. Second, an attempt to include other variables, particularly car ownership and motoring costs, in the demand model. Currently, the income variable in the model's equation includes the indirect effect of car ownership.

11.7 Final Conclusion

Despite the massive and complex nature of policy reform, a methodology has been developed that allowed for an up-to-date evaluation of the long-term impacts of the bus deregulation policy package on the main stakeholders, comparison with an alternative regime adopted in London and isolation of the impacts of a controversial part of the package (subsidy reduction). The aims and objectives of the research set out in chapter 1 have therefore been almost fully achieved. Thus, the research contribution is that it updated the literature and filled a gap in knowledge by performing an evaluation of the long-term impacts of policy reform.

Overall, the deregulation package has been welfare negative over the period of assessment, when compared to a counterfactual scenario. Although the government has enjoyed clear gains from subsidy reductions, they unfortunately came at the expense of bus users and workers, whose losses have always (throughout the period under review) remained consistent. This lends support to the case for subsidy of the local bus industry in deregulated areas. The welfare results also show that the effects of deregulation were most harmful during the first decade after it was introduced.

In London, the competitive regime seems to benefit society as a whole, although bus users slightly lost out during the mid-1990s, when subsidy reached its lowest point.

Our findings would seem to support the assertion of Gwilliam et al. (1985a) that competition for the market is preferable to competition in the market. There appears to be limited competition for bus services outside London and the resultant configuration of higher fares and services is consistent with oligopolistic competition (Evans, 1990), although more recent studies suggest a degree of monopolisation (Competition Commission, 2011). However, Beesley and Glaister (1985a) were correct in their forecasts of substantial reductions in operating costs and of limited undesirable spin-offs, see Table 11-1 for further comparison.

The unconvincing outcomes of deregulated industry and the long-term shifts in some key trends point to the need for re-regulation of the bus services. This is verified by the concept of the 'regulatory cycle' in the local bus industry (Preston, 1999; Gwilliam, 2008). In the meantime, Labour governments in particular have introduced some measures, in the Transport Acts of 2000 and 2008, to partially regulate the 'free' market in order to mitigate its harmful effects. Our findings also highlighted a political cycle that directly impacts public transport, as demonstrated by the preference of Labour governments for regulating the markets and the Conservatives' contrary belief in the power of deregulation and the free market.

We have found some evidence of supply side economies of scale at the industry level. The implied elasticity of total costs with respect to VKM is 0.895 suggesting slight economies of scale. One could infer that these also apply at the firm level (but we do not have firm level data) - and this may be a partial explanation for the limited amount of competition. It should be noted that there are also size related purchasing power advantages related to fuel, vehicles and general access to capital.

Based on the evidence of supply side economies of scale, it can also be argued that the big operators are trying to benefit from being big and small at the same time (Preston, 1999)[113]. We have not been able to investigate demand side economies related to the provision of branded ticketing, integrated information and services - but this could be a further factor in some cases.

In regards to bringing in case study examples from across the regions, this is impossible given the lack of consistent data at this level of aggregation. Request of STAT100 data to be used in this research was refused by the DfT. All other attempts to acquire data directly from the authorities in these cities were also failed; the main reason for rejecting my requests was that to protect commercial confidentiality of bus operators in these areas.

Table 11-1 the historical bus policy debate: who was right at each stage

Has deregulation:	First decade	Second decade	Most recent years	Who was right?
1. Encouraged competition?	No, except in few areas during the first few years after deregulation	No	No	The opponents of deregulation seem to rightly predict that

[113] Preston, J. (1999). Big and Small is Beautiful: The Emerging Organization Of The Pan-European Bus Industry. In *World Transport Research: Selected Proceedings of the 8th World Conference on Transport Research* (No. Volume 4).

				competition was limited and small group in nature
2. Reduced cost?	Yes, substantial cost reductions were observed.	A reverse in the decline trend is observed. Cost has started to increase since late 1990s	No, cost continues to increase.	The proponents of deregulation seem to rightly predict that, although this is not the case in the longer term.
3. Reduced fares and increased services and demand	No, fares have substantially increased and demand dropped in a rate sharper than the historical (declining) rate observed since 1950s. Service level has increased but had small impact on demand as mostly wasted on unproductive forms	No, fare increases and demand losses continued Furthermore, services have started to decline (reverse in the trend observed in the first decade).	No, fare increases and services losses continued. Although the demand started to increase for the first time, this was temporarily and should be attributed to the free concessionary travel schemes rather than the deregulation impacts.	The opponents of deregulation seem to rightly predict that outcomes in line with oligopolistic competition
4. Had no undesirable spin-off.	Yes, no environmental or congestion issues were raised except in very limited cases (limited in time and place)	Yes	Yes	The proponents of deregulation seem to rightly predict that there were no adverse side effects.

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