# Bus and Shared-Ride Taxi Use in Two Small Urban Areas

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**The demand for publicly owned fixed-route, fixed-schedule bus service was compared with the demand for privately owned shared-ride taxi service in Davenport, Iowa, and Hicksville, New York, through on-board surveys and cab company dispatch records and driver logs. The bus and shared-ride taxi systems in Davenport competed for the off-peak-period travel market. During off-peak hours, the taxis tended to attract social-recreation, medical, and personal business trips between widely scattered origins and destinations, while the buses tended to attract shopping and personal business trips to the CBD. The shared-ride taxi system in Hicksville, in addition to providing many-to-many service, competed with the countywide bus system as a feeder system to the Long Island commuter railroad network. In each study area, the markets of each mode of public transportation were similar. There were no statistically significant differences between bus and shared-ride taxi users in Davenport relative to ability to drive, household income, employment status, number of automobiles available to the household, and physical capabilities. Bus and shared-ride taxi users in Hicksville differed slightly in age, household income, number of automobiles available to the household, and distance from home to bus stop. In general, a major portion of the market of both shared-ride and taxi systems were of people likely to be dependent on some form of public transportation for some of their trips.**

Although the concept of demand-responsive transportation has been studied extensively, its most common form, the taxicab, has received little attention. Most of the research and development in demand-responsive transportation has been concerned with the publicly owned fleets of small buses and vans known as dial-a-bus or dial-a-ride systems, and the taxicab has been regarded as a relatively expensive, premium service that transports only one fare at a time. This image may be partially to blame for the fact that the taxicab is largely ignored in transportation planning.

The relatively few studies of taxicab operations have shown that taxis serve many markets (1, 2, 3, 4, 5, 6) and transport large numbers of housewives, senior citizens, nondrivers, the poor, the unemployed, and the handicapped as well as wealthier residents, male white-collar workers, tourists, and nonresident businessmen. They are used for work and business-related trips to and within CBDs and for short social, shopping, medical, and personal business trips.

In many small cities and in many suburbs of large metropolises, buses and taxicabs operate within the same jurisdictions and may compete for the same public transportation market. Two examples of small communities in which buses and taxis coexist are Davenport, Iowa, and Hicksville, New York. The markets, economic characteristics, organization, management, and operation of the taxicab systems serving these communities were analyzed in a recent study (7). This paper analyzes the demand for bus and taxicab service in these cities to provide an insight into the roles and potential of privately owned demand-responsive transportation in such areas.

## DISTINCTIVE FEATURES OF PROJECT

Several features of this project distinguish it from much of the previous research on demand-responsive transportation and taxicab use. First, the project was concerned with two taxicab systems that operated in a manner more like a dial-a-ride service than like a typical taxicab service. Both cab companies used the ride-sharing method of operation in which, in scheduling and routing the cabs, the dispatcher attempts to pool passengers traveling in the same direction into the same cab. Additional riders are accommodated in a cab only when the passengers already in the cab are not unduly inconvenienced. Accordingly, cabs are seldom diverted more than four blocks and are never required to backtrack to serve additional passengers. One of the principal advantages of this method of operation is higher vehicle productivity. At present, ride sharing is not widely practiced by the taxicab industry. In many cities it is either specifically prohibited by ordinance or is permitted only on the consent of the first passenger. It is also precluded in cities where taxi operators are required to use meters. Although the shared-ride taxi systems of Davenport and Hicksville are not the only operations of this type in the United States, the actual number appears to be small. There are, however, indications that the number is increasing. Second, this project involved a study of

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demand-responsive transportation services that competed with conventional fixed-route, fixed-schedule bus services for some of its market. Most of the publicly owned demand-responsive transportation systems currently operating have been implemented to provide public transportation where none previously existed, to replace lightly used bus routes, or to augment available bus and rapid-rail transit service. Finally, unlike most previous studies of actual demand-responsive transportation systems, this project was not a demonstration project, nor was it concerned with new or experimental services. The cab company in Hicksville had been offering shared-ride taxi service since 1961, while the cab company in Davenport had initiated it in 1967. Both systems were therefore well established.

## BACKGROUND

### Study Areas

The study areas of Davenport, Iowa, and Hicksville, New York, are dissimilar in location, size, population characteristics, and other respects. Davenport is one of four incorporated communities in a cluster known as the Quad Cities, a metropolitan area having a population of approximately 300 000. It is the largest of the four communities, with a 1970 population of nearly 98 500, almost 11 percent higher than in 1960. Situated along the Mississippi River, the Quad Cities are an important midwestern trade and industrial center. Hicksville, however, is an unincorporated community in Nassau County on Long Island. It is the smaller of the two study areas in terms of population, with a 1970 population of 48 100, 4.6 percent lower than in 1960. Although it, too, is the site of a large number of diverse industries, it is also a major transportation hub, with the local Long Island Railroad station handling the largest number of commuter rail passengers of any station on the island. Household incomes and the number of automobiles per household are much higher in Hicksville than in Davenport, while the population of Davenport contains a higher percentage of persons over 65 years old. These differences in the characteristics of the two areas enabled the researchers to determine the markets for shared-ride taxi service in dissimilar communities.

### Bus Services

The bus systems serving Davenport and Hicksville are typical of many interurban bus systems throughout the United States. Both operate on fixed headways along established routes that converge in the CBD. Both have had the same ruinous problems of rising costs and declining patronage that have plagued much of the transit industry. Consequently, at the beginning of this study, both were making the transition from private to public ownership and operation.

### Shared-Ride Taxi Services

Although both taxi systems provide shared-ride service, the two differ in several important respects. The Davenport firm maintains a smaller fleet—approximately 20 Checker cabs, compared to approximately 30 Dodge passenger cars in Hicksville—to cover a much larger service area. Although the fare schedule in each community is based on a network of zones, that of the Davenport system is considerably lower. [For the shared-ride level of service, the base fare in Davenport is 75 cents with an incremental charge of 25 cents/zone, while in Hicksville the minimum fare is $1.00 with an incremental charge of $0.32/km ($0.50/mile).] This disparity in the fare levels reflects the different market strategy of each firm. The management of the system in Davenport is more interested in increasing its share of the market and maintaining high volumes through relatively low fares but the Hicksville strategy involves higher rates and a carefully controlled fleet size in order to maintain a wide profit margin. These differences may affect the level of performance and the market composition of each system.

### Data Collection

The primary sources of information for this study were the dispatching records maintained by the shared-ride taxi companies, and the reports of the bus and taxi users themselves. A special form, the customer data record, designed to record the information on cab dispatch tickets and driver logs, was completed for each request for cab service. The data obtained from this form included the time at which the request for service was received, the time at which a cab was dispatched to handle the request, the origin and destination of the trip, arrival times of the cab at the origin and destination, the number of passengers involved, and the level of service (shared- or exclusive-ride) requested. Between April 1973 and January 1974, information on the operation of the shared-ride taxi systems was collected for 20 days in Davenport and 17 days in Hicksville.

Two surveys using a dual questionnaire that consisted of a form to be completed while traveling in the bus or cab and a form to be completed later and returned by mail were conducted in each study area. Additional information was obtained from a home interview survey of the general public in each study area.

## LEVELS OF RIDERSHIP

During the study period the demand for shared-ride taxi service in Davenport averaged 1040 (from 750 to 1530) passengers/weekday, 1100 passengers/Saturday, and 650 passengers/Sunday. During the same period, the demand for shared-ride taxi service in Hicksville averaged 700 (from 380 to 970) passengers/weekday, 440 passengers/Saturday, and 250 passengers/Sunday. Both cab companies also offered regular taxi service that assured the passenger the exclusive use of the cab. However, this service was provided only upon request and for a much higher fare, and the demand for it was virtually nonexistent.

More persons traveled by bus than by shared-ride cab in Davenport; the buses usually carried 2500 to 3000 passengers on weekdays. However, between 1967 and 1972 patronage of the bus system had declined from 1.5 million to 750 000 passengers/year, while patronage of the shared-ride taxi system had risen from 174 000 to 485 000 passengers/year. Accurate estimates of bus patronage in Hicksville were not available. Since the bus system serves all of Nassau County and has 10 of its 67 routes converging at the regional shopping center and commuter rail station located near the center of Hicksville, the number of passengers from Hicksville itself could not be determined.

## COMPARISON OF ROLES AND MARKETS

One of the main objectives of this project was to determine the roles performed by the buses and taxis in Hicksville and Davenport, the markets served by each mode, and the amount of competition between the two modes through an analysis of the characteristics of bus and taxi trips, the characteristics of bus and taxi users, and the frequency of bus and taxi use. Although each

type of public transportation can perform certain functions better than the other, demand-responsive transportation services can replace poorly utilized portions of a conventional bus system and at the same time complement conventional fixed-route mass transit service.

## Trip Characteristics

### Temporal Distribution

One of the more obvious differences in the use of the bus and shared-ride taxi services is in the percentage of daily trips made during peak hours by bus and taxi.

| Place | Bus | Taxi |
|---|---|---|
| Davenport | 39 | 20 |
| Hicksville | 40 | 28 |

The concentration of demand for fixed-route bus service in the peak periods shows clearly that the bus systems are used intensively for daily commuting: The bus systems carried more than half of their passengers in the off-peak hours, but these buses were usually less than half full. The cab companies attracted a majority of their riders during periods of low-density travel demand. The analysis of the time distributions of shared-ride taxi trips showed an important difference in the roles of the two systems with the Hicksville cab company transporting a higher proportion of passengers in the peak periods than the Davenport company. This difference in peak-period demand is explained by the role of the Hicksville cab system as a feeder service to the Long Island Railroad.

### Spatial Distribution

The spatial pattern of bus and shared-ride taxi trip destinations showed another major distinction between the use of the bus and taxi services in Davenport. Although the CBD attracts a high percentage of both bus and taxi trips, the origins and destinations of cab trips are more widely scattered: Sixty-eight percent of the bus trips originate or terminate in the CBD but 62 percent of the shared-ride taxi trips begin and end at places outside it. The bus system in Davenport does not compete effectively with the shared-ride taxi system for trips that are not oriented toward the CBD because all of the routes radiate from the CBD, making trips between two noncentral locations lengthy and circuitous unless both trip ends are near the same bus route.

The shared-ride taxi service, however, does compete with the bus system for short trips to and from the CBD during off-peak hours. The individual choice between bus or cab involves a trade-off between the low bus fare and the more personalized door-to-door service of a taxi, and persons who travel frequently by public transportation tend to choose the bus while others tend to choose the taxi.

Taxi trips in the Hicksville area are much more highly centralized. On a typical weekday, approximately 65 percent of the taxi passengers travel to or from the CBD. The local commuter rail station and the Mid Island Plaza regional shopping center, both of which are located in the CBD, are the most frequent origins and destinations of shared-ride taxi trips.

The bus and shared-ride taxi systems in Hicksville compete for the trips to and from the CBD, particularly those trips to and from the commuter rail station. Approximately 52 percent of the bus and 65 percent of the taxi trips beginning and ending in Hicksville on a typical weekday are oriented toward the CBD. Residents often chose the taxi service instead of the bus service for trips to the commuter rail station because, at the time of this study, the bus schedule was not well coordinated with the train schedule. To many other residents, the taxi is the only form of public transportation available because their homes are located a long distance from a bus stop.

Since the bus system serving Hicksville links many of the communities in Nassau County, another possible role for the local shared-ride taxi system would be to provide a feeder service to the bus system for long trips within the county, but the bus and taxi systems were not as well integrated as the taxi and commuter rail systems at the time of this study.

### Trip Purpose

The percentage distribution of bus and taxi trips by purpose is shown below:

| | Davenport | | Hicksville | |
|---|---|---|---|---|
| Trip Purpose | Bus | Taxi | Bus | Taxi |
| Work | 59 | 47 | 62 | 55 |
| School | 5 | 3 | 7 | 3 |
| Shopping | 18 | 9 | 23 | 18 |
| Social-recreation | 5 | 11 | 2 | 7 |
| Medical | 4 | 18 | 2 | 6 |
| Personal business | 9 | 12 | 4 | 11 |

Both the bus and taxi services in Davenport are most frequently used for traveling to and from work. The bus system, however, carries a significantly higher proportion of the work trips. These trips are normally made during the peak periods to work locations in the CBD: taxi work trips are usually those made to noncentral work locations or at irregular times or both, such as after the bus system has ceased operation for the night.

The distribution of nonwork trips shows several other differences in the roles of the bus and shared-ride taxi services in Davenport. The bus system is used more frequently (over 40 percent of its nonwork trips) for shopping. The shared-ride taxi service is used to a lesser degree for shopping and to a greater degree (over 80 percent of the nonwork trips) for social-recreation, medical, and personal business purposes. These infrequent trips, which are normally made during periods of low-density travel demand and between widely scattered locations, are served well by regular or shared-ride taxi services.

Both the bus and shared-ride taxi systems in Hicksville are used primarily for work and shopping trips. The taxis are commonly used by commuters for transportation to and from the commuter rail station rather than directly to and from work location. As in Davenport, the taxis carry a higher percentage of social-recreation, personal business, and medical trips than the buses.

Because of its role as a feeder system, the Hicksville shared-ride taxi system carries a significantly higher percentage of work trips than does its counterpart in Davenport. There is also a significantly higher demand for shared-ride taxi service to shopping facilities in Hicksville. Other differences and similarities in the demand for shared-ride taxi service in the two study areas are shown in Table 1, which lists the most common unidirectional taxicab movements in the order of their frequency of occurrence.

One important similarity between the two shared-taxi systems is the strong orientation of taxi trips toward residences. In each study area, most taxi trips were home-based: Trips directed to or from residences account for 83 percent of the total on the average weekday

**Table 1. Principal shared-ride taxi movements on weekdays.**

| Origin | Destination | Average No. Trips/Day | Percentage of Trips |
|---|---|---|---|
| Davenport | | | |
| Residence | Residence | 203 | 19.7 |
| Residence | Business | 189 | 18.3 |
| Business | Residence | 125 | 12.1 |
| Cab terminal | Residence | 78 | 7.6 |
| Residence | Medical facility | 50 | 4.9 |
| Tavern | Residence | 45 | 4.4 |
| Medical facility | Residence | 39 | 3.8 |
| Business | Business | 35 | 3.4 |
| Hotel-motel | Business | 21 | 2.0 |
| Hicksville | | | |
| Rail station | Residence | 135 | 19.4 |
| Residence | Rail station | 88 | 12.7 |
| Shopping center | Residence | 69 | 9.9 |
| Residence | Shopping center | 50 | 7.2 |
| Residence | Residence | 49 | 7.0 |
| Residence | Business | 41 | 5.9 |
| Business | Residence | 31 | 4.5 |
| Residence | Public facility | 26 | 3.7 |
| Rail station | Business | 21 | 3.0 |
| Public facility | Residence | 19 | 2.7 |
| Residence | Medical facility | 14 | 2.0 |

**Table 2. Characteristics of bus and shared-ride taxi users (percent distribution).**

| Characteristic | Davenport | | Hicksville | |
|---|---|---|---|---|
| | Bus Users | Taxi Users | Bus Users | Taxi Users |
| Sex | | | | |
| Male | 21 | 31 | 28 | 31 |
| Female | 79 | 69 | 72 | 69 |
| Age (years) | | | | |
| Under 16 | 4 | 3 | 7 | 1 |
| 16 to 21 | 13 | 12 | 19 | 12 |
| 22 to 44 | 23 | 41 | 29 | 42 |
| 45 to 64 | 38 | 29 | 39 | 41 |
| Over 64 | 23 | 14 | 7 | 4 |
| Household income ($) | | | | |
| Under 5000 | 32 | 31 | 20 | 5 |
| 5000 to 9999 | 33 | 33 | 23 | 20 |
| 10 000 to 14 999 | 18 | 19 | 26 | 33 |
| 15 000 to 19 999 | 11 | 11 | 20 | 23 |
| 20 000 and over | 5 | 6 | 11 | 18 |
| Employed | 67 | 63 | 70 | 70 |
| Retired | 15 | 11 | 5 | 3 |
| Housewives | 13 | 23 | 11 | 24 |
| Students | 12 | 7 | 21 | 5 |
| Handicapped | 5 | 9 | 3 | 4 |
| Nondrivers | 62 | 61 | 66 | 58 |
| Automobiles/household | | | | |
| None | 38 | 41 | 20 | 10 |
| One | 40 | 37 | 42 | 47 |
| Two | 16 | 18 | 28 | 33 |
| Three or more | 5 | 5 | 10 | 10 |
| Distance from home to bus stop (blocks) | | | | |
| 0 to 1 | 60 | 46 | 31 | 15 |
| 1 to 2 | 20 | 18 | 21 | 21 |
| 2 to 4 | 15 | 18 | 25 | 20 |
| 4 or more | 5 | 18 | 22 | 44 |

in Davenport and 84 percent in Hicksville. Relatively few trips originate or terminate at hotels and motels, indicating that local residents, rather than tourists, visiting businessmen, and other transients, constitute the major share of the market for shared-ride taxi service in both study areas.

The two shared-ride taxi systems were also alike in the kinds of markets that they did not serve: Industrial workers are a weak market for both systems. Neither fleet is used to any considerable extent to connect to other transportation facilities such as airports and intercity bus depots, or for trips to educational facilities.

Both cab companies provide many-to-many service, but the Hicksville taxi service tends to operate as a many-to-few system. The most frequent cab trips in Davenport are those between two residences and those between residences and myriad private business establishments. In Hicksville, however, approximately 42 percent of the trips made on an average weekday are to the commuter rail station and 17 percent are between residences and shopping centers, principally the Mid Island Plaza regional shopping center.

## User Characteristics

Because of the disparity in the fare charged by each mode, differences in the patterns of bus and shared-ride taxi use will also be determined by the personal characteristics of the users. Table 2 summarizes the socioeconomic characteristics of the bus and shared-ride taxi users in Hicksville and Davenport.

### Comparison of Bus and Shared-Ride Taxi Users

*Davenport*

Sex, age, and distance from home to bus stop are the only characteristics for which there were statistically significant differences between bus and shared-ride taxi users. Women are the predominant users of both modes, but the shared-ride taxi system carries a higher percentage of male passengers than does the bus. The taxis, on the other hand, transport a much higher percentage of housewives. The bus patrons tend to be older than the taxi users; in particular, senior citizens are a much larger fraction of the bus riders, possibly because of the reduced bus fare for such persons. During the school year, the buses also transport a higher percentage of students. Bus users are more likely to reside within a block of a bus stop, whereas taxi users are more likely to live more than 4 blocks away; however, a large majority of the passengers in both groups live within reasonable walking distance to a bus route.

With the exception of the differences noted above, the markets of each form of public transportation in Davenport are remarkably similar. There are no statistically significant differences relative to ability to drive, household income, employment status, number of automobiles available to the household, or physical capabilities. Nondrivers are a major portion of the market for each system. Most bus and shared-ride taxi users belong to households having a total annual income under $10 000. Approximately one-third of the customers of each mode are unemployed. Well over one-third of the passengers of each mode live in households without an automobile. In general, both modes attracted people who are likely to be dependent on some form of public transportation for many of their trips.

*Hicksville*

Bus and shared-ride taxi users in Hicksville differ slightly in age, household income, number of automobiles available to the household, and distance from home to bus stop. The buses transport a significantly higher percentage of students and other persons under 21 years old. Bus users tend to have lower household incomes; they are much more likely to come from households with incomes under $5000 and from households without an automobile. As in Davenport, the bus users tend to live closer to a bus route; in particular, they are more likely to live within a block of a bus stop, while taxi users are more likely to live more than 4 blocks away. The dis-

tances from home to bus stop, however, tend to be longer in Hicksville than in Davenport for both groups.

In many other respects, bus and shared-ride taxi users in Hicksville are alike: More than two-thirds of the passengers of both are women; more than two-thirds are employed; less than 10 percent are over 65 years old; a majority do not possess a driver's license. In general, both markets are of a mixture of commuters and persons dependent on some form of public transportation.

### Comparison of Shared-Ride Taxi Passengers

The markets of the two shared-ride taxi systems differ in several respects because of the differences in the compositions of the study area populations. The Davenport system, for example, carries a higher percentage of elderly persons, reflecting the higher proportion of elderly people in the population. Residents of the Hicksville area tend to have higher household incomes and belong to multi-car families, and so the relative frequency of shared-ride taxi users from households in upper income brackets and from multi-car families is greater in Hicksville. Because of the more limited coverage of the bus system in the Hicksville area, taxi users there tend to reside farther away from a bus stop. The Hicksville shared-ride taxi system transports a slightly lower percentage of unemployed persons; this is consistent with the role of the Hicksville system as a feeder service transporting workers to and from the commuter rail system.

### Bus and Taxi Trip Frequency

In both study areas, bus users tend to use the bus more often than taxi users use the cab, but, in each community, the total number of weekly trips per person was virtually the same for both groups, as given below.

| | Trips/Person by Transit | | Total Trips/Person | |
|---|---|---|---|---|
| Place | Bus Users | Taxi Users | Bus Users | Taxi Users |
| Davenport | 5.8 | 1.8 | 11.8 | 10.1 |
| Hicksville | 8.9 | 1.5 | 14.3 | 15.3 |

As a result of their more frequent use of their selected mode of public transportation, bus users tend to make a higher percentage of their total trips by bus than do shared-ride taxi users by the cab service. In Davenport 59 percent of the bus riders but only 32 percent of the taxi riders use their respective modes for more than half of their trips. While more than 50 percent of the taxi users make less than 30 percent of their trips by cab, a majority of the bus riders use the bus system for over 60 percent of their trips. Nearly one-third of the bus users travel solely by bus but only one-fifth of the taxi users travel solely by shared-ride taxi. Similar observations were made in Hicksville, where 59 percent of the bus users but only 22 percent of the taxi users make a majority of their trips by their respective modes of public transportation.

These findings imply that bus users are generally more dependent on public transportation. In particular, they include a higher percentage of captive riders who have no means of travel other than some form of public conveyance. In general, to most users the local bus system functions as their primary mode of transportation, whereas to most taxi users the shared-ride taxi system is a secondary or auxiliary means of travel, although for particular kinds of trips the taxi may be used as the principal mode.

## SUMMARY

Together, the two shared-ride taxi systems studied perform most of the roles that have been theoretically envisioned for demand-responsive transportation systems. The system in Davenport is an excellent example of a many-to-many demand-responsive service. It is especially useful for transporting residents between widely scattered origins and destinations during periods of low-density travel demand. Although the system in Hicksville also provides many-to-many service, it more closely resembles a many-to-few system because of the characteristics of its service area and the nature of the demand for its services (especially as a feeder system to the Long Island commuter railroad network).

The bus and shared-ride taxi systems in Davenport compete for the off-peak-period travel market. The taxis tend to attract social-recreational, medical, and personal business trips between widely scattered places not easily reached by bus, while the buses tend to attract shopping and personal business trips to the CBD. There is less competition between bus and shared-ride taxi services in Hicksville because the bus system is designed to serve all of Nassau County and not to provide particularly for circulation within Hicksville itself. The two modes, nevertheless, do compete for trips to the CBD and the commuter rail station there.

A major portion of the market for each shared-ride taxi system are people who are likely to be dependent on some form of public transportation for at least some of their trips. This is especially true in Davenport where bus and shared-ride taxi users are alike in ability to drive, household income, employment status, number of automobiles available to the household, and physical capabilities. There is therefore no reason to believe that shared-ride taxi services are unacceptable to the transportation disadvantaged such as the poor, the elderly, and the handicapped. Local elected officials and transportation planners in smaller urban areas should consider the alternative of subsidizing the transportation disadvantaged rather than subsidizing publicly owned transportation systems that may not always adequately serve the needs of these people. Designated groups can be subsidized by issuing transportation stamps as in West Virginia or by entering into contracts with private carriers to offer their services to these groups at a reduced fare. The latter approach is now being used or considered in at least eight small to medium-sized urban areas (8).

Additional research in taxicab use in small urban areas is needed to clarify the roles this mode could play in such communities. This research should also include other privately owned public carriers such as jitney, livery, and public limousine services.

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