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Labor Costs in Urban Mass Transit: A Case for Regulatory Reform

JOSEPH P. SCHWIETERMAN

ABSTRACT

When U.S. airlines, railroads, and motor carriers were deregulated, the incentives for organized labor in collective bargaining changed, causing more active participation in the containment of labor costs. Industrywide improvements in labor utilization and productivity resulted and much of the subsequent savings passed directly to the consumer. In the transit industry, regulatory reform has been largely overlooked as a mechanism to facilitate progress in collective bargaining. However, a unique sequence of events in Chicago--the growth of private transit--provides a clear demonstration of the potential of the private sector in an environment free from regulatory entry barriers. State and local regulatory bodies have not enforced applicable transit regulation and have permitted the private entrepreneurs to enter into direct competition with public transit operators. The implications of regulatory reform for organized labor in the transit industry are explored, focusing on the situation in Chicago. A case study example is provided of how the removal of regulatory entry barriers can alter the incentives of the public transit operator's labor force. The impact of the new low-cost services on the elasticity of demand and ridership levels of the city's public transit services is measured, and how these changes might affect the position of the labor force at the bargaining table is debated. The findings have important implications for assessing the potential benefits of regulatory reform in the urban transit industry.

The deregulation of U.S. airlines, railroads, and motor carriers has radically altered the course of collective bargaining in intercity transportation. Organized labor is participating more actively in the containment of operating costs, industrywide improvements in labor utilization are being made, and unions are relying less heavily on the strike-threat system to help settle contract disputes.

In the transit industry, regulatory reform has received little consideration as a mechanism to facilitate progress in collective bargaining. Research in this area has not adequately addressed the implications of regulation on the incentives of management and organized labor at the bargaining table. Many studies enthusiastically call for "innovation" or "cooperation" between labor and management in containing labor costs but few consider the potential contributions of an open, deregulated environment in achieving these objectives.

The implications of regulatory reform for collective bargaining in the transit industry are explored. Previous research that provides an effective outline of transit deregulation (1,2) is expanded by considering the issue from a more quantitative perspective. This analytical approach incorporates important economic variables that other studies, because of their qualitative orientation, have been unable to consider.

The organization of the paper is as follows. First, an overview of labor costs in the transportation industry is presented to provide the reader with an appreciation of the problem of rising labor costs under regulation. Evidence is cited to show how deregulation is fostering improvement in per-unit labor costs in air, rail, and motor carrier transportation. In the second section the issue of whether similar benefits could be realized through deregulation of the transit industry is explored. A case study of the emergence of low-cost private transit operators in the Chicago metropolitan area is presented to illustrate the extent to which the removal of regulatory entry barriers can alter the incentives of the public transit operator's labor force. By measuring the impact of the new entrants on the elasticity of demand and ridership levels of the Regional Transportation Authority (RTA), the city's public operator, an analysis is made of how these changes might facilitate progress in future transit collective bargaining.

OVERVIEW OF LABOR COSTS

Efforts to contain labor costs in the regulated transit industry have met with limited success. Despite continual attempts by public agencies to step up labor negotiations and rectify the adverse relationship between labor and management, labor costs continue to rise. The wages of municipal transit workers rose by 70 percent between 1950 and 1978, after adjustment for inflation (3), and many of the most extreme examples of featherbedding, which have long disappeared from other sectors of the transportation industry, remain intact in the U.S. transit industry. The dramatic rise in labor costs in proportion to other factor costs is shown in Figure 1. Wages, benefits, and salaries account for 50 percent of constant-dollar cost escalation in the industry since 1964, and they have risen 30 percent faster than the consumer price index (CPI) in the past 20 years (4).

Since 1973, labor costs have risen at almost twice the rate of transit supplies and materials, and public workers now earn over 30 percent more than their private-sector counterparts (4). Much of this increase is attributable to the steady decline in worker productivity that has occurred despite the introduction of labor-saving technology (5).

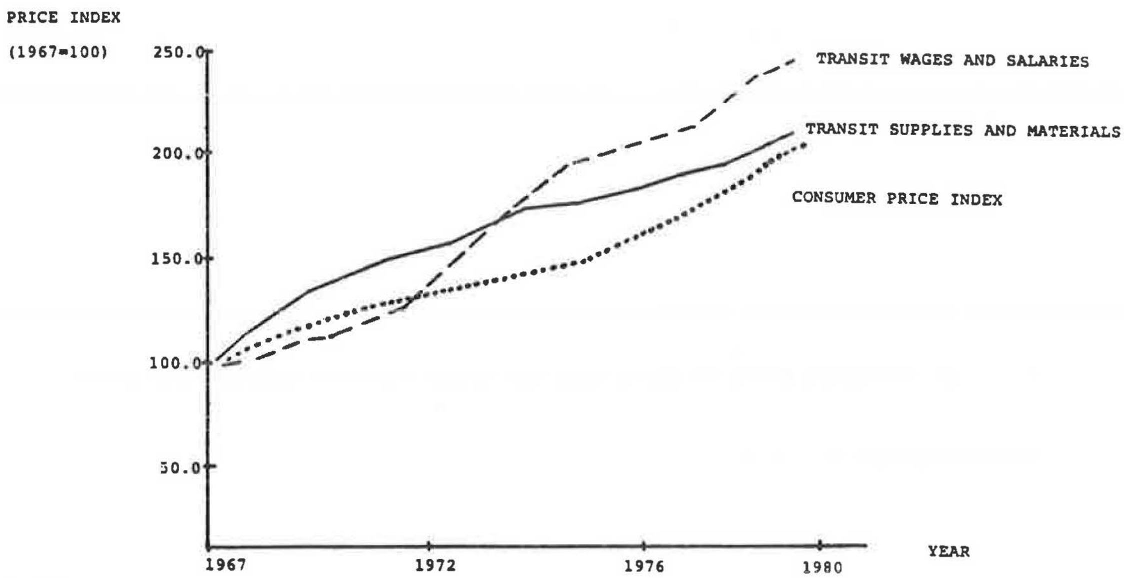


FIGURE 1 **Trends in public transit costs** *(4)*.

To blame rising transit labor costs on the intentions of organized labor is to miss the central question (6). Why are labor's demands satisfied so much more in the transit industry than in other industries? As suggested in the following sections, the experience of related industries indicates that the incentives and constraints of regulation are an important part of the answer.

The Airline Industry

Consider briefly the effects of regulatory reform on labor costs in domestic air travel. Between 1955 and 1975, labor costs in the airline industry rose in manner similar to that in the transit industry, with employee compensation rising from 138 percent to 161 percent of the average for American industrial firms. Salaries of in-flight personnel, such as pilots, mechanics, and flight attendants, rose at an even faster rate for most firms (4).

The Airline Deregulation Act of 1978 has brought a steady reversal of this trend. In the 5 years following its enactment, the competitive environment led to a decline in labor compensation rates for the industry from 161 percent of the all-industry average in 1978 to 158 percent in 1982 (4). These reductions have come in the form of salary "givebacks," work rule changes, and more efficient labor utilization procedures. Eight of the 11 largest airlines have successfully negotiated dual wage scales for in-flight personnel that allow compensation rates for new hires to more closely reflect their free-market value (7). Similar arrangements are rapidly being negotiated for pilots and mechanics of even the most profitable carriers.

Roland Wilder, Airline Officer of the Teamsters Union, summarized the impact of the Airline Deregulation Act on organized labor: "Economic pressures forced the unions to shift their principal focus to job security and retention. At the same time, airlines became far more conscious of controlling their labor costs as a means of countering the inroads of new, low-cost airlines." As long as a new entrant can "pressure existing carriers into reducing their own labor costs to be competitive, unions will continue to hear management requests for cost reductions" (7).

The Motor Carrier Industry

Deregulation has had similar effects on the unionized labor sector of the motor carrier industry. In an Iowa State University study of regulatory effects in the industry (8), it is concluded that regulation encouraged motor carriers to operate with less-than-optimal cost structures, route structures, and labor agreements. Within the 3 years following passage of the Motor Carrier Act of 1980, competitive pressure led to a decline in motor carrier industry wages from 119 to 114 percent of industry averages, and four of the five largest firms have negotiated work rule changes to substantially improve worker productivity (4). The influential Teamsters Union agreed to allow over-the-road drivers to make local deliveries, which significantly improved labor utilization on smaller shipments. Other studies provide similar findings and suggest that because of the rapid expansion of the nonunionized sector of the industry, the foregoing estimates probably understate the actual impact of deregulation on unit labor costs (9).

The Railroad Industry

Railroads and transit operators have historically been governed by similar work rules and operating procedures and often by the same labor organizations. The protection of the Railroad Labor Act of 1928 has led to compensation rates among the highest in all of industry. Railroad employees earned 20 percent more than their counterparts in comparable industries in 1955 and 61 percent more in 1980 (4). Other surveys report even greater wage and salary increases (3).

The effects of the Staggers Railroad Act in 1980 illustrate vividly the potential benefits of regulatory reform on collective bargaining. The liberalized branch-line procedures under the act, for example, provide organized labor with greater incentive to allow less restrictive operating procedures on marginal routes. This act enabled Consolidated Rail Corporation (Conrail), Milwaukee Road, and Chicago and Northwestern to negotiate union provisions to reduce labor costs on branch lines by using smaller crews and less rigid scheduling rules (10). Railroads are also reducing labor costs by negotiating productivity improvements and wage givebacks. The Illinois Central Gulf, Delaware and Hudson, Conrail, and Milwaukee Road have secured provisions that are expected to save millions annually through reduced crew requirements on express freight services. Several major western railroads have negotiated special crew arrangements for intramodal services. U.S. Class I railroads have reduced labor expenses per employee from 161 percent of the industry average in 1980 to 159 percent in 1982 (4), and these arrangements have led some observers to anticipate a drop to less than 145 percent by 1986 (10).

The dramatic progress in collective bargaining that deregulation has sparked in the 10 largest U.S. air, motor carrier, and rail operators is summarized in Table 1 (4,10,11; miscellaneous annual reports of airline, motor carrier, and railroad operations, 1980-1983). Regulatory reform has affected the three modes in vastly different ways, but the result has been a reduction in labor costs to a level more closely paralleling those in other industries. The success in these industries highlights the need to consider regulatory reform for the transit industry. The following section, by focusing on the elimination of regulatory entry barriers in Chicago's transit system, provides insight into this important issue.

TABLE 1 Trends in Transportation Industry Collective Bargaining Since Deregulation *(4,10,11)*

Trend	No. of Firms[a]
Airline Industry	
Reduced salaries and wages for existing employees	4
Reduced salaries and wages for new hires	6
Increased on-duty time for flight attendants	5
Changes in overtime pay provisions	4
Reduced fringe benefits and retirement compensation	4
Railroad Industry	
Elimination of locomotive crew member on certain services	3
Elimination of caboose or conductor on certain services	2
Special branch-line labor arrangements	4
Reduced applicability of overtime compensation	3
Elimination of 100-mile day	3
Wage and salary freezes	3
Wage and salary givebacks	2
Motor Carrier Industry	
Increased flexibility in scheduling and routings	3
Wage and salary freezes	2
Reduced fringe benefits	4
Provisions for increased worker productivity through elimination of certain work rules	3
Lower salaries to new hires	2

Note: Data also from miscellaneous annual reports of airline, motor carrier, and railroad operations, 1980-1983.

[a]Ten largest firms in each sector.

A CASE STUDY OF CHICAGO'S EMERGING PRIVATE TRANSIT OPERATORS

The effects of Chicago's new transit entrants on the incentives of the public transit operators' labor force are evaluated in this section. A graphical model is constructed to illustrate the shift in demand brought about by these new private operators and how this shift affects the consequences of various labor union positions at the bargaining table. Hypothetical bargaining scenarios are considered to show how this competitive environment might alter the course of future labor negotiations.

Chicago's private transit operators initiated service following a government-mandated fare increase of nearly 100 percent on publicly operated RTA rail services in 1981. Many questioned the need for such a dramatic fare increase, but few anticipated the rapid shift in market share that was to follow. Within weeks a fleet of more than 100 privately operated buses--nicknamed "subscription buses"--was in service to more than two dozen suburban communities. The private buses currently handle more than 5,000 passengers daily, mostly from lower-income groups, and have captured a market share of 30 percent or more from many suburbs (12). Able to provide service for as little as 4.3 cents per passenger mile--a full 7.3 cents below comparable RTA rail costs--the buses save many consumers more than $100 per month in transit expenses.

The great dependence of lower-income groups immediately led to a favorable public opinion of the private services and placed substantial pressure on regulatory bodies not to enforce applicable regulation under the Illinois Public Utilities Act. Many operators claim that compliance with such regulation would force discontinuance of the services and create financial hardship for those unable to afford RTA services.

The service hardest hit by these private operators is the Illinois Central Gulf (ICG) electrified commuter line operated by the RTA. The ICG corridor, linking the central business district with the city's southern suburbs, is the principal focus of this case study because it has experienced more than 60 percent of the total ridership loss.

As the marketplace became more competitive, demand shifted to the less expensive form of transit and has placed strong pressure on the RTA to better control wage and salary expense. In addition, because government subsidies do not fully cover public transit expenses, the RTA is forced to consider productivity improvements as a cost-cutting measure. The significance of each of these four factors in collective bargaining (demand shifts, labor costs, subsidization, and productivity improvements) is discussed in detail in the following sections.

Shifts in Demand

By providing consumers with a low-cost transit alternative, the emergence of privately operated bus services has increased the elasticity of demand for public transit services. The magnitude of the demand changes is difficult to measure, but a general estimate can be made by evaluating how marginal changes in RTA fares have affected its market share. (Analysis of the shift in demand for the public transit operator is conducted under the assumption that the only change occurring, and being evaluated, is the introduction of private-sector transit service.)

The RTA's average fare in the ICG corridor in December 1979, for example, was $1.17 (measured in constant 1982 dollars). At this fare, there was no ridership on private buses. When the average fare was increased to $1.41 in February 1981, private entrepreneurs entered the market and captured a market share of 400,000 passengers per year. The dramatic fare increase in July 1981 brought the average fare to $2.30, and 1,400,000 passengers rode the private buses. Inflation brought down the real cost of RTA fares in October 1983 and January 1984 to $2.15 and $2.08, respectively. The result was a successive decline in subscription bus ridership

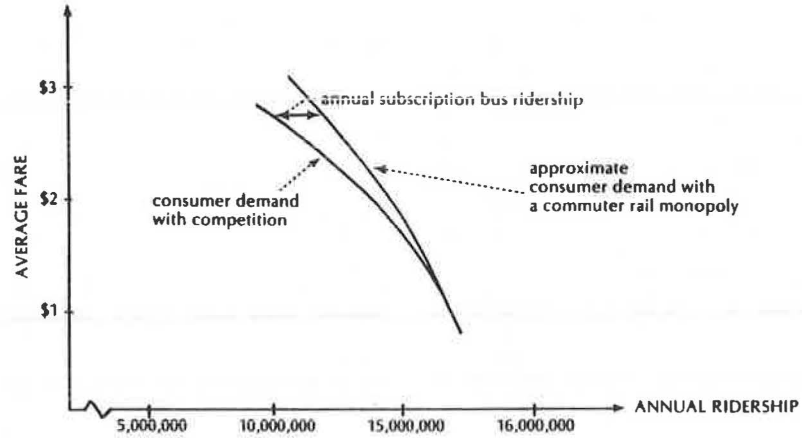


FIGURE 2 Effects of competition on the demand for ICG commuter rail service.

(11). By using these estimates and a simple regression analysis technique, a demand curve for RTA rail service can be constructed and the shift in demand brought about by low-cost private competitors estimated.

In Figure 2, the horizontal distance between the two curves can be interpreted as the annual ridership on subscription buses at a given price level. In the fall of 1982, for example, the average rail fare was $2.20, resulting in the use of private bus services in the corridor (45 buses in each direction daily) by about 1 million passengers.

The new curve has a more elastic slope; competition has magnified the consequences of fare increases on ridership. Because the slope of this curve determines the ability of the RTA to pass cost increases on to the consumer, it will be shown to greatly affect the incentives of the operator to contain costs.

Rising Labor Costs

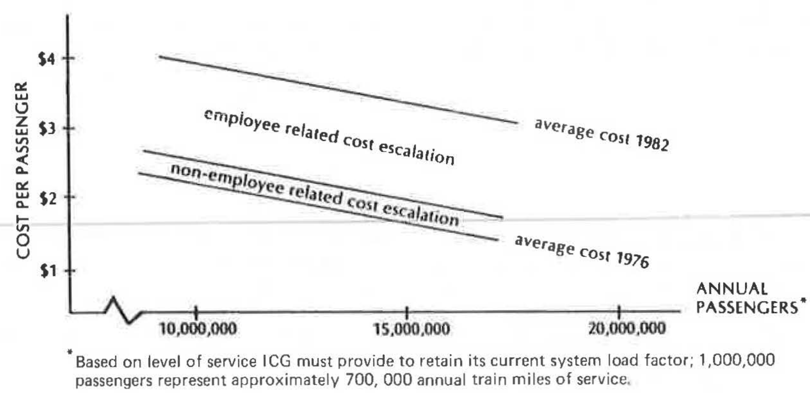
Since 1981, more than 66 percent of the ICG corridor's real escalation in cost has come in the form of labor expense. A survey of the expense account reported in the R-1 Report to the Interstate Commerce Commission (13) reveals that nearly 70 percent of the constant-dollar cost escalation is due to increased staff size, salaries, wages, benefits, and other employee-related costs. Some of the most significant cost increases in recent years, for example, have been incurred in the following areas:

1. Train crews,
2. Switch crews,
3. Engine crews,
4. Clerical and accounting,
5. Train operations administration,
6. Operations control,
7. Car maintenance administration, and
8. Fringe benefits.

Only about 30 percent of the real cost increases can be attributed to increased material and capital expenses (electric power, supplies, right-of-way maintenance, etc.).

The effects of this rapid rise in labor costs on the RTA's ability to provide cost-effective service can be best shown graphically. By using a cost model developed by Simpson and Curtin (11) for the RTA system and official cost data published in the R-1 Report, an approximation of the slope of the carrier's long-run average cost curve can be calculated to illustrate the effects of rising labor expense. [A more detailed description of the estimation process is presented elsewhere (11).]

Figure 3 shows how rising labor costs (in constant 1982 dollars) have shifted the carrier's average cost curve between 1976 and 1982 (11). This shift is divided into two components, employee-related cost escalation and non-employee-related cost escalation, which make up the supply curve of the public transit operator. This curve plays an important role in this analysis by indicating the level of service that the transit operator can provide with a given operating budget. If, for example, rising labor costs lead to a situation in which total costs exceed total revenues, the curve shows the amount of service that must be eliminated to rectify this shortfall.



*Based on level of service ICG must provide to retain its current system load factor; 1,000,000 passengers represent approximately 700, 000 annual train miles of service.

FIGURE 3 Cost escalation in the ICG Corridor *(11)*.

Subsidization Arrangements

A third factor that must be considered is subsidization. The degree to which this shift in demand affects the incentive structure for public transit employees depends on how the government's position toward increased subsidies is perceived. If, for example, it is believed that public institutions will systematically bail public transit out of financial hardship with larger subsidies, the presence of private competition obviously will not provide much incentive for cost containment. On the other hand, if it is perceived that the public sector is unwilling to increase subsidies, competition from the private sector will serve as a stimulus for reform in collective bargaining. In the latter case, cost escalation necessitates fare increases, service cutbacks, furloughs, reduced hiring, and other actions contrary to the interests of labor.

The following four scenarios depict likely real-world subsidization arrangements:

- Scenario 1: The public sector will effectively bail out the operator by financing 80 percent of the real cost increase. The remaining 20 percent will be financed through higher fares and service cutbacks.
- Scenario 2: The public sector will be willing to increase subsidies at 50 percent of the rate at which costs escalate. The remaining 50 percent must be financed through higher fares and service cutbacks.
- Scenario 3: The public sector will be unwilling to increase subsidies because of cost escalation.
- Scenario 4: The public sector will subsidize the operator only to the extent that the operator covers at least 60 percent of its costs. Deficits above this amount must be financed through higher fares and service cutbacks.

There is a whole assortment of other conceivable deficit-reimbursement scenarios, but these four are sufficient for illustrative purposes. On the basis of these scenarios, the average cost curve shown in Figure 3, and the demand information shown in Figure 2, the following discussion illustrates how the removal of regulatory entry barriers is likely to alter the collective bargaining process.

Consider a case in which organized labor seeks a 15 percent across-the-board increase in wages through collective bargaining. This shifts the average cost of transit upward and increases the discrepancy between the amount consumers are willing to pay (shown in the demand curve) and the cost of providing service (shown in the average cost curve). The situation (simplified for illustrative purposes) is graphically shown in Figure 4. How must the RTA respond to this upward shift in cost to remain financially viable? This depends on which deficit-reimbursement scenario is considered.

Consider Scenario 2, a situation in which the public sector is willing to increase subsidies at only half the rate of the cost escalation (roughly $2 million per year). The remaining half would necessarily be financed through fare increases and service cutbacks. Assume that the RTA selects a combination of fare increases and service cutbacks that keeps load factors roughly the same (i.e., it will not select an alternative that leads to more or less crowding on its trains).

If the RTA is protected from competition through regulation, the supply and demand information shown in Figure 4 indicates that the authority could cover costs by raising the average fare $0.36 to $2.46 and reducing service by roughly 40,000 train miles per year. This would result in the elimination of approximately four trains daily and the furlough of roughly 24 employees (11). With a total work force of 700, it is not difficult to see that such a small cutback would probably not induce organized labor to reconsider its request for a wage increase. The benefits of a 15 percent wage increase to the labor force appear to far outweigh the loss in job security.

It might be argued that the foregoing estimates overstate the need for service cuts because the public transit operator could choose simply to raise fares more dramatically rather than reduce service. This is plausible, but it overlooks the fact that price increases greatly supress ridership and quickly render major fare increases an unattractive alternative; with high elasticities of demand, service cuts are an essential component of any deficit-reduction plan.

In an environment free from regulatory entry barriers and open to private transit operators, the consequences of a wage increase are much more dramatic. Under the same deficit-reimbursement scenario, a 15 percent increase in wages (because of the higher elasticity of demand) requires the curtailment of 110,000 train miles of service per year (roughly 10 trains) and raising fares from an average of $2.10 to $2.45 per passenger. This would result in a ridership loss of approximately 1.6

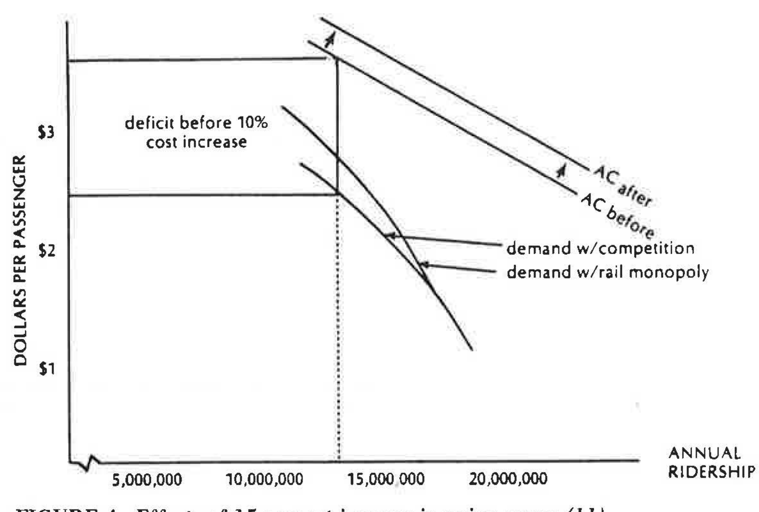


FIGURE 4 Effects of 15 percent increase in union wages (11).

million passengers per year and the furlough of 60 employees, 2.5 times as many as if regulation inhibited private operators from serving the market. With a reduced ability for management to raise fares to cover the cost increase, it is easily seen how the removal of entry barriers might influence the behavior of organized labor at the bargaining table.

The results are much the same under each of the four hypothetical subsidization scenarios (Table 2). Note that even when the public sector is willing to effectively bail out the carrier by financing 80 percent of the increase in cost (Scenario 1), the new entrants will have a measurable effect on the need for employee furloughs. The 15 percent wage increase would require the furlough of 24 employees under competition compared with 12 under a regulated monopoly.

In the most dramatic case--Scenario 4--competition increases sixfold the need for furloughs following the wage hike. Organized labor would have a strong incentive to reconsider its request for the wage increase in such a situation. A similar conclusion can be drawn in Scenario 3.

The union, of course, is not likely to have this type of detailed information on the consequences of their wage increase request. There is little question, however, that this threat of job loss will exert a powerful, persuasive pressure for organized labor to moderate their demands at the bargaining table.

Productivity Improvements

The removal of entry barriers for private competitors has created an incentive for public transit unions to agree to eliminate certain work rules that inhibit efficiency. A good example is the issue of split shifts. In Chicago's RTA system, unions have historically opposed efforts to employ labor on split shifts. However, management has sought split shifts to handle the highly peaked demand conditions that occur during the morning and evening rush hours more effectively. These conditions make it possible to schedule many train crews for only one inbound trip (during the morning rush hour) and one outbound trip (during the evening rush hour). Because the total work day often exceeds 8 hr, substantial overtime pay often must be given to these employees even though their total time on board the train may not exceed 2.5 hr per day.

TABLE 2 Effects of 15 Percent Real Increase in Wages on Job Security *(11)*

Condition	New Fare ($)	Necessary Service Cutbacks (daily round trips)	Approximate No. of Jobs Lost
Scenario 1			
Monopoly	2.40	1	12
With competition	2.40	2	24
Scenario 2			
Monopoly	2.46	2	24
With competition	2.45	5	60
Scenario 3			
Monopoly	2.45	3	36
With competition	2.50	6	72
Scenario 4			
Monopoly	2.40	1	12
With competition	2.70	7	84

Note: Scenario 1 = the public sector is willing to subsidize 80 percent of the cost increase; Scenario 2 = the public sector is willing to subsidize 50 percent of the cost increase; Scenario 3 = the public sector is unwilling to increase subsidies; Scenario 4 = the public sector requires the RTA to cover 60 percent of its costs.

Consider a situation in which management attempts to offset a 5 percent general rise in operating cost by utilizing labor on split shifts. Assume that only those train crews with more than 5 hr idle time at midday are subject to the change (about 30 percent) and that such a measure could reduce the costs of these crews by 25 percent (roughly equal to the amount of overtime pay that they are currently receiving). The public sector is assumed to be willing to finance only half of the increase in deficits through increased subsidies (Scenario 2).

If the public transit operator is protected from competition and there are no provisions to allow split shifts, the supply and demand information presented earlier indicates that the public transit operator would be required to raise fares $0.32 to an average of $2.42 per passenger and reduce 35,000 train miles of service per year to remain operative. If the carrier is able to secure provisions to utilize labor on split shifts, these figures drop to $2.39 and 18,000 train miles per year. In a regulated environment, a split-shift provision would essentially create about 10 jobs by enabling 12,000 train miles of service to remain operative (11). This is not likely to provide a great deal of incentive for a work force of 700 employees to agree to the change. One might expect that, to the union, the costs of split shifts in this situation would outweigh the resulting benefits of increased job security.

When regulatory barriers are removed and private operators are permitted to enter the market, the elasticity of demand and the benefits of split shifts are intensified. Without a split-shift clause, the public carrier would be forced to respond to the same 5 percent general rise in costs by raising fares to $2.40 and reducing 85,000 train miles of service. A split-shift agreement in this situation would reduce the necessary price increase to $0.10 to $2.32 and service curtailments to 31,000 train miles. It would, in essence, create about 30 jobs by preventing the elimination of 54,000 annual train miles of service. The benefits to the work force by allowing split shifts are more than doubled in a marketplace free from regulatory entry barriers. This relationship becomes apparent by inspecting the slope of the supply and demand curves described earlier [a more detailed explanation of the mathematical derivation of the foregoing estimates has been given by Schwieterman (11)]. Again, it is management's inability to pass on cost increases to the consumer that causes this dramatic change.

The important conclusion that can be drawn is that the private sector has created a powerful stimulus for the labor force to cooperate in efforts to revise work rules that hamper productivity in addition to reducing upward wage pressure. Subsidization arrangements, of course, will play an important role in the costs and benefits resisting work-rule reform. The data in Table 3 demonstrate that even under relatively generous subsidization arrangements the presence of the private sector greatly intensifies the consequences of such resistance.

If the public sector is willing to finance as much as 80 percent of the increase in cost, for example, the benefits to the union from split shifts are increased more than 50 percent in a competitive environment. When the public sector is less willing to finance cost escalation, the presence of private-sector operators magnifies the benefits of a split-

TABLE 3 Effects of Revision in Work Rules to Allow Split Shifts *(11)*

Condition	Necessary Service Cutbacks (daily round trips) Without Provisions for Split Shifts	With Provisions for Split Shifts	Approximate No. of Jobs Retained
Scenario 1			
Monopoly	1	0	8
With competition	2	1	12
Scenario 2			
Monopoly	2	1	10
With competition	4	2	30
Scenario 3			
Monopoly	3	2	12
With competition	5	2	36
Scenario 4			
Monopoly	2	1	10
With competition	5	2	40

Note: Scenario 1 = the public sector is willing to subsidize 80 percent of the cost increase; Scenario 2 = the public sector is willing to subsidize 50 percent of the cost increase; Scenario 3 = the public is unwilling to increase subsidies; Scenario 4 = the public sector requires the RTA to cover 60 percent of its costs.

shift agreement by as much as 400 percent (Scenario 4). Thus, the benefits of regulatory reform are not likely to be undermined by an overly generous public sector.

CONCLUSION

A case study of Chicago's emerging private-sector public transit operators demonstrates that the elimination of regulatory entry barriers in the transit industry could greatly facilitate progress in the collective bargaining process. Many of the same benefits that deregulation has brought forth in air, rail, and motor carrier collective bargaining might also be realized in a deregulated transit marketplace.

The model used in this analysis, though a simplification of the incentives and constraints of labor negotiations, illustrates the general consequences of deregulation for organized labor at the bargaining table. The failure of labor to participate more actively in efforts to contain spiralling labor costs can seriously reduce job security, even when the public sector fosters such escalation with generous subsidization arrangements.

An important conclusion is that some of the same market forces that have led to beneficial change in other sectors of the deregulated transportation industry also apply to the transit sector. The elimination of regulatory barriers in Chicago's ICG Corridor has exerted a subtle, persuasive pressure on the public transit system's labor force to help contain costs. It encourages the following types of changes:

1. Reductions in on-board crew requirements;
2. Provisions for split shifts;
3. Elimination of the 100-mile work day;
4. Revisions in existing work rules that prohibit train crews from engaging in certain switching and yard work;
5. Restraints on salaries, wages, and benefits in collective bargaining; and
6. General productivity improvement.

Because this paper provides only one case-study example, it cannot be concluded that regulatory reform will foster similar developments in other cities. But the analytical process set forth in this study may serve as a useful guideline for additional research. The model is useful in considering some of the important economic variables that cannot be adequately addressed in a more qualitative approach.

The goal of this paper has been to focus attention on these long-overlooked consequences of regulation in the transit industry; its conclusions are not intended to suggest that regulatory reform will provide a clear-cut solution to the problem of labor cost escalation. Although the factors that affect labor costs are many, complex, and deeply rooted, the elimination of regulatory barriers to entry is likely to provide a step in the right direction.

Unlike other labor cost containment programs, which all too often treat only the symptoms of the problem, increased competition addresses the problem itself by systematically altering the incentives that govern the behavior of management and organized labor in the transit industry. Through the use of proven market mechanisms, it bypasses bureaucratic and political inefficiencies that have inhibited collective bargaining in the past.

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Subsidies, Political Control, and Costs of U.K. Urban Bus Provision

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ABSTRACT

In this paper the impact of three aspects of public policy--levels of subsidy, objectives of controlling political authority, and central government's decisions regarding the appropriate scale of local operating units--on the costs of providing urban bus service in the United Kingdom is examined. A cross section of operations is surveyed by using standard econometric procedures and data for the financial year 1979-1980. Several alternative specifications are employed to test the sensitivity of the analysis to the implicit underlying economic assumptions of different model frameworks, and a wide variety of variables is incorporated to normalize across operations. The general conclusions are that public policies of the kind examined do, to differing degrees, exert an influence over the costs of public bus service provision.

Urban bus transit subsidies have risen substantially in recent years. In most countries the rise has been both in absolute terms and as a proportion of overall transit operating costs. The extent of the rise has varied enormously across countries. Countries such as the United States and France have tried to restrain fare increases below their prevailing levels of inflation with the consequential upward drift in subsidy support. A few countries, such as the United Kingdom, have increased subsidies in real terms, because the absolute costs of bus operations have risen faster than the average cost index, but because of government policy, which caused fares to increase broadly in line with the rate of inflation, subsidies as a proportion of costs have not risen so dramatically (1).

One of the main difficulties with providing urban public transit, and a major contributor to the recent rapid rise in costs, is the inherently technologically unprogressive nature of the industry (2). Essentially, there is only limited scope for altering the method of supplying a service by substituting cheaper inputs in place of other inputs where costs change. The particular problem has been that labor costs have tended to rise more rapidly than the costs of other inputs in a situation where manpower is a major component of the production process. The scope for replacing labor by other factors of production is limited.

Equally, on the revenue side, the changing composition of urban areas in which there is a gradual outflow of residents from the core, or inner city, has meant that for social and land use planning reasons many urban authorities have been reluctant to initiate a fare increase (even to cover the rising costs of supply in most countries other than the United Kingdom). This has been coupled with the use of public transport policy as an instrument of traffic management; it has been seen (at least by its advocates) as a second-best strategy for attracting potential motorists away from private automobiles, especially at peak commuting times.

Although these types of situations have something of a universal nature, the actual control and regulation of urban bus transit and the nuances of subsidy policy tend to be specific to individual countries. The central government in the United Kingdom, for example, has tended to exercise much stronger controls over subsidy policies at the local urban level than has been the experience of the United States, at least until recently.

In the U.K. Transport Supplementary Grant system, although local governments are given a high degree of flexibility in the way they use centrally allocated funds, the system still permits the national government to monitor and regulate expenditure at the urban level. Indeed, in the past funds have been withheld when a metropolitan area attempted to indulge in what the central government deemed a policy of excessive bus service subsidization. The system of cash/limits and more recently rate capping also provides control over, respectively, the expenditures of local government from the general support grants from the exchequer and the extent to which local property taxation may be increased. The legislation of the late 1960s [most notably the 1968 Transport Act and the 1969 Transport (London) Act] and the early 1970s (especially the 1972 Local Government Act) provides a framework of checks and balances that has been used, on occasion, by local groups to limit urban authorities' expenditures on bus provision, for example, the legal rejection of the "Fares Fair" transit subsidy scheme proposed by the Greater London Council in 1982.

Despite the fact that by international standards the level of subsidies enjoyed by urban bus operations in the United Kingdom is comparatively low (Table 1), there is still a growing concern about both their efficiency and their long-term funding. The concern may be specifically attributed to a number of factors. First, the absolute level of subsidies is seen as high by the central government, especially in the context of the overall macroeconomic philosophy of the Conservative administration with its focus on low public borrowing and taxation. Second, although there are central controls on local expenditure, there is still concern about their effectiveness. The debate is partly political, because many urban areas are controlled by Labour local governments, but it also proves to be much wider than a simple concern over transport subsidies, embracing an entire range of issues surrounding local

TABLE 1 International Comparison of Levels of Urban Transport Subsidy for 1977 *(3)*

Country	Subsidy (% of costs)	
	Small Towns[a]	Large Towns[b]
Australia	48	29
Canada	37	26
France	26	55
Netherlands	57	67
Sweden	25	41
United Kingdom	14	21
United States	24	26

[a]Population < 400,000.
[b]Population > 400,000.

autonomy and accountability. Transport is, given the powers vested in local authorities, a not insignificant component in these controversies.

The most important practical manifestion of future change here is likely to be the reformation of the metropolitan tier of local government in the major conurbations (and, in the longer term, the possible removal of the higher tier). There is thus likely to be a need to redefine responsibilities for urban transport finance. Finally, there is a growing interest in the overall efficiency of the urban transport system and, in particular, whether subsidies may result in reduced efficiency (which usually involves arguments couched in terms of X-efficiency as well as allocative efficiency). The question of privatization of certain urban rail services and of profitable, nationally owned inter-urban bus operations has led to consideration of possible extensions to the urban bus sector. Reports by the Monopolies and Mergers Commission (4) and the House of Commons Select Committee on Transport (5) have also highlighted broader matters of efficiency. The culmination of these debates was the publication in 1984 of the white paper Buses (6), which set out official proposals to initiate franchise bidding for many urban routes with free market conditions prevailing over much of the system.

The aim of this paper is to examine some of the more objective elements of these debates and to introduce a degree of quantification into what has often been essentially a qualitative series of arguments. In particular, the impact of subsidies and the attitudes of the local authority on the costs of providing urban bus services are examined.

There is mounting (although not yet conclusive) evidence from U.S. econometric studies that subsidies do ultimately lead (other things being equal) to higher costs of service provision (7-12), whereas cost savings may well come from leaving the supply of urban bus service to private companies (7,8,12, 13). Statistical analysis along these lines is generally lacking in the United Kingdom, in part because of inadequacies in both the coverage and reliability of data but also because, given the comparatively recent upsurge in concern over the levels of subsidy, more attention has been paid to devising methods of subsidy allocation.

Three specific (although interrelated) questions are addressed. First, is there any evidence that U.K. areas adopting high subsidy policies have experienced higher levels of cost than other areas? Second, does the political composition of the controlling authority (which, one assumes, reflects priorities and objectives) influence the costs of bus transit supply? Finally, is there any evidence to suggest, from the point of view of cost minimization, that the existing size of bus operations is optimal or should policies be adopted for their reorganization?

APPROACH

The econometric analysis required to answer questions of the foregoing type necessitates the specification of an appropriate cost function and its subsequent estimation. A number of fairly sophisticated frameworks have been developed in recent years [e.g., the transcendental logarithmic cost models (14-16), which permit a high degree of generality in the underlying assumptions required], but for reasons set out in the following discussion, a rather more traditional approach is favored here. [In fact, the data used have been subjected to a translog modeling study, but because of the nature of the data available, this only really proved suitable for analyzing the functional form of the cost equation and not for testing policy sensitivity (17).]

In this paper the emphasis is on simple linear and log-linear models, which, in economic terms, correspond to production functions of the Leontieff and Cobb-Douglas types, respectively.

The linear framework has been widely used in U.K. urban bus transport cost studies (18,19) and simply involves regressing costs against a set of explanatory variables. The linear nature of the model implies a so-called Leontieff technology with a zero-factor elasticity of substitution (i.e., one cannot substitute, say, capital for labor if the cost of the latter rises). Such a framework would seem to offer a general approximation to the technologically unprogressive nature of the bus industry mentioned earlier. Because estimation can, in most circumstances, be conducted by using ordinary least squares, this facilitates easy computation. These factors combined with the ease of parameter interpretation and the previous use of the model in U.S. work (9) suggest that some guidelines as to the sensitivity of costs with respect to transport policy may be forthcoming.

Given the need to hold nonpolicy effects constant in the analysis, the following general form of model would seem to be recommended:

Cost = f (size of operator, factor prices, homogeneity of services, physical and traffic environment, financial motivation, political control).

Although a linear regression framework of this kind has much to recommend it, there are, nonetheless, potential weaknesses. In particular, the model form tends to be intuitive in its formulation, although the exact acceptance of parameters tends to place reliance on statistical significance. Also the assumption of zero elasticity of factor substitution may be seen as extreme. An alternative model is the Cobb-Douglas function, which has been widely used in U.S. studies of bus costs in the context of both urban (20) and interurban (21) operations. This model has its weakness (as discussed in the following) but retains the advantages of relative ease of interpretation and computation.

The Cobb-Douglas specification (22) takes the following general form:

$$Y = a\, x_1^{\alpha_1}\, x_2^{\alpha_2}\, x_3^{\alpha_3} \qquad (1)$$

where Y is output and $x_1 \ldots x_3$ are three factor inputs (say, labor, capital, and fuel). The total cost function is, therefore,

$$TC = P_1x_1 + P_2x_2 + P_3x_3 \quad (2)$$

where $P_1 \ldots P_3$ represent the factor input prices.

Equations 1 and 2 are solved for each input (x) to obtain the demand equations for each. Thus,

$$x_1 = K_iY^{1/r} [(P_1{}^{\alpha 1/r} \cdot P_2{}^{\alpha 2/r} \cdot P_3{}^{\alpha 3/r} \cdot v)/P_i] \quad (3)$$

where

$$r = \alpha_1 + \alpha_2 + \alpha_3,$$

$$K_i = \alpha_i\ (a\alpha_1{}^{\alpha_1}\ \alpha_2{}^{\alpha_2}\ \alpha_3{}^{\alpha_3})^{-1/r}, \text{ and}$$

$$v = a^{-1/r}.$$

Substituting Equation 3 into the production function (Equation 1) and manipulating yields the total cost function:

$$TC = KY^{1/r}\ P_1{}^{\alpha 1/r}\ P_2{}^{\alpha 2/r}\ P_3{}^{\alpha 3/r} \quad (4)$$

where $K = K_1 + K_2 + K_3 = r\ (a\alpha_1{}^{\alpha_1}\ \alpha_2{}^{\alpha_2}\ \alpha_3{}^{\alpha_3})^{-1/r}$.

For estimation purposes the Cobb-Douglas function is conveniently linear in logarithmic form. In this case the exact specification employed follows that of earlier U.S. work (20), which is partly determined by data availability but also influenced by the potential for making useful comparisons. The basic operational form is, therefore,

$$TC = KY^{\beta_1}\ P_L{}^{\beta_2}\ P_F{}^{\beta_3}\ B^{\beta_4} \quad (5)$$

where the subscripts L and F relate to labor and fuel, respectively, and B is fleet size (as a proxy for capital). The linear form becomes

$$\ln TC = \ln K + \beta_1 \ln Y + \beta_2 \ln P_L + \beta_3 \ln P_F + \beta_4 \ln B + e \quad (6)$$

To introduce policy variables into this cost-minimizing framework requires that certain assumptions be made regarding their probable impact on cost structures. In this case they may be viewed as factors influencing the production technology employed, that is, as shift variables. Essentially, therefore, an attempt is made to see whether the short-run cost function is shifted (either up or down) as a result of subsidization, and so on. This does not mean a deviation from the idea of cost minimization per se on the part of management but an exploration of whether the nature of the activities of bus operations is so affected by subsidies, the political composition of the controlling body, and so on, that costs are significantly increased or decreased.

The Cobb-Douglas formulation, therefore, provides a hypothesis to be tested that is derived directly from microeconomic theory. The limitation to be borne in mind is that an implicit assumption of the Cobb-Douglas model is that the elasticity of factor substitution is unity, which, if bus transport is technologically unprogressive, cannot hold. Essentially the Cobb-Douglas model assumes complete ease of introducing more of a cheaper factor input if the costs of other inputs increase. There are arguments against this, however, which would seem to offer some justification for empirical analysis with this model form. There is scope in many instances for an urban bus operation to adjust relative factor inputs in the face of input cost variations by policies of rerouting and rescheduling. In other cases changes in operating practice (e.g., one-man operations or automatic fare collection) may provide greater flexibility than is often claimed.

THE DATA

There is no easily accessible national data source in the United Kingdom providing the type of information required for a detailed statistical examination of the sensitivity of urban bus costs to urban policies. This study relies heavily on a specific data base employing information collected by Higginson and White (23) with adjustments and additions made where helpful. The full data matrix covers a period of 8 financial years (1971-1972 to 1979-1980) and embraces 44 district council bus operations in England and Wales, 3 Scottish regional council fleets, 7 Passenger Transport Executives (PTEs), and London Transport. The data provide information for each operation in terms of physical measures (e.g., fleet size and patronage), financial variables (e.g., fuel costs and fare base revenue), and indicators of the local operating environment (e.g., population served). To this was added supplementary geographical information extracted from standard official sources.

The actual variables employed in the linear model are given in Table 2 together with the notation adopted. Although most of the variables are self-explanatory, one or two comments appear appropriate. The data are for a 1-year cross section--the financial year 1979-1980. The large number of missing cells for the earlier years of the data series precluded pooling over the full decade, and no useful purpose would have been served by pooling for the short period 1977-1978 to 1979-1980. Given the differing nature of the broad groupings of undertakings and the differing environments and legal frameworks under which they operate, dummy variables were introduced to see whether these factors significantly affected costs of provision. Scale is reflected in two different ways. The number of bus miles is introduced to reflect a genuine scale effect in the sense of magnitude of operations and potential costs savings resulting from this, whereas the number of buses is examined to see whether there are economies associated with the sheer size of operations.

TABLE 2 Variables and Notation

Variable	Definition
Dependent	
TC	Total operating costs per bus mile (pounds per 1,000 bus miles)
Independent	
X_1	Annual bus miles (million miles)
X_2	Buses
X_3	Bus miles 1980/bus miles 1979
X_4	Labor costs (thousand pounds per employee)
X_5	Peak/interpeak bus output
X_6	Acres per population served
X_7	Percentage of two-man operations
X_8	Miles per bus
X_9	Deviation from mean fuel cost per 1,000 bus miles (pounds per mile)
X_{10}	Bus miles per staff (1,000 bus miles per employee)
X_{11}	Takes value of 1 for districts; otherwise 0
X_{12}	Takes value of 1 for Scottish regions; otherwise 0
X_{13}	Takes value of 1 for PTEs and London Transport; otherwise 0
X_{14}	Takes value of 1 for Conservative-controlled area; otherwise 0
X_{15}	Takes value of 1 for Labour-controlled area; otherwise 0
X_{16}	Percentage of total revenue coming from subsidies
X_{17}	Passengers (1,000s)
X_{18}	Staff
X_{19}	Population served (1,000s)

Although a limited amount of analysis is possible on the determinants of various cost components (e.g., traffic operating costs; management, welfare, and general costs and servicing; repairs and maintenance costs), the attention here is focused on total operating costs per bus mile. [Details of results obtained at a more disaggregated level, in which costs are broken down into their various components, are to be found elsewhere (24)]. Costs and other variables are normalized by bus mileage to reduce statistical problems of heteroscedasticity.

RESULTS

Leontieff Technology

In Table 3 the results are given of a number of runs in which the simple linear framework was used. A number of simple transformations were also examined and several of these are included. In general a stepwise regression approach was adopted to sift through for significant variables, although where it was believed that a variable was likely on strong a priori grounds to influence costs of bus service provision, this was forced into the regression. All the policy-sensitive variables reflecting subsidies, political control, and size or scale of operations were examined both in the context of the stepwise procedure and by being forced either individually or in combinations into the regression.

Models 1 and 2 represent results with no attempt to reflect policy factors other than scale of operations. As can be seen, slightly more than 70 percent of the variations in total operating costs can be explained by variations in a limited number of independent variables. Model 1 offers a quadratic form (i.e., nonlinear), which provides a good fit to the data based on labor output and population served. Costs rise (as one may expect, given the network spread effect) with population served. Costs rise initially with staff employed after an initial fall (i.e., $X_{10} < 0$; $X_{10}^2 > 0$). This may seem rather perverse but is not inconsistent with early work in the United Kingdom (17) explained in terms of the catch-all nature of the variable. Model 2 provides a variation by including labor costs (the stepwise regression being tested with no transformations), which offers intuitively more satisfactory results. Operating costs rise with labor costs and population served but fall (i.e., $X_{10} < 0$) with increased labor productivity.

A key point in both of these simple models is that both the scale variable (X_1) and the size variable (X_2) prove insignificant statistically, which suggests that in these simple specifications there is no evidence that the size of operations pushed up costs.

Interestingly, the dummy variables reflecting the nature of operations (e.g., district council or PTE) proved statistically insignificant in the calculations. Further, additional regressions based only on the sample of district council bus operations proved very similar in their nature to those for the full set of bus fleets. This would appear to suggest that the differing remits under which the various forms of urban bus providers operate have no significant impact on their costs.

Models 3 to 5 introduce the subsidy and political control variables into the analysis. Equations 3 and 4 simply involve introducing X_{16} into the stepwise procedure to examine the extent to which operating costs are affected by levels of subsidy. (Again this was done with and without the inclusion of transformations.) The subsidy variable proves statistically significant. Interpretation is not simply, however, in the single-equation framework. Of course, one explanation may be that high subsidies induce laxity in management and this in turn leads to higher costs of provision. Alternatively, however, the reasons that subsidies are provided may well be influenced by the costs of provision of bus services in various cities; operations in high-cost areas are provided by funds to compensate them for their inabilities to raise revenues through the fare box. Whereas such variables as peak- and off-peak service, population served, and so on, attempt to reflect these cost variations, they are unlikely to do so perfectly. Only a comprehensive equation system beyond the scope of this study could shed light on the exact direction of causation.

Model 5 embraces both the subsidy variable and the political control dummies [in the latter case only the Labour control (X_{15}) and the Conservative control (X_{14}) were included; other authorities, i.e., no overall control or control by another party, were omitted from the procedure]. The two political control dummies do not perform well when included in tandem but provide consistent results when introduced separately; the Conservative control dummy yields negative coefficients consistently and the Labour control dummy is associated with positive coefficients. (Model 5 simply shows the case of the inclusion of the Conservative control dummy.) Of course, the simple interpretation of this is that Labour control means (other things being equal) that the costs of providing urban bus services will be

TABLE 3 Results from Linear Equation Models

Independent Variable	Dependent Variable[a] by Model (pounds per 1,000 bus miles) 1		2		3		4		5	
	Coefficient	t-Ratio	Coefficient	t-Ratio	Coefficient	t-Ratio	Coefficient	t-Ratio	Coefficient	t-Ratio
Constant	2,150.3		1,442.3		2.046		1,354.5		1,436.7	
X_4			44.95	2.43						
X_5							49.84	2.76		
X_8									-0.017	4.02
X_{10}	-203.3	3.71	-77.22	8.46	-186.2	3.31	-72.32	7.90		
X_{10}^2	7.622	2.53			6.884	2.25				
X_{13}									154.6	1.99
X_{14}									-32.29	1.02
X_{16}					1.16	1.23	1.905	2.09	1.68	1.28
X_{18}					0.039	3.05			0.049	1.95
X_{19}	0.040	3.08	0.045	3.57			0.041	3.35	-0.176	1.42

Note: Definitions of variables are shown in Table 2. R^2 for the models is as follows: Model 1, 0.703; Model 2, 0.701; Model 3, 0.706; Model 4, 0.719; Model 5, 0.531.
[a]Operating costs per bus mile.

higher than they would otherwise be, whereas Conservative control means that they will be lower. Several qualifying points must, however, be made.

First, the level of significance of the political control dummies is poor; they had to be forced into the stepwise regression, indicating that the statistical foundations of this conclusion are tenuous. Second, the introduction of the political control dummies generally reduces the absolute t-ratio associated with the subsidy variable (X_{16}) and results in smaller coefficients, which indicates potential problems of multicollinearity. Finally, the point needs repeating that the analysis is based on single-equation models and thus simultaneous equation bias may be exerting an influence (e.g., Labour authorities may be elected in areas where, for a variety of reasons, there is a desire on the part of the electorate to have high-cost urban public transport).

Cobb-Douglas Model

The Cobb-Douglas calculations essentially involve employing regression procedures to estimate the parameters of Equation 6 and those reflecting policy effects (the latter being entered directly into the otherwise log-linear specification). The main findings are shown in Table 4 where the notation is as given earlier with the addition of S for subsidy level, PE for the peak/off-peak ratio, PC for a dummy reflecting political control by the Conservative Party of the local administration, and D for the urban population residential density. Both the dependent variable, total operating costs, and the independent variables are divided through by bus mileage per operation to minimize potential problems of heteroscedasticity.

The actual data base employed in these calculations relates solely to the 44 district council bus fleets. This is because they offer a more homogeneous set of undertakings and avoid possible distortions due to extreme observations. (Examination of the full data base produces broadly identical results, but London Transport in particular tended to be an outlier.) The sample is also large enough to facilitate sensible estimation.

The introduction of subsidies into the specification seen in Equation 8 provides the parameters of Model 1. Subsidies would appear to push up costs (S is significant at the 90 percent level), but the model is not entirely satisfactory given the sign and level of significance of the price-of-fuel variable (P_F). Model 2, therefore, excludes P_F. [Interestingly, the rather perverse P_F has proved equally problematic in U.S. studies of a similar nature (20).] In practical terms, although the overall model is more satisfactory, the exclusion of P_F makes little difference to the sign or level of statistical significance of the subsidy variable.

The fleet-size variable (B) is significant in both equations and takes a positive sign, indicating the existence of negative scale effects. This result differs from the findings of the linear model but may, in part, be due to the rather smaller range of variables employed. Indeed, as may be seen in the following discussion, the addition of further variables reduces both the size of the parameter (slightly) and the degree of statistical significance.

Model 3 introduces both a fuller range of variables to reflect the nature of the conditions under which the various operators provide bus services and also the political nature of the responsible authority. The results are clearly similar to those obtained from the linear models; subsidies tend to correlate with higher costs of provision, whereas Conservative-controlled urban areas have, other things being equal, lower costs of provision. The parameters are, however, not statistically significant at the 10 percent level, so once more caution must be exercised in placing excessive weight on the findings. Further, the adjusted coefficient of determination ($\bar{R}^2$) suggests that the addition of the three variables does nothing to enhance the explanatory power of the model.

CONCLUSIONS

In this paper an attempt has been made to use available U.K. data to examine the impact of a number of policies on the costs of providing urban bus services. Two modeling approaches are examined: one is essentially empirical in its underlying basis, whereas the other is more directly derivable from standard economic theory. In general the approaches yield broadly similar conclusions, although the statistical strength of the policy-sensitive variables is sometimes rather weak.

Broadly, costs of urban bus services would appear to be higher in those areas where subsidies are greater and where the Conservative Party does not have control of the responsible local government. There is limited evidence of scale economies from the data, which suggests that administrative reorganization of bus operations to change the scale of operations either upward or downward is not really justified by the analysis. [A caveat is that this type of result obtained from U.S. studies employing methods similar to those used here has subsequently been reworked with translog cost functions and dis-

TABLE 4 Results from Cobb-Douglas Model

Independent Variable	Dependent Variable[a] by Model 1 Coefficient	1 t-Ratio	2 Coefficient	2 t-Ratio	3 Coefficient	3 t-Ratio
Constant	1.561		1.530		1.573	
ln Q	-0.034	0.69	-0.035	0.72	-0.041	0.81
ln P_L	0.729	7.05	0.730	7.15	0.741	6.79
ln P_F	-0.008	0.15			-0.019	0.32
ln B	0.183	2.21	0.181	2.24	0.180	1.81
S	0.281	1.43	0.283	1.46	0.228	1.07
PE					0.001	0.01
PC					-0.028	1.20
D					-0.009	0.32

Note: R^2 for the models is as follows: Model 1, 0.756; Model 2, 0.762; Model 3, 0.746.

[a]Log of total bus operating costs per bus mile.

economies of scale have emerged. A similar reworking of this data set (17) produced identical results, although the conclusions regarding subsidies, and so forth, proved robust.]

Of course, evidence of higher costs of service provision is not in itself necessarily a bad thing. Demand factors may, for example, mean that higher costs are associated with greater benefits with resultant enhanced net benefits, demand here being viewed in a social sense rather than the more traditional economic idea of effective demand. Similarly, costs may be higher because working conditions and methods of labor payment push them up. Although in one sense this may be viewed as inefficient, in another sense an enhanced working environment may in itself be seen as an additional cost that society ought to bear. The conclusions reached previously, therefore, should be seen in this wider context of a cost-benefit assessment and as only contributing to one side of the equation. In the past, however, there has been a tendency to focus on the benefit side in the United Kingdom to the almost total neglect of costs and efficiency.

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An Economic Analysis Computer Package for Urban Highway Improvements

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ABSTRACT

The structure and operation of an interactive FORTRAN computer package to perform economic analyses on highway improvements are described. The computational methodology of the program is discussed; this includes defining the broad range of alternatives, computing highway segment costs, computing intersection delay costs, computing intersection accident costs, and performing an economic analysis of the alternatives. Next, the overall design and operation of the program are outlined along with descriptions of the inputs and outputs of each program within the package. The various program options available to the user are also presented. In addition, the data file structure within the package and the programs provided to update existing files are discussed. A comparison of a four-way stop sign control with a fully actuated traffic signal is then presented to illustrate one application of the package.

Transportation planners and engineers are confronted daily with the task of identifying the best projects among what may be a never-ending list. In the area of economic evaluation, state-of-the-art tools help the analyst to identify the most economically efficient project (1). However, such tools do not always address the specific range of projects within a given city, nor do such manual methods lend themselves to quick and easy solutions that are consistently reproduced.

Computer programs have also been designed to perform the economic evaluation of alternative highway improvements (2,3). But, again, these programs do not always address the specific needs of the user. Along this line, the city of Lincoln, Nebraska, requested that the University of Nebraska develop a highway economic analysis computer package to operate on their VAX-11/750 minicomputer. The Highway Economic Analysis computer package was the result.

The general specifications for the program included the following items:

1. Program methodology should generally follow that of the AASHTO manual (1);
2. The program should be interactive and user friendly;
3. The methodology should be revised where needed to include a broader range of highway facilities, intersection types, and control strategies;
4. When available, local data should be used instead of national averages; and
5. All data files accessed by the package should be located outside the individual programs and, in addition, the package should provide for quick and easy updating of all data files.

The remainder of this paper includes a discussion of the computational methodology and an outline of the program operation. In addition, a sample application of the package for comparing a four-way stop control with a signalized control is presented.

GENERAL METHODOLOGY

As mentioned earlier, the package design is based on the AASHTO methodology for estimating highway user benefits. The general steps include (a) defining alternatives and project types, (b) computing highway segment user costs, (c) computing intersection delay costs, (d) computing intersection accident costs, and (e) performing an economic analysis.

Defining Alternatives and Project Types

The package design permits great flexibility in modeling alternative highway improvements for analysis. First, an alternative improvement might consist solely of highway segments selected from 11 different types of highway segments:

1. One way,
2. Two lane,
3. Two lane with common left-turn lane,
4. Two lane with left-turn lanes,
5. Four lane undivided,
6. Four lane with painted median,
7. Four lane divided,
8. Six lane undivided,
9. Six lane divided,
10. Four-lane expressway, and
11. Six-lane expressway.

Second, the user can specify one or more intersections or railroad crossings for a given alternative. Intersection types include signalized, stop-signed, and railroad crossings. Third, any combination and number of segments, intersections, and railroad crossings up to the program limitations may be specified. The package will accommodate up to 10 alternatives made up of 999 segments and 99 intersections.

The user can analyze a broad array of projects, including the following:

1. Constructing a new facility;
2. Widening an old facility;
3. Eliminating existing horizontal curves;
4. Changing vertical grades;
5. Separating vertical grades;
6. Adding lanes at an intersection;
7. Changing traffic control from stop signs to signals and vice versa;
8. Changing signal type, coordination, or timing;

9. Implementing traffic safety countermeasures; and
10. Eliminating railroad crossings.

Computing Segment User Costs

User costs on highway segments are a function of the type of facility, traffic characteristics, geometric characteristics, and surface quality. Segment user costs are divided into four categories: vehicle operating costs, travel-time costs, discomfort and inconvenience costs and, accident costs.

Vehicle Operating Costs

Vehicle operating costs include those for fuel, oil, tires, maintenance, and time-dependent vehicle depreciation. Operating costs are often categorized as tangent running costs, grade costs, curvature costs, and speed-change costs. Tangent running costs (in dollars per 1,000 vehicle miles) are those operating costs incurred at the average running speed on a level tangent section of highway. Grade costs (in dollars per 1,000 vehicle miles) are those additional operating costs incurred when a vehicle travels up or down a vertical grade, and curvature costs (also in dollars per 1,000 vehicle miles) are the additional operating costs incurred as a vehicle travels around a curve. Speed-change costs (in dollars per 1,000 vehicle miles) are the additional operating cost incurred when a vehicle decelerates to a reduced speed and accelerates back to the running speed.

The computer package includes data files of 1980 operating cost tables (4) for the following vehicles: (a) large, medium, and small automobiles; (b) pickup trucks; (c) two- and three-axle single-unit trucks, and (d) four- and five-axle semitrailers. However, the individual programs do not access every operating cost table. Instead, operating cost tables derived for a composite set of vehicles, including a composite automobile, medium truck, and heavy truck, are used. The user periodically produces his own composite cost tables by entering the desired vehicle mix and cost adjustment factors in a separate file-handling program. Thus, the base 1980 vehicle operating cost tables remain unchanged and composite tables can be changed quickly outside the main program structure. The package also includes another file-handling program for loading in new or revised data files as new data become available.

The following operating cost tables are included in the package:

1. Tangent running costs as a function of speed, grade, and present serviceability index (SI = 4.5, 3.0, 1.5);
2. Speed-change costs as a function of volume-to-capacity ratio (v/c) on the highway segment;
3. Excess operating cost tables as a function of approach and slowdown speed (accessed by the intersection delay programs described in the following); and
4. Curvature costs as a function of speed and degree of curvature.

Travel-Time Costs

Travel-time cost is the value of the drivers' and passengers' travel time (dollars per 1,000 vehicle-hr) to traverse the length of the highway segment at the running speed. The user enters his own value of time (dollars per hour) for automobiles, medium trucks, and heavy trucks. One way to express value of time per vehicle hour is as a function of the time saved per trip and the vehicle occupancy as outlined in Chapter II of the AASHTO manual (1).

Discomfort and Inconvenience Costs

Discomfort costs (dollars per vehicle hour) are a function of the degree of congestion measured by the v/c. As the v/c increases, discomfort costs increase.

Accident Costs

Segment accident costs (dollars per 1,000 vehicle miles) include costs due to fatal, injury, and property-damage accidents on the highway segment. The package includes a set of accident rates and costs for the 11 types of highway facilities. Similar to the operating cost tables, the data file for the accident cost data can be updated periodically.

Procedure for Computing Segment Costs

Highway segment costs are estimated by carrying out the following steps:

1. Estimate or field measure the volume (vehicles per hour per lane) on the highway segment;
2. Estimate or field measure the average vehicle running speed (mph) on the segment (as an option the computer package will compute operating speed as a function of the v/c ratio and design speed);
3. Find the tangent running cost at the given running speed, grade, and surface condition;
4. Find the added curvature costs as a function of speed and degree of curvature;
5. Find the speed-change costs as a function of speed and v/c;
6. Compute the total segment operating costs;
7. Compute the time to travel the length of segment;
8. Compute the time costs;
9. Compute the discomfort and inconvenience costs;
10. Find the accident rate accident cost per accident;
11. Compute the accident costs on the segment; and
12. Compute the total annual segment costs.

Computing Intersection and Railroad Crossing Delay Costs

Intersection vehicle delay is a function of the type of intersection geometry and control, traffic volume, vehicle mix, and turning volumes. Railroad crossing delay is a function of train volume, train speed, traffic volume, and vehicle mix.

Vehicle delay is divided into the following three components:

1. Stopped or idling delay (hours per vehicle) is that time delay incurred by vehicles stopped at an intersection,
2. Deceleration delay (hours per vehicle) is the time required for a vehicle to decelerate from the approach speed to a stop, and
3. Acceleration delay (hours per vehicle) is the time required for a vehicle to accelerate from a stop to the approach speed.

Total intersection delay is the sum of the stopped, deceleration, and acceleration delays.

Vehicle delay influences both time costs and operating costs as a vehicle enters and leaves an intersection. Time and operating costs will increase as vehicle delay increases and decrease as delay decreases. The vehicle delay costs are divided into the following categories:

1. Stopped or idling delay time cost (dollars per vehicle hour) is the value of time due to the added delay at an intersection,
2. Stopping delay cost (dollars per hour) is the added time cost due to the added delay of decelerating to a stop and accelerating from the stop to approach speed,
3. Idling operating cost (dollars per 1,000 vehicle-hr) is the added vehicle operating cost due to vehicle idling while stopped at the intersection, and
4. Stopping operating cost (dollars per 1,000 stops) is the added vehicle operating cost due to decelerating to a stop and accelerating from the stop to approach speed.

The general steps to compute the delay for each intersection approach follow:

1. Estimate approach volume (vehicles per hour),
2. Compute the average stopped delay per vehicle,
3. Compute stopping delay per vehicle,
4. Compute the number of vehicles stopping,
5. Compute the added time costs due to the stopped delay and accelerating and decelerating,
6. Compute vehicle operating costs due to stopped delay and accelerating and decelerating,
7. Compute total delay time and operating delay costs, and
8. Compute total annual intersection delay costs.

The Highway Economic Analysis computer package computes intersection delay costs for three different types of intersections: signalized, stop-signed (two- or four-way), and railroad crossings. The primary difference in the intersection programs is in the computational algorithms for computing vehicle delay, which are based on available methods (2,3,5). The user's manual for the package includes the computational methods for both the intersection delay and accident costs discussed in the following (6).

Computing Intersection Accident Costs

Intersection accident costs are a function of the number and type of accidents at the intersection. Each accident is classified as a fatal, injury, or property-damage accident and the total number of accidents is converted to equivalent property-damage only (EPDO) accidents. The EPDO is then multiplied by the average cost of property-damage accidents to find the total intersection accident costs (5).

In the case where a safety countermeasure such as intersection channelization is implemented, the number of accidents under the improved condition is estimated by the package and a new EPDO is computed. To estimate the number of accidents under the improved condition, the program first accesses a data file of accident reduction factors for each type of correctable accident and countermeasure. The intersection types included in the package are as follows:

1. Major/major, signalized;
2. Major/collector, signalized;
3. Collector/collector, signalized;
4. Major/major, stop-signed;
5. Major/collector, stop-signed;
6. Major/collector, stop-signed;
7. Local/local, stop-signed;
8. Local/local, stop-signed;
9. Local/local, yield-signed;
10. Local/local, no signal.

The following safety countermeasures are included:

1. Markings
   a. Arrows and ONLY's
   b. Stop bars
2. Signs
   a. Advisory
   b. Warning
   c. Regulatory
   d. Sight hazard
   e. Speed limit
3. New signals
   a. Intersection signal
   b. Intersection beacon
   c. Approach beacon
4. Modified signals
   a. 12-in. signal heads
   b. Exclusive right turn
   c. Protected left turn
   d. Remove permissive red
   e. Two-phase to multiphase
   f. Yellow clearance
   g. All red
   h. Progression
5. Geometrics
   a. Intersection widening
   b. Approach widening
   c. Concrete median
   d. Remove median

The accident reduction factors are then multiplied by the existing correctable accidents to compute the number of accidents under the improved condition, which is used to compute a new EPDO, and the new accident costs are computed by multiplying the new EPDO by the average cost of property-damage accidents.

The general steps to compute intersection accidents are summarized as follows:

1. Find the existing fatal, injury, and property-damage accidents for the year under consideration (the user also has the option to use the internal intersection accident default values);
2. Find the number of rear-end, right-angle, left-turn, right-turn, and fixed-object accidents for the year under consideration;
3. Estimate the average daily traffic;
4. Compute the EPDO;
5. If no safety improvement is made, compute the annual accident costs under existing conditions;
6. If a safety improvement is made, estimate the number of accidents reduced as a result of the improvement;
7. If accidents are reduced, compute the new EPDO; and
8. Compute the estimated annual accident costs under the safety improvement.

Performing the Economic Analysis

This computer package carries out a present-worth economic analysis on each project alternative. First the package computes the total segment and intersection user costs for each alternative for a first and last analysis year. On the basis that user costs grow uniformly between the first and the last analysis year and a stated discount rate, the program computes the present worth of the user costs over the analysis period with respect to a given base year. The package also computes the present worth of the build costs for each alternative (input by the user) with respect to the same base year. The net present worth and a benefit-cost ratio are then computed for each alternative with respect to the null alternative.

PROGRAM DESIGN AND OPERATION

The computer package is written in FORTRAN for the Digital Equipment Corporation's VAX-11/750 minicomputer. Written in version 2.0 of VAX FORTRAN, the package also operates on the VAX-11/780. The following programs make up the main structure of the package: (a) main driving, (b) segment user cost, (c) signalized-intersection delay cost, (d) stop-signed intersection delay cost, (e) railroad crossing delay cost, (f) intersection accident cost, (g) build cost, and (h) output formatting. All the programs and data files for the package take approximately 3,000 blocks of permanent disk storage. Additional permanent storage is required because the package produces several data files as it runs; the amount of storage required varies according to the total number of alternatives and the total number of segments and intersections for each alternative.

Generally, each program produces one file for the input data and one file for the output data, which are organized by indexed "keys" that uniquely identify each stored record. For instance, the keys for the signal data files include the following: project name, alternative name, alternative number, intersection number, approach number, and analysis year (first or second). Input and output data files produced by the package are permanent files that are opened and closed each time a particular program is run. New data are inserted into the appropriate position within a file according to the keys while the old data are maintained. Files are accessed later by using the same keys. When finished with the files, the user may either delete them or rename and retain them in storage by using standard VAX commands.

In the following section a description is given of how the user runs the package, and the inputs and outputs of each program within the package are discussed.

RUNNING THE PACKAGE

The first menu in the package asks the user to enter a project name and alternative name (up to 10 characters each) and the number of alternatives (up to 10). For instance, the user may have a project entitled Lincoln, an alternative name Test, and two alternative projects. The user also enters the desired discount rate in decimal form to be used in the economic analysis, a base year, a first year, and a last year of the analysis period.

The next menu asks the user to select one of the five user cost categories: segment cost, signalized-intersection delay cost, stop-signed intersection delay cost, railroad crossing delay cost, or intersection accident cost. Upon selection, the program control is transferred to the appropriate user cost program, which is further described in the following. Each time the user completes the data entry for a particular user cost category, the program computes the user costs for that particular segment or intersection and writes them into a file.

Upon termination of the user cost session for a given alternative, program control is transferred to the cost menu. The number of years, calendar years, and costs for engineering, construction, right-of-way, periodic maintenance, traffic control devices, and routine annual maintenance are entered on a series of menus. After the data for the build costs have been entered, the program computes the net present worth and benefit-cost ratio of each alternative.

Step-by-step procedures for running the individual programs and a discussion of the inputs and outputs for each program are covered in the following sections.

Segment Cost Program

The segment cost program computes highway users' costs for each separate segment of the highway. In order to run the program the user must input the following data for each segment: facility type (11 categories); area type (urban or rural); segment length (miles); capacity (vehicles per hour per lane); peak and off-peak lane volume (vehicles per hour); number of peak and off-peak hours; operating or design speed (miles per hour); percentage of accident reduction on the segment; percentage of vehicle mix; value of time (dollars per vehicle hour) for automobiles, medium trucks, and heavy trucks; percentage of grade; surface quality (1 = poor, 2 = fair, 3 = good); and degree of horizontal curvature.

If the user enters design speed, the segment cost program computes the operating speed as a function of v/c, design speed, and facility type. Otherwise the program uses the operating speed input by the user. Users also have the option of either entering their own figures for capacity or defaulting to the internal capacity tables. On the basis of operating speed, grade, and curvature, the program computes the travel-time costs, tangent running costs, speed-change costs, curvature costs, discomfort and inconvenience costs, and the total segment user costs.

The program output includes the following items:

1. Echo of the program input of facility type, area type, capacity, volume, speed data, accident reduction, vehicle mix, and value of time, grade, surface quality, and curvature;
2. Output of the yearly costs for travel time, tangent running, discomfort and inconvenience, speed change, curvature, and total segment for each highway segment.

Signalized-Intersection Delay Cost Program

The signalized-intersection delay cost program computes the delay costs for signalized intersections under pretimed and full or semiactuated control with or without coordination. In order to run the program the user enters the following data for each approach of the intersection: signal cycle time (seconds); through, left, and right green times (seconds); type of left- and right-turning movements (prohibited, permissive, protective, or protective/permissive); traffic signal control type; signal coordination type based on platoon arrival patterns; number of through, right, and left lanes; peak-hour factor; approach speed (miles per hour); number of peak and off-peak hours; peak and off-peak volume (vehicles per hour) for each lane in the approach; vehicle mix; and value of time (dollars per vehicle hour) for automobiles, medium trucks, and heavy trucks. The user also has the option of entering his own average delay (seconds per vehicle) and number of vehicles stopping per lane rather than computing delay and vehicles stopping.

The signalized-intersection delay cost program first computes the average vehicle delay (seconds per vehicle) on a lane-by-lane basis for each approach, beginning with the right lane and moving toward the left lane. The program then computes vehicle idling time and operating costs, vehicle accelerating and decelerating time and operating costs, and the total signalized-intersection delay costs.

The program outputs include the following items:

1. Echo of the program inputs, including volume data, geometry data, speed data, signal-phasing data, left-turn type, control type, and arrival pattern type; and
2. Average vehicle delay (seconds per vehicle) for the intersection, idling delay time and stopping time costs, idling operating cost and stopping operating cost, and total delay cost for each intersection. All costs are in dollars per year.

Stop-Signed Intersection Delay Cost Program

The stop-signed intersection delay cost program computes the delay costs for both two-way and four-way stop-controlled intersections. The user enters the following data for each approach: number of approach lanes, number of opposing lanes, approach speed (miles per hour), number of peak and off-peak hours, peak and off-peak approach volume (vehicles per hour), peak and off-peak opposing volume (vehicles per hour), vehicle mix, and value of time (dollars per vehicle hour) for automobiles, medium trucks, and heavy trucks. For a two-way stop-controlled intersection and a T-intersection the user enters data only for the approaches that are signed. The user has the option of entering his own average approach delay (seconds per vehicle) rather than computing vehicle delay.

The program first computes the average vehicle delay (seconds per vehicle) on each approach, the vehicle idling time and operating costs, the vehicle time and operating costs due to accelerating and decelerating, and the total stop-signed intersection delay costs.

The outputs of the stop-signed intersection delay cost program include

1. Echo of the program inputs of approach and opposing volumes and geometry for the intersection and
2. Output of the average vehicle delay (seconds per vehicle), idling and stopping time costs, and idling and stopping operating costs for each approach and for the intersection. All costs are in dollars per year.

Railroad Crossing Delay Cost Program

The railroad crossing delay cost program computes the vehicle delay costs due to train blockage at railroad grade crossings. The user enters the following data: number of trains per day, number of cars per train, average car length, train speed, vehicle approach speed (miles per hour), vehicle slowdown speed due to the railroad crossing, average daily traffic, vehicle mix, and value of time (dollars per vehicle hour) for automobiles, medium trucks, and heavy trucks. The user can also enter his own average approach delay (seconds per vehicle) and number of daily vehicles stopping instead of computing delay and vehicles stopping.

The railroad crossing delay cost program computes the train blockage (seconds) of the intersection, the average vehicle delay (seconds per vehicle), the vehicle idling and stopping time costs, the vehicle idling and stopping operating costs, and the total yearly railroad crossing delay costs. The program outputs include the following:

1. Echo of the program inputs of vehicle and train volume, vehicle and train speed, and average daily traffic, and
2. Output of average vehicle delay (seconds per vehicle), idling and stopping time costs, idling and stopping operating costs, and the total railroad crossing delay costs in both directions for the approach. All costs are in dollars per year.

Intersection Accident Cost Program

The intersection accident cost program computes the accident costs of either an unimproved or an improved intersection. To run the program, the user enters the following items: intersection type; average daily traffic; number of fatal, injury, and property-damage accidents; number of right-turn, left-turn, rear-end, right-angle, and fixed-object accidents per year; and number and type of safety countermeasures. The user has several options in running this program. First, if specific accident data are not known, an estimated accident reduction factor can be entered. Second, the program will estimate the accidents for the last analysis year if the user choses not to enter his own accidents in the last year.

The intersection accident cost program first computes the EPDO and then computes the yearly intersection accident cost as a function of the average cost of a property-damage accident.

The output includes

1. Echo of the input data of intersection type; number of fatal, injury, and property-damage accidents; number of right-turn, left-turn, rear-end, right-angle, and fixed-object accidents; average daily traffic; and the number and type of safety countermeasures; and
2. EPDO, accident rate, and accident costs (dollars per year).

TABLE 1 Sample Input Data

	48th Street		R Street	
Location	NB	SB	EB	WB
Geometry				
Right lane	0	0	0	0
Through lane	2	2	1	1
Left lane	1	1	1	1
Volume[a] (vph)				
Through lane 1	275	392	112	196
Through lane 2	275	392	71	30
Left lane	54	180	-	-
Total	604	964	183	226
Signal Timing[b] (sec)				
Green	77	91	19	19
Left-turn green	7	7	0	0
Right-turn green	0	0	0	0

[a]Peak-hour factor = 0.90.

[b]120-sec cycle, good progression; NB and SB lefts are protective or permissive; EB and WB lefts are permissive.

Build Costs

When the user has finished entering user cost data for a given alternative, he then enters build cost data for that alternative. After all the build cost data have been entered for an alternative, program control transfers back to the user cost programs to enter input data for the next alternative. The program terminates when the build costs for the last alternative are entered.

The following cost data are entered for each alternative:

1. The number of engineering years and the engineering cost (dollars) for each year,
2. The number of construction years and the construction cost (dollars) for each year,
3. The number of years for which right-of-way will be acquired and the right-of-way cost (dollars) for each year,
4. The number of years for which traffic control devices will be installed and the installation cost (dollars) for each year,
5. The number of years of periodic maintenance and the periodic maintenance costs (dollars) for each year (e.g., resurfacing costs), and
6. The annual routine maintenance costs (dollars per mile).

Sample Application

The following example illustrates the use of the Highway Economic Analysis computer package to compare two alternative types of traffic control at the intersection of 48th and R Streets in the city of Lincoln, Nebraska. Due to large-vehicle delays experienced at the intersection, the city proposes to replace the existing four-way stop control (Alternative 1) with a fully actuated traffic signal (Alternative 2). The new traffic situation consists of the same basic geometry but with improved channelization and widening.

The existing geometry, existing volume data, and proposed signal timing are given in Table 1. It is assumed that there will be no traffic growth, and the normal (off-peak) and peak traffic are assumed to be equal. The analysis also assumes a vehicle mix of 97 percent automobiles, 2 percent medium trucks, and 1 percent heavy trucks and a value of time of $6, $14, and $16 per vehicle hour for automobiles, medium trucks, and heavy trucks, respectively.

For this analysis, the base year is 1984, the first analysis year is 1984, the last analysis year is 2004, and the discount rate is 10 percent. Construction costs of $250,000 are assumed to be expended in 1984 and $60,000 of the signalization costs is expended in 1984 and the same amount in 1999, on the assumption that the signals will be replaced within 15 years.

Figures 1, 2, and 3 are printouts of the input data for the stop-signed and signalized intersections for both analysis years of 1984 and 2004. The program outputs for the stop-signed and signalized intersections are given in Figures 4 and 5, respectively. (In Figure 1, N > F stands for near lanes or volume, F > N stands for far lanes or volume, L > R stands for opposing lanes or volume from the left, and R > L stands for opposing lanes or volume from the right.)

As indicated in Figure 4, the average intersection vehicle delay under the four-way control (Al-

PROJECT: LINCOLN ALTERNATE NAME: TEST ALTERNATE NUM: 01

STOP SIGNED INTERSECTION INPUT

1984

Int	App	App Spd	Stop Type	%MT	%HT	Value or Time Auto	Value or Time Mtrk	Value or Time Htrk	Normal Volume Hrs	Normal Volume Thru N>F	Normal Volume Thru F>N	Normal Volume Opp L>R	Normal Volume Opp R>L	Normal Lanes Thru N>F	Normal Lanes Thru F>N	Normal Lanes Opp L>R	Normal Lanes Opp R>L	Peak Volume Hrs	Peak Volume Thru N>F	Peak Volume Thru F>N	Peak Volume Opp L>R	Peak Volume Opp R>L	Peak Lanes Thru N>F	Peak Lanes Thru F>N	Peak Lanes Opp L>R	Peak Lanes Opp R>L
01	01	35.	4	0.02	0.01	6.0	14.0	16.0	22	604.	964.	183.	226.	3	3	2	2	2	604.	964.	183.	226.	3	3	2	2
01	02	35.	4	0.02	0.01	6.0	14.0	16.0	22	964.	604.	226.	183.	3	3	2	2	2	964.	604.	226.	183.	3	3	2	2
01	03	35.	4	0.02	0.01	6.0	14.0	16.0	22	183.	226.	964.	604.	2	2	3	3	2	183.	226.	964.	604.	2	2	3	3
01	04	35.	4	0.02	0.01	6.0	14.0	16.0	22	226.	183.	604.	964.	2	2	3	3	2	226.	183.	604.	964.	2	2	3	3

PROJECT: LINCOLN ALTERNATE NAME: TEST ALTERNATE NUM: 01

STOP SIGNED INTERSECTION INPUT

.2004

Int	App	App Spd	Stop Type	%MT	%HT	Value or Time Auto	Value or Time Mtrk	Value or Time Htrk	Normal Volume Hrs	Normal Volume Thru N>F	Normal Volume Thru F>N	Normal Volume Opp L>R	Normal Volume Opp R>L	Normal Lanes Thru N>F	Normal Lanes Thru F>N	Normal Lanes Opp L>R	Normal Lanes Opp R>L	Peak Volume Hrs	Peak Volume Thru N>F	Peak Volume Thru F>N	Peak Volume Opp L>R	Peak Volume Opp R>L	Peak Lanes Thru N>F	Peak Lanes Thru F>N	Peak Lanes Opp L>R	Peak Lanes Opp R>L
01	01	35.	4	0.02	0.01	6.0	14.0	16.0	22	604.	964.	183.	226.	3	3	2	2	2	604.	964.	183.	226.	3	3	2	2
01	02	35.	4	0.02	0.01	6.0	14.0	16.0	22	964.	604.	226.	183.	3	3	2	2	2	964.	604.	226.	183.	3	3	2	2
01	03	35.	4	0.02	0.01	6.0	14.0	16.0	22	183.	226.	964.	604.	2	2	3	3	2	183.	226.	964.	604.	2	2	3	3
01	04	35.	4	0.02	0.01	6.0	14.0	16.0	22	226.	183.	604.	964.	2	2	3	3	2	226.	183.	604.	964.	2	2	3	3

FIGURE 1 Input for stop-signed intersection, 1984 and 2004.

PROJECT: LINCOLN ALTERNATE NAME: TEST ALTERNATE NUM: 02

SIGNALIZED INTERSECTION INPUT
SIGNAL PHASING DATA
2004

		NORMAL PERIOD								PEAK PERIOD							
Int	App	Cycle	Green	Left Green	Right Green	Left Type	Right Type	Ctrl Type	Arr Type	Cycle	Green	Left Green	Right Green	Left Type	Right Type	Ctrl Type	Arr Type
01	01	120.	77.	7.	0.	4	2	3	4	120.	77.	7.	0.	4	2	3	4
01	02	120.	91.	7.	0.	4	2	3	4	120.	91.	7.	0.	4	2	3	4
01	03	120.	19.	0.	0.	2	2	4	4	120.	19.	0.	0.	2	2	4	4
01	04	120.	19.	0.	0.	2	2	4	4	120.	19.	0.	0.	2	2	4	4

PROJECT: LINCOLN ALTERNATE NAME: TEST ALTERNATE NUM: 02

SIGNALIZED INTERSECTION INPUT
VOLUME AND LANE INPUT
2004

				VALUE OF TIME			NORMAL PERIOD							PEAK PERIOD						
							VOLUME				LANES			VOLUME				LANES		
Int	App	%MT	%HT	Auto	Mtrk	Htrk	Hrs	Vol	PHF	Spd	Rt	Th	Lt	Hrs	Vol	PHF	Spd	Rt	Th	Lt
01	01	0.02	0.01	6.0	14.0	16.0	22	604.	0.90	35.	0	2	1	2	604.	0.90	35.	0	2	1
01	02	0.02	0.01	6.0	14.0	16.0	22	964.	0.90	35.	0	2	1	2	964.	0.90	35.	0	2	1
01	03	0.02	0.01	6.0	14.0	16.0	22	183.	0.90	35.	0	1	1	2	183.	0.90	35.	0	1	1
01	04	0.02	0.01	6.0	14.0	16.0	22	226.	0.90	35.	0	1	1	2	226.	0.90	35.	0	1	1

FIGURE 2 Input for signalized intersection, 2004.

PROJECT: LINCOLN ALTERNATE NAME: TEST ALTERNATE NUM: 02

SIGNALIZED INTERSECTION INPUT
SIGNAL PHASING DATA

1984

		NORMAL PERIOD								PEAK PERIOD							
Int	App	Cycle	Green	Left Green	Right Green	Left Type	Right Type	Ctrl Type	Arr Type	Cycle	Green	Left Green	Right Green	Left Type	Right Type	Ctrl Type	Arr Type
01	01	120.	77.	7.	0.	4	2	3	4	120.	77.	7.	0.	4	2	3	4
01	02	120.	91.	7.	0.	4	2	3	4	120.	91.	7.	0.	4	2	3	4
01	03	120.	19.	0.	0.	2	2	4	4	120.	19.	0.	0.	2	2	4	4
01	04	120.	19.	0.	0.	2	2	4	4	120.	19.	0.	0.	2	2	4	4

PROJECT: LINCOLN ALTERNATE NAME: TEST ALTERNATE NUM: 02

SIGNALIZED INTERSECTION INPUT
VOLUME AND LANE INPUT
1984

				VALUE OF TIME			NORMAL PERIOD							PEAK PERIOD						
							VOLUME				LANES			VOLUME				LANES		
Int	App	%MT	%HT	Auto	Mtrk	Htrk	Hrs	Vol	PHF	Spd	Rt	Th	Lt	Hrs	Vol	PHF	Spd	Rt	Th	Lt
01	01	0.02	0.01	6.0	14.0	16.0	22	604.	0.90	35.	0	2	1	2	604.	0.90	35.	0	2	1
01	02	0.02	0.01	6.0	14.0	16.0	22	964.	0.90	35.	0	2	1	2	964.	0.90	35.	0	2	1
01	03	0.02	0.01	6.0	14.0	16.0	22	183.	0.90	35.	0	1	1	2	183.	0.90	35.	0	1	1

FIGURE 3 Input for signalized intersection, 1984.

PROJECT: LINCOLN ALTERNATE NAME: TEST ALTERNATE NUM: 01

STOP SIGNED INTERSECTION OUTPUT

Int	1984 Int Volume	1984 Ave Delay	1984 TIME COSTS Idle	1984 TIME COSTS Stop	1984 OPER. COSTS Idle	1984 OPER. COSTS Stop	1984 Total	2004 Int Volume	2004 Ave Delay	2004 TIME COSTS Idle	2004 TIME COSTS Stop	2004 OPER.COSTS Idle	2004 OPER.COSTS Stop	2004 Total
01	47448.	57.0	1718047.	605848.	184309.	344322.	2852525.	47448.	57.0	1718047.	605848.	184309.	344322.	2852525.

PROJECT: LINCOLN ALTERNATE NAME: TEST ALTERNATE NUM: 01

TRANSPORTATION COST/BENEFIT ANALYSIS
SUMMARY REPORT

BASE YEAR: 1984 DISCOUNT RATE: 0.10
FIRST YEAR: 1984
LAST YEAR: 2004

HIGHWAY USER COSTS

SEGMENT COSTS	FIRST YEAR	LAST YEAR
ACCIDENT COSTS	0.	0.
TIME COSTS	0.	0.
D&I COSTS	0.	0.
RUNNING COSTS	0.	0.
SPD CHN COSTS	0.	0.
CURV COSTS	0.	0.
TOTAL SEG COSTS	0.	0.
INTERSECTIONS		
SIGNALIZED	0.	0.
STOP SIGNED	2852525.	2852525.
RAIL CROSSINGS	0.	0.
ACCIDENT COST	0.	0.
TOTAL INT COST	2852525.	2852525.
TOTAL USER COST	2852525.	2852525.

HIGHWAY BUILD COSTS

	PRESENT WORTH
PRELIM. ENGINEERING	0.
CONSTUCTION	0.
PERIODIC MAINTENANCE	0.
RIGHT-OF-WAY	0.
TRAFFIC CONTROL	0.
ROUTINE MAINTENANCE	0.
TOTAL COST	0.

FIGURE 4 Output for stop-signed intersection.

PROJECT: LINCOLN ALTERNATE NAME: TEST ALTERNATE NUM: 02

SIGNALIZED INTERSECTION OUTPUT

Int	1984 Int Volume	1984 Ave Delay	1984 TIME COSTS Idle	1984 TIME COSTS Stop	1984 OPER. COSTS Idle	1984 OPER. COSTS Stop	1984 Total	2004 Int Volume	2004 Ave Delay	2004 TIME COSTS Idle	2004 TIME COSTS Stop	2004 OPER.COSTS Idle	2004 OPER.COSTS Stop	2004 Total
01	47448.	15.2	337660.	273049.	37920.	155182.	803810.	47448.	15.2	337660.	273049.	37920.	155182.	803810.

PROJECT: LINCOLN ALTERNATE NAME: TEST ALTERNATE NUM: 02

TRANSPORTATION COST/BENEFIT ANALYSIS
SUMMARY REPORT

BASE YEAR: 1984 DISCOUNT RATE: 0.10
FIRST YEAR: 1984
LAST YEAR: 2004

HIGHWAY USER COSTS

SEGMENT COSTS	FIRST YEAR	LAST YEAR
ACCIDENT COSTS	0.	0.
TIME COSTS	0.	0.
D&I COSTS	0.	0.
RUNNING COSTS	0.	0.
SPD CHN COSTS	0.	0.
CURV COSTS	0.	0.
TOTAL SEG COSTS	0.	0.
INTERSECTIONS		
SIGNALIZED	803810.	803810.
STOP SIGNED	0.	0.
RAIL CROSSINGS	0.	0.
ACCIDENT COST	0.	0.
TOTAL INT COST	803810.	803810.
TOTAL USER COST	803810.	803810.

HIGHWAY BUILD COSTS

	PRESENT WORTH
PRELIM. ENGINEERING	0.
CONSTUCTION	250000.
PERIODIC MAINTENANCE	0.
RIGHT-OF-WAY	0.
TRAFFIC CONTROL	74364.
ROUTINE MAINTENANCE	0.
TOTAL COST	324364.

FIGURE 5 Output for signalized intersection.

ternative 1) is approximately 57.0 sec and the total annual delay costs for the intersection are $2,852,525. Figure 4 also shows a summary report for Alternative 1. Because the alternative does not include any segments, all segment costs listed in the summary report are equal to zero, whereas annual intersection delay costs are equal to $2,852,525. Build costs for this alternative, the "null alternative", are all equal to zero.

Figure 5 shows that the signalization of the intersection would greatly reduce the average intersection vehicle delay from 57.0 to 15.2 sec and thereby reduce the annual intersection delay costs to $803,810. The present worth of the build costs for the signal alternative includes a $250,000 construction cost and a $74,364 traffic control cost.

The economic comparison of the two alternatives is given as follows:

Alternative	Net Present Worth ($)	Benefit-Cost Ratio	Present-Worth Costs ($)	
			User	Build
1	0.	1.00	24,664,778.	0.
2	17,390,150.	54.61	6,950,265.	324,364.

It may be seen that the present worth of the user costs for Alternative 1 is approximately $24.7 million compared with a present worth of approximately $7.0 million for Alternative 2. Thus, the benefit-cost ratio for Alternative 2 compared with that for Alternative 1 is approximately 55, reflecting the high savings in user travel time due to reduced vehicle delay and the relatively low implementation cost of Alternative 2.

SUMMARY

The foregoing example illustrates only one application among scores of potential applications of the Highway Economic Analysis computer package. This package is a highly versatile tool that permits the user to evaluate urban as well as rural highway projects ranging from traffic control measures and intersection widening to surface rehabilitation and major new construction. Alternatives may include single highway segments or isolated intersections or many segments and many intersections with different types of control. In addition, the level of analysis may vary from planning applications to detailed traffic control or final design applications. Moreover, the user is afforded great flexibility in changing all the internal tables as needed. For this, special file-handling programs permit the user to update existing operating cost tables within the package by changing the specific values, the vehicle mix, or the cost update factors. Other tables such as capacities and intersection accident costs can also be easily changed by the user to reflect local needs.

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Pricing Options for Urban Transportation Modes

ATHANASSIOS K. BLADIKAS and WILLIAM H. CROWELL

ABSTRACT

Urban transit is in many ways in serious financial trouble, and its primary source of revenue--fares--is politically difficult to establish and change. In addition to raising funds, fares must often redistribute income, spur local development, and help reduce automobile use. This multipurpose situation is similar to the one that Boiteux handled in his examination of the publicly owned French electric utility industry. Bailey and Willig did similar analyses of long-distance telephone rates. The goal was to have prices that efficiently related to services' marginal costs and elasticities of demand, generated an acceptable level of profits (or deficits), and maximized the public's welfare from these services. The pricing analyses presented follow a similar approach; the Metropolitan Transportation Authority in New York City is used as the case study. Net benefit changes (revenues plus consumer surplus) were shown to be greater from efficiently set peak and off-peak fare differentials than for flat fares. These results were found to be fairly insensitive to changes in the fare elasticities of demand. In fact, the differential-fare approach looked best when the gap between peak and off-peak elasticities and marginal cost values was greatest. This was not an attempt to find the optimal or welfare-maximizing set of fares, but rather to show which transportation pricing options maximized public welfare within given budgetary constraints.

Considerable attention has been given in recent years to the manner in which transportation modes are priced in urban areas. Growing transit deficits, overcrowded highway networks, the high social cost of capacity expansion, and the growing realization that current pricing methods are often inefficient have all combined to make the revision of such methods a regular part of public policy discussions. In addition, the notion of viewing transportation services in a systems context rather than merely as separate modes has received widespread acceptance. The field of transportation, and public utilities in general, is greatly complicated by the multiple and frequently changing policy goals that pricing, financing, and subsidization decisions often face. Fares may be raised one year to decrease the deficits for fiscal reasons and then lowered in another year in order to reduce environmental pollution, relieve congestion, or stimulate economic activity; both fare change decisions affect the demand not only for transit but also for private automobile use. Attempts to provide transportation services efficiently in such a policy setting are often difficult and frustrating.

In the classical economic sense, a particular mode is being used inefficiently when the demand or supply or both of its services are greater or less than they would be if the true cost and demand functions were known and reflected in the price structure. In terms of pricing theory, a system of interacting modes would operate efficiently if the prices charged in each market were set equal to marginal costs (the cost increment required to provide an additional unit of service). This concept is particularly important for transport modes because of the typical peaking of demand during rush hours that requires a physical plant and staffing level well above that required in off-peak periods. The concept of marginal cost pricing is therefore often referred to as "peak-load" and "congestion-cost" pricing and has received extensive treatment in the transportation economics literature (1-3). However, marginal cost pricing for transportation services may lead to operating deficits that are beyond available subsidy levels, forcing planners to deal with what economists call "second-best" pricing. On the basis of the original insights of Dupuit, Hotelling (4), and Steiner (5), methods were sought to solve the paradox of industries in which costs are decreasing. These analyses were furthered by Baumol and Bradford (6), who showed in probably the most widely quoted analysis of the problem what Ramsey had demonstrated in 1927 (7), namely, that any government entity (or private firm) that wanted to use efficient (but not strictly marginal cost) pricing schemes could use both demand elasticities and marginal cost information to determine how the fare in each market should differ from the marginal cost.

Most of the efforts using this type of Ramsey pricing approach have dealt with the pricing policies of public utilities, with a very important contribution coming from Marcel Boiteux of France, who demonstrated how the electric utility industries could determine prices in their various service areas (8). Willig and Bailey (9) developed a multiservice pricing model for various interrelated telephone services that maximized the consumer benefits of an existing system within specified budget constraints. It is this type of analytical approach that is pursued in this paper.

CONSUMER SURPLUS AND THE PRICE ELASTICITY OF DEMAND

The operating position of a transit agency could generally be shown as in Figure 1 by fare and output levels F_2 and Q_2 somewhere between the breakeven (Q_1) and optimum (Q_3) levels. As output is expanded by lowering the fare, the gap between average cost (AC) and average revenues increases; for example, BD increases and DF decreases as a greater deficit is incurred for the sake of a more optimal pricing scheme. The demand curve (D'D") indicates what consumers are willing to pay for the provided services. According

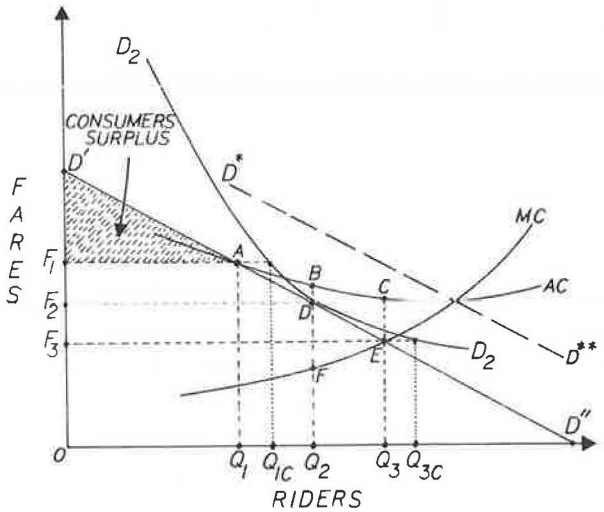

FIGURE 1 Transit supply and demand functions.

to Hicks' concept of "equivalent variation," the consumer welfare gained from a reduction in price would be equal to the maximum amount that a consumer would pay to bring about the reduction (10). The surplus value at any fare level F_i would equal 1/2 (OD' - OF_i) • Q_i, which clearly increases as the fare is lowered.

An operator or public official wanting to maximize this type of consumer benefit (which is closely associated with ridership) faces a number of constraints. In terms of allocational efficiency, by lowering the fare below F_3, riders would not be covering marginal costs (MC). This constraint places an upper limit on welfare at fare level F_3 = MC. The second limitation is that caused by the existence of increasing returns (decreasing average costs), which produce deficits equal to CE when prices are equal to marginal cost without any price differentiation (i.e., the same price at all times). Therefore, if one wishes to eliminate deficits, fares have to increase to F_1. This places a lower limit on welfare, at least for publicly owned systems that may not be profit seekers. This does not mean that increasing returns and optimal pricing cannot be compatible with a profitable operation. One can envision a hypothetical shift in the demand function of transit, possibly caused by a major increase in retail gasoline prices, for example, to D*D** in Figure 1, where a fare set equal to marginal cost would also be equal to average cost. At such an expanded output level, the operator in this hypothetical situation would be functioning with the lowest possible average costs.

Measurement of the consumer surplus level in a market is a direct fallout of the estimation of the demand function for that good or service, and the demand function can be determined from estimates of the price elasticity of demand. The important factor here is that there are significant differences in transit demand elasticities for different modes and in various transit "markets," especially as delineated by such factors as time of day, day of the week, and direction. Even with transit elasticities given, assumptions need to be made about the overall shape of the demand functions. As demonstrated in Figure 1, one could assume that the relation between price and demand is a linear one (D'D"), with a constant slope (dQ/dF) but with elasticity increasing with price [e.g., with $E = -(dQ/dF) \cdot (F_i/Q_i)$, as $F_i \rightarrow D'$ and $Q_i \rightarrow 0$, F_i/Q_i increases, and with dQ/dF constant, this results in a steadily increasing fare elasticity as fares increase]. A second assumption could be that fare and demand adjustments will occur in the same proportion over the full range of fares, for example, that elasticity will be constant (curve D_2D_2 in Figure 1). This type of hyperbolic function would result in an elasticity greater than that of the linear function for fare decreases and less than that for fare increases. In Figure 1, after a fare increase from F_2 to F_1, the new demand level Q_{1C} under the constant elasticity assumption is greater than Q_1 under linear assumptions, whereas the reverse holds for Q_{3C} and Q_3 for a fare decrease to F_3. Consumer surplus is also greater under the constant elasticity assumptions, because the area under D_2D_2 is not only greater than that under D'D" at all fare levels but is actually infinite (the demand curve D_2D_2, as a hyperbolic function, will never intersect the fare axis). A linear demand function will be of the following form:

$$Q = a + bF \quad (1)$$

and the constant elasticity demand functions will be of the following form:

$$Q = KF^E \quad (2)$$

where

Q = demand level (ridership),
F = fare, and
E = fare elasticity.

OUTLINE OF RAMSEY PRICING METHODOLOGY

To set the stage generally for this analysis, assume an operation with a set of n markets with price and output sets $(p_1, p_2, \ldots, p_n)$ and $(x_1, x_2, \ldots, x_n)$. If the goal were to maximize some measure of consumer surplus as a function of market prices such as $W = f(p_1, p_2, \ldots, p_n)$, subject to the profit constraint $B = g(p_1, p_2, \ldots, p_n) = M$, then, by using the LaGrangian multiplier method, it would be desirable to maximize the following function:

$$h = f(p_1, p_2, \ldots, p_n) + \lambda[g(p_1, p_2, \ldots, p_n) - M] \quad (3)$$

Therefore, consumer surplus can only be maximized if

$$\partial h/\partial p_i = 0$$

or

$$\partial W/\partial p_i = \lambda \partial B/\partial p_i \quad \text{for all } i \quad (4)$$

According to the Hicksian concept of consumer surplus, the welfare of an individual consuming quantity x_1 at price p_1 would be increased at a rate equal to x_1 for a one-dollar price reduction and he would therefore be willing to pay up to that amount to bring about the price change (10). Accordingly, for a change in price of p_1, the rate of change in welfare is

$$\partial W/\partial p_i = -x_i \quad (5)$$

From Equations 4 and 5,

$$-x_i = \lambda \partial B/\partial p_i \quad (6)$$

If MC_i, MR_i, and E_i represent marginal cost, marginal revenue, and price elasticity of demand, respectively, then

$$MR_i = p_i + x_i \cdot (\partial p_i/\partial x_i) \quad (7)$$

This assumes that $\partial p_i/\partial x_j = 0$; that is, that the cross-elasticity of demand between markets is zero.

Marginal profit can now be defined as follows:

$$\partial B/\partial p_i = (MR_i - MC_i) \cdot (dx_i/dp_i) \quad (8)$$

Combining Equations 6, 7, and 8 and using the definition of the elasticity of demand [Bladikas and Crowell give a complete derivation (11)], the following expression may be obtained:

$$[(p_i - MC_i)/p_i] \, E_i = K \quad (9)$$

where $K = (1 + \lambda)/\lambda$.

The relationship shown in Equation 9 states that for every good or service i, the amount by which price p_i varies from marginal cost will depend on the elasticity of demand for that good. If all E_i's are equal, prices in all markets will differ from marginal cost by the same proportions. However, when demand elasticities differ, these proportions will differ; E_i thereby determines, along with marginal cost, the proper level of prices (or fares in this context); for example, as E_i increases, $(p_i - MC_i) \div p_i$ decreases, and

$$E_i[(p_i - MC_i)/p_i] = E_j[(p_j - MC_j)/p_j] = K \quad (10)$$

where K is the Ramsey pricing constant.

THE BASIC PRICING MODEL

On the basis of what has been presented so far, a set of computer-based models was developed to recalculate the fares of a given set of urban transportation "markets" so that Equation 10 is satisfied for all of them. The following data must be provided for each transit market to be analyzed:

- Marginal cost,
- Current fare levels,
- Ridership levels, and
- Price elasticity of demand.

Alternative values for marginal costs and elasticities are provided where no exact measurements are available to allow the model to perform a sensitivity analysis of different combinations of these values. After the foregoing information has been read, the model applies the Ramsey pricing methodology for each combination of the given marginal cost and elasticity alternatives. The procedure begins by the calculation of total profit (or loss) from all modes and time periods at the current fare and ridership levels, as follows:

$$SUMP = \sum_{i=1}^{I} \sum_{j=1}^{J} Q_{ij} \, (F_{ij} - C_{ij}) \quad (11)$$

where

SUMP = total profit (or loss),
Q = ridership,
F = fare,
C = marginal cost,
I = number of modes, and
J = number of time periods.

After the total profit (or loss) has been obtained, the demand functions for every mode and time period are determined from Equation 1 or 2 depending on the user's choice. The iterative process begins by setting the demand for the first mode and time period equal to a very high value and obtaining the associated Ramsey constant (K). By using the Ramsey constant, the elasticities, marginal costs, new prices (fares), and quantities (ridership) are computed for all modes and time periods in a way that will satisfy Equation 10. The new prices and demand levels determine new profit levels, which are added and compared with the initial total profit (SUMP). If they are not at least as large as SUMP, a new iteration begins by decreasing slightly the very high demand of the first mode and time period and repeating the process. The iterations continue until the current profit becomes at least equal to the original one. When this happens, control is passed to a subroutine that calculates and prints the following output variables for every mode and time period:

- Original and final fares (PRICE and PNEW),
- Original and final ridership (QUANT and QNEW),
- Original and final elasticities (EL and ELNEW),
- Marginal cost (COST), and
- Percent changes in ridership, revenue, fare, and welfare (%DQ, %DREV, %DP, %DW).

In addition to the foregoing information the output contains the following cumulative results for all modes and time periods:

- Total change in revenues (CHREV),
- Total change in cost (CHCOST),
- Total change in profits (CHPROF),
- Total change in welfare (CHWELF),
- Total net change (CHNET, the sum of CHPROF and CHWELF), and
- Effectiveness index (EINDEX, the ratio CHNET/CHPROF).

The process is repeated until all combinations of alternative elasticity and marginal cost values have been analyzed.

Minor modifications of the algorithm produce a variety of pricing models that can be grouped into four major categories according to the following:

1. The programming language and implementation hardware (FORTRAN for mainframes and BASIC for microcomputers),
2. The shape of the demand function used (linear or hyperbolic),
3. The iteration procedure (constant increments or increments that are proportional to demand and inversely proportional to elasticities), and
4. The presence or absence of special constraints on fares or ridership for any mode or time period.

Any model type can be picked from each of the four categories. It is possible to use, for example, a mainframe-based, constant-elasticity, constant-iteration-increment, unconstrained model. Therefore, there is a total number of 16 (2^4) possible model types. The variable-iteration-increment models are simply faster but less accurate than the constant-iteration-increment models provided that the constant increment is small (about 1/100 for the ridership for linear demand and 1/100 of 1 cent for hyperbolic demand functions). Full program listings may be found elsewhere (11).

A MULTIMODAL CASE STUDY

The New York City area was chosen for an application of the model in a large, multimodal urban setting.

Every conceivable mode of public transportation exists in New York City, but not all existing modes were included because some are insignificant when compared with others in terms of their annual ridership. The Metropolitan Transportation Authority (MTA) is the major provider of public transportation services in the New York City area. The multimodal nature of the MTA allows the results produced by the pricing models to validate one of their major aims--to efficiently adjust prices while maintaining the total system's profit (or deficit). In an area where different organizations own and operate the commuter railroad, the tolled road facilities, the buses, and the rapid transit system, it would be institutionally more difficult to implement a Ramsey pricing approach, because some modes may benefit considerably more than others. In New York City, however, a resident of Forest Hills working in Manhattan's financial district may go to work by (a) driving a car and paying a toll collected by the Triboro Bridge and Tunnel Authority (TBTA), (b) taking the Long Island Rail Road (LIRR) commuter rail line, or (c) using the city's transit system run by the New York City Transit Authority (NYCTA). But TBTA, LIRR, and NYCTA are all MTA subsidiaries, and a change in the price structure will simply reallocate revenues in the various MTA "pockets." Shifting of funds among MTA entities has been in effect since the 1960s through the use of TBTA surpluses to finance deficits of the NYCTA and commuter rail operations.

Input Data

The data used for this multimodal case study are presented in Tables 1-3. Prices do not reflect the latest increases that became effective in January 1984. Only two time periods are used (peak weekday and off peak for all other times) and only the four major modes within the MTA are considered. NYCTA's bus and rail operations are treated as two separate modes, whereas LIRR was the only commuter rail operation. "Tunnel and bridge" represents vehicular traffic entering Manhattan from Queens, Brooklyn, and the Bronx via TBTA tolled facilities.

Ridership estimates were obtained from UMTA Section 15 reports and annual reports of TBTA and LIRR. Three elasticity alternatives are used. Basically, there are two ways of determining elasticities: use values from ridership changes due to fare changes in either the system under consideration or similar systems in other areas. For New York's transit system, the Regional Plan Association (RPA) (12) estimated demand functions and related price elasticities of demand that were -0.16 for the subway and -0.31 for the bus services. However, these are overall elasticities across all time periods, and other studies (13-16) show that no demand formula is applicable in all situations. Such factors as the transit mode in question, trip purpose, time of day or day of the week, and similar specifics effectively create an array of demand situations or "markets."

The elasticity values for the subway and bus modes presented in Table 2 vary about the average figures suggested by the studies just mentioned. The base elasticity figure for the TBTA tunnels and bridges was based on these studies and on a brief analysis of the changes in demand levels after toll increases. Unfortunately, no data were available on elasticities by time of day, so it was assumed that the ratio of peak to off-peak elasticity was the same as that for subway services. The same ratio was used for the commuter rail elasticities, a basic figure that was extrapolated from estimates made by the New York State Department of Transportation (17).

The marginal cost values calculated for each of the transport services are rough estimates. No rigorous empirical attempt was made to determine these cost functions, because data were not sufficient for the systems in question. For this reason, a range of cost values was tested and it is assumed that marginal costs for all modes and time periods remain constant over the range of demand levels being considered.

TABLE 1 Multimodal Case Input Data: Price and Ridership

Mode	Price ($)	Ridership (000,000s) Peak	Off Peak
Subway	0.75	623	415
Bus	0.75	334	281
Commuter rail	2.00	43	40
Tunnel and bridge	1.25	50	186

TABLE 2 Multimodal Case Input Data: Cost and Elasticity Alternatives

Period	Mode	Cost ($) 1	2	3	Elasticity (absolute value) 1	2	3
Peak	Subway	0.69	0.92	1.15	0.08	0.10	0.13
	Bus	0.71	0.94	1.18	0.15	0.20	0.25
	Commuter rail	3.00	4.00	5.00	0.15	0.20	0.25
	Tunnel and bridge	0.70	0.80	1.10	0.08	0.10	0.13
Off peak	Subway	0.35	0.46	0.58	0.15	0.20	0.25
	Bus	0.35	0.47	0.59	0.30	0.40	0.50
	Commuter rail	1.50	2.00	2.50	0.30	0.40	0.50
	Tunnel and bridge	0.35	0.40	0.55	0.15	0.20	0.25

TABLE 3 Multimodal Case Input Data: Likely Demand Functions

Mode	Linear	Constant Elasticity
Subway	$Q = 1.261*10^9 - 2.24*10^8(F)$	$\ln Q = 20.734 - 0.16(\ln F)$
Bus	$Q = 8.05*10^8 - 2.54*10^8(F)$	$\ln Q = 20.191 - 0.31(\ln F)$
Commuter rail	$Q = 1.09*10^8 - 1.27*10^7(F)$	$\ln Q = 18.019 - 0.31(\ln F)$
Tunnel and bridge	$Q = 2.74*10^7 - 3.02*10^7(F)$	$\ln Q = 19.244 - 0.16(\ln F)$

Given the current prices and quantities and the basic overall elasticities, linear (Equation 2) and constant elasticity (Equation 3) demand functions can be produced for all modes, as shown in Table 3. The linear demand functions imply that the fare at which ridership will be eliminated (Fe) is $5.43 for subways, $3.17 for buses, $8.45 for commuter rail, and $9.06 for tunnels and bridges. These values imply further that current consumer surplus [1/2 x (Fe - F) x Q] is $2.45 billion for subways, $0.74 billion for buses, $0.27 billion for commuter rail, and $0.92 billion for tunnels and bridges. The total consumer surplus is therefore $4.4 billion. These figures are given to provide a base for comparing the relative magnitudes of the output variables produced by the models.

Results from the Constant-Iteration-Increment Models

Only results from the constant-iteration-increment models are presented, because the variable-iteration-increment models are simply faster and cruder tools. Because the prices suggested by the models are not very different for the various cost and elasticity alternative combinations, the results of the first cost and elasticity alternative only are shown in Table 4.

It is obvious from the results that all low-elasticity peak periods are charged more than the high-elasticity off-peak periods. Some of the price changes are rather significant. For example, peak-period commuter rail passengers are charged 72 percent more and off-peak bus passengers have their fares reduced by 39 percent. However, in spite of the large individual price variations, the model produces minor overall changes for the average transportation services user in the area. If ridership and revenues for all modes and time periods are added together, under the original pricing scheme 1.972 billion trips are made, which generates $1.701 billion of revenues. Thus the price of the average trip is 86.24 cents. If the prices suggested by the model are implemented, total ridership increases by 1.6 percent to 2.004 billion, the average trip becomes 2.2 percent less expensive (84.35 cents), total revenues are reduced by 0.5 percent or $8.9 million, and consumer surplus is increased by $18 million, or 0.4 percent. Therefore, if a systems approach is taken, the overall changes are for all practical purposes negligible. This is a perfect illustration of the impacts of Ramsey prices. They simply redistribute revenues among the various "markets" by charging differential prices, but without producing any significant overall changes.

MODELS WITH CONSTRAINTS

An area's transportation system not only satisfied the basic mobility needs of its population, but also can be used to serve or promote other purposes and causes. Therefore, although the prices suggested by a Ramsey pricing methodology may make economic sense, there might be other overriding concerns that dictate a different price structure. Peak-period vehicular traffic may have to be limited because of environmental reasons, whereas it might be desirable to increase off-peak travel for economic development reasons. Because of political realities, transit fares may not be able to increase above a certain level and may not fall below another because of system capacity constraints. The constrained versions of the models provide the user with a tool that can model such special local situations. Only a ridership constraint example is presented here. A variety of constrained model results may be found elsewhere (11). Tables 5 and 6 give the results of setting a lower limit on the ridership of the subway peak period, which was limited to 580 million passengers (round-off errors produce a QNEW of 579.9 in Table 5). The linear demand model was used and the detailed results from only the first cost and elasticity alternative combinations are shown. Cumulative changes produced by all nine cost and elasticity alternatives from the constrained and

TABLE 4 Sample of Results from Linear Demand Function Unconstrained Model

		Changes in				Final	
Mode	Period	Ridership (%DQ)	Revenue (%DREV)	Fare (%DP)	Welfare (%DW)	Ridership (QNEW) (000,000s)	Final Fare (PNEW) ($)
Subway	Peak	-2.96	32.99	37.06	-5.84	604.5	1.03
Bus	Peak	-2.81	15.40	18.73	-5.54	324.6	0.89
Commuter rail	Peak	-10.81	53.48	72.09	-20.46	38.4	3.44
Tunnel and bridge	Peak	-0.19	2.15	2.35	-0.38	49.9	1.28
Subway	Off peak	4.13	-24.55	-27.55	8.43	432.1	0.54
Bus	Off peak	11.85	-32.32	-39.48	25.09	314.3	0.45
Commuter rail	Off peak	3.65	-8.96	-12.17	7.43	41.5	1.76
Tunnel and bridge	Off peak	6.83	-41.82	-45.54	14.13	198.7	0.68

Note: Cumulative results (in millions of dollars, except EINDEX): CHREV = -8.9, CHCOST = -9.1, CHPROF = 0.26, CHWELF = 18.1, CHNET = 18.4, EINDEX = 0.0069.

TABLE 5 Results from Constrained Model

		Changes in				Final	
Mode	Period	Ridership (%DQ)	Revenue (%DREV)	Fare (%DP)	Welfare (%DW)	Ridership (QNEW) (000,000s)	Final Fare (PNEW) ($)
Subway	Peak	-6.92	73.58	86.48	-13.36	579.9	1.40
Bus	Peak	-6.77	35.31	45.13	-13.08	311.4	1.09
Commuter rail	Peak	-14.45	67.95	96.31	-26.81	36.8	3.93
Tunnel and bridge	Peak	-4.25	46.66	53.18	-8.33	47.9	1.91
Subway	Off peak	-0.11	0.63	0.74	-0.22	414.5	0.76
Bus	Off peak	7.29	-18.78	-24.29	15.11	301.5	0.57
Commuter rail	Off peak	-0.57	1.33	1.91	-1.14	39.8	2.04
Tunnel and bridge	Off peak	2.48	-14.46	-16.53	5.02	190.6	1.04

TABLE 6 Comparison of Results from Constrained and Unconstrained Models

Alternative		Variable ($000,000s)					
Cost	Elasticity	CHREV	CHCOST	CHPROF	CHWELF	CHNET	EINDEX
Constrained							
1	1	449.7	-57.6	507.3	-520.5	-13.2	-0.0261
1	2	263.2	-49.0	312.2	-309.0	3.1	0.0101
1	3	130.9	-40.8	171.7	-154.3	17.4	0.1011
2	1	459.0	-94.8	553.8	-547.5	6.3	0.0114
2	2	271.1	-91.5	362.6	-341.6	20.9	0.0577
2	3	123.9	-85.7	209.7	-175.3	34.3	0.1637
3	1	492.4	-14.5	637.4	-607.5	29.9	0.0469
3	2	300.2	-15.2	452.2	-407.5	44.7	0.0988
3	3	134.9	-15.2	287.3	-229.4	57.9	0.2016
Unconstrained							
1	1	-8.9	-9.1	0.265	18.1	18.4	0.0069
1	2	-9.9	-10.5	0.597	24.3	24.8	0.0042
1	3	-13.7	-13.8	0.077	30.8	30.9	0.0004
2	1	-27.3	-27.8	0.562	23.8	24.3	0.0043
2	2	-34.3	-35.7	1.373	31.0	32.3	0.0023
2	3	-44.8	-45.3	0.414	40.1	40.5	0.0098
3	1	-50.6	-51.1	0.523	31.3	31.8	0.0061
3	2	-67.1	-68.1	1.046	41.1	42.1	0.0040
3	3	-85.7	-86.7	0.967	52.0	52.9	0.0055

unconstrained versions of the model are also presented for comparison purposes.

The unconstrained linear demand model produces a peak subway ridership that ranges from 593.4 to 609.4 million for the various cost and elasticity alternatives. Therefore, by restricting peak subway ridership to 580 million, that ridership can effectively be reduced between 2.3 and 4.8 percent. With the exception of the first cost and elasticity alternative, which produces a negative net change and therefore a negative effectiveness index, all other cost and elasticity combinations continue to produce positive overall net changes after the constraint has been placed. However, the effectiveness indices of the constrained model are one to three orders of magnitude smaller than they were in the unconstrained model. This deterioration of the constrained model's effectiveness is not so much a result of reductions in net change (for the last two cost and elasticity combinations the constrained model actually produces slightly higher net changes) as it is mainly from the rather dramatic profit increases of the constrained model (two to three orders of magnitude higher than those of the unconstrained model). The high profit changes are produced from the higher price that the constrained model has to charge the peak-period subway users in order to turn away some of them and reach the specified limit. The higher peak-period subway fare produces in turn higher prices for all other modes and time periods through the Ramsey constant (Equation 10). The higher prices produced another interesting difference. The positive net changes produced by the unconstrained version were a result of increased benefits to both the transportation system (more profits) and its users (higher welfare). In addition, the user benefits were from one to three orders of magnitude higher than the system benefits. This situation was reversed dramatically when the constraint was placed. Although the net changes remained roughly the same (except for the first cost and elasticity alternative combination), only the transportation system received benefits, whereas the users had to suffer a considerable reduction in their welfare.

Naturally, there are limits to what one can do with prices alone. Unrealistically high or low constraints either will produce no results at all, because the model will not be able to meet the nonreduction of the current profit criterion, or will produce unreasonable results. For example, if an off-peak subway ridership goal of 480 million is forced on the system, the model indicates that the new fare for this mode and time period should be -$0.03. This indicates that if it is desired to attract 480 million passengers to the subways during the off-peak period, they have to be paid 3 cents a trip. The correct interpretation is that the constraint was too high, and it is impossible to attract 480 million passengers through pricing incentives alone. Generally, it is impossible to know in advance whether a constraint is reasonable. Its feasibility has to be investigated in most cases by trial and error.

MODEL LIMITATIONS

The model results appear to depend on the assumptions that those deterred from peak-period use of all modes will shift to off-peak trip making. Because the model treats the various modes as independent rather than substitute services, with no measure of cross-elasticity of demand among the modes, it is difficult to determine what portion of the 30,000 former daily users of rush-hour commuter rail service would (a) travel at another time period but still use the railroad, (b) make the same trip but by a different mode, or (c) not make the trip at all. The answer to this question is crucial to the understanding of the impact of such fare and toll adjustments on the economy of the city. It must be remembered, however, that (a) one can still drive into Manhattan without using a tolled facility and (b) there are other transit and paratransit options available (e.g., express bus, taxi, and various semilegal van services), most of which are not under MTA control. The very presence of untolled bridges directly adjacent to tolled river crossings shows that there are other economic or political considerations that prevent the efficient control of the city's transportation network and that tend to move feasible pricing policies away from Ramsey-type solutions.

Environmental policies might conflict with any program for higher transit fares in any time period. The models call for considerably higher subway and commuter rail fares, whereas an increase in vehicular trips across the MTA's toll facilities is projected. According to the results in Table 4, for example, annual transit use is expected to increase by 1.3 percent, and bridge and tunnel crossings would increase by 5.3 percent. Therefore, these types of changes in transportation pricing could possibly conflict with the environmental goals of reduced vehicular travel.

The major limitation of the Ramsey pricing models was seen during the discussion of ridership constraints. As is the case with all goods and services, travelers do not choose transportation services only on the basis of their fares. Comfort and other amenities are quite often more important factors than the fare, but they are not included in the model. In addition, the models do not assume any interaction between the transportation system and the economy in which it operates and serves. Demand levels are determined without a check to see whether the local economic activity is capable of producing these levels or, conversely, what impacts the new demand levels will produce on the local economy.

DISTRIBUTIONAL ASPECTS OF RAMSEY PRICING

The changes that the models produce for the overall average fares are very minor. However, the charges paid by individual travelers in different time periods vary considerably, which implies a redistribution of the system's cost burdens. The results in Table 4, for example, imply a 33 percent, or $155 million, increase in peak-period subway user charges, whereas revenue expectations for other periods are lowered by $78 million, or 25 percent. At this point, the differences between equity and efficiency must be stressed. The Ramsey pricing model and the welfare-revenue trade-off considerations discussed previously both dealt with the defining of efficient pricing policies, that is, those that increase total welfare without any consideration of its distribution before or after the price change. Concerns over the equity of pricing or taxation policies, however, can also be made a part of fiscal decisions. These two very distinct economic characteristics are inexorably linked in the realities of the political process and in economic thinking as well. Although either one may be treated separately for analytical ease, the links between them must always be kept in mind.

A consumer surplus methodology can be envisioned that would bring the public's concern over the welfare of certain groups into the fare policy decision process by including not only marginal costs and revenues but also some form of distributional weights as an additional constraint on fare selection. With three rough income classifications (low, medium, high) and the eight time-period and modal combinations of the case study, the following distribution could be defined:

l_{ij}, m_{ij}, h_{ij} = portion of service X_{ij} that is purchased by the low (medium, high) income group

where X_{ij} is, for example, off-peak bus trips.

Let us assume that some set of weights has somehow been specified that expresses quantitatively the desire of the policymakers to influence transit pricing through the addition of certain income characteristics of the riders in the various transit submarkets. When combined with the l, m, h (for all ij) measures of ridership income distribution, a composite equity index of the following form could be constructed:

$$I_{ij} = w_l l_{ij} + w_m m_{ij} + w_h h_{ij}$$

where w_l, w_m, and w_h are the weights that the agency places on a unit of benefit that each of the three income groups receives. If the additional equity-based distributional variable (I_{ij}) is to be included, the basic Ramsey optimizing formula for the most efficient pricing policy (Equation 10) should be changed to the following:

$$(P_{ij} - MC_{ij})E_{ij}/P_{ij} = K_{ij}/I_{ij} \qquad (12)$$

With the higher values of I_{ij} given to favored groups, this would mean that the higher the values of I_{ij}, the lower the price for that service.

The net impact of any public program or policy on the general welfare or that of specific groups depends on the benefits received and the costs borne by the groups in question. Just as the incidence of the fare must be traced, so also must the distributional characteristics of the other taxes used to support transit operations be estimated. Typically, the assumed impact of the fare receives the bulk of the public consideration, whereas the other fiscal tools that actually raise the majority of the transit funds are left relatively undiscussed. Crowell has shown that the mechanisms employed by local tax systems are relatively regressive (18). Policy arguments, therefore, in favor of providing, say, low-fare benefits to riders principally on the basis of their income redistributive effect have two basic weaknesses:

1. The profile of the city's transit ridership shows that the median income of riders is actually above that of the general population, especially in congested peak periods when the system's costs are highest and an even higher-income population of work-trip travelers predominates; and
2. The tax revenues used to support these services are mainly from fairly regressive local tax sources that would effectively cancel any distribution of the services' benefits supposedly for the poor. In addition, the benefits from improved service or a low-fare policy may be shifted by market forces to the landowners whose property value is increased through improved transit access; and with a property tax system that drastically underassesses the land portion of real estate, it is very difficult to "capture" the benefits accrued by these high-income individuals (19).

MODEL SENSITIVITY TO INPUTS

The models are for all practical purposes insensitive to the elasticity assumptions. This insensitivity to elasticity values is not very obvious from the summary results that have been presented because of the huge total annual riderships of the systems, which produce relatively large overall changes for a difference of even 1 cent in price. But, given a marginal cost alternative, changing the elasticities produces differences in the suggested fares that are at most 4 cents (or 1 percent), whereas in most cases they remain identical. On the other hand, given an elasticity alternative, changing the marginal costs produces differences in the suggested prices that typically range between 5 and 10 percent and go as high as 40 percent for the commuter rail mode. Typically, therefore, the models are about 10 times more sensitive to changes in marginal cost than to changes in demand elasticity. Unfortunately, marginal cost is the only variable for which "hard" estimates are not generally available. Higher off-peak and lower peak-period marginal cost values would mean a lower potential payoff from a Ramsey-type pricing approach.

SUGGESTIONS FOR PUBLIC POLICY AND FURTHER RESEARCH

The results of the pricing model applications and the transit taxation options point out two principal areas for public attention:

1. The current flat-fare approach that is in vogue among transportation agencies generates a lower level of benefits to its users than would be possible under a pricing method that took into consideration the demand and cost characteristics of the systems under their control. This same kind of pricing methodology could also be used to account for such social costs as pollution, inefficient use of scarce resources, or traffic congestion. Differential fares have been used in other areas around the world and in parts of the United States, and of course are very common in such private industries as the telephone companies, airlines, and other market situations with large fixed investments and considerable peaking of demand.

2. Municipalities should begin to look less at nontransportation taxes as sources of earmarked support for transportation operations and more at the use of rational pricing of transportation services as a way of raising revenues, avoiding unnecessary expansion of highway or transit systems, and increasing the benefits received by the travelers in their region. The pricing model showed in part how a more sensible pricing approach could be shaped. In addition, the ability of a local government to carry out income distribution through the transit system is severely limited because of the use of the system by many travelers who are not poor and the considerable economic disruption that levying a fairly heavy progressive taxation on a local level might cause in terms of the flight of firms and upper-income citizens trying to avoid the tax.

The results of the pricing modeling effort showed that Ramsey pricing could be applied to a multimarket transportation agency, but the model's predictive ability is rather sensitive to changes in the cost assumptions. Unfortunately, no accurate cost information exists. Section 15 of the Urban Mass Transportation Act is a step in the right direction, but transit is still very much behind other industries as far as data on unit costs are concerned. In addition, more up-to-date information on the users' income distribution could help to resolve some of the conflicts surrounding the claims of the regressivity (or progressivity) of various transportation prices. Accurate cost and user characteristics data, together with the inclusion of modal and time-period cross-elasticities, would make future versions of the models very precise planning and policy tools that can answer questions on the equity as well as efficiency of differential pricing.

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The Contestability of the U. K. Interurban Bus Market

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ABSTRACT

An examination of the nature of the market for interurban bus provision in the United Kingdom is offered. It is sought to establish the extent to which this market exhibits those characteristics generally associated with contestability. The 1980 U.K. Transport Act, which essentially deregulated a large part of the interurban bus industry, provides an important dynamic component to the analysis and permits an examination of whether the industry behaved as one would expect if it were contestable in the face of a major shift in regulatory controls. Some general comments are offered as to the direction future policy may take if the economic efficiency of the market is to be enhanced in the longer term.

Concern about the realism and policy relevance of traditional economic models of market structures led to considerable research efforts in the late 1970s to improve the understanding of how particular types of markets function. Of specific relevance to the transport sector was the development of a body of theory explaining the behavior and offering policy prescriptions for what have been termed "contestable markets" (1-4). Evidence has been forthcoming from the United States that many transport markets are, by their nature, essentially contestable (5). Further, the theory offers an intellectual underpinning for the recent phase of deregulation in the United States (e.g., as exemplified by the Airline Deregulation Act, 1978; the Motor Carriers Act, 1980; the Staggers Rail Act, 1980; and the Bus Regulatory Reform Act, 1982) given that the policies being pursued broadly follow those that would appear to maximize efficiency in a contestable market.

Interest in the theory of contestable markets and deregulation policies has attracted somewhat less attention in the United Kingdom, partly because the majority of entry and pricing controls that historically related to transport activities were relaxed well over a decade ago under the 1968 Transport Act and related legislation. The justification for these changes was normally couched in terms of pure theories of competition rather than contestability and debate centered on traditional concerns over "excessive competition" and "monopoly exploitation." In consequence, minimal work has been conducted to examine the extent to which U.K. transport markets exhibit characteristics of contestability. The passing of the 1980 Transport Act, however, now provides an important watershed in policy that offers scope to examine the degree of contestability that exists in one, albeit rather limited, U.K. transport market. More specifically it permits an examination of the interurban express bus industry and provides an opportunity to see to what extent this conforms to the much more subtle theories of multiproduct, natural monopoly that recent work has advanced. The dynamics of change brought about by the switch from the highly regulated environment of the pre-1980 situation to the much more flexible regime now prevailing provides the type of circumstance that is likely to highlight those characteristics of the market (if they exist) that point to contestability.

The paper is divided into a number of sections. The two sections that follow provide background material by offering, first, a brief outline of the development of regulatory policy with respect to the U.K. interurban bus sector and, second, a summary of the main elements of contestability theory. Next the nature of the U.K. interurban bus industry is examined against the background of the criteria established, to test for contestability. This analysis is, however, static and it is the penultimate section that, by examining the events following the 1980 Transport Act, offers a more thorough analysis by seeking to see whether the changes that occurred correspond to those one would anticipate, a priori, if a contestable market were suddenly freed from entry and exit restraints. The final section offers both some concluding comments and some suggestions as to how remaining regulations may be modified to further enhance the efficiency of the industry.

REGULATION OF THE U.K. BUS INDUSTRY

There are numerous readily accessible detailed histories of U.K. interurban bus activities (6-8) and the intention here is simply to provide a superficial overview for background purposes.

Before 1930, regulation of bus transport was exercised through the Town Policy Clauses Acts of 1847 and 1890, which were designed initially to control taxicab activities and subsequently those of horse-drawn buses. The acts enabled local authorities to obtain powers (they were not automatic) from central government to license vehicles and operators offering carriage service but not those operating on a private-hire basis. The legislation was intended to cope with the problems of horse-drawn transport and was not designed to confront the problems associated with the greater speed and distance afforded by the development of the motorized bus.

The 1930 Road Traffic Act laid the foundation of official policy for the next half-century. The legislation was brought about in part as a device to improve safety standards and increase the stability of the industry (which was seen to be weakened by "excessive competition") but also, in part, to cause the development of a comprehensive network of services to meet social as well as commercial criteria.

The country was divided into traffic areas, each with a licensing system administered by traffic commissioners. The licensing regime was designed to affect levels of service as well as to ensure each vehicle's fitness. Services were divided into stage carriage and express carriage for fare-setting purposes; the latter was distinguished by the setting of minimum rather than actual fares. As far as this study is concerned, however, the key element introduced in 1930 was that relating to service licensing. In this context, when considering an application, the commissioners were required to take into account

1. The suitability of the routes on which a service may be provided under the license,
2. The extent, if any, to which the needs of the proposed routes or any of them are already adequately served,
3. The extent to which the proposed service is necessary or desirable in the public interest, and
4. The needs of the area as a whole in relation to traffic (including the provision of adequate, suitable, and efficient services; the elimination of unnecessary services; and the provision of unremunerative services) and the coordination of all forms of passenger transport including transport by rail.

Even if the application was granted, the commissioners could lay down conditions to licenses regarding fare levels, publication of timetables and fare schedules, and the exact location of pickup and set-down points for passengers.

The result of the legislation was that entry into and exit from particular services proved extremely difficult. In general, there is evidence that the commissioners tended to favor larger undertakings in the granting of licenses (7), which made market penetration by newcomers particularly difficult. The commissioners' interpretation of licensing item 4 in the foregoing list resulted in high levels of cross-subsidization (by route, by distance, and by time of day) because bus operations frequently had to take up unprofitable services in order to obtain licenses for more lucrative ones; they had to be seen to be meeting "the needs of the area as a whole." The idea of what constituted a bus service also tended to be rigid with only limited scope for innovation on the part of operators.

Although the 1930 act, essentially unchanged, formed the basis of regulation before the 1980 Transport Act, there was a brief period in the late 1940s and early 1950s when there was experimentation with a somewhat different approach. The 1947 Transport Act established the British Transport Commission (BTC) with the remit to provide a coordinated, multimodal transport system. The commission took over, mainly by purchasing, a substantial range of interurban bus operations, which gave it, by 1952, a fleet of some 14,000 vehicles operating across the country. A near-monopoly of BTC services existed over large parts of the United Kingdom. The key point about BTC activities was that they were not the subject of traffic commissioner control; essentially it was intended that the BTC would act as its own regulatory agency. Unfortunately, this period, because of both the gradual nature of BTC acquisitions and the phased changes in the law, provides no real clues as to the type of market that would, in the longer term, have emerged. A change of government in 1952 and the passing of the 1953 Transport Act resulted in the reinstatement of the traffic commissioners with their pre-1947 powers.

Legislative changes in the 1960s (Transport Acts of 1960, 1962, and 1968) did little to change the powers of the traffic commissioners with respect to interurban bus services, although the establishment of Passenger Transport Executives (PTEs) in the larger combinations tended to result in a de facto removal of their influence in urban areas. The legislation also resulted in some changes in the organization of the nationalized interurban bus fleets.

The recent phase of deregulation was, in many ways, in complete contrast to the 1978 Transport Act that immediately preceded it. The 1978 legislation permitted the introduction of car sharing and community bus services outside traffic commissioner control and thus effectively increased the flexibility of the sector. This effort, however, was relatively marginal. More important, the traffic commissioners were given new criteria on which to base the award of licenses; in particular, they were now to take into account

1. Any transport policy or plans that had been made by the local authorities concerned and had been drawn to the commissioner's attention by those authorities,
2. The transport requirements of the area as a whole (including both the commissioner's own traffic area and, so far as was relevant, adjoining traffic areas) and of particular communities in the area,
3. The need to provide and maintain efficient services to meet these requirements,
4. The suitability of the route on which a service may be provided under the license, and
5. The convenience of those who are disabled.

In effect this extended the coordinating role of the commissioners in license allocations and placed more emphasis on the need to take account of the views of the local governments involved. Fare policy was also modified so that the commissioners were to consider the nature of the service concerned as well as the public interest. The act represented, therefore, something of a retrenchment of policy and a strengthening of regulatory control.

The 1980 act substantially changed the emphasis and nature of licensing laws. Although there were changes in the public service vehicle operator's license system, the important change from the point of view of this paper relates to the road service license. First, the legislation reclassified types of bus transport and abolished road service licenses for express carriage. Second, it made it easier to obtain licenses in general and limited the power of the commissioners to impose conditions. Finally, trial areas were designated where road service licenses are not needed for stage carriage services.

The exemption of express services from road service licensing is of considerable importance. The definition of such services under the act is couched in terms of the distance every passenger travels--this must exceed 30 miles. In effect, therefore, long- and medium-distance interurban bus transport is no longer subject to entry and regulation, although operators are still required to deposit particulars of services with commissioners responsible for the areas in which the services commence. It is this market, and the impact of the changed regulatory environment governing it, that provides the basis for much of the subsequent discussion.

THEORY OF CONTESTABLE MARKETS

The theory of contestable markets argues that under certain conditions (notably that potential entrants have access to all production techniques available to incumbents, that potential entrants are not prevented from trying to attract the incumbents' customers, and that entry decisions may be reversed without costs) there may exist a socially efficient competitive equilibrium with only one active firm in the market. Quite simply, if the essential conditions prevail, the fear of potential entry into the market by a new entrant will so contain the existing supplier that no abnormal profits will be earned in the long term and prices will be set to ensure that they equate with marginal cost (i.e., are socially efficient).

There is no intention here of trying to lay down all the subtleties of argument underlying the theory of contestable markets [this is fully covered by Baumol et al. (1) and a critical review is offered by Brock (9)]. Nevertheless, one or two features and definitions of specific relevance to this study justify comment.

A contestable market may exist if there is only a single product, but it may also occur if there are multiple products. Interurban bus activities are essentially multiproduct by nature: not only do services provide a variety of potential pickup and drop-off point combinations, but a return route is essentially different from the outward journey. The multiproduct nature of the industry presents the possibility of exploitation of economies of scope. These differ from economies of scale in that lower unit costs result from providing a range of outputs, which is different from the more conventional scale effect where one is concerned with the costs of increasing the output of a single product. The notions of economies of scope and scale are central to ideas of sustainability, that is, the ability of a firm to remain the sole supplier of a service even when market entry is open. Essentially, the monopoly is sustainable if (a) the supplier covers his costs and (b) there is no other combination of outputs that a potential competitor could supply at lower cost without making a loss. In other words, economies of scope in a contestable market imply that a monopoly supplier offering a service will, while still recovering only his costs, do so in the most economically efficient manner possible.

The important question here is to determine the extent to which the U.K. interurban bus industry conforms to these ideas of multiproduct contestability. Baumol et al. (1) provide a useful set of guidelines as to the features to look for in practice:

- Establish which of the sector's outputs can be provided most economically by a monopoly and which are naturally competitive,
- Determine the degree of contestability in the market,
- Determine the obstacles to contestability and evaluate the problems of their elimination,
- Determine whether sustainable combinations of output exist,
- Quantify (and qualify if necessary) the sustainable configurations,
- Identify any second-best or externality problems that may influence one's view of efficiency, and
- Check for potential institutional inhibitions that may influence the way the market is viewed.

Although some of these features can be sought in a static examination of an industry, if there has been a long period of stringent regulation, it is unlikely that an undistorted picture would emerge. Thus although a simple examination of the nature of the U.K. interurban bus sector may offer guidelines as to the extent of contestability, these are unlikely to be more than broad indications. A study of the impact of regulatory reform (as embraced in the 1980 act) provides important confirmations and scope for further analysis. Therefore attention is focussed mainly on express services, because this is the area where deregulation can provide supplementary evidence as to the extent of contestability.

THE U.K. INTERURBAN BUS INDUSTRY

The main feature of most interurban express services is that outside factors influencing the demand on each route tend to be relatively constant and also, in many instances, potential total demand is relatively thin. To meet this demand a supplier has a range of alternative technologies available--most notably a variety of vehicle sizes, each with a specific operating cost profile. In general terms (assuming, for example, that vehicles of the same vintage and other characteristics are concerned) the costs of providing a seat mile of service decrease with the capacity of the bus used. [Figure 1 shows the relevant cost curve (10).] There are thus economies of scale to be enjoyed from using larger vehicles. Such economies, however, do not constitute a barrier to entry into the industry because buses are readily available, both purchased and transferred from other services. All technologies are openly available. The sector therefore meets the criterion of a contestable market in that although economies of scale of the type outlined may exist, they do not present technical restrictions on free entry into or exit from the market. (Exit is facilitated by the ability of any supplier to transfer vehicles to other services should profits not be forthcoming from existing ones.)

What exists, therefore, is a potential in an unregulated market for suppliers to compete for that market. The total market may be limited in its scale (i.e., each route is sparse) and thus efficiency suggests that competition between firms within the market may not minimize costs (the advantages of employing large vehicles cannot be reaped) but equally a monopoly supplier would not be in a situation to exploit his position for fear that competitors might move in.

Sunk costs are seen by those who developed the theory of contestable markets to be one factor that could lead to monopoly rates. In the context of urban bus operations these relate mainly to track, garaging, and terminal costs. Track is provided centrally and access is open to all bus users on payment of the requisite tax. However, the method of charging may be distortive in the United Kingdom, because a substantial part of the fee is based on an annual (not use) levy. Thus a new firm entering the interurban bus market, if it is not transferring vehicles from other routes, meets a financial barrier that the incumbent bus operator who has paid the annual exise fee does not. From a policy point of view this method of recovering fixed costs of track, therefore, results in a potential distortive

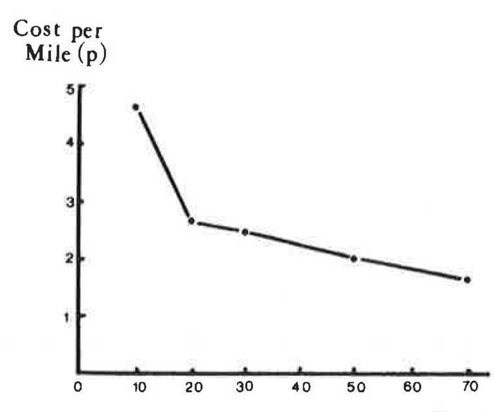

FIGURE 1 Economies of scale in bus size (10).

situation, but this is an institutional factor, not an intrinsic characteristic of the market.

Other costs that may a priori be considered sunk, such as the provision of necessary garage facilities, appear from the available empirical evidence to actually vary directly with the mileage of service provided. Glaister and Mulley (7), for example, find a direct linear relationship between garage size and costs in their examination of bus operations in eastern England. There would appear, therefore, to be little evidence that such costs pose a barrier to entry.

Problems may arise in the U.K. interurban bus industry in the cost of providing terminal and access facilities for travelers. If there is one suitable pickup facility in an area and this is controlled by the existing operator, potential new operators who are refused access are de facto confronted with an infinite cost. In a different context, Laker Airways encountered this problem when they tried to obtain gate and terminal space at Kennedy Airport for trans-Atlantic flights; airlines with surplus capacity essentially refused to give Laker access (11). As seen in the following discussion, in terms of the situation that emerged following the 1980 Transport Act in the United Kingdom, the control of terminal facilities and the very high sunk costs associated with providing new, duplicate facilities (where possible) reduces the ease with which potential competitors can enter a monopolized market.

A final consideration in static terms is the basis on which interurban bus operators compete with other modes of transport. In the U.K. context this is essentially competition with the private car and rail (there are few routes on which air transport competes with bus modes). For minimum distortion and maximum efficiency, the terms of competition should be equitable and prices should be determined by costs. In practice, questions may be raised about the extent to which railway services are subsidized as opposed to that for express bus transport (given the problems of allocating joint track costs of passenger and freight services on the rail mode, the answer is not clear cut) and the degree to which the private motorist pays his full track costs (12). Distortions in the pricing of competing and complementary modes clearly affect the mode split and may thus result in greater or less demand for bus services on specific routes than efficient, across-the-board pricing would produce. The effect on the interurban bus sector is that economies of scope may increase or decrease as a result of this (technically the minimum cost vector of services will be affected) and influence the optimal nature of supply.

In summary, there is some evidence from the static analysis that the interurban bus sector does exhibit many of the features of a contestable market. Where there do appear to be deviations, these stem rather more from the effects of government policy toward both the industry and related industries than from the nature of the market per se.

THE IMPACT OF THE 1980 ACT

Static analysis may be enlightening, but it must be viewed from the position of an established regulatory environment. When a regime of regulation has been in place for a long period of time, it is extremely difficult to separate out the inherent nature of the market from that induced by the details of the regulations.

Any change from a regime involving major restrictions on market entry to one of greater liberalization is going to result in a period of transitional disequilibrium. There is also an inevitable problem in examining both the nature of the elements of this transitional phase and the final outcome: Deregulation essentially means that one of the major sources of information--details contained on license applications--ceases to exist.

The immediate effect of the enactment of the Transport Act in October 1980 was a considerable reorganization within the express bus sector. Six major private companies combined to form a consortium, British Coachways, offering services from London to a range of major destinations. (The actual number of companies involved subsequently varied, averaging about 10, but later, from 1981, declined sharply.) The companies accepted the deregulation enthusiastically and the consortium was intended to provide a major competitor to the publicly owned National Express, embracing the express activities of the National Bus Company (in England and Wales) and the Scottish Bus Group. In particular, it was intended to provide a high-speed, no-frills network service at low fares (often at 50 percent of the National Express level before deregulation). The public sector replied by both reducing fares and improving service quality.

In addition, several small independent operators (formerly specializing generally in stage or contract work) initiated new express services, usually from their base area to London. The number of genuinely new entrants was, however, extremely small (12) and concentrated on specific routes, for example, Stagecoach operations between Scotland and London-Blackpool.

The effect of this reorganization was an initial overall increase in supply of interurban express services (Figure 2) and a decrease in the prevailing levels of fare (Table 1). In addition, the quality of service improved, not simply in terms of the speed and frequency of services but also in terms of the comfort and range of facilities offered on vehicles. On-board toilets became more common and, in some instances, premium services such as the Rapide offered hostess services and video-TV entertainment. Some general idea of the effect of deregulation on the nature of the vehicle fleet may be gleaned by looking at its composition. In 1978 less than 40 percent of newly registered vehicles were heavyweight (i.e., most suited to use on high-speed

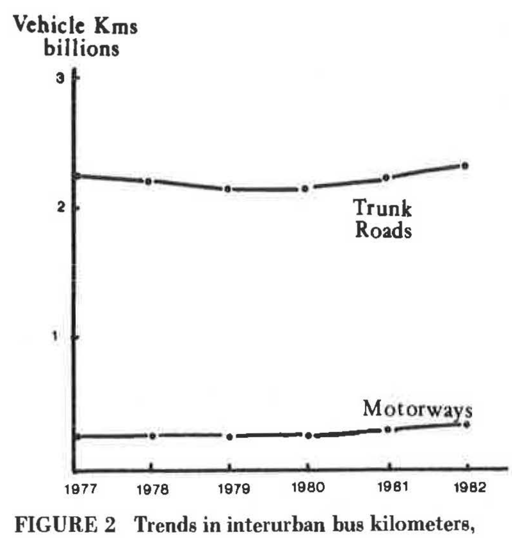

FIGURE 2 Trends in interurban bus kilometers, 1977-1982.

TABLE 1 Guide to Fare Charges on Selected Routes in the East Midlands *(12)*

Route	Type of Ticket	Index of Fare Charges[a] 1978	1980	1983
Nottingham-London	Single	142	89	100
	Return	135	84	100
Derby-London	Single	128	83	100
	Return	115	69	100
Nottingham-Norwich	Single	212	152	100
	Return	227	149	100
Nottingham-Blackpool	Single	109	135	100
	Return	243	134	100
Nottingham-Oxford	Single	147	97	100
	Return	146	96	100
Nottingham-Skegness	Single	167	111	100
	Return	159	107	100
Nottingham-Clacton	Single	157	110	100
	Return	148	107	100

[a]After July.

motorways), but by 1982 this number had risen to 67 percent.

The impact on the transport market was a marked increase in the use of interurban bus transport (although a part of this must be attributable to the general economic depression in the country, which led to a switch to cheaper modes of transport). Tables 2 and 3 (13) show the official data on express buses relating to passenger trips and receipts, respectively, but a change in definition in 1980-1981 (from one based on fare levels to one based on distance) distorts the picture. A more useful indicator is the impact on specific routes. National Bus, for example, experienced an increase of 186,250 passengers (over a base figure of 175,000) between 1979 and 1981 on routes between the major East Midlands centers and London. By the end of 1980, services between London and Manchester and London and Birmingham experienced an increase of about 200 percent in passengers over the number a year earlier. Because of peculiarities in the licensing system, these latter routes formerly provided services with poor frequency and were thus ripe for expansion, but even on routes such as London-Newcastle, where capacity had not been severely restricted in the past, the number of passengers increased by nearly 50 percent. In some cases the increased number of passengers represented mainly generated traffic (e.g., London-Newcastle) but there was also, in many instances (14), a change in mode share in which traffic switched from rail to express bus. Some 160 express coaches, for example, now carry some 8,000 long-distance commuters into and out of London each day, most of whom formerly used rail.

TABLE 2 Express Coach Passenger Trips, 1974-1982 *(13)*

Year	No. of Passenger Trips (000,000s) National Bus	Municipal Operators	Scottish Bus Group	Private	Total
1974	16	1	-	41	58
1975	18	-	1	39	58
1976	15	-	1	41	58
1977	12	1	1	36	50
1978	10	1	-	33	44
1979	9	1	1	33	44
1980	9	1	-	29	39
1981	8	-	1	6	17
1982	12	-	1	5	18

Note: Discontinuities exist in the series because of changes in legal definitions of bus services in 1976-1977 and 1980-1981.

TABLE 3 Express Coach Receipts, 1974-1982 *(13)*

Year	Receipts (£000,000s) National Bus	Municipal Operators	Scottish Bus Group	Private	Total
1974	14.9	0.1	1.5	11.0	27.5
1975	22.3	0.1	2.3	13.9	38.6
1976	26.8	0.2	2.9	16.4	46.4
1977	26.3	0.3	3.3	17.0	46.9
1978	22.2	0.4	3.4	16.3	42.3
1979	24.6	0.3	3.9	17.2	46.1
1980	29.7	0.4	4.2	21.7	56.0
1981	24.2	-	5.3	11.6	41.1
1982	38.2	-	6.1	13.7	58.1

Note: Discontinuities exist in the series because of changes in legal definitions of bus services in 1976-1977 and 1980-1981.

The immediate impact of deregulation, therefore, is consistent with the idea that the interurban bus industry is essentially contestable. If it had been a traditional monopoly that had previously been restrained by entry controls, it would appear likely that deregulation would have resulted in higher fares, reduced supply, and higher revenue. Alternatively, if it were naturally highly competitive in the conventional way, it would be expected that deregulation would result in lower fares, increased supply, and lower revenue. The actual outcome (lower fares coupled with increased supply and enhanced revenue) does not conform with either of these scenarios, but it indicates that contestable forces are at work. The longer-term effects offer further confirmation.

After nearly 4 years of deregulation, it is clear that the major market supplier, National Express, has become once more a monopoly supplier on many routes on which private operators had in 1980-1981 initially offered new services. Others now operate joint services with National Express (e.g., Whittles). Further, a succession of companies withdrew from British Coachways, and by January 1982 the consortium had essentially collapsed. (In some instances private operators, such as Wallace Arnold between London and South Yorkshire, have combined with National Express and the Scottish Bus Group to provide pooled services.)

Some examples help to illustrate the nature of the withdrawal of private operators from much of the express market. In late 1980 three new operators joined National Express in providing services between London and South West England, but by 1982 they had withdrawn. Similarly, in the East Midlands seven operators announced new services to London to compete with National Express at prices below the scale offered by National. The reaction of National Express in immediately reducing its fares forced almost instant withdrawal of all but four of these. Three of the private operators still provide their regular services (this may be explained in part by the specific nature of the market, which, because of its sparsity of population, does not conform with that needed to match the high-frequency type of service that characterizes National Express); the fourth withdrew in 1982.

It should be noted that there are exceptions to this picture and, for example, on the London-Scottish routes the reluctance (or inability) of the Scottish Bus Group to introduce high-quality services has resulted in retention by the independents of a high market share (15). These exceptions are, however, limited and generally (with the exception of the East Midlands cited previously) relate to relatively high-density routes on which load factors are sufficiently high that a number of operators may survive in the market.

In many ways this is almost exactly what one would have anticipated in a perfectly contestable market. National Express, by providing a network of services, can cope with the costing problems associated with markets in which, because of the nature of the infrastructure, demand tends to be concentrated in one direction (i.e., into London) but diffuse in the other (i.e., out of London). In a situation in which entry is restricted, however, the incentive for efficiency is weak and thus costs tend to rise. Deregulation permitted new entry at fare levels potentially profitable to the private operators if load factors could be pushed up. Competition, however, brought a response from National Express (and, in fact, from the railways, which fought to recover traffic by innovative pricing policies) both in terms of lower fares and improved services. The economies of scope enjoyed by National Express (and the Scottish Bus Group) permitted the market on most routes to be recaptured from the independents. The threat of possible new entrants has, however, prevented National Express from raising fares although a monopoly position has been established.

Although many consider it desirable, rigorous econometric analysis of the current state of the interurban bus market is made difficult by the paucity of reliable data. It is possible, however, to conduct some basic regression analyses based on a simple property of contestable markets. If a market is contestable, one would expect the same cost-fare relationship to hold for each route (other things remaining equal) irrespective of whether actual competition exists or not. When there is only one operator, the fear of new entrants will force the adoption of the same cost-fare policy as that on routes on which more than one firm operates. To examine this, 16 broadly similar National Express Rapide services were selected, 10 representing a monopoly supply situation and 6 representing situations in which one or more competitors vie for the traffic with National Express. Simple linear regressions were then run to relate the single fare charged by National Express in 1984 to the route mileage of each service and to a dummy dichotomous variable in which a value of zero was taken if there was no competitor and unity if there was competition. The result was as follows:

$$\text{FARE} = 1.727 + 0.04\ \text{MILES} - 1.73\ \text{COMPETITION}\ (R^2 = 0.914).$$

This superficially appears to suggest that although fares increase by just over 4 pence for each additional mile, overall they are still £1.73 lower on routes where actual competition exists. This is, however, misleading. The COMPETITION variable is not statistically significant even at the 60 percent level, and its omission has little effect on either the overall statistical fit of the model or the value of the MILES variable. This suggests that, in fact, fares are determined almost entirely by mileage (essentially a proxy of cost) and are unaffected by whether there is actual competition or not. The data limitations must make this conclusion tentative, but the calculations do appear, however, to offer support for the notion that the market for U.K. interurban bus services is, since deregulation, broadly contestable.

Although this picture is, to a considerable extent, complete, there remain one or two features of the history of deregulation that indicate that the market for interurban bus services is still not perfectly contestable. First, the newcomers to the market frequently found difficulty in obtaining suitable terminal sites: Pickups often had to be at unmarked curbside locations or hotels, and in London several operators had to make do with temporary facilities at a disused railway yard (subsequently closed). Ticketing posed similar problems although innovations here in terms of standby arrangements and on-board payment allowed a degree of flexibility. The lack of established agents, however, still presents a serious handicap to new entrants. In effect, the necessary infrastructure was under the control of the established operators and access proved extremely difficult for the new entrants. From a public policy point of view, sunk costs were acting as an impediment to competition and offering scope for some degree of monopoly exploitation by the established suppliers (mainly National Express).

Second, although there are no real barriers to effective market entry into the express bus market posed by scale economies in the traditional sense, there may still be one form of economy that permits, other things remaining equal, existing operators to earn monopoly rates to some degree. This type of economy has been called "economies of experience" (16). In some ways these may be viewed as sunk costs, although it is difficult to perceive of policies to handle them of the type conventionally advocated by those interested in contestable markets. Firms already in a market have gained experience in both the problems of serving that market and the specifics of the demand for express bus services. A newcomer does not have this experience, and, by its nature, it cannot be acquired rapidly. In consequence, a firm in situ can enjoy limited monopoly rates, even in the long term, because of this situation. Deregulation essentially meant freedom to compete with the established operator but not in a virgin market where all suppliers were new.

SOME CONCLUSIONS

This paper has provided evidence that the interurban bus sector in the United Kingdom operates in an essentially contestable market. The evidence from the years after the 1980 act suggests that on many routes a monopoly supplier is efficient and can sustain its position in the face of potential competition from new entrants. This does not, however, mean that the market is perfectly contestable. There are certain entry costs that outside operators would have to bear that are sunk as far as the established supplier is concerned and that thus are, effectively, a barrier to entry. Although public policy may be directed toward removing part of this problem (notably in relation to terminal facilities), there may still be some barriers (in the form of economies of experience) that permit the established supplier to enjoy some monopoly profits.

In general, public policy, as exemplified by the 1980 act, basically meets the requirements of policy for a contestable market (11). Price and market entry policy is coordinated and restrictions have been removed. Small firms may enter the market with no greater legal impediment than large ones, and there is extensive intermodal competition on a broadly equitable basis (e.g., British Rail is committed to operate intercity services commercially and has the pricing freedom to do so). Finally, there are few impediments to prevent operators from leaving the interurban bus market should it prove unprofitable and, with the exception of certain terminal costs, the majority of sunk costs are the responsibility of government and do not bear especially on potential entrants. In addition to these essentially intra-industrial efficiency criteria, the system of quality control through the operator and public service vehicle licensing system acts as a restraint on excessive generation of negative externalities (such as accidents resulting from poor vehicle maintenance).

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Intercity Bus Service Changes Following the Bus Regulatory Reform Act of 1982

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ABSTRACT

The Bus Regulatory Reform Act of 1982 (BRRA) increased entry and exit flexibility for regular-route intercity bus firms and created a process for preemption of burdensome state regulations, particularly those dealing with exit. Congress directed the Motor Carrier Ratemaking Study Commission to study the impacts of these changes. The results of that study regarding changes in bus service are presented. In the year following implementation of the BRRA, carriers filed to discontinue service to 2,154 points. Most of the points losing service had small populations; 80.7 percent had less than 2,500 persons and had been receiving a very low level of service. Revenue and cost data for a number of the route segments at issue indicated annual carrier losses of $7 million on variable costs and more than $13 million on a fully allocated cost basis. A number of routes did not have any revenue, indicating that few users would be affected by discontinuance. Against these service losses must be balanced the positive effects of increased competition resulting from 225 applications for regular-route authority, of which 71 percent were for regular-route intercity service. The competitive pressures for new services and fare reductions between larger cities provide benefits such that the overall effect of increased entry and exit flexibility has been positive even though a small number of bus riders have experienced an absolute loss of service.

The Bus Regulatory Reform Act of 1982 (BRRA) [P.L. 97-261, 96 Stat. 1104 (49 U.S.C.A. 10922)] was a comprehensive package of revisions designed to deal with a number of problems experienced by the intercity bus industry in recent years. Among many other changes, the BRRA significantly eased requirements for entry into the intercity bus industry. Entrants no longer need satisfy the traditional standard of public convenience and necessity. The Interstate Commerce Commission (ICC) is now required to grant regular-route authority to firms that are fit, willing, and able to provide the service, unless the applicants' proposal is not in the public interest. The entry reforms also allow removal of "closed-door" restrictions that have prevented carriers from serving intermediate points on existing routes.

In the past, the states, rather than the ICC, were the primary regulators of exit. However, the BRRA provides for preemption of state regulatory decisions, which were found by the ICC to be a burden on interstate commerce. Although the states retain their ability to review and pass judgement on service discontinuances, the ICC has become the final authority through the creation of an appeals process, with definite standards for the ICC to follow in permitting abandonments denied by the state.

In passing the BRRA, Congress anticipated that increased freedom to enter and exit from the industry could possibly have negative effects on those using intercity buses, particularly passengers in small towns and rural areas and those over the age of 60. Therefore, Congress directed the Motor Carrier Ratemaking Study Commission to determine the impact of the BRRA on persons over the age of 60, particularly those living in small cities and rural areas, and to assess the effect on intrastate bus services. As part of that effort, an overall assessment was made of the impact of entry and exit reforms following passage of the BRRA. This paper summarizes the results of that assessment.

THE IMPACT OF SERVICE DISCONTINUANCES

With respect to service discontinuances, two points must be made at the outset to put the remaining discussion in the proper perspective: Intercity bus service is not nearly so prevalent as commonly thought, especially in small communities and rural areas, and the number of places served by intercity buses has been on the decline for years.

Because intercity buses serve so many more places than other common carrier modes (air and rail), it is often supposed that intercity bus service is ubiquitous, a part of rural and small town life across the country. In fact, according to one study of the availability of public transportation in small towns, only 42 percent of towns having a population of 2,500 to 10,000 had intercity bus service available, whereas only 10.9 percent of rural towns of less than 2,500 had such service (1). Of 189 predominantly agricultural counties, only 43 percent had an intercity bus service point, and of 298 persistently low-income counties, just over 50 percent had a bus stop within the county. On the average, residents of agricultural counties had to travel 23 miles to the nearest bus stop, and residents of persistently low-income counties had to travel 9 miles to the nearest intercity bus stop (2,p.12). The unavoidable conclusion is that much of rural and small town America has gone without intercity bus service in the past. A study commission witness confirmed this assessment (E.T. Wellhausen, Motor Carrier Ratemaking Study Commission hearing, July 1983): "The Bus Regulatory Reform Act of 1982 does not create new massive hardships...because frankly commercial bus service is already so limited that it is, for all practical purposes, nonexistent in most small...communities."

Also noteworthy is the decline of intercity bus service over the years. In 1978, the American Bus Association reported that from September 1968 to December 1977, the number of points served had declined from 16,800 to 15,035, a decrease of 1,765, or 10.5 percent (3,pp.4-9). A 1980 study by the U.S. Department of Transportation found that some 1,800 communities had lost intercity bus service since 1972, and that in 10 case studies of rural areas the bus industry had been reducing rural service before implementation of the BRRA (4,p.41).

The fact remains, however, that the BRRA preemption provisions will result in loss of bus service for some passengers as carriers abandon operations over unprofitable routes. The reason for this is not at all difficult to understand. All the states that have studied intercity bus route profitability have concluded that a substantial amount of the bus industry's route mileage is unprofitable. The Georgia intercity bus study, for example, indicates that 20 to 25 percent of intercity bus miles in Georgia are unprofitable (5,pp.71,77). According to the Indiana Department of Transportation, approximately 80 percent of the routes in that state are unprofitable (6,p.61). Although intrastate fare increases will help to preserve service over some routes, others are so plainly unprofitable that abandonment is unavoidable.

Changes in Bus Service

The BRRA created a mechanism by which carriers could appeal state abandonment decisions to the ICC under certain circumstances or if the state had refused to take action in a timely fashion. However, the carrier seeking discontinuance of intrastate services still has to make initial application for abandonment to the state regulatory authority and follow the correct state procedure. The carriers have followed this sequence of procedures in their abandonment activities since passage of the BRRA. Of the points abandoned, 135, or 10 percent of the total, were discontinued as a result of the carrier appeals to the ICC under the provisions of the BRRA. The remainder were handled at the state level, either in state abandonment proceedings or simply through changes in bus service schedules without state review.

The BRRA, and its provisions setting variable cost recovery standards for evaluating abandonments, may well have had an effect on the states that did grant abandonments to the carriers. In addition, it is unlikely that the carriers would have filed such a large number of abandonment requests if the BRRA had not been implemented. For these reasons the study commission considered all abandonments following enactment of the BRRA to be attributable to it, even though the majority of the points abandoned were discontinued as a result of proceedings at the state level.

Data concerning the identity and number of points losing service since enactment of the BRRA have been gathered from several sources. One source was the carriers themselves. Greyhound Bus Lines, Inc., and Trailways, Inc., were asked by the study commission to provide detailed information concerning the routes they have or are proposing to abandon, the points losing service, the abandonment procedures that they followed, and the costs and revenues associated with abandoned service points, if available. Both carriers were cooperative in providing the requested data.

A second source of information was the ICC. As part of its study of terminal ownership, it had surveyed all the regular-route carriers. In that survey, the carriers were asked to list all points they proposed to abandon. The ICC provided the study commission with that information as well.

The study commission was also presented with the results of a survey of the states conducted by AASHTO jointly with the National Association of Regulatory and Utility Commissioners (NARUC). The AASHTO/NARUC survey asked state governments to list points losing service, points gaining new service, points receiving replacement service, and points receiving subsidized service as a result of the implementation of the BRRA. The survey was conducted in late June, and the results were presented to the study commission at its hearing in Des Moines, Iowa, on July 17, 1983.

Finally, the study commission consulted the September 1982 and November 1983 issues of Russell's Official National Motor Coach Guide, the national timetable listing of intercity bus service, to determine which communities actually lost intercity bus service during the year following enactment of the BRRA.

One source of inconsistency was that carrier filings in state discontinuance proceedings listed route segments proposed for abandonment rather than the points along these segments that were receiving service. Often the route segment descriptions were the same as those of the state route authority, which often listed every point or junction on a route, even those that had not been listed in timetables. It was apparent that state utility commissions and carriers had difficulty using the route descriptions to determine the points actually facing a loss of service. These difficulties created some of the discrepancy between the AASHTO/NARUC survey results and the carrier-supplied lists of points being abandoned.

A related source of inconsistency was the fact that many states apparently included all the points listed in their route authority descriptions as losing service, even though many of them had not been listed in bus timetables for some time, if ever. It appears that many of the points listed by the states may once have had bus service, but that service had been dropped in the years before the passage of the BRRA. Thus, the loss of service to these points predates the BRRA, and is not included in this study as attributable to the act. At least one state contended that carrier accounts of points losing service understate the problem because some of the carriers' service points that remain in the timetables have no indication that service is provided.

The study commission found only a few instances of this undercounting, but attempted to verify all points listed by any source as losing service by using Russell's guide as a check. Although some intercity bus carriers are not listed in Russell's, for the most part they are small local firms whose service changes are dealt with in state proceedings without invoking the provisions of the BRRA. Carriers not listed in Russell's guide are effectively outside the national intercity bus system.

Another major source of difficulty in identifying those places losing service was that the surveys and lists obtained by the study commission were all snapshots of the situation at different points in time. The AASHTO survey describes the service changes implemented as of the end of June 1983, although some states listed not only the places where service discontinuances had already occurred but also those for which proceedings were under way. The carrier lists supplied to the ICC are dated the end of August 1983, but they show both the points already dropped and those that the carriers are proposing to abandon. The final check used by the study commission was the September 1982 and November 1983 issues of Russell's guide, showing service as of November 1, 1983.

By cross-checking these sources, the study commission was able to reconcile most of the many inconsistencies and to construct a reasonably accurate list of the service changes rightfully attributable to the BRRA. The data are summarized in Table 1.

Points Actually Losing Service

Table 1 lists the number of points by state that actually lost service during the year following enactment of the BRRA. It also lists the number of points by state that carriers are proposing to abandon but that have yet to lose service. Combining the two gives a total of 2,154 points abandoned as a result of the BRRA. Table 1 contains the individual state totals as well.

Section 16 of the BRRA allows carriers to apply to the ICC for permission to discontinue intrastate services over interstate routes when they have been denied such permission by the state regulatory authority or if that authority has failed to take action on such a petition within 120 days of the carrier's initial complete filing with the state agency. That same section requires the ICC to grant the carrier petition unless it finds, on the evidence of persons objecting to the petition, that the discontinuance is not consistent with the public interest or that continuing the transportation service will not result in an unreasonable burden on interstate commerce. In assessing the degree of reasonableness of such a burden, the ICC is directed by the BRRA to place great weight on the extent to which intrastate and interstate revenues from the services at issue are less than the variable costs, including depreciation, of the service. Three other considerations are (a) the National Transportation Policy enunciated in 49 U.S.C. 10101, (b) whether the carrier has been offered a subsidy to continue the service, and (c) whether it is the last service available to the communities on the affected routes and what alternatives may be available.

Eighteen cases had been decided by the ICC by the end of November 1983. In 15 of the 18 cases, the ICC agreed with the petitioning carrier, allowing the service at issue to be discontinued. The precedents were set in the first decision on a complete case [Petition of Greyhound Lines for Review of a Decision of the West Virginia Public Service Commission, Pursuant to 49 U.S.C. 10935, before the Interstate Commerce Commission, Docket No. MC-1515 (Sub-332), decided August 23, 1983], in which Greyhound Lines, Inc., petitioned for review of the decision by the West Virginia Public Service Commission denying permission to discontinue certain services. Greyhound demonstrated that the variable costs of providing the service exceeded the revenues and the ICC decided to permit the abandonment. Much the same line was followed in the other cases, with the variable cost and revenue criteria being the major deciding factors.

In the one case in which the carrier petition was denied [Petition of Virginia Stage Lines for Review of a Decision of the West Virginia Public Service Commission, Pursuant to 49 U.S.C. 10935, Docket No. MC-59238 (Sub-74), decided September 9, 1983], Virginia Stage Lines sought permission to abandon services in West Virginia after the West Virginia Public Service Commission denied such permission. The ICC also denied the carrier permission to abandon because the carrier had failed to provide and support, as mandated, data and exhibits presenting the variable costs and revenues associated with the services in question. Virginia Stage Lines had presented state-wide cost and revenue figures rather than route-specific data. In the remaining case [Petition of Greyhound Lines for Review of a Decision of the Georgia Public Service Commission, Pursuant to 49 U.S.C. 10935, Before the Interstate Commerce Commission, Docket No. MC-1515 (Sub-331), decided July 22, 1983], the ICC dismissed for lack of jurisdiction a petition by Greyhound for permission to discontinue services in Georgia, because the record did not indicate that state procedures had been followed by the carrier.

Thus, the cases to date indicate that the ICC will permit carriers to abandon intrastate service over interstate routes if the carrier can demonstrate that its variable costs exceed the revenues produced by the services in question. It seems unlikely then that carriers will bring such petitions in the future unless they have developed such evidence. With the necessary specific supporting data, the carrier can expect approval from the ICC to abandon that point. For that reason, the study commission considers it likely that all of the points on routes that the carriers have appealed to the ICC for permission to abandon will in fact eventually lose service.

TABLE 1 Loss of Intercity Bus Service During the Year Following Enactment of the BRRA

State	No. of Points by Category: Lost Service	Proposed for Abandonment	Total
Alabama	47		47
Arkansas	43		43
California	81	43	124
Colorado	24		24
Connecticut	17		17
Delaware	3		3
Georgia	46	2	48
Idaho	27		27
Illinois	98		98
Indiana	96		96
Iowa	57		57
Kansas	26	5	31
Kentucky	45	17	62
Louisiana	38	5	43
Maine	50		50
Maryland	7	1	8
Massachusetts	16		16
Michigan	172		172
Minnesota	89	2	91
Mississippi	27	3	30
Missouri	102	12	114
Montana	10	1	11
Nebraska	12		12
Nevada	29		29
New Hampshire	7		7
New Jersey	6		6
New Mexico	12		12
New York	37		37
North Carolina	57	2	59
North Dakota	31		31
Ohio	101		101
Oklahoma	63	5	68
Oregon	48		48
Pennsylvania	41		41
Rhode Island	2		2
South Carolina	32		32
South Dakota	9		9
Tennessee	61	6	67
Texas	14	86	100
Utah	20		20
Vermont	1		1
Virginia	136	5	141
Washington	29		29
West Virginia	75	1	76
Wyoming	14		14
Totals	1,958	196	2,154

How significant the loss of service at these points may be depends in part on the kind and extent of service existing before abandonment. For each point abandoned, the study commission collected information on the type of stop (scheduled, flag, highway, discharge only, call and demand, or not indicated) and the frequency of service (more than daily, less than daily, weekly, seasonal, or one way). A summary of the service data is presented in Table 2 (7, Appendix B). As is indicated, 49 percent of the points losing service were scheduled stops, 46.5 percent were flag or highway stops, and 4.5 had some other service arrangement, including those points with no stop listed in timetables. As for frequency of service, 26.3 percent had service more than daily, 55 percent had daily service, and 16.7 percent had less-than-daily, seasonal, weekly, or one-way service. The figures clearly indicate that most of the points being abandoned had a very low level of service. This is not surprising if one considers that the carriers would long ago have abandoned many of these points but for regulation and thus had every incentive to provide only the minimal level of service necessary to meet regulatory requirements.

Population Distribution of Abandoned Points

Table 3 (7, Appendix B) contains state-by-state population distributions for the points being abandoned, of which 937, or 43.5 percent of the total, had no listed population. Although census figures are available for some unincorporated places, some of the abandoned points have no population figure available, either because they did not meet the census definition of a "place" or because they have no population. There was a population of less than 1,000 at 448, or 20.8 percent of the total. The number of places with a population between 1,000 and 2,499 was 354, or 16.4 percent of the total. Places with a population between 2,500 and 9,999 persons totaled 315, which was 14.6 percent of the total. Points with a population of 10,000 or more numbered 100, or 4.6 percent of the total. As is evident, most of the points being abandoned have very small populations; 80.7 percent have a population of less than 2,500, and 95.3 percent have a population of less than 10,000. This was perhaps to be anticipated. One analyst has suggested that 5,000 is the minimum population concentration capable of supporting an intercity bus stop (8).

TABLE 2 Service Previously Rendered to Points Losing Intercity Bus Service During the Year Following Enactment of the BRRA *(7)*

	Type of Stop						Frequency of Service					
State	Flag	Scheduled	Highway	Discharge Only	On Call	Not Indicated	More Than Daily	Less Than Daily	Daily	Seasonal	Weekly	One Way
Alabama	26	15		2		4	12	7	23		1	
Arkansas	14	27	2				11		22		6	4
California	29	88	4	2	1		35	15	67	4		3
Colorado	8	13	1	1	1		11	1	12			
Connecticut	1	16					2	6	7		2	
Delaware	3						2					1
Georgia	28	19				1	28	1	17			1
Idaho	4	16	5	2			7	1	19			
Illinois	60	24	10	3		1	25	12	41	2	5	12
Indiana	37	51	5	1		2	10	32	35		16	1
Iowa	11	37	4	4		1	12	1	41			2
Kansas	16	13		2			4	2	15			10
Kentucky	42	14	1	3		2	9		41			10
Louisiana	25	18					20		18			5
Maine	16	31	1			2	23		24	1		1
Maryland	6	1	1				1	1	6			
Massachusetts	3	13					6	2	5		3	
Michigan	82	78	4	6		2	41	2	53		58	16
Minnesota	28	44	8	1		10	8	10	62			1
Mississippi	12	11	2			5	8		15			2
Missouri	64	41	5	4			20		88			6
Montana	4	4	2			1	8		2			
Nebraska	3	9							12			
Nevada	10	17	1		1		11	4	10	1	1	2
New Hampshire		6		1			1		6			
New Jersey		2				4			1			1
New Mexico	9	2		1			7		2			3
New York	22	12				3	5	2	22		5	
North Carolina	25	25	3		2	4	12	1	31		10	1
North Dakota	8	8	15				18		13			
Ohio	50	48	1	1		1	16		77		3	4
Oklahoma	18	45	3			2	19		44			3
Oregon	11	36		1			23		24			
Pennsylvania	12	28				1	16		19		5	
Rhode Island		2							1		1	
South Carolina	20	9	3				9		18			5
South Dakota	4	4	1				1		8			
Tennessee	42	18	3	3		1	25		32			9
Texas	59	24	16	1			39	2	43		3	13
Utah	7	6	7				7		13			
Vermont				1					1			
Virginia	32	106		1		2	25	1	109			4
Washington	7	22					21		8			
West Virginia	29	46				1	4	3	65			3
Wyoming	7	7					2		10	2		
Totals	894	1,056	108	41	5	50	564	106	1,182	10	119	123

TABLE 3 Population Distribution of Points Losing Intercity Bus Service During the Year Following Enactment of the BRRA (7)

	No. of Points by Population				
State	Less Than 1,000	1,000-2,499	2,500-9,999	10,000 and Over	Total
Alabama	17	13	17	0	47
Arkansas	34	5	4	0	43
California	87	18	13	6	124
Colorado	24	0	0	0	24
Connecticut	6	2	5	4	17
Delaware	3	0	0	0	3
Georgia	17	14	16	1	48
Idaho	20	6	1	0	27
Illinois	53	18	20	7	98
Indiana	49	20	18	9	96
Iowa	33	15	9	0	57
Kansas	15	11	4	1	31
Kentucky	33	16	9	4	62
Louisiana	27	6	7	3	43
Maine	28	8	12	2	50
Maryland	4	2	0	2	8
Massachusetts	7	1	5	3	16
Michigan	93	34	34	11	172
Minnesota	67	15	8	1	91
Mississippi	20	7	3	0	30
Missouri	92	10	8	4	114
Montana	11	0	0	0	11
Nebraska	5	6	1	0	12
Nevada	25	1	3	0	29
New Hampshire	1	3	2	1	7
New Jersey	2	1	2	1	6
New Mexico	12	0	0	0	12
New York	26	5	3	3	37
North Carolina	40	8	9	2	59
North Dakota	30	1	0	0	31
Ohio	44	16	26	15	101
Oklahoma	40	15	11	2	68
Oregon	39	3	6	0	48
Pennsylvania	22	12	5	2	41
Rhode Island	0	0	0	2	2
South Carolina	16	7	7	2	32
South Dakota	9	0	0	0	9
Tennessee	41	11	13	2	67
Texas	71	18	9	2	100
Utah	16	1	2	1	20
Vermont	0	0	1	0	1
Virginia	123	5	10	3	141
Washington	22	4	3	0	29
West Virginia	49	15	9	3	76
Wyoming	12	1	0	1	14
Totals	1,385	354	315	100	2,154

Revenue and Cost for Services Discontinued

The study commission asked Greyhound and Trailways to supply the same cost and revenue information used in discontinuance proceedings at the state level. Table 4 (7, Appendix C) presents a summary by state of the revenues and costs associated with the route segments proposed for discontinuance. The figures in Table 4 are derived from the data supplied by the carriers, which presented the available information by route segment for each state. It should be noted that cost and revenue data were available for only some of the route segments at issue, because the carriers apparently developed and provided such information only when requested by state regulatory authorities or for presentation to the ICC in appeals of state decisions. The states did not request such information in every case, often focusing only on the route segments with the highest ridership or the most public response in the hearing process. If the sample of route segments for which data are available is biased, the bias is likely to be toward the inclusion of the most viable of the route segments for which the carriers sought discontinuance.

In a number of states, the disputes over proposed discontinuances focused on the method employed by the carriers, primarily Greyhound, to determine the costs and revenues associated with the route segments being proposed for abandonment. Much of the concern stemmed from Greyhound's use of a one-week or two-week ticket and bus bill sample to generate annual revenue figures, expanding the sample result by a factor relating the sales during that period to sales for an entire year.

Other state contentions about revenue and cost data included assertions that carriers had filed schedule changes that made their service inconvenient to users just before the sampling period, thus leading to an understatement of potential revenues. Also, a number of states requested information from carriers on statewide revenues and costs as relevant to discontinuance proceedings. The ICC examined these contentions as state decisions were appealed and found the methods used by the carriers to be reasonable and within the regulations implementing the BRRA.

The revenue and cost statements are the best available evidence of bus use at abandoned points, because data on ridership and package express shipments are not available. A review of the revenue figures in Table 4 clearly shows that both passenger and package express revenues on abandoned routes were extremely low; there was no estimated revenue in many cases. Even if the methods used by the car-

TABLE 4 Revenues and Costs Associated with Service to Points Losing Intercity Bus Service During the Year Following Enactment of the BRRA (7)

State	Revenues ($)	Variable Costs ($)	Loss on Variable Costs ($)	Fully Allocated Costs ($)	Loss on Fully Allocated Costs ($)
Alabama	121,060	770,523	649,192	1,539,400	1,418,339
California	38,122	101,351	63,229	203,704	165,582
Georgia	148,416	1,937,646	1,789,230	3,908,249	3,759,833
Illinois	47,574	230,118	182,544	431,925	384,351
Indiana	56,550	391,230	334,680	782,893	726,343
Iowa	24,867	215,793	199,392		
Kansas	18,458	47,954	29,496	93,690	75,232
Kentucky	181,956	1,005,842	823,886		
Maine	6,639	174,834	168,195	352,910	346,271
Minnesota	126,656	478,104	351,448	940,273	777,617
Missouri	57,053	74,052	16,999	137,147	80,094
Nebraska	1,880	49,243	47,363	98,621	96,741
New York	128,366	526,560	398,194	1,049,332	920,966
North Carolina	82,543	339,302	256,759	672,718	590,175
Ohio	318,759	655,127	336,368	1,100,034	781,275
Oklahoma	168,707	219,979	51,272	421,481	252,774
Oregon	60,823	200,341	139,518	369,847	309,024
Pennsylvania	95,298	223,641	128,343	437,171	341,873
Tennessee	410,180	1,180,985	770,805	2,316,418	1,906,238
Wyoming	11,344	13,698	2,354		
Totals	2,105,351	8,836,323	6,739,267	14,819,813	12,932,728

riers to estimate revenues were in error by several hundred percent, most of the abandoned route segments would not have come close to covering the carriers' variable costs of providing the discontinued services. It appears, therefore, that the carriers have been heavily cross-subsidizing the routes they are now abandoning, losing nearly $7 million per year as compared with their variable costs. The carriers' projected losses are much higher, of course, when revenues are compared with fully allocated costs; the amount rises to roughly $13 million.

The lack of revenues associated with the routes abandoned suggests that, to date, the carriers have been dropping their most unprofitable route segments. Although it is probable that many of the carriers' remaining routes would also be considered unprofitable if examined individually, the carriers can be expected to continue serving those routes, which feed the trunk systems and therefore contribute to overall system profitability. Hence it does not appear that there will be a second wave of abandonments to follow the one that took place immediately after enactment of the BRRA. Representatives of both major carrier systems have stated that in the future they plan to abandon additional routes only on an incremental basis.

Also, although some individuals will suffer a loss of bus service, the number of such users is very small, and in many cases no users will be affected. Those who live at abandoned points will lose convenient access to intercity bus services, but because they had not been using the available bus service, the impact of that loss is likely to be negligible in most cases. The availability of resources saved to the bus companies for use elsewhere may well benefit the majority of bus passengers.

THE IMPACT OF NEW ENTRY

The BRRA substantially changed the policies and procedures of the ICC regarding new entry. The primary change was replacement of the former public convenience and necessity standard for new applicants with one of public interest [Sec. 6 (b)]. The burden of proof in an application for new authority now shifts from the carrier requesting new authority to those protesting it, and the grounds for protest have been narrowed considerably. In the past, competitors could stall a new entrant indefinitely by filing a protest that required rebuttal by the entrant. In order to avert a new entry, protestants themselves must now provide evidence that the new service is contrary to the public interest. It is now to be presumed that increased competition will benefit the public unless proven otherwise. In addition, the BRRA now enables carriers to apply directly to the ICC for both interstate and intrastate authority, for intrastate authority only, or for removal of state operating authority subject only to a show of fitness. All of these changes have the effect of opening entry into the bus industry.

Unfortunately, it is yet too early to determine precisely what the overall impact of new entry will eventually be. In part this is because firms responding to the regulatory reforms enacted in the BRRA are more likely to utilize the exit provisions to reduce losses before they turn to the opportunities presented by relaxed entry standards. In addition, the procedures for exit have a number of well-defined steps, each with mandated time limits, whereas the entry provisions offer more possibilities for delay as protestants present their cases. Even after a carrier receives new authority, management may take some time to arrange to operate the new service, whereas it may not require very much time at all to end a service. In view of this, any assessment at this time of the bus industry's response to the entry reforms enacted in BRRA is preliminary. The same must be said for conclusions regarding the impact of industry actions on the bus-riding public.

Applications Filed Since Enactment of the BRRA

As might be expected, the number of applications for new operating authority has increased greatly. According to a Greyhound compilation (W.L. McCracken, Greyhound Bus Lines, Inc., Oct. 19, 1983, unpublished data) as of October 10, 1983, 1,706 applications for charter authority had been filed since enactment of the BRRA, 764 by existing firms and 942 by first-time applicants. The filing of charter applications has increased 511 percent over the previous 5-year average. Regular-route applications during the same period totaled 225, an increase of

275 percent over the average of the 5 previous years. The predominance of charter applications is not surprising given both the perceived and actual higher profitability of charter and special operations. The increase in charter applications is certain to drive down charter fares, a development that will benefit the majority of bus passengers (American Bus Association, Nov. 1983, unpublished data).

Regular-Route Applications by Type and Mileage

The 225 applications for regular-route authority embody requests to operate a total of 46,686 route miles. Not all of these applications have been granted nor have all those granted been implemented. Nevertheless, the interest of the carriers in providing new services is apparent.

Table 5 lists the type of authority sought by carrier grouping. As can be seen, the majority of applications (153) and route miles (38,733) are for both combined interstate and intrastate authority and removal of intrastate operating restrictions. Independent carriers not affiliated with either the Greyhound or the Trailways systems account for most of the applications, 63.5 percent, and slightly more than 50 percent of the route miles. Eight applications, representing 1.7 percent of the route mileage, are for fitness-only authority, indicating that carriers have thus far done little to extend service to places that do not already have it or to those that are losing their last service. The likely reason is that such places have not shown the ability to support intercity bus service.

Despite the lack of fitness-only applications, it appears that the carriers are interested in regular-route intercity services, and not just those services to casinos and airports or for long-distance commuters (mainly to New York City). In Table 6, 71 percent of the applications, or 87 percent of the route miles, are for service that is apparently intercity in nature, whereas 29 percent of the applications, or 13 percent of the route miles, are for casino, commuter, or airport services. These categorizations by type of service sought are based on the abbreviated general route descriptions and may include services in each category that are intercity, although they serve another more specialized function as well.

Although the overall picture could be clearer, one development is evident. There will be increased competition on routes between large population centers. These improvements will not be confined just to the largest cities as was the case with airlines.

TABLE 5 Regular-Route Authority Applications by Carrier Group During the Year Following Enactment of the BRRA

	Carrier Group				
Type of Authority	Greyhound	Trailways	NTBS	Independent	Total
Interstate and intrastate					
Applications	13	16	26	66	121
Route miles	2,078	4,872	6,820	15,799	29,420
Interstate only					
Applications	0	4	3	52	59
Route miles	0	707	382	5,929	7,018
Restriction removal					
Applications	–[a]	12	3	20	35
Route miles	3,249	3,756	194	2,114	9,313
Fitness only					
Applications	0	1	2	5	8
Route miles	0	16	491	279	786
Totals					
Applications	13	33	36[b]	143	225[b]
Route miles	5,327	9,351	7,887	24,121	46,686

Source: W.L. McCracken, Greyhound Lines, Inc., Oct. 19, 1983, unpublished data.
Note: NTBS = National Trailways Bus System, independent carrier not affiliated with Trailways, Inc.
[a]Restriction removal applications were included with interstate and intrastate applications.
[b]Includes two applications that were not classified.

TABLE 6 Type of Service Sought by Regular-Route Applications During the Year Following Enactment of the BRRA

	Carrier Group				
Type of Service	Greyhound	Trailways	NTBS	Independent	Total
Intercity					
Applications	13	33	35	79	160
Route miles	5,327	9,351	7,888	18,045	40,611
Atlantic City					
Applications	0	0	0	20	20
Route miles	0	0	0	3,627	3,627
Commuter					
Applications	0	0	0	29	29
Route miles	0	0	0	1,246	1,246
Airport					
Applications	0	0	0	16	16
Route miles	0	0	0	1,202	1,202
Totals					
Applications	13	33	35	144	225
Route miles	5,327	9,351	7,888	24,120	46,686

Source: W.L. McCracken, Greyhound Lines, Inc., Oct. 19, 1983, unpublished data.

Service improvements can also be expected in metropolitan areas in the form of more schedule options, newer equipment, and upgraded terminal facilities brought on by the increase in competition and by availability of revenue that was previously used to subsidize unprofitable markets. Consequently, urban residents, who constitute approximately 70 percent of the intercity bus travelers, should soon see a noticeable increase in the quantity and quality of the bus service that they receive.

Applications for Replacement Service

It is difficult to determine the extent to which applications for authority represent replacement services to points that have been abandoned by another carrier. The applications themselves, with the exception of the fitness-only applications, do not consistently state whether the services they propose would replace services previously offered by other carriers. The ICC, as part of its survey on terminal ownership, asked carriers to list points to which they had restored service, which provided some information on the extent of replacement services. The AASHTO/NARUC survey of states also included a question on replacement service, and some carrier responses to study commission information requests listed instances of replacement service. This information has been used to construct Table 7, in which the points known to be receiving replacement service are listed by state, with both the previous and the replacement carrier shown. Table 7 is illustrative, rather than exhaustive. It shows that in some cases lower-cost regional carriers may see opportunities in routes abandoned by the major carriers, though interest thus far has been limited. Given the extremely poor revenues of many of the routes for which the larger carriers are seeking discontinuance, it would not be surprising if even low-cost carriers could not see themselves as being able to serve these routes profitably.

Effect of Entry on Service to Small Communities

A contention of those opposing relaxed entry standards has been that service to small communities will suffer as a result of losing cross-subsidies from former monopoly routes now subject to competition. This argument arose during the debate over the BRRA (9). It was raised again by the protestants in recent Greyhound application proceedings [Docket No. MC-1515 (Sub-324, 325, 326, and 327), filed January 1983]. Greyhound sought certificates to transport passengers over 147 regular routes. On 29 of those routes, Greyhound was opposed by various protestants, many of whom contended that granting Greyhound authority to operate over the routes at issue would result in such a large diversion of traffic and consequent loss of revenue that they would be forced to reduce service to small communities. Trailways, Inc., protested the Greyhound applications, stating in part [verified statement of M. Myers in Protest of Trailways, Inc., in the Matter of Greyhound Bus Lines, Docket No. MC-1515 (Sub-324), filed March 31, 1983]: "If, however, Greyhound traffic diversions from a grant of new service requests contained in these applications cause the magnitude of losses that I have projected, then Trailways will have no alternative but to eliminate service to many small communities."

Similarly, on behalf of the independent carriers in the National Trailways Bus System (NTBS), Trailways, Inc. stated that these firms, which "are uniquely oriented to small and rural communities," would also be forced to reduce or eliminate marginally profitable rural services. A number of the other independent carriers raised the same issue in the various proceedings in this case.

This argument was dismissed by the ICC for lack of evidence. The ICC found that it is not specifically shown that the service to any small community will need to be reduced by the protestants, nor is it shown that replacement service is unavailable from new carriers that may emerge to meet passenger needs abandoned by applicant and protestants [Docket No. MC-1515 (Sub-324)]. The ICC concluded that granting the Greyhound applications would not seriously impair service to small communities or commuter bus operations.

The contention that service to small communities will be harmed by new entry depends on the assump-

TABLE 7 Examples of Replacement Service by State During the Year Following Enactment of the BRRA

State	Previous Carrier	New Carrier	Source of Data	No. of Points Receiving Replacement Service
Alabama	Trailways	AAA Transport	AASHTO/Trailways	7
Arkansas	Trailways	Jefferson	Trailways	1
Idaho	Empire Lines	Greyhound	AASHTO	2
Iowa	Missouri Transit	Mo-Tran	AASHTO	24
	Midwest Coaches	Jack Rabbit	AASHTO	9
Kansas	Trailways	Trans State Trailways	Trailways	13
	Trailways	Viking Trailways	Trailways	1
	Trailways	KG Lines	Trailways	2
Maine	–[a]	Bangor and Aroostock	ICC survey	1
Maryland	Baltimore-Solomons Bus Lines	Charter Bus	AASHTO	2
Michigan	Greyhound	Tower Bus	AASHTO	3
New Jersey	–[a]	De Camp Bus	ICC survey	4
	Trailways	Fullington Trailways	Trailways	1
New York	Trailways	Greyhound	ICC survey	4
North Carolina	Trailways	Trailways Southeastern	Trailways	3
Oregon	Pacific Trailways	Willamette Valley Stage Lines	Trailways	5
Pennsylvania	Trailways	Susquehanna Trailways	Trailways	8
Virginia	Trailways	James River	ICC survey	1
	Greyhound	Piedmont Coach	ICC survey	1
Washington	Greyhound	Bremerton-Tacoma Stages	ICC survey	3
South Dakota	Midwest Coaches	Jack Rabbit American	AASHTO	1
Wisconsin	Greyhound	American Trailways	AASHTO	5
	Greyhound	Wisconsin-Michigan Coaches	AASHTO	13
Total				114

[a]Previous carrier not listed in survey.

tion that intraservice cross-subsidies exist and should be continued. The issue in this case is cross-subsidies from a profitable route to an unprofitable one rather than cross-subsidies from interstate to intrastate services or from charter to special services to regular-route service. Obviously, both revenues and costs vary from route to route, and some routes are more profitable than others. Under the exit provisions of the BRRA, firms are essentially free to abandon services when variable costs exceed revenues. Sound management practices should lead a firm to drop such service regardless of new entry on other routes. It would not be sensible, however, for a firm to drop service on a marginally profitable route in response to a loss of profits on a high-profit route, because this would merely compound the loss. A major thrust of the BRRA, however, is the reduction or elimination of cross-subsidies between various types of service or different routes.

The study commission was unable to find any evidence that service to small communities has been or will be jeopardized by the entry of additional competitors. The larger, high-cost carriers are abandoning the most unprofitable of rural services while seeking to initiate service over routes previously closed to them by regulation. Although larger carriers may divert some revenue from smaller firms in these markets, the smaller firms have the advantage of lower costs, which will allow them to continue rural services for which there is little competition from the larger firms. Smaller firms are not likely to eliminate even marginally profitable rural service in response to reduced profits on their better routes.

SUMMARY

The evidence presented to the study commission indicates that the BRRA will have a negative effect on very few people. Although witnesses believed that attention to the problems of those few is important, they agreed that the solution does not lie in continued cross-subsidization and forced service on unprofitable routes.

The groups affected negatively by the BRRA include intrastate passengers, who will in the future pay fares more representative of the true costs of providing service, and residents of or visitors to communities that lose convenient access to intercity bus service. However, the magnitude of the hardships imposed on these individuals will not approach the benefits accruing to most intercity bus riders. Passengers traveling in the larger markets will pay lower fares for better service. New competition between existing bus companies will result in downward pressure on fares, especially those high fares previously charged in captive markets. Charter fares will drop, and passengers will be offered more service options. The remedies provided in the BRRA will also improve the financial performance of most intercity bus companies. This increased financial viability will not be a boon strictly to the intercity bus industry. Increased earnings will enable carriers to compete more effectively for funds with which to maintain a fleet that attracts existing and potential passengers.

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Abridgment

Intercity Bus Deregulation: The Impact on Urban and Rural Public Transportation Systems in the Provision of Intercity Bus Feeder Service

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ABSTRACT

The impact of the Bus Regulatory Reform Act of 1982 on urban and rural transportation systems in requiring these systems to provide intercity bus feeder service is analyzed. It is concluded that requiring these systems to provide such feeder service will generally be beneficial to these systems if they do not have to be redesigned. If redesign is necessary to accommodate this type of feeder service, these urban and rural systems will probably not be an effective means of maintaining access for a given community to intercity bus service. Rather than subsidized intercity bus feeder service, it will be more effective for government to subsidize intercity bus service to be provided by an intercity bus carrier.

With the passage of the Motor Carrier Act of 1935, U.S. intercity bus carriers engaged in interstate commerce were placed under the jurisdiction of the Interstate Commerce Commission (ICC) and were subjected to ICC price, entry, service, and financial regulations. Under the ICC's interpretation of the act, entry by new intercity bus carriers and expansions of new routes (other than through merger or acquisition) by existing carriers were highly restricted. Also, intercity bus carriers faced little intramodal price competition. Because of financial difficulties incurred in the 1970s arising from intermodal competition, the intercity bus carrier industry by the late 1970s began to petition for economic regulatory reform in order to have the flexibility to compete in the marketplace as well as to promote operating efficiency. In September 1982, Congress enacted the Bus Regulatory Reform Act (BRRA) (P.L. 97-261, 96 Stat. 1104), which substantially reduced entry and exit controls at both the federal and state levels and prepared the way for complete deregulation of intercity bus rates (1-3).

The impact of the BRRA on the intercity bus industry (passengers and freight) has been well documented (4-6). However, there is an important aspect of the BRRA that has received little or no attention: its impact on urban and rural public transportation systems. The BRRA allowed established carriers to abandon regular-route intercity bus service in many sparsely populated communities. Consequently, urban and rural public transportation systems in many of these communities have had to serve increasingly as intercity bus feeder systems to transport individuals to distant intercity bus stops. The purpose of this paper is to analyze the impact of requiring these urban and rural public transportation systems to provide such intercity bus feeder service.

OVERVIEW AND BACKGROUND

The BRRA represented the first significant change in intercity bus regulation since the Motor Carrier Act of 1935. Similar to prior legislation affecting truck and air transportation, the objective of the act is to deregulate intercity bus transportation in order to substitute competitive market forces for regulatory decree in the determination of fares and schedules. By removing regulatory barriers to entry into and exit from profitable and unprofitable routes, the major provisions of the act are directed toward granting bus companies the flexibility to rationalize their route structures. Rather than being required to prove that service is necessary, future entrants will basically be judged by a "fitness only" criterion. Exit from unprofitable routes will be permitted if the carrier can demonstrate that the variable cost of service exceeds revenues (7,p.39).

In addition to the prevailing trend toward deregulation, passage of the BRRA was also motivated by the past financial performance of intercity bus firms. From 1980 to 1982, the net operating income of all carriers decreased 56.8 percent, falling from $132 million to $57 million annually (5,p.4). This decline in revenues is directly attributable to decreased demand stemming from increased intermodal competition. The one competitive edge traditionally held by the bus industry, low fares, is rapidly being eroded by stabilized gasoline prices and increased price competition from the newly deregulated airlines. This competition has limited the demand for intercity bus service primarily to the young, the elderly, and low-income segments of the population in general.

Regulation of the intercity bus industry has been conducted at two levels of government. At the federal level, the ICC approves fares, exit, and entry along interstate routes. Regulation on intrastate routes and intrastate portions of interstate routes is the responsibility of state commissions. Historically, state agencies have enforced a lower fare structure and have been less willing to approve requests to abandon service along unprofitable routes than the ICC. As a result, it has often been charged that the higher fares on interstate routes have necessarily cross-subsidized nonprofitable local routes (5,p.71). This system of dual regulation created a unique problem in the deregulation of the industry.

Deregulation at the federal level alone would not have been sufficient to promote workable competition. As long as state commissions could deny requests for abandonment or higher fares, the interstate trunk lines would have needed to continue to produce higher fare revenues in order to make up for losses experienced on unprofitable routes that could not be abandoned. Existing carriers were placed at a financial disadvantage when competing with new interstate entrants that are not required to cross-subsidize unprofitable routes. To avoid such situations, the BRRA gives the ICC power to preempt state regulatory decisions that deny higher fares or requests to abandon unprofitable routes.

As with other recently deregulated industries, the full effect of the BRRA on intercity bus service will not be known for some time. Of particular importance to this paper is the impact of BRRA's exit provisions on the intercity bus industry. The act has accelerated the historical trend toward discontinuance of regular-route service to many sparsely populated communities. The ICC notes that between 1972 and 1980 (before the BRRA), approximately 1,800 communities lost all intercity bus service. This figure represents about 10 percent of the total number of communities receiving intercity bus service in 1972. In January 1984, the ICC reported that in the one year since enactment of the BRRA, 1,322 named places had been eliminated from time schedules (5,p.80). In May 1984, the Motor Carrier Ratemaking Study Commission (MCRSC) reported that 2,154 points with a total population of 4,292,412 had been abandoned as a result of the BRRA (4,pp.350,356).

According to the MCRSC study (4), the average population of points losing service was slightly less than 2,000. The obvious implication is that low-density regions are bearing the brunt of deregulation. It has often been stated, however, that this was not an unintended result of the BRRA. It is interesting to note that most discontinuances have been requested by the dominant carrier, Greyhound. More than 1,100 of the 1,322 places eliminated from scheduled service in 1983 (according to the ICC) had been receiving service from Greyhound. Another 82 discontinuances were attributed to service cancellations by Trailways and its affiliate carriers, and only 125 discontinuances were reported by all other carriers. Apparently, the major carriers are continuing to consolidate most of their activity along trunk lines between major population centers, leaving smaller communities to be serviced either by smaller or by no intercity bus carriers at all.

Communities that lose intercity regular-route bus service may be classified into three groups:

1. Communities that retain alternative intercity bus service on a different carrier,
2. Communities within larger urban areas that have lost all direct scheduled intercity bus service, but where the larger urban area retains service at some other point or points, and
3. Communities that are self-contained (or not a part of a larger urban area) and that have lost all direct scheduled intercity bus service.

Communities of type 2 typically have an urban public transit system that provides service between the community and the larger urban area. This public transit system can act as a feeder system in transporting community intercity bus passengers to intercity bus service points in the larger urban area. Communities of type 3 typically have no public transportation system that provides service to a neighboring community where intercity bus service is still available.

In an early survey (4,pp.80-83) by the ICC of communities where regular-route intercity bus service had been dropped or was proposed to be dropped, communities of types 1, 2, and 3 constituted 19.2, 20.8, and 60 percent, respectively, of the total number of these communities. Obviously, the severity of the loss of intercity regular-route bus service was the greatest for type 3 communities. This follows because they are less likely to have a public transportation system to provide intercity bus feeder service to distant communities and because they constitute the largest number of communities losing intercity bus service. Furthermore, because intercity bus passengers tend to have incomes that are lower than the national average, intercity bus passengers in type 2 and 3 communities are less likely to have access to the private automobile as a means of reaching intercity bus service points in neighboring communities. Hence, if intercity regular-route bus service is to remain an alternative means of transportation for individuals in type 2 and 3 communities, not only will greater pressure be placed on existing public transportation systems to provide intercity bus feeder service (as found in communities of type 2) but also new rural public transportation systems will be established in communities of type 3.

IMPACT OF INTERCITY BUS FEEDER SERVICE ON PUBLIC TRANSPORTATION SYSTEMS

Public transportation systems are defined in this paper as government-owned or government-financed systems (or firms) that provide local for-hire passenger service in urban and rural areas. Only public transportation systems are considered in this study because they include an overwhelming majority of all local systems. However, the results of the study can readily be generalized to apply to private systems.

Urban public transportation systems may provide transit as well as paratransit services. Rural public transportation systems primarily provide only paratransit services. Transit service is scheduled, fixed-route passenger service such as scheduled, fixed-route bus, subway, and streetcar service. Paratransit service is that provided within urban and rural areas other than the scheduled, fixed-route service.

Transit Service

As stated in the foregoing, if intercity bus service is lost to communities of types 2 and 3, pressure will be placed on urban and rural public transportation systems in these communities to provide intercity bus feeder service to intercity bus stops in distant communities. For communities of type 2, pressure generally will be placed on urban public transportation firms to provide feeder service; for communities of type 3, the pressure will be placed on rural public transportation systems. If fixed-route transit that connects with intercity bus stops in distant communities is already in place and if the demand for feeder service is less than the unused vehicle capacity on these routes, little or no burden will be placed on the public transportation system to provide service.

If the feeder demand exceeds the unused vehicle capacity on the fixed route or routes, the transportation system will have to add additional vehicles. However, there will be a benefit to existing riders as well as to those of the feeder route or routes in that with the additional capacity, the frequency of service will increase (or the headway time between vehicles will decrease). With an increase in frequency of service, passenger waiting time on average along the route will decrease and thus improve the quality of service. The improvement in quality of service, in turn, would be expected to further increase ridership along the route. Thus, if transit fixed routes are already in place that would serve as feeder routes to an intercity bus stop, the impact of the feeder ridership on the routes will generate a net benefit to the transportation system in that they would contribute to the cost of formerly unused vehicle capacity (and therefore decrease the subsidy required if they were previously subsidized) or lead to an improvement in service (i.e., an increase in the frequency of service). However, if public transportation management does not increase vehicle capacity when feeder demand exceeds unused capacity, quality of service along the route will deteriorate because of the overcrowding of vehicles.

If fixed-route transit is not currently available to feed passengers into intercity bus stops, the transit system will probably not establish a new fixed route to provide such service. This follows, because surveys generally indicate that intercity bus travel is an infrequent event for most users.

Paratransit Service

Paratransit has generally been classified as either demand-responsive or commuter services. Demand-responsive services are characterized as being unscheduled, such as exclusive-ride taxi and dial-a-ride services. Exclusive-ride taxi service refers to that service where the passenger has exclusive use of the vehicle. Dial-a-ride includes shared-ride taxi and demand-responsive bus services where a shared vehicle provides door-to-door service on demand to a number of passengers with different origins and destinations. Commuter paratransit are those forms of paratransit such as carpools and subscription buses that follow a fixed time schedule but a variable route. These services are referred to as commuter (or ridesharing) paratransit services, because they are primarily used for commuter or work trips. Transit and paratransit services are discussed in more detail elsewhere (8).

Dial-a-ride has been utilized by urban transit systems primarily as a feeder service or as a substitute for costly fixed-route, scheduled transit service. It has also been employed in urban areas to transport the elderly and handicapped. As a feeder service for transit systems, dial-a-ride has been utilized as a collector or distributor of passengers to and from the fixed routes of transit systems. Rural public transportation systems often provide only dial-a-ride service.

Dial-a-ride paratransit represents the most plausible alternative to fixed-route transit service for providing intercity bus feeder service. Commuter paratransit services would probably not be a workable alternative, because they follow a fixed time schedule and are generally used for frequent trips.

Dial-a-ride service may be classified as many-to-many service, many-to-one cycled service, or many-to-one subscription service. Many-to-many dialaride service is one for which point-to-point service is provided anywhere within a service area. It is not ideally suited as a feeder service to a fixedroute transportation system or as an intercity bus feeder service because it attempts to satisfy diverse travel desires.

In many-to-one dial-a-ride service, passengers are picked up at their door as with many-to-many service, but all passengers are taken to a common destination (and vice versa), which may be a transfer point to fixed-route transportation service. In many-to-one cycled service, vehicles are scheduled to arrive at or leave the destination (or transfer) point at regular intervals. Vehicles are routed through the service area to drop off and pick up passengers and then return to the transfer point in time for the next scheduled cycle. Because cycle lengths can be set equal to the fixed-route's headway, many-to-one cycled service is ideally suited to be a feeder service.

Many-to-one subscription service is a more restrictive service than many-to-one cycled service in that it restricts the time of service by requiring all passengers to reserve service on a standing basis. Because subscription service implies regular ridership, a fixed (or regular) dial-a-ride route could be devised. Given that subscription service implies regular ridership, it has most frequently been utilized for work trips and thus is not ideally suited for use as an intercity bus feeder service for infrequent intercity passengers.

If a many-to-one cycled dial-a-ride service is already in place where the common destination point coincides with a transfer point to intercity bus service, and if unused vehicle capacity exists, little or no burden would be placed on the public transportation system to provide feeder service to the intercity bus stop. However, there would probably be an additional benefit to current riders as well as the intercity bus feeder riders in that their waiting and travel times to the common destination (or feeder) point would probably decrease (i.e., there would be an improvement in the quality of service). This follows, because with an increase in ridership, the origin pickup points for a given dial-a-ride vehicle are likely to be closer together. Hence, there will be less time in waiting for a vehicle and less travel time involved in reaching the common destination (or transfer point).

If the intercity bus feeder demand exceeds capacity and if additional capacity (i.e., vehicles) is added to the system, a similar improvement in the quality of service would occur. If the public transportation management does not increase capacity, the quality of service may or may not deteriorate. Specifically, as stated in the foregoing, there will be an expected improvement in quality of service from the increase in ridership. However, with demand exceeding capacity, congestion will arise in terms of longer waits for an available vehicle seat. Hence, if the negative impact of congestion on the quality of service outweighs the improvement in quality of service from greater ridership, service will deteriorate; otherwise, it will improve.

Suppose the many-to-one cycled dial-a-ride service that is already in place has a common destination point that does not coincide with the intercity bus transfer point. Further suppose that the public transportation system considers making this intercity bus transfer point a common destination point as well. If so, even with the increase in ridership (from intercity bus transfers), the dial-a-ride service will probably deteriorate (assuming that no additional vehicle capacity is added), because two common destination points have to be satisfied. Alternatively, this deterioration in service may be averted if sufficient vehicle capacity is added.

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Intercity Bus Passenger Profile

FREDERIC D. FRAVEL

ABSTRACT

The Bus Regulatory Reform Act of 1982 required the Motor Carrier Ratemaking Study Commission to assess the impact of the act on persons over the age of 60, particularly those living in rural areas and small towns. As part of that assessment, national and state surveys of bus passengers were reviewed to determine the age distribution, income, trip purpose, availability of a driver's license, availability of an automobile or truck, and means of access transportation of intercity bus passengers. The largest percentage of intercity bus passengers are young, and the next largest user group is the elderly. Most trips are taken for social or recreational reasons, including visiting family and friends and sightseeing. Bus passengers as a group have much lower median household incomes than those traveling on other modes, although the income distribution of bus passengers varies from state to state. Approximately two-thirds of all bus passengers have a driver's license, and a majority of them have a vehicle available in the household. Yet that vehicle was not available to the passenger for that trip between 47.5 and 70 percent of the time, according to three state surveys. The evidence presented indicates that although a majority of bus passengers had no private alternative for that trip, intercity bus service has only a minor role in meeting the most essential mobility needs.

As a part of the Bus Regulatory Reform Act of 1982 [P.L. 97-261, 96 Stat. 1104 (49 U.S.C.A. 10922)] Congress directed the Motor Carrier Ratemaking Study Commission to determine the impact of the act on persons over the age of 60, particularly those living in small cities and rural areas, and to assess its effect on the quality of intrastate bus services.

An important first step in the task of the study commission was to examine the current literature regarding the characteristics of bus passengers. In particular, the age distribution of the bus-riding population, the purposes for which they use bus transportation, and any significant differences between interstate and intrastate bus riders had to be known to provide a basis for any assessment of the impact of changes in service.

DEMOGRAPHIC CHARACTERISTICS

National Travel Survey

Unfortunately, there is a lack of data that would enable one to obtain a complete picture of the social, economic, and trip-making characteristics of intercity bus passengers. The National Travel survey (NTS) of the 1977 Census of Transportation (1) provides the most recent publicly available national data describing intercity bus passengers and the trips that they take. The census data have a major limitation in that only information about trips in which a traveler went to a place at least 100 miles from home and returned is included, which excludes many shorter intercity bus trips. In addition, there is no distinction between regular-route bus trips and those made on charters and tours, which may have very different ridership characteristics. Finally, the data are national, with no disaggregation into intrastate or interstate categories. However, despite these limitations the census survey data are important because of the information that is provided, as discussed in the following paragraphs.

Traveler Characteristics

As may be seen in Table 1 (1,pp.35-39), intercity bus passengers compared with those of other modes have a lower median income, are more likely to be black or of Spanish origin, and are much more likely to be female. The educational background of intercity bus passengers is very similar to that of automobile travelers, particularly those traveling with camping equipment, but much lower than that of rail or air passengers. The percentage of bus passengers whose residence was not in a Standard Metropolitan Statistical Area (SMSA) (population 50,000 or greater) is 30.25 percent, slightly less than that for automobile passengers, which is 33.59 percent for those traveling with camping equipment and 32.36 percent for those without such equipment. However, it is very different from that for rail users and air travelers, of whom 19.15 and 18.34 percent, respectively, did not reside in an SMSA.

Age Distribution

The age distribution of bus passengers also is significantly different from that of the other transport modes as may be seen in Table 2 (1,pp.35-39). Fifty percent of intercity bus passengers are 24 years of age or less, according to the census, whereas 13.36 percent are over 65. Bus passengers are either young or old, with relatively little representation from the age groups in between. Air passengers, by contrast, are drawn heavily from the middle age groups.

Trip Characteristics

The trip characteristics of bus passengers vary considerably from those of other modes, as may be seen in Table 3 (1,pp.13-22). Compared with the other common carrier modes, the trip purpose of bus passengers is most notable for the lack of business trips; instead most bus passengers are visiting friends or relatives, traveling for entertainment, and sightseeing. Even compared with automobile users traveling without camping equipment, the low level of business travel by bus is remarkable, as is the low percentage of bus trips made to attend to personal or family affairs or for medical reasons. Bus trips tend to be shorter than rail trips and much shorter than air trips, although the mean number of persons on the trip is similar for all three common carrier modes. As with the residence of trip makers, the destinations of bus travelers are more likely to not be in an SMSA than those of rail or air passengers.

Nationwide Personal Transportation Study

A second source of data describing the travel behavior of Americans is the Nationwide Personal Transportation Study (NPTS) (2,3). Conducted in 1969 and again in 1977, this survey overcomes the limitations of the NTS regarding trip length by including trips of all lengths in its survey of a sample of travelers. Unfortunately, the NPTS cannot provide any information about the use of intercity buses by persons over the age of 60, because such trips constitute only a small percentage of all travel. Of the 2,411 bus trips in the NPTS sample, only 72 are more than 30 miles long. Because persons over the age of 65 make approximately 10 percent of all bus trips (local and intercity combined), less than 10 of the bus trips in the NPTS file were made by persons in this age group, far too few from which to

TABLE 1 Traveler Characteristics *(1)*

	Mode				
	Automobile or Truck				
Characteristic	With Camping Equipment	Without Camping Equipment	Bus	Rail	Air
Median income ($)	16,081	17,136	12,996	17,927	18,975
Black or other (%)	7.88	2.41	20.52	15.96	7.84
Spanish (%)	3.74	3.81	4.79	1.38	3.90
Age					
Mean	32.00	29.50	33.20	36.50	37.50
Median	28.60	26.80	23.80	33.20	35.30
Education (%)					
Elementary	30.12	34.06	34.82	20.20	16.13
High school	42.44	42.71	42.74	30.45	36.26
College	27.44	23.22	22.44	49.35	47.67
Sex (%)					
Male	49.81	54.60	38.75	49.75	50.20
Female	50.19	45.40	61.25	50.25	49.80
Non-SMSA residence (%)	32.36	33.59	30.25	19.15	18.34

TABLE 2 Age of Traveler *(1)*

Age	Percentage by Mode: Automobile or Truck, With Camping Equipment	Automobile or Truck, Without Camping Equipment	Bus	Rail	Air
Under 18	27.84	33.05	36.27	18.55	14.32
18-24	14.10	11.91	14.12	14.14	11.88
25-34	17.56	18.19	9.56	18.88	21.72
35-44	12.18	14.14	8.09	13.82	15.83
45-54	11.93	11.40	9.26	12.09	15.38
55-64	9.43	7.58	9.33	11.91	11.86
65 and over	6.96	3.73	13.36	10.60	9.02

draw any meaningful conclusions (S. Liss, FHWA, Nov. 29, 1983, unpublished data).

Nevertheless, the NPTS provides data on the degree to which persons over the age of 60 use different transportation modes. In Table 4 the data indicate that for all trips, local and intercity, persons in this age group rely on the automobile and truck for a greater percentage of trips than do all persons combined. Note, however, that bus and streetcar use by this age group is also somewhat greater than that for all persons, although it still is a small percentage of all trips. Bus and streetcar use by this population segment declined over the period from 1969 to 1977, whereas automobile and truck use increased. Although these figures obviously reflect the fact that most trips included in the sample are less than 30 miles in length, they illustrate that most persons over the age of 60 continue to rely on the private automobile to meet mobility needs and that for this group the trend is toward increased automobile use and reduced dependence on the bus and streetcar.

The 1969 NPTS also provided data on differences in travel between persons living in unincorporated areas and those living in incorporated places. Persons aged 65 to 69 living in unincorporated areas traveled 55 percent of the time as drivers of automobiles, percent of the time as passengers in automobiles, and about 1 percent of the time by bus. Those 70 and over traveled 51 percent of the time as drivers of automobiles, 41 percent as passengers in automobiles, and less than 1 percent of the time by bus. The same study shows that in incorporated areas, persons aged 65 to 69 traveled 55 percent of the time as drivers of automobiles, 31 percent of the time as passengers in automobiles, 6 percent of the time by bus, and 1 percent of the time by small truck. The group aged 70 and older traveled 50 percent of the time as drivers of automobiles, 41 percent as passengers in automobiles, 1 percent by small truck, and 5 percent by bus.

STATE SURVEYS

In addition to the NTS and NPTS, information about bus riders is available from a number of studies performed by or on behalf of state governments concerned about the future of intercity bus services. Intercity bus studies that include surveys of bus users are available from Indiana (4); Iowa (5); Georgia (6); Michigan (7); New Mexico (8); North Carolina (9); Oregon (10,11); Tennessee (12); Texas (13); Washington, Oregon, and Idaho (14); and Wisconsin (15). The data from these surveys are perhaps more useful than the national information because none of the states restricted the trip length for which they collected data; instead, they collected data from all persons using buses within that particular state. All the state surveys deal exclusively with regular-route scheduled service. Beyond these few similarities, the state surveys vary considerably in the types of questions asked, the response categories, and the method of data collection. However, it is possible to present a summary of these surveys to illustrate a number of facts about the users of intercity buses and to compare them with the national data already described.

Age

The NTS and state surveys both show that generally bus passengers are either young or old, with relatively little representation from the age groups in the middle. The elderly are not the largest group of intercity bus riders nor are they found on intercity buses in numbers disproportionate to their representation in the general population. Younger riders compose the largest percentage of all bus riders. Table 5 presents the age distributions of bus riders from 10 state surveys. Each state used slightly different age categories to collect the data, but they support the national results. Relatively few bus riders are drawn from middle age groups; most are either young or old. Young riders make up a larger percentage than do the older age groups.

TABLE 3 Trip Characteristics *(1)*

Characteristic	Mode: Automobile or Truck, With Camping Equipment	Automobile or Truck, Without Camping Equipment	Bus	Rail	Air
Trip purpose (% household trips)					
Visit relatives or friends	35.69	18.72	23.62	36.02	22.02
Business	21.90	5.76	4.56	37.16	50.69
Convention	1.83	1.13	3.89	2.32	4.11
Outdoor recreation	11.69	45.80	10.69	2.27	2.67
Entertainment	7.09	8.77	16.79	5.77	5.47
Sightseeing	3.77	9.08	13.85	4.49	4.73
Personal, family, or medical affairs	12.99	5.70	7.83	10.48	7.09
Shopping	0.82	0.24	0.80	0.36	0.06
Other	4.22	4.80	17.95	1.11	3.17
Round-trip distance (miles)					
Mean	487	710	585	878	1,845
Median	338	400	396	456	1,586
Destination not in SMSA (%)	45.70	61.65	29.62	10.12	13.11
Mean no. of persons on trip	1.8	2.2	1.2	1.3	1.2

TABLE 4 Trips by Persons in Selected Age Groups by Means of Transportation, 1969 and 1977 *(2,3)*

Mode	All Persons (%)	Age Group of Tripmaker (%) 60-64	65-69	70 or More
Automobile and truck				
1977	92.2	95.7	94.6	94.6
1969	90.7	91.7	93.2	93.8
Bus and streetcar				
1977	2.3	2.4	4.0	3.5
1969	2.7	4.6	4.6	4.0

Note: Total percentages do not sum to 100.0 because other modes have been omitted from this summary table.

TABLE 5 Age of Bus Passengers

Age Group	Percentage of Total
Georgia: 1980 *(6,p.148)*	
Up to 17	7.0 (8.0)[a]
18-29	47.4 (43.0)
30-39	11.2 (10.4)
40-49	11.0 (12.7)
50-59	8.7 (10.4)
60-64	3.3 (5.2)
65 and over	11.4 (10.4)
Indiana: 1980 *(4,p.37)*	
Up to 17	2.5
18-24	24.7
25-34	17.0
35-44	11.0
45-54	13.4
55-64	13.7
65 and over	17.7
Michigan: 1977 *(7,p.17)*	
Up to 18	6.1
19-29	46.9
30-39	11.2
40-49	9.2
50-64	15.3
65 and over	11.3
New Mexico: 1980 *(8,pp.35,59)*	
Up to 18	8.6 (14.6)[b]
18-24	22.8 (25.6)
25-34	19.7 (22.0)
35-44	10.2 (7.9)
45-54	7.2 (9.1)
55-64	11.6 (9.8)
65 and over	13.9 (10.1)
No response	6.0 (0.9)
North Carolina: 1982 *(9,p.7)*	
Up to 20	23
21-29	31
30-39	16
40-49	9
50-59	10
60-and over	11
Oregon: 1976 *(11,p.13)*	
Up to 16	10
16-44	52
(16-35)	9
45-65	20
65 and over	18
Tennessee: 1981 *(12,p.56)*	
Up to 16	7.1
16-25	38.0
26-35	17.5
36-45	10.9
46-55	9.2
56-65	9.4
65 and over	8.0
Texas: 1981 *(13,p.116)*	
Up to 18	7.7[c]
18-29	42.7
30-39	15.1
40-49	9.5
50-64	15.0
65 and over	10.0
Washington, Oregon, Idaho: 1982 *(14,pp.3-9)*	
Up to 16	9.5
16-34	41.0
35-44	7.0
45-60	12.0
60 and over	30.6
Wisconsin: 1976 *(15,p.19)*	
Up to 18	14.1
18-24	32.0
25-34	13.2
35-44	6.5
45-54	7.5
55-64	11.2
65 and over	10.2

[a]Figures in parentheses are percentage of intrastate passengers only.
[b]Figures in parentheses are percentage of New Mexico residents.
[c]Only those aged 12 and over were surveyed.

Income

Bus passengers, including persons over 60, have much lower median incomes than do passengers of other intercity transportation modes, as was seen in Table 1, which presents data from the NTS. State surveys of bus passengers that provide income data also show that many bus riders have very low household incomes. Table 6 provides the distribution of household income for bus passengers surveyed in Texas; Oregon; Michigan; Georgia; New Mexico; Wisconsin; Washington; Oregon, and Idaho; Indiana; and Tennessee. The state studies each used different income range categories. However, it is possible to conclude that there is a substantial percentage of bus riders with household incomes below $10,000, ranging from 30.8 percent in New Mexico to 60 percent in Oregon. In Michigan 37 percent had incomes less than $9,000, and in Georgia 34.7 percent were in the same category. In Tennessee 41 percent had a household income less than $7,500. Additional information concerning the income of bus passengers may exist in the market research efforts of the carriers. This information is generally considered proprietary, but Greyhound did present some summary statistics to the American Bus Association (16). These indicate that passenger characteristics may well differ by firm, because Greyhound passengers appear to have slightly higher incomes than do bus passengers generally (see Table 1). Almost 50 percent of Greyhound passengers under the age of 35 make more than $15,000 per year; 30 percent of all Greyhound passengers earn more than $20,000, of which 21 percent earn more than $25,000.

Thus, although it can be said that intercity bus riders include a disproportionate number of low-income passengers, particularly when compared with the passengers on other common carrier intercity modes, by no means do all intercity bus passengers fall into that category.

TABLE 6 Family Income of Bus Passengers

Income Range ($)	Percentage of Total
Texas: 1980 *(13,p.103)*	
0-10,000	45
10,000-20,000	33
20,000-30,000	13
30,000+	9
Oregon: 1976 *(11,p.15)*	
Less than 5,000	36
5,000-9,999	24
10,000-14,999	16
15,000+	24
Michigan: 1977 *(7,p.16)*	
Less than 2,999	13
3,000-5,999	13
6,000-8,999	11
9,000-11,999	9
12,000-14,999	10
15,000-24,999	18
25,000+	11
No response	16
Georgia: 1980 *(6,p.146)*	
Less than 2,999	4.8 (3.6)[a]
3,000-5,999	7.7 (9.6)
6,000-8,999	22.2 (25.5)
9,000-11,999	30.0 (28.3)
12,000-14,999	18.8 (19.9)
15,000-24,999	11.8 (9.6)
25,000+	4.6 (3.6)
New Mexico: 1980 *(8,pp.37,60)*	
1,000-4,999	14.1 (18.3)[b]
5,000-9,999	16.7 (20.4)
10,000-14,999	16.2 (15.2)
15,000-19,999	8.8 (12.5)
20,000-24,999	6.9 (6.4)
25,000+	9.6 (8.8)
No response	27.7 (18.3)
Wisconsin: 1976 *(15,p.21)*	
0-4,999	18.8
5,000-9,999	16.8
10,000-14,999	12.6
15,000-19,999	10.5
20,000-24,999	6.5
25,000+	8.8
No response	26.0
Washington, Oregon, Idaho: 1982 *(14,pp.3-9)*	
Less than 5,000	12.6
5,000-7,500	13.9
7,500-10,000	13.2
10,000-15,000	18.1
15,000-20,000	10.7
20,000-25,000	8.7
25,000-35,000	13.4
35,000-50,000	7.6
Over 50,000	1.8
Indiana: 1980 *(4,p.37)*	
0-5,000	33.0
5,000-10,000	25.0
10,000-20,000	22.0
20,000-30,000	12.0
30,000-40,000	3.0
40,000+	4.0
Tennessee: 1982 *(12,p.56)*	
Under 7,500	41.0
7,501-15,000	29.0
15,001-25,000	17.9
25,001-35,000	7.7
35,001+	4.3

[a]Figures in parentheses are percentage of intrastate passengers only.
[b]Figures in parentheses are percentage of New Mexico residents.

Trip Purpose

As mentioned in the discussion on the NTS (Table 3), the trip characteristics of bus passengers vary considerably from those of other modes. The state surveys of bus passengers present similar results. The major conclusion that can be drawn from the state surveys is that the most common trip purpose of bus users is to visit friends or relatives or for social or recreational purposes. Table 7 presents the percentage of bus users in each state according to their reasons for taking the surveyed trips. To provide a summary exhibit, some interpretation of category definitions was necessary; differences in wording are noted in the footnotes.

As can be seen in Table 7, the percentage of riders visiting or traveling for other social or recreational reasons is the largest category in every state; the lowest percentages occur in those states that also include "return home" as a separate category. Also of note are the low percentages of users traveling for nondiscretionary purposes. Work trips varied from 7.5 to 20.3 percent, with various categories of business ranging from 3.8 to 28.0 percent. Medical trips, often cited as a critical use of intercity bus services, range from 1.0 to 12.4 percent of all trips, depending on the state. Shopping trips constitute between only 1.2 and 3.0 percent of all trips. School trips were also a small percentage, ranging from 1.5 to 8.0 percent of the trips surveyed.

These findings generally support the NTS results, although the NTS included several categories of discretionary travel that, if combined, are even larger than the state surveys indicate, perhaps because of the charter and tour trips included in the NTS sample.

These findings are not surprising if one recognizes that essential trips for shopping, work, personal business, or medical purposes are usually local and occur frequently, perhaps even daily. In a 1980 study for the U.S. Department of Transportation (17, pp. 3-5, 3-7, and 7-12 to 7-19), the transportation alternatives available for such essential, frequent trip needs were evaluated and it was found that intercity bus service had a low potential for meeting these needs, primarily due to infrequent service and inconvenient schedules. Intercity bus services were rated as having only moderate potential for trips to visit friends and relatives and high potential for sightseeing and other recreation trips.

The survey data reviewed for this study indicate that the trip purposes given by bus passengers reflect their own similar evaluations of the potential of the intercity bus for meeting various trip needs. Most intercity bus travel does not involve essential medical, work, or shopping trips.

Access to Automobile

The information on the social, economic, and trip-making characteristics of bus passengers may lead to the hypothesis that the bus is the mode of last resort and that bus passengers have no alternatives. The NTS does not provide data concerning the availability of alternatives, but a number of states do. Several of these studies have asked bus riders whether they had a driver's license, how many automobiles and trucks were owned by the bus passenger's household, and, in a few instances, whether the trip could have been taken if bus service had not been available. The findings are summarized in Tables 8 and 9.

Note in Table 8 that approximately two-thirds of the surveyed intercity bus passengers did have a driver's license. Yet, as indicated in Table 9, in three of the states, the question of whether an automobile was available to the passenger for that trip brought a negative response 47.5 to 70 percent of the time. Given this admittedly limited evidence, it would appear that perhaps one-third of bus passengers have no choice due to lack of a driver's license or an automobile, whereas an additional percentage of bus passengers simply did not have an automobile available for that particular trip. Compared with other public transportation modes, the bus is more likely to be used by those with no option, but many passengers apparently choose to ride the bus even though they are capable of driving and have an auto or truck available in their household.

A number of the state surveys also asked bus passengers how they traveled to the bus station from their trip origin and how they got from the bus station to their final destination. The data in Table 10 indicate that for the 10 states listed, an average of 60.7 percent of surveyed bus passengers used a private automobile to get to and from the bus station. The remaining percentage is accounted for by other modes, including taxi, local city bus, walking, and other intercity bus services. Because most of the surveys were conducted in the larger termi-

TABLE 7 Trip Purpose *(4,6,7,9-15)*

Purpose	Percentage by State: Oregon	Georgia Interstate and Intrastate	Georgia Intrastate Only	Texas	North Carolina	Michigan	Wisconsin[a]	Washington, Oregon, Idaho	Indiana	Tennessee
Work	11.0	12.8	15.1	11.5	9.0	14.4	7.5	11.7	20.3	8.8
Shopping	2.0	1.2	2.4	–	3.0	1.0	1.0	1.2	3.0	–
Business	12.0[b]	12.6	12.4	–	28.0[b]	16.5	–	3.8	–	10.7
Visit friends or relatives	50.0[c]	48.9	45.4	37.7	–	48.5	33.7	36.7[d]	43.0	49.5
Vacation	–	10.4	4.0	7.3	–	6.2	9.5	22.2	16.9	18.1
Other social or recreational	11.0[e]	0.4	0.8	–	50.0	–	–	–	–	–
Medical	5.0	7.0	12.4	4.7	1.0	–	1.1	2.6	4.0	4.6
School	2.0	4.8	5.2	3.8	8.0	–	2.5	1.5	3.0	6.8
Military	16.0	–	–	–	1.0	–	–	–	–	–
Return home	–	–	–	26.4	–	–	30.7	–	–	–
Other	6.0	1.5	2.4	8.7	1.0	13.4	5.7	18.8	9.0	1.4
Move	–	–	–	–	–	–	–	1.4	–	–

[a]Wisconsin survey asked for "Activity at Destination."

[b]"Personal Business" was the actual category name in North Carolina and Oregon.

[c]"Social" was the actual category name in Oregon.

[d]Actual category was "Social."

[e]"Recreation" was the actual category name in Oregon.

TABLE 8 Availability of Driver's License Among Intercity Bus Passengers

State Surveyed	Hold Driver's License (%)	Without Driver's License (%)
Oregon *(11,p.15)*	69.0	31.0
Wisconsin *(15,p.20)*	80.3	19.7
Georgia *(6,p.148)*	66.2	33.8
North Carolina *(9,p.2)*	67.0	33.0
Texas *(13)*	75.1	24.9
Washington, Oregon, Idaho *(14,pp.3-8)*	70.0	30.0

TABLE 9 Availability of Household Automobile for Surveyed Intercity Trips

State Surveyed	Automobile Available (%)	No Automobile Available (%)
Wisconsin *(15,p.20)*	42.5	47.5
North Carolina *(9,p.2)*	30.0	70.0
Texas *(13)*	47.9	52.1
Washington, Oregon, Idaho *(14,pp.3-8)*	78.2	21.7

TABLE 10 Intercity Bus Passenger Use of Automobile to Reach the Bus *(6,p.144)*

State Surveyed	At Trip Origin (%)	At Trip Destination (%)	Combined Origin and Destination (%)
Georgia *(6,p.144)*	56.5	63.4	(60)[a]
Iowa *(5,p.62)*	-	-	73.0
Michigan *(7,p.6)*	53.0	52.0	(52.5)[a]
Oregon *(10,p.78)*	-	-	59.0
Tennessee *(12,p.56)*	-	-	62.1
North Carolina *(9,p.1)*	74.0	74.0	74.0
Wisconsin *(15,p.8)*	-	-	55.0
Texas *(13,p.116)*	68.4	68.4	68.4
Oregon *(11,p.11)*	59.0	52.0	(55.5)[a]
New Mexico *(8,p.40)*	-	-	47.5
Combined mean			60.7

Note: Data do not include taxi use.
[a]Calculated mean of percentage of automobile use at origin and at destination.

nals in each state, the automobile use figure is probably lower than it would be in smaller towns or rural areas where taxi and local bus are unavailable and where walking distances are greater due to lower population density. These results support the notion that approximately one-third of all intercity bus passengers do not have a car or a driver's license available, whereas the other two-thirds have vehicles that are not necessarily available for that intercity trip.

The lack of cross-tabulations of age and automobile availability does not permit any conclusion as to whether older Americans are more dependent on intercity bus service than other groups. However, the Indiana Intercity Bus Study found that 47 percent of elderly bus passengers could not have made a particular trip without bus service, a higher percentage than for any other age group (4). Thus, it may well be that older Americans have fewer alternatives than younger bus riders, although again the evidence is limited.

SUMMARY

The foregoing studies provide the most complete information available concerning the age distribution, trip purpose, and the availability of private automobile alternatives to intercity bus passengers. However, the published results present only incomplete evidence, because cross-tabulations of age group by trip purpose, automobile availability, SMSA, or rural residence are simply not available in the NTS, the NPTS, or the state surveys.

The evidence indicates that intercity bus service generally is not used to meet essential trip needs for work, shopping, medical, or personal business purposes. Most essential bus trips are local in nature, whereas intercity bus service is oriented toward infrequent intercity travel and thus is most often used for social or recreational purposes. For the significant percentage of persons living in rural areas who do face a transportation disadvantage, intercity bus service plays only a minor role in meeting the most essential mobility needs.

These impressions appear to be confirmed by a recent survey of residents and bus users in eight small towns, four with intercity bus service and four without, that was made in rural Oregon to study the role of intercity bus service (18). In each town an inventory of alternative freight and passenger services was made. The survey revealed that older Americans often have a van available to meet their transportation needs. The Oregon study found that although some older Americans depend on intercity bus service for particular kinds of out-of-town medical treatment, in general it is the nonelderly, low-income, and some package express customers who would be most disadvantaged by the loss of intercity bus service.

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Bus Station Security: Crime at Intercity Bus Stations

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ABSTRACT

The issue of crime at California's intercity bus stations is examined through a review of records maintained by public and private carriers and by law enforcement agencies at the federal, state, and local levels. None of these sources provides complete information on crime at intercity bus stations. Intercity carrier records of station crime are generally inaccurate and incomplete, in part because of confusion over definitions of crimes and discretionary reporting practices. National crime statistics, and the police agency records from which they are compiled, do not identify crimes on the basis of a specific location. Newspapers were used as a supplementary source of information but proved to be of limited value because of inconsistencies in their coverage of these crimes. Crimes reported during 1983 at California bus stations are reviewed, and the legal implications of crime for bus station operators and specific countermeasures to station crime are also discussed. To overcome the current deficiencies in transportation security, a uniform transportation crime-reporting (UTCR) system is proposed.

Crime in the transportation environment (statutory offenses committed within the vehicles, facilities, property, or other domain of a public or private transportation system) has a documented negative impact on public transportation (1). This study examines the issue of crime at intercity bus stations, those places defined as "service points where tickets for transportation services are sold and facilities for passenger comfort may be provided" (2) and where, according to experts in the field of transportation security, most transportation-related crimes occur (3).

This study is focused on the state of California, where there are approximately 270 bus stations (4). Nearly 70 percent of these stations, however, are locations with fewer than 100 bus departures per week; many are places where the sale of tickets for transportation service is incidental to some principal activity or interest such as the sale of groceries, pharmaceuticals, or automobile parts. Such stations do not come within the scope of this review because criminal acts committed there may not necessarily reflect or typify transportation-related crime.

Information was sought for 30 of the remaining 85 stations, including the largest 25 statewide (based on number of departures per week). It is here that the greatest volumes of passengers are served and where one would expect to find the greatest crime problem.

Crime is an unacceptable element in public transportation. To combat the problem at intercity bus stations, public and private operators have at their disposal a variety of methods of deterrence. However, because no single countermeasure is equally effective against all crimes, the selection of appropriate countermeasures must be based on complete and accurate information describing the nature and extent of crime at a given station. Such information may be best obtained through the uniform transportation crime-reporting (UTCR) procedures discussed in this paper.

Many different methods are currently used to report and record transportation-related crimes. The use of disparate reporting methods, however, promotes confusion and makes comparative analyses difficult. Inadequate reporting by operators may hinder the development of effective security programs.

State and local governments, regulatory agencies, and individual carriers have a vested interest in reducing the occurrence of crimes, as well as an obligation to provide protection for those who use public transportation. The failure to provide adequate protection to the traveling public may lead to a decline in bus ridership, loss of revenues, and, as this study shows, legal proceedings as victims of crime seek compensation through the courts. In the conclusion of this paper, recommendations are made that will serve to correct deficiencies in transportation security and provide a sound basis for the development of station security programs.

SOURCES OF INFORMATION

National Statistics

Transportation-related crime is not distinguished from other crime in national crime statistics (5). The Federal Bureau of Investigation (FBI) and local police agencies do not, as a general rule, track crimes by specific location.

Police Agencies

Among police agencies it is customary to track crimes according to the type of offense rather than the location. Most agencies can, with the aid of computers, generate lists of crimes within a given section (typically four square blocks) of a large city, but these lists are often of insufficient detail to permit a statistical review of crimes at a specific street address. In smaller cities, however, it is often possible to obtain location-specific information from local police.

Carriers

Attempts to gather crime data directly from bus operators met with failure as often as success. Although the nation's two major bus carriers maintain records of their crime experience, only one cooperated fully with requests for crime data. The other declined to provide any information.

Newspapers

Some, but not all, bus station crimes are covered in the newspapers. A 1983 "shooting" by a bus station security guard was reported in the Fresno Bee; however, a "murder" reported by the same carrier at its Los Angeles terminal received no mention in the Los Angeles Times. Although this research method proved laborious and of limited value, it did provide a challenge to the claim by another major carrier that no "significant" problems occurred in any of its California stations during 1983. The Richmond Independent and Gazette, for example, reported that on Tuesday, October 5, 1983, a bus terminal clerk was shot in the chest as "stunned patrons stared in disbelief" (6), and that on Wednesday, December 29, 1983, the pregnant wife of the man who was shot during the October robbery was robbed at gunpoint at the same bus station (7).

Although these combined data-collection strategies provided an indication of the nature and extent of bus station crimes, no single source or combination of sources provided a complete picture of crime in California's intercity bus stations. Only those few operators with a dedicated police force (and therefore adequate reporting procedures) had any indication of the full extent of problems within their stations.

UNIFORM CRIME REPORTING

Nearly all crimes in the United States are defined by statutes that contain definitions of offenses and set legal limits on punishments that can be imposed on convicted defendants. These definitions and penalties may vary from state to state. The manner in which crimes are reported also may vary.

Background

In the 1920s, the International Association of Chiefs of Police (IACP) envisioned the need for uniform statistics on crime in the United States, and its committee on Uniform Crime Records developed and initiated a voluntary national data-collection effort in 1930 to overcome the difficulties of comparative analyses. Today, the Uniform Crime Reporting (UCR) program is administered by the FBI and encompasses more than 15,000 law enforcement agencies nationwide that contribute crime statistics directly or through appointed state agencies. These data are collected on a monthly basis and are assembled, published, and distributed annually by the FBI to contributing agencies, state UCR programs, and others interested in the nation's crime problem (8).

Basis for Data Collection

The collection of crime data on a systematic scale is based on the need to compile certain basic data for local administrative and operational purposes. Local law enforcement officials need to know the number and kinds of criminal acts that occur, the number of offenses cleared by arrest, and the personal characteristics of those arrested (8). A uniform reporting system makes these studies possible, permits the development of cost-effective programs of selective enforcement, and provides a sound basis for the appropriate selection of other countermeasures. There is a need for similar studies within the intercity bus industry as a prerequisite to improving passenger safety, protecting against lost revenues, and avoiding unnecessary litigation.

Index Crimes: Part I Offenses

Because of their seriousness and frequency of occurrence, eight offenses have been chosen to make up a crime index and serve as indicators of the nation's crime experience. A single definition has been adopted for each of the chosen offenses to ensure meaningful crime data. These eight offenses, presented and defined in Table 1, are collectively referred to as Part I crimes. All other offenses are designated as Part II crimes.

Reporting Transportation-Related Crimes

The recognition of transportation-related crime as a special problem has given rise to a growing interest in the uniform reporting of these crimes. UMTA, for example, has undertaken a study to investigate the feasibility of a national uniform crime-reporting system for transit operators (Mandex, Inc., Vienna, Va., unpublished data). In California, the Security Committee (composed of representatives from public transit agencies in the San Francisco Bay Area) of the Regional Transit Association (RTA) has recently taken steps to adopt a method of uniform reporting. This effort is noteworthy in that the consolidated report form presents an immediate and clear picture of the crime situation and identifies opportunities for the selective application of countermeasures.

Uniform reporting is facilitated by the use of an appropriate incident report form. To this end, Shirazi and Payne at the University of California, Los Angeles, have developed a codified reporting method that lends itself to computer analysis and has potential application in the public and private transportation sectors nationwide (Shirazi and Payne, UCLA, unpublished data).

In Michigan, a transportation crime-reporting system (TCRS) has been in place since the mid-1970s to monitor crimes on board buses and at bus stops. This sophisticated program encompasses the tricounty area of southeast Michigan (more than 50 percent of the state population) and assists regional authorities in maintaining a unified ridership security effort. The success achieved on this regional scale points to the potential for the success of a UTCR system at the statewide level that would include both public-and private-sector operators.

PUBLIC INTERCITY BUS STATIONS

Of the nearly 270 bus stations in California, only a few are publicly owned. Among these are the Transbay Terminal in San Francisco (one of the largest in the United States) and the El Monte Station in Southern California (one of the most heavily used). The Los Angeles Union Passenger Terminal, although primarily rail oriented [National Railroad Passenger Corporation (Amtrak)], is a service point for one nationwide intercity bus carrier and so has been included in this study. New publicly owned transit facilities have been constructed in Santa Cruz, Santa Ana, and Oceanside.

TABLE 1 Part I Offenses *(8)*

Offense	Definition
Homicide	The willful (nonnegligent) killing of one human being by another
Rape	The carnal knowledge of a female forcibly and against her will
Robbery	The taking or attempting to take anything of value from the care, custody, or control of a person or persons by force or threat of force or violence and/or by putting the victim in fear
Aggravated assault	An unlawful attack by one person upon another for the purpose of inflicting severe or aggravated bodily injury
Burglary	The unlawful entry of a structure to commit a felony or a theft
Larceny-theft	The unlawful taking, carrying, leading, or riding away of property from the possession or constructive possession of another
Motor vehicle theft	The theft or attempted theft of a motor vehicle
Arson	Any willful or malicious burning or attempt to burn, with or without intent to defraud, a dwelling house, public building, motor vehicle, or aircraft, personal property of another, etc.

Transbay Terminal

The Transbay Terminal was originally a commuter rail terminal built in 1939 as part of the San Francisco-Oakland Bay Bridge project. It served interurban trains operated over the bridge by Southern Pacific, Sacramento Northern, and the Key System. In 1959, following removal of tracks from the bridge, the facility was converted to a transit and commuter bus terminal (9). Today the Transbay Terminal is used by local and intercity operators including AC Transit, Golden Gate Transit, SamTrans, Trailways Lines, Amtrak Connecting Bus, and the San Francisco Muni. Several charter operators also initiate service from the Transbay Terminal.

In 1980 the average daily bus traffic totaled 3,814 departures and arrivals. By 1995 this figure is projected to rise to 6,220 buses serving 77,500 passengers per day (9).

Security at this state-owned facility is the responsibility of the California State Police (CSP). The data presented in Table 2 for this terminal, provided by the CSP, represent only a fraction of the reports taken. Not included is the large volume of reports of suspicious persons, noncriminal disturbances, or juvenile offenses that were taken at this location. Aggravated assault and larceny-theft were the most frequently reported index crimes at this station in 1983.

Santa Cruz Metro Center

A new facility for transit bus operations has been completed in downtown Santa Cruz. It is located adjacent to a privately owned intercity bus terminal. No figures on crimes at the new Metro Center were available at the time of this writing, but a number of newspaper articles from previous years reported crimes at the adjacent bus station. Commercial security guards provide protective services at the new transit facility.

Santa Ana Transit Terminal

The local transit district has recently completed work on this new facility to serve one of California's largest transit systems. The Santa Ana Transit Terminal incorporates closed-circuit television (CCTV), bulletproof glass, and rest room alarm features as part of its security program. In addition, uniformed guards and transit personnel maintain a high level of visibility at the terminal. Local police officers routinely patrol the station and the facility is locked and guarded during nonbusiness hours. No Part I offenses have been reported at this station since its opening in April 1984.

Oceanside Transit Center

A new intermodal facility for bus and rail has been completed in Oceanside and has been fully operational since January 1984. Several Part I offenses were reported at this new station in the first 6 months of operation, including aggravated assault,

TABLE 2 Summary of Reported Station Offenses, 1983

Offense	Transbay Terminal	Union Passenger Terminal	El Monte Station	Data for Greyhound by Agent Reporting: GLI[a]	CPD	BPD	Total	Percentage of Total
Part I								
Homicide	-	-	-	-	-	-	-	-
Rape	2	-	-	-	-	-	2	0.4
Robbery	14	6	-	4	1	-	25	5.1
Aggravated assault	25	4	2	26	1	-	58	12.0
Burglary	3	123	16	5	-	-	147	30.5
Motor vehicle theft	3	1	32	11	-	-	47	9.7
Larceny-theft	62	92	11	28	3	-	196	40.7
Arson	-	3	-	3	-	-	6	1.2
Total	109	229	61	77	5		481	
Part II								
Simple assault	-	-	-	-	-	-	-	-
Counterfeiting	1	-	-	1	-	-	2	0.3
Fraud	-	-	-	-	-	-	-	-
Embezzlement	-	-	-	-	-	-	-	-
Stolen property	-	-	-	-	-	-	-	-
Vandalism	14	13	4	10	-	-	41	5.8
Weapons	13	-	-	4	-	-	17	2.4
Prostitution	-	-	-	-	-	-	-	-
Sex offense	3	3	-	-	-	-	6	0.8
Drug offense	32	7	3	3	-	-	45	6.3
Gambling	3	2	-	-	-	-	5	0.7
Family/child	-	-	-	-	-	-	-	-
Driving under influence	-	-	-	-	-	-	-	-
Liquor laws	-	-	-	-	-	-	-	-
Drunkenness	243	165	-	14	30	2	454	64.0
Disorderly conduct	32	-	-	5	6	-	43	6.0
Vagrancy	-	-	-	-	.3	-	3	0.4
Other	49	19	-	5	14	6	93	13.1
Total	390	209	7	42	53	8	709	

Note: All shootings, stabbings, and assaults not specified as "simple assault" appear as "aggravated assault." Percentages of total Part I and Part II crimes may not add up to 100 because of rounding.

[a]GLI = Greyhound Lines, Inc.; CPD = Calexico Police Department (incidents not reported by GLI); BPD = Blythe Police Department (incidents not reported by GLI).

robbery, and larceny-theft. A CCTV system had been installed at this facility but there were no uniformed police or security guards during that period.

Los Angeles Union Passenger Terminal

Although primarily rail oriented, the Los Angeles Union Passenger Terminal is also used by a major intercity bus carrier. Daily passenger volumes vary according to season. During the summer months as many as 50,000 people may pass through the station in a week's time. Security at this facility is the responsibility of the Amtrak Police.

The data presented in Table 2 for this facility were provided by the Amtrak Police. These figures indicate that 94 percent of the reported Part I crimes were burglaries and thefts. Most of these offenses, however, involved the removal of items from automobiles in the parking areas. Because these parking areas are used by many persons who do not use the terminal, these particular crime figures do not necessarily reflect problems experienced by passengers alone. Drunkenness accounted for 78 percent of all the Part II crimes at this station in 1983. Most of these cases involved transients, according to police officials. A CCTV system was installed at the onset of the Olympic Games in 1984.

San Bernardino Busway: El Monte Station

This facility serves approximately 17,000 people on an average day and is shared by the local transit district and a major intercity carrier. Security is the responsibility of the transit police, whose enforcement capabilities at this station are augmented by CCTV. In Table 2 the data indicate that during 1983 the greatest volume of reported crimes (47 percent) at this station was motor vehicle theft. The parking areas were not monitored by camera. Aggravated assault and larceny-theft were the least frequently reported Part I crimes. No cases of homicide, rape, robbery, or arson were reported by the transit police.

REPORTING BY MAJOR CARRIERS

Although it is relatively easy to obtain available crime data from public agencies as a matter of public record, the task proves more difficult when common carriers are concerned. These companies are under no obligation to disclose what is now considered to be proprietary information.

Imprecise Reporting

Comparative studies based on the data released by private-sector carriers must remain tentative. Some of the information obtained in this study proved erroneous or of insufficient detail to allow distinctions, for example, between aggravated assault and simple assault. The problem of obtaining accurate crime data appears to stem from the manner in which the information is initially collected by these carriers.

Security guards, bus drivers, terminal managers, or other assigned station personnel, none of whom usually have any training in criminal terminology or reporting techniques, prepare incident reports and submit these reports through various channels to the main offices. Thus, what may be reported as a robbery at one location may be reported as a burglary at another when, in fact, a theft (UCR definition) has been committed at each. Similar discrepancies were noted among reports prepared by public carriers that had no personnel trained in UCR techniques.

Discretionary Reporting

The accuracy of data obtained from private intercity carriers is further diminished by discretionary reporting. Certain crimes such as vagrancy and drunkenness are evidently so common in bus stations that they are usually not reported, and some incidents are not reported even if they involve police participation.

An illustration of this discrepancy was found at Calexico, California, where no incidents were reported during 1983 by one major nationwide carrier. Local policy department records indicate, however, that officers were summoned to the company's terminal 58 times during the year. These incidents included robbery, aggravated assault, and larceny-theft.

These discrepancies between carrier records and police reports may be due to differences of opinion as to what constitutes crime. The unmistakably serious nature of these incidents and the absence of incident reports, however, suggests discretionary reporting. A UTCR system would help to overcome this problem.

Although major carriers require station managers to report all incidents as a matter of policy, this does not appear to be strictly enforced, and there is evidently no means of monitoring compliance. The main interest in filing reports appears to be the need to have records in the event of subsequent legal action (5).

Available Data

Records kept at the main offices of nationwide bus carriers are incomplete and inaccurate. Company officials do not know the full extent of problems within their stations, and the information that may be obtained from a carrier must therefore be used with caution. Table 2 presents data released by one major nationwide carrier, Greyhound Lines, Inc., for selected stations. Although no definitive conclusions can be drawn from these data due to their demonstrated inaccuracy, certain observations may be made. During 1983,

- Of all crimes reported by Greyhound, 65 percent were Part I offenses;
- Of all Part I crimes reported by Greyhound, 39 percent were violent in nature (homicide, rape, robbery, and assault);
- Of all reported crimes (Parts I and II), 25 percent were violent in nature;
- The most frequently reported Part I offense was larceny-theft;
- Assault (simple and aggravated) was the second most frequently reported Part I offense; and
- Drunkenness and vandalism were the most frequently reported Part II offenses.

These observations may not necessarily reflect the actual situation in privately owned intercity bus stations. The data are inadequate, and therefore the nature and extent of crimes in these stations remain unknown. Although the observed percentage of violent crime may indeed reflect the private-station situation, it may also reflect the carrier's desire to have records on hand in the event of ensuing court action. The number of reported thefts is consistent with this posture in that it may reflect the company's need for records in the event of insurance claims.

Figure 1(a) shows the relative percentages of all index crimes reported statewide during 1983 by the California Department of Justice. Figure 1(b) shows the same trend among reporting publicly owned bus stations during the same period. Figure 1(c) shows index crimes reported in 1983 at selected privately owned bus stations. The pattern shown statewide and at publicly owned bus stations is not repeated at these privately owned bus stations.

Although private stations show a higher percentage of violent crimes, it cannot be concluded that they are more dangerous than publicly owned stations or that passengers there are at higher risk of becoming victims of crime. The data for these stations are incomplete and inaccurate, and therefore the observed difference remains unexplained if it cannot be attributed to imprecise or discretionary reporting practices on the part of the carrier and its agents.

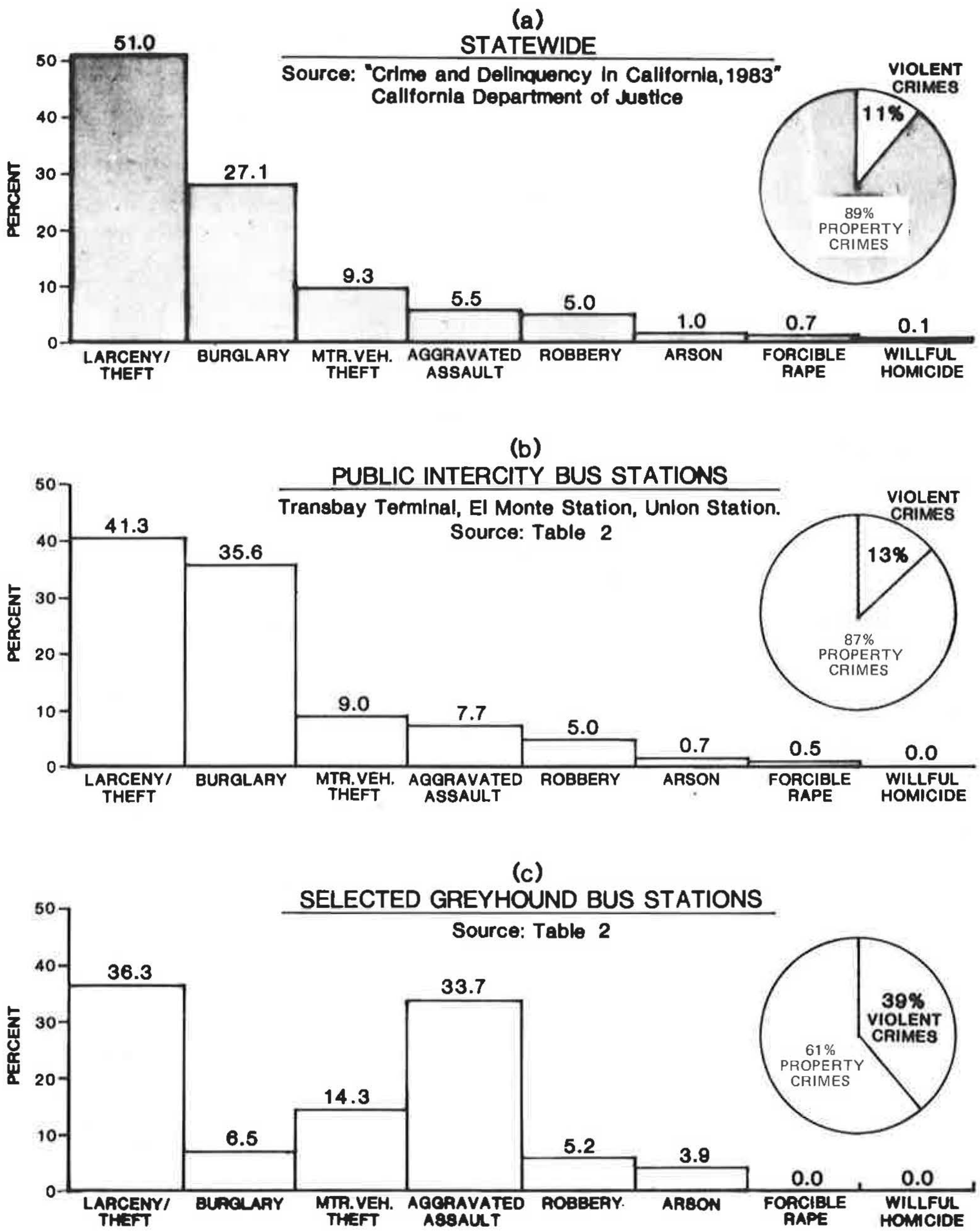
LEGAL IMPLICATIONS

Owners and managers of bus station facilities have been involved in litigation arising from incidents of crime occurring on station premises. In 1976 a North Carolina jury awarded a woman $150,000 for damages suffered during an assault in a bus company's terminal. The jury determined that the carrier had been negligent in providing proper security for the 25-year-old woman. After the verdict, the jury foreman said that the jurors believed that the carrier "was responsible for the highest degree of care of its passengers." Another terminal incident occurred in Miami in 1974. Here the jury awarded $350,000 to a woman who was severely beaten in the ladies' room. The plaintiff argued that the carrier did not provide adequate security (10).

The justification for suits of this nature may be found in state public utility codes or government codes. California's Government Code, Section 835, for example, provides that

> a public entity is liable for injury caused by a dangerous condition of its property if the plaintiff establishes that the property was in a dangerous condition at the time of the injury, that the injury was proximately caused by the dangerous condition, that the dangerous condition created a reasonable foreseeable risk of the kind of injury which was incurred, and that either: (a) A negligent or wrongful act or omission of an employee of the public entity within the scope of his employment created the dangerous condition; or (b) The public entity has actual or constructive notice of the dangerous condition under Section 835.2 a sufficient time prior to the injury to have taken measures to protect against the dangerous condition.

Criminal activity may constitute a dangerous condition as established in Slapin v. Los Angeles International Airport [65 Cal. App. 3d 484 (1976)] and Swaner v. City of Santa Monica [150 Cal. App. 3d 489 (1984)]. The key to liability in this area of law, as the next case shows, is the condition of the property combined with a foreseeable risk that injury will result from that condition.



NOTES: Violent Crimes are Aggravated Assault, Robbery, Forcible Rape, and Willful Homicide.
Property Crimes are Larceny/Theft, Burglary, Motor Vehicle Theft, and Arson.

FIGURE 1 Comparison of reported index crimes, 1983.

In a unanimous decision released October 17, 1984, the California State Court of Appeal upheld a county court's ruling that a major carrier could not have foreseen the 1981 stabbing and sexual attack on a 13-year-old girl as she waited for a bus connection on a bench outside the depot of a small California town. The appellate court agreed that the carrier was obligated "to protect her from the criminal acts of third persons if those acts might reasonably have been foreseen" (11). In this case, however, the carrier could not be held accountable because there were no previous violent incidents or other circumstances that should have alerted the carrier to the potential danger. There was "nothing in the nature or operation of the Auburn depot [suggesting] that such an attack was more likely there than on any other business premises" (11).

The failure by any public or private operator to maintain adequate records and to carefully monitor crimes experienced at its stations may lead to serious consequences. Full and accurate crime incidence reports will assist in the early recognition of potentially dangerous conditions that need remedy and will indicate precisely which measures are best suited to prevent crime at a given station.

ADDRESSING THE PROBLEM

Methods of deterrence with potential application to bus stations can range from the basic elements of bus station design (sight-line distance, lighting levels, and so forth) to sophisticated electronic devices and techniques. Richards and Hoel have summarized various such methods and the effectiveness of these measures against different types of crime (3). Countermeasures are best determined from an analysis of crime data.

The first consideration in the development of a security program for a bus station should be the location of the station. Many stations are found in the inner areas of cities where increasing age and deterioration of facilities have been factors in the development of high crime rates. Because station crime is often a manifestation of the street crime around it, the existing or planned location of a station will determine, in part, the type of crimes that may be expected and the appropriate countermeasures that might be taken.

Another important consideration is the general character or appearance of the station. If it is dark, of drab color, dirty, pervaded by odors, noisy, or marked with graffiti or other evidence of vandalism, users will perceive it as unsafe because these conditions are often associated with unsafe environments (1). The timely repair of vandalism and high standards of cleanliness have been advocated as a basic means of enhancing perceived security.

A higher level of station security is possible through analyses of crime data. The most effective countermeasures can then be selected. A few countermeasures have been so widely tested and proved effective that they have essentially become standard design options. The use of vandal-resistant materials, access control, alarm systems, and electronic locks and keys are a few examples. However, CCTV systems and the presence of uniformed police are perhaps the best known and most effective of these commonly employed strategies.

CCTV Systems

The use of multiple CCTV cameras in bus station settings permits the monitoring of many locations simultaneously. Security personnel may be dispatched or police notified to interrupt suspicious activities before crimes are actually committed.

Uniformed Police

The single most effective deterrent to crime may be the presence of uniformed police officers (1,5). Private intercity bus carriers often contract with commercial security firms for protective services. Security guards, however, have limited training and no police powers (5).

At some bus stations, off-duty police officers are employed as security guards. In other situations, local police departments may assign a contingent of officers to police the local transit systems. Another emerging strategy is the use of dedicated transit police whose sole jurisdiction is the transportation system.

SUMMARY AND RECOMMENDATIONS

There is growing national concern over crime in the transportation environment. An unsafe system is an unacceptable one and therefore one that becomes increasingly subject to economic and legal liability.

Public and private transportation authorities have at their disposal a variety of methods for the deterrence of crime. The selection of appropriate and cost-effective countermeasures, however, must be based on complete and accurate information describing the nature and extent of crimes at a given location. Such information is best obtained through a UTCR system. Although increasing numbers of transit agencies across the United States are recognizing these facts and adopting programs based on the FBI's UCR program, there remains considerable room for improvement in this area.

In an attempt to examine the nature and extent of crime in California's bus stations, this study discovered a paucity of data, which stems from a lack of uniform crime-reporting procedures. This lack of uniformity has given rise to inaccuracies in the data obtained from public and private carriers and has fostered a condition that permits discretionary reporting. Claims by some carriers that no problems had occurred at selected bus stations during 1983 could not be supported.

Data obtained from police records, carrier records, and newspapers are not in agreement with respect to the number and types of crimes occurring at intercity bus stations. These differences are more likely due to discretionary and imprecise reporting on the part of bus companies than to a failure to recognize crime when it occurs. Inadequate data preclude the efficient design of security programs by forcing operators to apply countermeasures randomly or in isolation.

The information obtained through this study suggests that the nature and extent of crimes may vary from station to station. So too should any crime prevention program. This is the driving principle behind the Crime Prevention Through Environmental Design (CPTED) concept, which seeks to derive benefits from the concerted effect of complementary strategies.

The available figures also indicate that among UCR index crimes, motor vehicle theft, burglary, larceny-theft, and aggravated assault were the most frequently reported offenses at California's largest intercity bus stations during 1983. Although uniformed police and CCTV are among the most effective countermeasures against these offenses, neither of these measures was used at most of the 30 stations that came within the scope of this study. Only the El Monte station employed both countermeasures, and it recorded only 2 assaults and 11 larceny-thefts during the 1983 study period--the least of any major California bus station.

To overcome the current lack of information and to alleviate the burden that crime places on owners and operators of bus station facilities and their patrons, certain steps are necessary. The following recommendations provide a starting point toward the improvement of existing conditions:

- The implementation of a UTCR system is urgently needed for all transportation operators, public and private, statewide. Such a program would permit the establishment and monitoring of a baseline figure for crime in the transportation environment and would indicate which steps could be taken when necessary to enhance the personal security of those who use bus transportation. It would also promote the cost-effective selection of countermeasures and protect operators from potential declines in ridership, loss of revenues, and legal liability.
- Existing police agencies should indicate by means of a location code on their incident report forms whether a crime occurs in the transportation environment. Such codes, entered into a computer system, would aid in monitoring the accuracy of reports obtained through the proposed UTCR program and assist police authorities in allocating resources.

• Security guard training should include instruction in criminal terminology and basic uniform crime-reporting techniques. This will aid in improving the quality of reports submitted by carriers that employ security guards.

Additional research should be conducted to detail the scope, cost, and administration of the suggested UTCR program; to bring about its implementation; and to monitor the effectiveness of preventive programs that will logically result from the data thus collected. In cooperation with the intercity bus industry, data supplied on station patronage levels can be joined with UTCR data to develop accurate crime exposure levels and perform other analyses that will place the problem of crime at intercity bus stations in the proper perspective.

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Discussion

Robert J. Forman*

This paper presents a number of concerns, particularly the impact that its conclusions would have on regular-route intercity bus carriers.

The actual purpose of the paper was to determine the extent of crime in intercity bus terminals and report to the California legislature. This clearly suggests a preconceived need for possible legislation in this area. Yet, the paper's primary conclusion was that there is a need to develop a uniform crime-reporting system modeled after the national UCR program.

The suggested benefits from a UCR system would include reduced legal implications to users of such facilities, the ability to develop specific security countermeasures, and a lessening of concern for safety by the traveling public using bus terminals. Not all of these perceived benefits were objectively documented.

The legal implications resulting from possible inadequate security at a terminal are a matter of concern to all carriers. Increasingly, our society is prone to file suit for any event that adversely affects them during the course of their use of either public or private facilities.

With the advent of national uniform crime statistics, a ready source for adverse information is available. Without taking into consideration the hundreds of millions of passengers carried annually, such crime statistics of the national bus system can and have been used to mislead a jury. Such statistical information could be used to attempt to establish gross negligence on the part of the facility operator, thereby opening the door to punitive damages. The real danger to the carrier is that many states do not allow punitive damage awards to be covered by insurance. Therefore, they come directly out of the operating revenue of the carrier and, depending on their magnitude, could force the carrier into bankruptcy.

This is not idle speculation. At Trailways Lines we have seen increasing efforts on the part of plaintiffs' attorneys to attempt to establish a base to pursue punitive damages because significantly higher monetary awards can be granted versus those for normal tort-limited damages.

The end result for a carrier or an operator of a bus terminal is to provide a reasonable level of security at terminals in an effort to limit exposure to lawsuits.

Security countermeasure programming from uniform data is extremely questionable. Other than the environmental location of the terminal, its overall layout, access, and lighting, no specific countermeasure development is to be gained by this type of statistical data gathering.

The reality is that most intercity bus terminals in larger cities were built many years ago at a time when their neighborhoods and our society were much different than they are today. With the passage of time many of these neighborhoods have deteriorated, creating a crime problem around the terminal. During this same period of time, the intercity bus industry's overall economic fortunes have declined; therefore, because of the lack of adequate capital in the 1980s, a massive relocation of these facilities is clearly impossible.

The other two security countermeasures suggested are CCTV and uniform patrol. Both of these countermeasures have limitations. It is recognized that the mere knowledge of CCTV can have an "omnipresent" effect on the public. In reality, the uniformed personnel or supervisory personnel present to monitor what is seen by CCTV is limited. In addition, if a videotape recorder is attached to the system, it still requires equal viewing time to see what has happened.

Uniformed patrol has proven to be the most effective overall deterrent to crime in bus terminals, whether these are security personnel without police power or off-duty policy officers used as security guards. Security personnel with full police powers are recognized as having this authority by the public. However, other uniformed security guards do provide an overall positive deterrent effect. Intercity bus companies cannot always hire off-duty policy officers for security because of local legal restrictions or city policy decisions. Thus the carrier is left with the uniformed security force as their patrol alternative. Trailways has set up specific guidelines, including written duties and responsibilities for security guards, and we satisfy ourselves as to their selection and training before engaging an outside security force.

Regardless of the approach taken, with the types of incidents that are occurring in any particular terminal, these are the only two productive countermeasures available to any carrier.

Finally, the paper does not take into consideration the distinction between company-operated terminals, city-operated transportation centers, or commission agents. Commission agents fall in two categories: those whose only business is to run a small community bus terminal providing all of the usual services and, in smaller communities, an established business that has agreed to work on a commission basis to represent and sell tickets for the intercity bus companies.

The wage and hours laws make it important that the intercity bus carrier maintain an arm's-length relationship with these commission agents. As a result, the carrier can exert little control over

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these independent businessmen as to the manner in which they will maintain security other than an overall general requirement that the agent provide a safe, clean, and secure facility. Granted, many of these commission agents are in small towns where crime is less of a problem than it is in large metropolitan areas.

The authors assert that there is a public perception or concern that intercity bus terminals are unsafe. In support of this argument, they cite two references that relate to urban mass transit, which were funded by UMTA. Because an intercity bus carrier may be in a transportation center also utilized by an urban mass transportation system, these studies cannot be construed to reflect the same situation that intercity bus terminals experience, in my view. Any attempt to relate crime problems from one environment to another without more substantial evidence is without merit and should not be used in support of a conclusion that uniform reporting of crime data is a current need within our industry.

Although the authors attempted to obtain more broad-based data from intercity bus carriers as to the incidence of crime in their facilities, the lack of such information should not be a basis for supporting the conclusion of a need for uniform crime reporting for bus terminals.

The nation's two largest intercity bus companies, Trailways and Greyhound, both have terminal incident-reporting requirements, which were never intended to be used as crime-reporting data-collection instruments. Instead these are reports that are to be prepared and filed to protect the company from tort claims arising from incidents in their facilities. This has historically met the needs of the intercity bus operator. The authors should not suggest that these reports are not useful when they have satisfied the business needs of these two companies. Because these incident reports did not fulfill the authors' research needs, this should not be perceived as a need to now create an entire new reporting requirement and add a significant paper burden to an industry whose resources are stretched to the extreme. Therefore, it is my opinion that there is no overriding need to create yet another administrative paperwork burden for the intercity bus company as suggested in this paper.

Authors' Closure

Our conclusion that there is a need to develop uniform crime statistics arose from the discovery of inadequate crime data, not from any preconceived scheme for new legislation, as suggested by Forman.

The relationship between the UTCR system and security programming could not be more lucid. Accurate data will indicate potential problems at bus stations. Countermeasures specific to those problems may thus be selected. Confusing data only impede careful planning and design.

The adoption of a UTCR system will not predispose the bus industry to litigation. Bus company records have always been subject to subpoena by the courts. The UTCR system will, among other things, only improve the quality of these reports. Poor record keeping may prove to be a greater and indefensible liability. The reporting methods that have "historically met the needs of the intercity bus operator" may have grown obsolete in modern society.

We agree that the report does not distinguish between company-owned terminals and commission agent stations. We submit, however, that bus passengers do not make such distinctions either. The point is therefore irrelevant in the minds of the traveling public with concern for personal safety.

We cannot agree with Forman's assertion that the principles of crime perception do not apply equally to users of transit and intercity bus transportation. A common denominator between these two services has been the bus station experience addressed by our paper.

Finally, we would like to take this opportunity to restate that the details of the proposed UTCR system remain to be investigated. UTCR does not necessarily imply an additional paperwork burden but rather encourages an improvement in the quality of reports. In some cases, an adjustment of existing practices may be all that is necessary to enhance the quality of crime data and to augment security at intercity bus stations.

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The Impact of Bus Deregulation on Small Towns

MARY KIHL

ABSTRACT

The impact of bus deregulation on small towns is discussed. Because much of the discussion before the passage of the Bus Regulatory and Reform Act of 1982 focused on potential impacts on small communities, the purpose of this paper is to consider the initial impacts on residents of communities for which bus service was discontinued. A survey of former ticket agents in Iowa generated information regarding several key aspects of those impacts: the age and number of former riders, the type of service for which they relied on intercity transit, the amount of package service performed, the level and persistence of protest regarding discontinuance, and the availability of alternative forms of service.

Discussion before the passage of the Bus Regulatory and Reform Act (BRRA) of 1982 frequently focused on the potential impacts on small communities. Opponents of deregulation anticipated that bus companies would quickly take advantage of the opportunity to streamline routes by dropping service to large numbers of small towns that were admittedly unprofitable stops. The Missouri Public Services Commission argued that this "could prove to be devastating not only to individual bus riders who depend on the service but to communities at large who are finding themselves increasingly isolated particularly in light of diminishing airline and Amtrak availability" (1,p.197).

Supporters of deregulation countered by citing the experience afforded by the Florida Deregulation Act of 1980 and the deregulation of the trucking industry. In both cases, as stated by James C. Miller of the Federal Trade Commission, "experience has shown that service to small communities has either held steady or improved under deregulation" (1,p. 96). In Florida, no formal complaints (about loss of service) were received from small towns. Only one newspaper story appeared, highlighting the loss of a one-bus-a-week service from Apalachicola to Tallahassee. Four riders were inconvenienced. Although Trailways dropped service to eight small towns in northern Florida, it increased its total mileage by 7.5 percent. Greyhound similarly dropped service to towns in central Florida but increased its mileage by 8 percent. Of the total of 15 towns losing this service, half were picked up by other carriers (1, pp.118-119).

An objective study commissioned by the U.S. Senate noted that in the bus industry, unlike in other modes of transport, there is no economy of scale. Small communities can compete with large ones. Therefore, according to the director of the Transportation Consumer Action Project (1,p.206), "in the near term service to small towns seems to be no more threatened than to larger cities." In fact, on the basis of available financial data, the bus industry is "healthier in rural areas than in highly urbanized areas" (1,p.206). Other studies were less certain of positive impacts. "Bus patrons can look forward to any number of results--numerous schedule changes, fare increases and decreases, loss of service to some markets while other more attractive service corridors see increased service" (2,p.3). The potential loss of service should be counted as a significant cost in that it would lead to "further concentration of the industry which would lead to higher fares and in turn less service" (3,pp.10-21).

Nevertheless, most commenters subscribed to the view that bus deregulation would have at most a minimum effect on the residents of small communities. Deregulation would naturally mean that unprofitable routes could be discontinued and schedules streamlined. Nevertheless, because so few rural riders depended on bus transportation, the expectation was that those who were inconvenienced by reduced bus schedules would either find alternative forms of transportation or travel to the closest remaining bus stop to board a through bus (4,p.423).

Now, 2 years after deregulation, it is appropriate to look back at the initial impacts on the residents of small towns. Presumably if bus companies were constrained from streamlining service only by the regulations imposed by the BRRA, removal of those barriers would stimulate a sizable number of notices of service cancellation. Additional changes would come more gradually, but after 2 years the pattern of a deregulated bus industry would emerge. This study is therefore intended to discern this pattern and to assess the level of impacts on rural residents.

The focus of this paper is the state of Iowa; it is part of a larger study that will examine the relative levels of impacts on residents of small communities in other parts of the country as well. Unlike other studies [notably, the Motor Carrier Ratemaking Study Commission report to the President (4) and a report by the Secretary of Transportation, Neil Goldschmidt (5)], which have provided aggregate analyses based primarily on changes in printed schedules and reports of bus companies, the current study will take a more focused approach: the impacts identified at the rural community level.

The expectation is that impacts may vary among communities relative to availability of alternative forms of transportation and the characteristics and persistence of riders. For purposes of this paper, persistence will be noted both in the number of riders boarding at a stop and in the level of protest accompanying discontinuance of service.

Iowa was chosen as the pilot state for this analysis for several reasons, both substantive and procedural. First, Iowa is well known for its rural-small-town orientation. Of the 3 million residents of Iowa, 41 percent live in towns with less than 2,500 population. The state has only one city of 200,000 and eight cities with population levels of more than 50,000 (6). Second, the intercity bus has traditionally been the primary form of transportation for rural Iowa. More than 300 communities are still served by at least one intercity bus a day, whereas air service is only provided to 20 Iowa cities and is directed outside the state. Rail service is limited to the extreme southern part of the state and is provided at undesirable times of day (2,p.7). Third, the state has a well-coordinated regional transit system that is being used to organize alternative forms of transit.

Within Iowa, therefore, it should be possible to observe not only impacts of deregulation in small towns, but also the potential for alternative transit modes in small communities. Procedurally, Iowa was selected because of its proximity to the researcher and the fine cooperation afforded by the Iowa Department of Transportation.

The approach taken in this paper will be, first, to describe briefly the state of intercity transit and ridership in Iowa; second, to describe the procedure used to generate community-level data; third, to assess the findings; and fourth, to place the study in a broader perspective and to offer conclusions.

INTERCITY TRANSIT IN IOWA

Through the 1940s and 1950s in Iowa, much as in other parts of the United States, the intercity bus industry enjoyed considerable prominence in the area of public transportation. In fact, five out of every six intercity trips provided by public carriers were by bus in the years 1946-1948. Within Iowa ridership reached a peak of 27 million in 1946 (2,p.10). Since the 1950s intercity buses have continued to carry more passengers than either trains or airplanes, but the automobile has been clearly established as the dominant form of intercity travel. Demand for intercity bus service has continued to fall and as a result, the bus network has diminished and service to a number of communities has been cut. The graph in Figure 1 shows the dramatic decline in bus ridership in recent years (2,p.8).

Since the 1940s, when the bus network reached its most extensive level, the route system has contracted slowly but noticeably, although the basic route structure has remained the same. As the maps in Figure 2 indicate, Iowa's transit service has been along a set of dedicated east-west and north-south corridors. Less-profitable routes have been dropped gradually throughout the period; the major elimination was before 1972 (2,p.16).

Three areas of the state have been most affected by route elimination: the two tiers of counties in southern and southwestern Iowa, eastern Iowa along the Mississippi north from Davenport, and central Iowa west of Des Moines. The first two of these areas lost service before 1972, whereas service to central western Iowa was greatly curtailed in 1972-1982. Routes were added primarily in response to the completion of the Interstate system. I-80 traverses the state east and west, and I-35 runs north and south through the middle of the state connecting Minneapolis with Kansas City. I-29 runs along the western border of the state through Sioux City and Council Bluffs and into Missouri.

A significant number of certificate authority transfers occurred during the 40-year period 1942-1982. For example, five carriers left the state or went out of business between 1942 and 1962, but nine new carriers entered the state. Within the last 20 years, six additional carriers left the state and were replaced by eight new ones. Only six carriers have provided consistent service throughout the period--Greyhound Lines, Jefferson Lines, Missouri Transit Lines, River Trails Transit Lines, Scenic Hawkeye Stages, and Trailways Lines. Nevertheless, all these changes have led primarily to route modifications rather than to wholesale changes in the network (2,pp.10-17).

Bus deregulation has not ushered in any major changes in these established trends. There was an expected flurry of announced cancellations soon after the BRRA became effective in January 1982. Greyhound announced plans to cancel stops in 28 communities, 17 of which had had regularly scheduled service; the rest had been flag stops, highway stops, or passenger-discharge-only stops. Stagecoach Lines planned to eliminate 7 stops; Iowa Coaches, 10 stops; Trailways, 2 stops; Missouri Transit, 1 flag stop; and Scenic Hawkeye Stages, 1 scheduled stop. Midwest Coaches had planned to eliminate three stops but subsequently declared bankruptcy. All together, 57 stops were identified for discontinuance by May 1983 (4,pp.B-37 to B-41). The bulk of Greyhound's changes were in response to a decision to stop services to the towns along IA-6, because parallel service was being provided along I-80, about 4 to 6 miles to the south. Appeals from communities and the substitution of Jack Rabbit Lines for Midwest Coaches reduced the number of stops discontinued to 37. Twenty-five were dropped in December 1982 and a

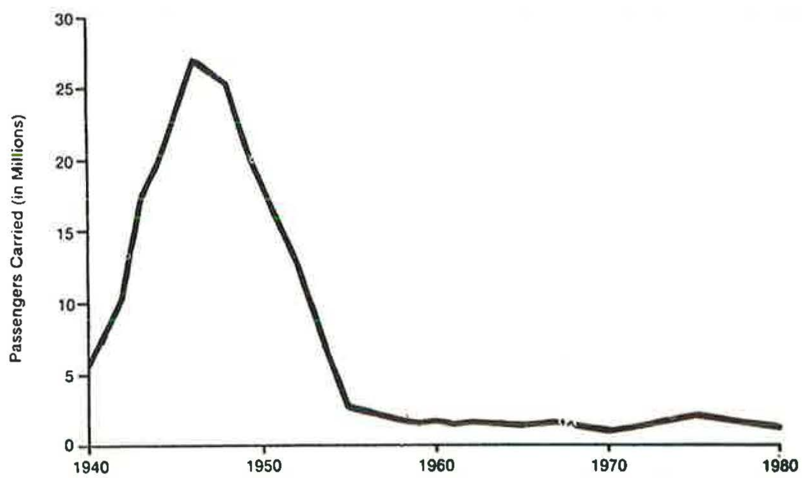

FIGURE 1 Ridership trends in Iowa intercity passenger buses: 1940-1980.

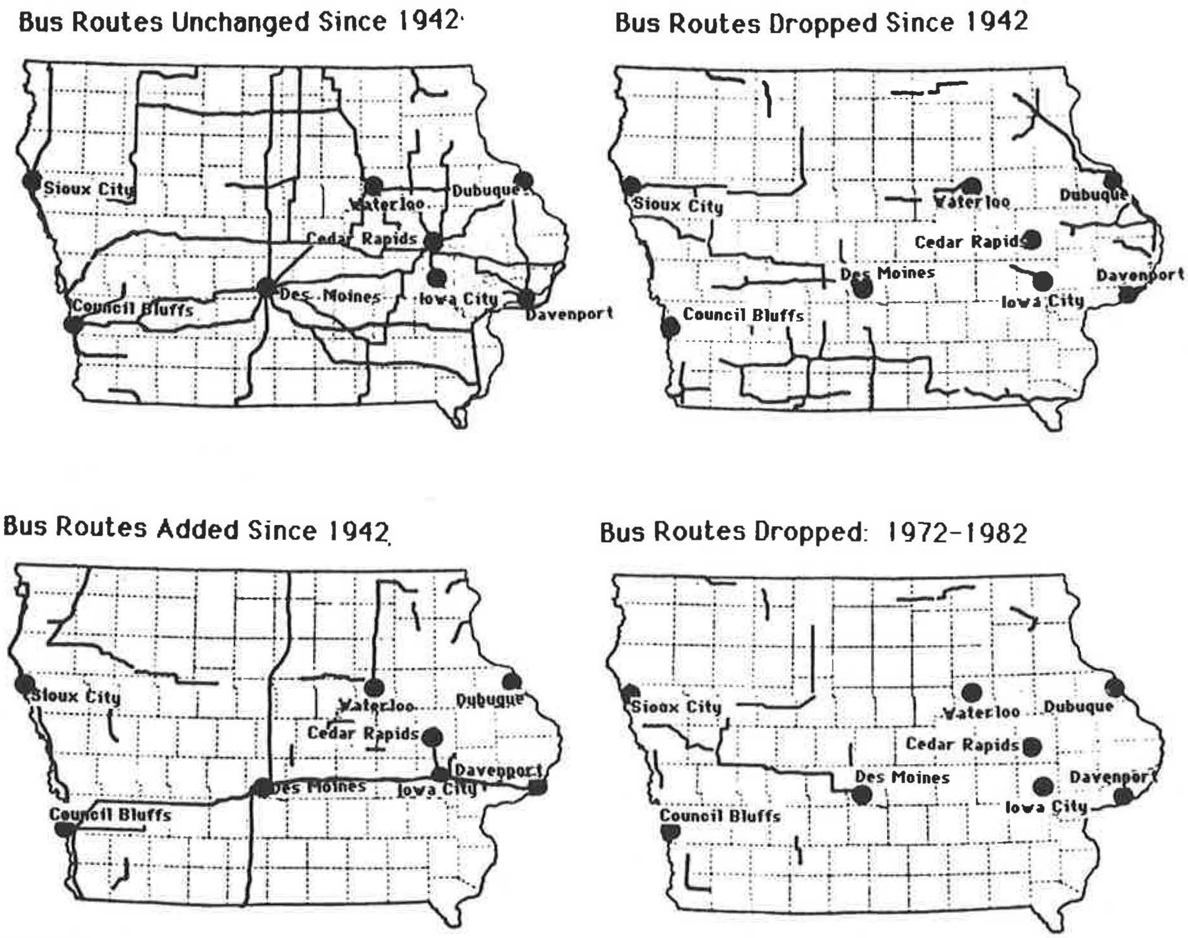

FIGURE 2 Iowa transit service: 1942-1982.

smaller group of 12 was dropped in January 1983. No further formal requests for discontinuance have been received, although informally service has been halted along a Trailways route in southwestern Iowa (Iowa Department of Transportation and Iowa Transportation Regulatory Authority, unpublished data). The Iowa Transportation Regulatory Authority also reports that no formal protests have been received from any affected community since January 1982.

PROCEDURE

Because most communities where service was discontinued were small and lacked formal leadership, the shortage of formally registered complaints is not surprising. This study intended to probe more closely into concerns expressed in affected communities. All sources agree that ridership from small towns is relatively low. Yet accurate data on ridership by stop are not available. Neither the bus companies nor the state regulatory agencies kept such data, even before deregulation. Since deregulation, record keeping is solely at the discretion of the private companies. Consequently, information on ridership before deregulation and information regarding alternative travel modes must be obtained on a stop-by-stop basis from former ticket agents. Community-wide surveys would have potentially gained information on a broader base of impacts but the manageability of such an investigation plus the complexity in isolating impacts associated with changes in bus travel militated against such an effort. For purposes of this study, therefore, former ticket agents were regarded as surrogate spokespersons for the affected communities. Variation in accuracy and interest in reporting was taken as a given constraint much as it is with any attitudinal research.

The target population of ticket agents was identified from among the 37 regularly scheduled stops listed for discontinuance in the May 15, 1984, report submitted by the Motor Carrier Ratemaking Study Commission (4). For 34 of these stops, addresses and telephone numbers of former ticket agents were found in the back issues of the (Iowa) Transit Atlas. A review of these stops in conjunction with Russell's guide (7) indicated that not all had actually been eliminated. Nevertheless, they were retained in the sample for comparative purposes. It was also felt that responses of riders to a temporary reprieve from discontinuance would provide further insight into the potential ridership from small communities, which had been initially deemed marginal by the bus industry.

Brief survey instruments were then mailed to each of the ticket agents for which an address was obtained. Because there was some confusion regarding the continued availability of service in several towns, all agents were sent a survey form with two sets of questions, one directed toward those towns with continued service and one for those for which service had been discontinued. The agents were then directed to answer the appropriate set of questions. Information solicited in both sets of questions was very similar--average monthly ridership, number of packages collected, percentage of senior citizens among riders, the length of trip of riders. Those without service were asked about available travel alternatives and distance to the nearest operating stop, whereas those with service were asked about changes in ridership and package service since deregulation took effect in 1982. Nine questionnaires were returned, but follow-up telephone interviews generated a total of 24 responses, or a response rate of 73 percent. A higher return rate was not possible given the number of telephones disconnected and the closing of businesses that had sold tickets and served as bus stops. As is typical of bus service in small communities, all of the agents contacted had handled bus tickets and packages as an extra feature at their regular place of business (5). Locations included gas stations, cafes, motels, hardware stores, and convenience stores.

THE FINDINGS

A review of the findings from the survey indicated that 8 of the responding locations still had bus service and 16 had lost service as a result of deregulation. None of the stops had or served large numbers of passengers. The numbers ranged from about 8 a month to about 60 a month. As might be expected, larger numbers of passengers had used those stops with continuing service. Although 68.8 percent of the stops where service had been discontinued handled less than 10 passengers a month, all those with continuing service handled more than 10 passengers a month. Thirty-seven percent of these handled more than 50 passengers a month. All these figures are well below the median of 50 departures per week for an average small town as identified in the U.S. Department of Transportation study of bus service in small towns (5,p.30). Package handling differed similarly between stops with continuing service and stops at which service had been cancelled. Of the stops at which service had been discontinued, 43.8 percent had handled 10 or less packages a month and 81.3 percent had handled 50 or less packages a month. Among those stops with continuing service, 62.5 percent had handled more than 50 packages a month. Nevertheless, there were some surprises. One cancelled stop had handled more than 100 packages a month. There were also two cancelled stops that had sold more than 50 tickets a month. Hence if impacts are measured only in terms of numbers of people inconvenienced, reports from these Iowa towns would clearly indicate minimum impact. However, assessment must also consider the type of riders inconvenienced.

The literature generally indicates that bus passengers differ from passengers on other modes of transportation in that a larger proportion are senior citizens and have lower incomes than either train or air passengers. Across the country college-age students also form a large percentage of bus riders. The implication is that bus passengers include more who are disadvantaged and far more who are captive riders than do other modes of public transportation. Among various states that have conducted analyses of the characteristics of bus riders, the proportion of seniors and youthful riders differs as do reports of income level. For example, a Tennessee study presented a series of passenger profiles for different cities that indicated that the age of the typical passenger was 20 in Chattanooga, Memphis, and Nashville, whereas the average passenger was between 56 and 65 years old in Cookville. The average income of Tennessee bus riders was between $7,501 and $15,000 in 1981 (8). In the state of Washington, 30 percent of bus riders were under the age of 25 and 30 percent were more than 60 years old, whereas 40 percent of the riders had family incomes of less than $10,000 (9).

Among the former ticket agents responding to the survey in Iowa, half reported that more than 75 percent of the former riders were senior citizens. This proportion differed considerably for those Iowa towns that still had bus service. Among those towns with bus service, 62 percent reported that less than half of their riders were seniors. Few ticket agents indicated any sizable number of young riders. An income-related question was not possible on a survey directed toward ticket agents.

Another general observation regarding bus passengers is that they travel shorter distances than do train or air passengers. For example, one report noted that the average distance of a bus trip was only about 125 miles (10,p.3). The reports from the Iowa ticket agents appeared to confirm this finding. Among the former ticket agents 62 percent noted that more than three-quarters of the passengers traveled less than 100 miles and within Iowa. That proportion was somewhat less for stops with continuing service. In three-quarters of those communities, 50 to 74 percent of the passengers bought tickets for trips of less than 100 miles. Except for towns near the state borders, only a small proportion of stops had riders traveling out of state. Among those locations with discontinued service only 25 percent reported that a substantial number of passengers had purchased out-of-state tickets. Of the stops with continuing service 62 percent indicated substantial interstate travel; most trips were to neighboring Omaha, Nebraska, or to Sioux Falls, South Dakota. Jack Rabbit Lines, now serving towns in the extreme northwestern part of Iowa, is based in South Dakota and runs shuttles to Omaha. Only one location, which is near a large lake with boating and camping facilities, indicated substantial long-distance interstate travel.

The primary trip purpose for those riding the bus is generally noted as to visit friends and relatives or for social or recreational use. This was true for by far the largest proportion of riders in surveys conducted in Oregon, Georgia, Texas, Michigan, Wisconsin, Idaho, Indiana, and Tennessee and recorded in a study by the Motor Carrier Ratemaking Study Commission (4,p.309). In a 1978 report of the American Bus Association, it was noted that 88 percent of bus trips were for personal visits or recreation. Although no quantifiable data on trip purpose could be acquired from former ticket agents, anecdotal reports obtained at the conclusion of the follow-up telephone interviews confirmed that Iowa's bus riders also travel for family visits or recreation. Trips to school by college-age youth appear to be highly seasonal and not a substantial factor in the towns surveyed.

Since 1976 senior citizens and other transportation-disadvantaged persons in Iowa have been provided an increasing amount of short-distance public transit service for trips to the doctor, social service agencies, personal business locations, congregate meal sites, shopping, and handicapped training programs (2,p.7). However, only two ticket agents were aware of a rural public transit service. Except for the automobile, only intercity bus service can provide for independent recreational travel and visits to family and relatives outside of town. Reports supplied by ticket agents underscored the former riders' reliance on the intercity bus for this service and the lack of adequate replacement service to fill this need. For example, one agent cited a former passenger who had to cancel her annual vacation trip because there was now no way to get to a city about 60 miles away where the tour group assembled. Other agents commented that former passengers just do not have the opportunity to travel outside town any longer. They underscored the traditional independence of older Iowans, which prevented them from asking friends or relatives to drive them to other towns or cities. Quantifiable information on whether former riders had drivers' licenses or access to automobiles could not be obtained from ticket agents. Nevertheless, anecdotal information gained in the telephone interviews appeared to confirm the findings of the Motor Carrier Ratemaking Study Commission in assessing impacts of deregulation on older Americans. Their report noted that on the basis of rider surveys in Georgia, North Carolina, Texas, Washington, and Wisconsin, approximately one-third of the intercity bus passengers had either no driver's license or no vehicle available for the trip (4,pp.274,310,311). The majority of the ticket agents who noted a high proportion of senior citizen riders also noted that these individuals had no other means of travel.

The distance to the nearest continuing bus stop is, of course, another measure of relative impact, given the availability of means to get there. The Motor Carrier Ratemaking Study Commission reported that surveys of riders and households in North Carolina found that 68 percent of the respondents lived within 9 miles of the nearest bus stop. In Tennessee 63.4 percent of the bus passengers lived within 10 miles of a bus stop (4,pp.383-384). Among the small towns losing service in Florida, all were within 9 to 21 miles of continuing service (1,p. 118). The findings in Iowa suggested an average distance that was considerably farther than that in the other states. The range reported was from 1 to 36 miles; 69 percent of the former agents noted that the next stop was more than 11 miles away; and 37 percent stated that the next stop was more than 20 miles away. For only two locations did discontinuance have a minor impact. In these cases streamlining service had moved the stop from a downtown location to the highway 1 mile away. For those towns with the nearest bus stop more than 20 miles away, the impact of discontinuance was effectively to eliminate intercity bus travel for the residents unless they had personal access to an automobile.

As indicated in the foregoing discussion, persistence of the ridership can be determined in part by the number of passengers who board the bus at a specific stop. Another important measure in determining salience of demand for service, however, is the level and regularity of protest generated by the discontinuance. In Iowa as in Florida little formal protest has been noted. There have, however, been two exceptions. In one town slated for discontinuance of service, a local church leader mobilized citizens to protest the loss of transportation by the residents in the town's senior citizens' home. The effort was most successful. One of the hearings relating to the BRRA was held in that small town, and Greyhound Bus Lines dropped their plans to bypass the town. Unfortunately since then ridership from that town has fallen off considerably. Only about 20 people a month now buy tickets compared with about 80 a month in 1982. Package shipments used to gross about $400 a month, and now the figure has fallen to about $200 a month. The ticket agent believed that the publicity surrounding the initial plan to drop the stop has continued to affect its use. People regularly call in and are surprised that the stop is still functioning (Iowa Department of Transportation, unpublished data).

In one other town the ticket agent urged disappointed riders to write to the company complaining about discontinuance. They did, but received no response. There was then no effort to follow up with the Iowa Department of Transportation or the Iowa Transportation Regulatory Authority. In the case of at least one community, service was withdrawn so abruptly that even the ticket agent was not informed; consequently no formal protest was initiated. With deregulation, bus companies have not always believed it necessary to announce discontinuance, although that is specified in the BRRA. Consequently an unprofitable route in west central Iowa was informally abandoned (Iowa Department of Transportation and Iowa Transportation Regulatory Authority, unpublished data). The ticket agent from another town appeared to sum up the feelings of many: "It's too late. We were talked out of railroads on a national level [and now we are losing our buses too]."

A number of ticket agents, however, reported informal protests. Former riders came in and complained about service cancellation. Two years after service discontinuance some agents are still receiving calls requesting information about bus service and expressing concern that there is no longer a bus stop nearby. Former passengers at 62 percent of the discontinued stops had registered informal protests. All stops that had handled more than 10 passengers a month noted informal protests as did half of those that had had less than 10 a month. The amount of protest was not significantly related to either the proportion of riders traveling out of state or to the distance they generally traveled within the state. The percentage of former riders over age 60 also was insignificantly related to the amount of informal protest received. Concern over elimination of specific stops is therefore not linked to any segment of the transit-oriented public. Despite the small numbers of actual riders involved, the effect on the quality of life of individual Iowans living in small towns is substantial.

Dissatisfaction regarding discontinuance of bus service generated comments regarding the increased cost of package shipment as well as greater restrictions on the type of packages that could be shipped. All ticket agent respondents indicated that without bus service, shipments are generally made by the United Parcel Service (UPS). Yet Iowans, much like others affected by the discontinuance of bus service, quickly discovered that UPS does not offer weekend delivery and does not handle irregularly shaped packages or packages weighing more than 50 lbs. One former agent indicated that a major firm in his town had to make arrangements to transport materials to the nearest bus stop 17 miles away because UPS could not handle the size and shape of its products.

The impacts of deregulation have not, however, been totally negative. Among several of the stops still operating, the number of passengers has increased because dedicated bus riders have made the effort to travel from discontinued stops to the closest available stop. After a number of stops on IA-6 had been closed, Greyhound Lines initiated a new stop at an exit on I-80. This stop was also designated as the rest stop for Greyhound buses traveling along the Interstate. Six to eight buses stop a day and riders get off and make purchases at the restaurant while the buses refuel. The income generated by this change has been considerable and additional employees have been hired to handle the rush periods. The relative benefits of this change need to be weighed against the inconvenience to residents of the small towns who travel to this highway stop.

In general the impact of the discontinuance of stops on the economy of the towns involved has been minimal. Few of the main businesses of the ticket agents were adversely affected. Three agents indicated a loss in revenue from package service, but the others indicated that there was so little financial return associated with package shipping that it was not worth the paperwork involved. The majority indicated that so few people were passengers or shippers that the economy of the towns was relatively unaffected.

BROADER PERSPECTIVES AND CONCLUSIONS

The costs involved in continuing regular bus service to towns generating as few as 10 passengers a month are no doubt prohibitive, and if bus service is to continue at all, companies must have the right to streamline service as has been advocated by Greyhound and other bus companies (1,11). Nevertheless, the costs of deregulation to affected residents of small communities are not minimal. When numbers are aggregated, the interests of small towns can and are often overlooked. The ease of entry into as well as exit from service was underscored by those maintaining that deregulation could benefit small towns (1,p.125). Within Iowa, Jack Rabbit Lines has indeed assumed service to some of the towns abandoned by Midwest Coaches when it went bankrupt, but this process was also possible under earlier legislation. Routes of Ottumwa Trailways have also been adjusted to include some different towns in southeast Iowa. However, on the whole, deregulation has not stimulated smaller companies to enter the market to serve more small towns, unlike the situation in Florida (1). A concept that potentially could have far greater positive impact on small towns was suggested by the Iowa Department of Transportation. With the aid of a grant from UMTA, a demonstration project featuring interaction between a variety of public and private transit services and Jefferson Bus Lines, an affiliate of Greyhound, was initiated in fall 1984.

Five of Iowa's public transit regions that are traversed by Jefferson Lines have developed individual plans for feeder service to the Jefferson Lines through stops at several key transfer points. The types of feeder service range from a demand-responsive taxi to a regularly scheduled connecting bus (Iowa Department of Transportation, unpublished data). A telephone number with an 800 area code provides information on connecting service to travelers who can potentially connect with Jefferson Lines. The hope is that through such a feeder service, small towns that are not directly served by a line-haul bus can have access to transit facilities.

No needs studies have been conducted but the expectation is that there is sufficient latent demand in small Iowa towns to generate ridership. Most of the towns specifically targeted for feeder service were not among those to which intercity bus service had been discontinued. However, one of the towns now connected by a feeder bus was included in the survey. That town, which manufactured recreational vehicles, had lost service 2 years ago and had a unique need for return transportation for individuals who had delivered recreational vehicles to nearby towns. Intercity bus service had not been heavily used in the town before, but the specific needs of these individuals warranted some type of service. In another substate transit region a town had earlier requested service from the Jefferson Lines, thereby indirectly suggesting a need. In still another substate region residents of a town that has never had service are being mobilized for participation by a volunteer transit advocate. The town should have a potential base for ridership because it houses a community college and is located in an area of the state that has a fairly sizable low-income population.

These various experimental projects are unified only in that they all are intended to deliver passengers to transfer points on the Jefferson Lines through bus. Should they be successful in providing a needed outlet for potential riders in these towns, the experiment might well be replicated for other small towns. As such, the interlining project suggests a potential benefit to small towns that would not have been possible without deregulation.

In conclusion, it is apparent that the impacts of bus deregulation on the residents of small communities of Iowa have held few surprises. The changes in the bus schedules and discontinuance of stops have affected relatively few individuals, but those affected represent an important element of the population in a state like Iowa, which is dominated by small towns and rural areas and which has the third highest population of elderly citizens in the nation (12). Because there are no alternative forms of travel available to individuals living in isolated communities, the impact on their quality of life is substantial. The automobile, the preferred means of transportation for most Iowans, is not available to small-town residents who cannot drive. Public transit, which is well developed in Iowa, is an answer to a number of travel needs but cannot provide for individual visits to relatives and friends and cannot answer the need of older Iowans for independent travel. Changes in package shipments, although again not critical to large segments of the population, affect small shippers in isolated towns, and this group is again an important portion of the population of a state with numerous, scattered small businesses.

The public-private feeder system may have the potential of meeting the needs of residents of a number of small towns and even in its initiation responds to the needs expressed in many states for public assistance in mitigating the impacts of bus deregulation on small towns (9,13,14). It is hoped that the program can proceed with a minimum expenditure of federal funds in concert with local public and private initiatives.

The impacts of bus deregulation on residents of small towns cannot be disregarded because of the small numbers of people involved. Instead imaginative ways must be found to respond to the needs of those people, given the environment created by deregulation.

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The Domestic Demand for Airmail Service by the U.S. Postal Service

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ABSTRACT

The domestic demand for air freight service (i.e., the domestic air transportation of U.S. mail by the U.S. Postal Service) is investigated. Two types of air freight service are considered--loose sack and containerized. Input share equations derived from minimizing the translog cost function for the U.S. Postal Service are estimated. It is concluded that the own-price elasticity of demand for airmail service by the U.S. Postal Service is responsive and that the elasticity for containerized service is generally more responsive than that for loose-sack service. Consequently, air freight carriers can increase airmail revenue by decreasing rates for containerized service relative to those for loose-sack service.

Given the availability of data from the U.S. Postal Service (USPS), the purpose of this paper is to investigate the domestic demand for air freight service by USPS (i.e., in the air transportation of U.S. mail). Even if data were available for other types of air freight service, it would still be desirable to investigate separately the air freight demand for U.S. mail. Because freight transportation is an input into the firm's production process, an explicit freight demand equation can be derived from the cost function of the firm (or shipper). A similar approach was adopted by Friedlaender and Spady (1) for rail and truck freight transportation. Alternatively, studies that do not consider an explicit freight demand equation but rather simply regress transportation volume against rates, shipment characteristics, and other variables that are intuitively appealing make evaluation of the results difficult because of the uncertainty of the biases introduced by the specification error.

AIR FREIGHT DEMAND FUNCTION

In providing mail service, USPS hires designated air carriers to transport mail to destination cities or distribution centers. Air carriers, in turn, provide two general types of air service: loose sack and containerized. Containerized service involves the transportation of mail in containers supplied by the designated carriers; loose-sack (noncontainerized) service involves the transit of mail by means of the conventional canvas bags. For a sufficiently large volume of mail destined for a given location, air carriers are in a position to charge a lower rate for containerized service, because it reduces the handling costs of large mail shipments at air terminals. Therefore, the advantage of containerized versus loose-sack service to USPS is that the container rate per pound mile for a sufficiently large volume of mail (to a given destination) is lower than the corresponding loose-sack rate. Alternatively, if the mail poundage to be shipped is less than the minimum necessary quantity for containerized shipment, the loose-sack rate per pound mile will be lower. Hence there is a breakeven point in terms of mail poundage at which the two rates are identical.

Because decisions related to USPS's demand for air freight service are made at its airmail facilities, a cost function for these facilities will be specified in the following discussion. This function, in turn, will be used in the derivation of input share equations that indirectly consider the demand for loose-sack and containerized air service by USPS.

An airmail facility (AMF) is a regional collection and distribution center, that is, a central post office where outgoing mail from local post offices is consolidated for air freight movement to destination AMFs. In addition, it is a facility where incoming mail is received and distributed to local post offices. Therefore, for analytical purposes, an AMF may be treated as a firm that produces output (volume of mail moved) by combining optimal levels of productive inputs on the basis of cost minimization. Thus, in addition to the primary inputs discussed previously (i.e., the two air transit modes), labor and capital will be utilized. AMFs will employ various types of labor (e.g., office worker, dock driver, and managerial labor). Likewise, the capital input for AMFs will be heterogeneous in nature, consisting of floor space, vehicles, and various types of mechanized sorting equipment.

For smaller regional AMFs it is likely that for-hire truck transportation is an economically feasible alternative to air freight transit of mail. In fact, a 1982 report by the U.S. General Accounting Office (2) recommended that short-haul high-cost mail be diverted to for-hire truck carriers. Such an option, however, is not workable for long-haul routes of the larger AMFs considered in this study. Therefore, for-hire truck carriers are not included in the AMF variable-cost function. For the AMFs treated here, mail is moved either by USPS trucks (included in the capital variable) or by the two air transit modes.

Let us assume that the general form of the USPS short-run variable-cost function for a given AMF (where capital is the fixed input) may be expressed as

$$VC = VC(W_{Ai}, W_{Lk}, Q; \bar{K}_m) \quad (1)$$

where

- VC = short-run variable cost incurred by a given USPS AMF,
- W_{Ai} = air freight rate per pound mile incurred by a given USPS AMF for the ith type of air freight service,
- W_{Lk} = wage rate per hour incurred by a given USPS AMF for the kth type of labor,
- Q = pounds of airmail transported from a given USPS AMF, and
- $\bar{K}_m$ = fixed amount of capital of the mth type at a given USPS AMF.

Friedlaender and Spady (1), in utilizing this methodology, have included inventory cost variables in the short-run cost function. For the USPS case, however, such variables are clearly unnecessary because inventory costs are zero by definition. Such costs are a factor only when output is owned by the firm. Note that the output variable specified in Equation 1 is outgoing mail only. A better output variable would be total mail volume (i.e., incoming and outgoing) handled at a given AMF. Data limitations, however, precluded this approach. Therefore outgoing volume was used as a proxy on the assumption that the ratio of outgoing to total mail volume is reasonably stable. Because the AMFs in this sample are relatively homogeneous in terms of size, this assumption would appear to be reasonable.

In order to derive a specific functional form for the USPS air freight demand function (i.e., an input share or direct demand function), it is assumed that Equation 1 can be expressed as a translog approximation. This function can be viewed as a second-order Taylor's series expansion in the logarithms of the variables of Equation 1.

Specifically, the translog approximation of the foregoing short-run cost function given in Equation 1 can be written as follows:

$$\begin{aligned}
\ln VC = {} & \alpha_o + \sum_i \alpha_i \ln W_{Ai} + \sum_k B_k \ln W_{Lk} \\
& + \gamma \ln Q + \sum_m \theta_m \ln \bar{K}_m \\
& + \sum_{ik}\sum A_{ik} \ln W_{Ai} \ln W_{Lk} + \sum_i B_i \ln W_{Ai} \ln Q \\
& + \sum_k D_k \ln W_{Lk} \ln Q + \sum_{im}\sum E_{im} \ln W_{Ai} \ln \bar{K}_m \\
& + \sum_{km}\sum F_{km} \ln W_{Lk} \ln \bar{K}_m + \sum_m G_m \ln \bar{K}_m \ln Q \\
& + \sum_{ij}\sum H_{ij} \ln W_{Ai} \ln W_{Aj} + \sum_{ks}\sum I_{ks} \ln W_{Lk} \ln W_{Ls} \\
& + \sum_{mr}\sum N_{mr} \ln \bar{K}_m \ln \bar{K}_r + (1/2) J (\ln Q)^2 \\
& + (1/2) \sum_i M_{ii} (\ln W_{Ai})^2 + (1/2) \sum_k O_{kk} (\ln W_{Lk})^2 \\
& + (1/2) \sum_m P_{mm} (\ln \bar{K}_m)^2 \quad i \neq j,\ k \neq s,\ m \neq r
\end{aligned} \quad (2)$$

Differentiation of this equation with respect to the input price ($\ln W_{Ai}$) of air freight service yields the following input share equation for this service:

$$\begin{aligned}
E_{Ai}/VC = \partial \ln VC / \partial \ln W_{Ai} = {} & \alpha_i + \sum_k A_{ik} \ln W_{Lk} + B_i \ln Q \\
& + \sum_m E_{im} \ln \bar{K}_m + \sum_j H_{ij} \ln W_{Aj} + M_{ii} \ln W_{Ai}
\end{aligned} \quad (3)$$

where E_{Ai} is the expenditure on air freight service of the ith type by a given USPS AMF.

From Shephard's lemma (3) the input share Equation 3 may be interpreted as a derived demand equation for a given AMF for freight service of the ith type. This interpretation follows, because E_{Ai} may be alternatively expressed as $W_{Ai}X_i^*$ where X_i^* is the cost minimizing input service level of the ith type of air freight service.

EMPIRICAL RESULTS

Data for estimation of input share Equation 3 for the ith type of air freight service were obtained from USPS. Two types of air freight service are considered--loose sack and containerized. However, the incorporation of containerized service in this study greatly reduced the size of the sample, because relatively few AMFs utilize containerized service. This follows because only relatively large AMFs can take advantage of the lower containerized rates. A city of the size of Norfolk, Virginia, for example, does not have sufficiently large amounts of airmail (for given destinations) for the containerized rate to be less than the loose-sack rate. Consequently, the Norfolk USPS airmail facility receives only loose-sack air freight service. Although the incorporation of containerized service in this data set greatly reduced the sample size, it is believed that the likely future importance and growth of containerized air service warrants its inclusion in the study.

Given the incorporation of containerized service, the data set is therefore restricted to 17 USPS AMFs for the 1981 USPS fiscal year. Data on capital costs were not available; thus it is assumed that the rental price of capital (W_{cm}) is constant across sample AMFs. Hence W_{cm} will not appear in the equation to be estimated. Because the AMFs in this sample are homogeneous in terms of relative size, it is probable that the variance in W_{cm} is small. Therefore, this assumption may be less restrictive than it initially appears. With respect to labor, available data were in terms of average wage rates (i.e., direct labor compensation per employee). It is therefore not possible to distinguish between different types of labor at each AMF. Consequently, in the equation to be estimated, a single labor input is included. Finally, because two types of air freight service are being analyzed, only one cross-price coefficient will appear in each equation. Thus the input share equation for the ith type of air freight service is of the following form:

$$S_{Ai} = \alpha_i + A_i \ln W_L + B_i \ln Q + H_{ij} \ln W_{Aj} + M_{ii} \ln W_{Ai} \qquad (4)$$

where W_L is the average wage rate per hour incurred by a given USPS AMF and $S_{Ai} = E_{Ai}/VC$. (Note that if i refers to loose-sack air service, then j will refer to containerized air service and conversely.)

A requirement for the cost function (from which Equation 4 would be derived) to be well behaved is that it be homogenous of degree 1 in input prices. This requirement implies the following restrictions on the parameters in Equation 4:

$$\alpha_{LS} + \alpha_C + \beta = 1 \qquad (5)$$

$$B_{LS} + B_C + B_L = 0 \qquad (6)$$

$$A_i + H_{ij} + M_{ii} = 0 \qquad i = LS, C, L; \quad j = LS, C \qquad (7)$$

where β is the intercept parameter in the labor input share equation. (Note that LS refers to loose-sack service, C refers to containerized service, and L refers to labor.)

Because there are only three variable inputs (labor, loose-sack air service, and containerized air service), it is unnecessary to estimate an input share equation for labor. However, because the input share equations are jointly determined, it is necessary to impose symmetry restrictions on M_{ij}. Specifically:

$$M_{ij} = M_{ji} \qquad i \neq j, \ i; \ j = LS, C, L \qquad (8)$$

Because the input share Equation 4 is not a direct demand equation, estimates cannot be obtained of the own-price elasticity of demand for loose-sack and containerized air freight service directly from these equations. However, Berndt and Wood (4) have shown that the own-price elasticities for loose-sack (ε_{LS}) and containerized (ε_C) air service can be derived for a given USPS AMF by using the following relationships:

$$\varepsilon_{LS} = (M_{LS,LS}/S_{A,LS}) + S_{A,LS} - 1 \qquad (9)$$

$$\varepsilon_C = (M_{C,C}/S_{A,C}) + S_{A,C} - 1 \qquad (10)$$

where M_{ii} is the same as defined previously, $S_{A,LS}$ is the estimated input cost share for loose-sack air service for a given AMF, and $S_{A,C}$ is the estimated input cost share for containerized air service for a given AMF.

The estimated input share equations for USPS air freight service by using a cross section of 17 USPS airmail facilities in fiscal year 1981 are as follows:

$$S_{A,LS} = \underset{(-0.02308)}{-0.4428} + \underset{(2.3462)}{0.0786} \ln W_L + \underset{(0.2990)}{0.0027} \ln Q + \underset{(1.3614)}{0.0185} \ln W_{A,C} - \underset{(-3.1884)}{0.0971} \ln W_{A,LS} \qquad \bar{R}^2 = 0.2488 \qquad (11)$$

$$S_{A,C} = \underset{(-0.02906)}{-0.4260} + \underset{(2.1307)}{0.0458} \ln W_L + \underset{(1.1719)}{0.0070} \ln Q + \underset{(1.3614)}{0.0185} \ln W_{A,LS} - \underset{(-3.2744)}{0.0644} \ln W_{A,C} \qquad \bar{R}^2 = 0.1458 \qquad (12)$$

(t-Statistics are given in parentheses.)

The signs of the coefficients in Equations 11 and 12 agree with a priori expectations with the possible exception of the wage variable ($\ln W_L$). The positive sign for the wage coefficient in both equations indicates that as the average wage rate for labor increases, the proportion of variable cost allocated to air freight service for a given AMF is expected to increase. Initially the result appears to be counterintuitive. However, as previously noted, only relatively large AMFs are considered in this study. If larger AMFs incur higher wage costs per unit of labor and spend more on air freight service (as a percentage of total variable cost) than relatively smaller facilities, it therefore follows that the sign of the wage coefficient would be positive. In Equation 11, the own input price and wage variables are significant at the 0.01 and 0.05 levels, respectively; in Equation 12, these variables are significant at the 0.01 and 0.10 levels, respectively. Note that the sign of $\ln W_{A,C}$ in the loose-sack input share and the sign of $\ln W_{A,LS}$ for the containerized input share equations are positive but insignificant. This result is expected, because loose-sack and containerized transit modes are not substitutes. For containerized transit to be feasible on a cost-minimization basis, it is necessary that $Q \geq Q_{min}$ (where Q_{min} is the minimum required volume for containerized shipment); otherwise loose-sack service is less expensive. Therefore, rational behavior precludes substitutability between the two modes.

TABLE 1 Own-Price Elasticity of Demand for Loose-Sack and Containerized Air Mail Service

	Type of Service	
Origin Point	Loose Sack	Containerized
Atlanta	-1.88681	-13.92982
Boston	-2.76906	-5.76914
Cleveland	-6.55869	-3.31143
Denver	-1.88118	-6.52904
Dallas/Ft. Worth	-2.49213	-10.43473
Detroit	-2.41454	-8.86267
Newark	-1.69706	-1.86677
New York-Kennedy	-1.76288	-3.07705
Los Angeles	-1.95935	-5.84351
Minneapolis	-2.80426	-3.72580
Chicago-O'Hare	-3.33218	-15.64017
Portland	-1.58988	-3.68895
Seattle	-1.73881	-2.31735
San Francisco	-4.02041	-2.54078
San Juan	-2.53856	-4.63075
Sacramento	-2.90853	-10.25611
St. Louis	-4.45354	-3.31143
Avg	-2.26970	-3.88397

By using Equations 9 through 12, the own-price elasticities for loose-sack and containerized air freight service for each AMF in the sample were computed and are presented in Table 1. For every AMF except three, the own-price elasticity for containerized service was more responsive than that for loose-sack service. The three exceptions are the Cleveland, San Francisco, and St. Louis AMFs. In the consideration of all AMFs, the average own-price elasticity for containerized service of -3.88397 was more responsive than the average of -2.26970 for loose-sack service. Further, note that the own-price elasticity for both air freight services is responsive for every AMF.

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