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Variations in Driver Wage Rates and Opportunities for Transport Cost Reduction

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1. ABSTRACT

THIS PAPER summarizes the results of research into the impact of organizational and technological characteristics of urban passenger transportation firms on driver wage patterns. It was expected that wage rates would be greater in firms with organizational factors such as large size, monopoly position, subsidization, and unionization. Wage rates were also expected to ining the greater skill required and greater responsibility and liability.

Models were developed to investigate the impact of these two types of factors on driver wage rates using data collected from different passenger carriers in the Philadelphia area. Regression results confirmed that the average driver wage rate in a firm did indeed increase with increasing vehicle size and also with firm size (used to measure the organization factor). The form of the model for vehicle size effects also permitted estimation and testing with data for other cities, and the same pattern was observed. Both patterns are consistent with institutional theories of wage determination.

After presenting examples of the recrease with the size of vehicles, reflectlationships uncovered in this research, some implications of these results for the management of transport systems are discussed. Particular attention is paid to possible strategies for reducing costs by means of organizational arrangements that take advantage of the influence of organization size on costs. Also discussed are some implications for offering new types of services afforded by such strategies.

2. INTRODUCTION

With increasing competition resulting from the reduced regulation in many sectors of transportation, pressure to reduce costs is more intense than ever before. Furthermore, the greater freedom that carriers now have to select the amount, quality, and price of the transport services they offer demands that they understand the cost implications of variations in both the services and in the organizational arrangements by which these services might be offered. Even in the case of carriers that are not expected to cover all costs from traffic revenues, such as mass transit and intercity rail passenger service, there is increasing pressure to reduce deficits and hence subsidies from general taxes, which absent fare increases translates into pressure for cost reduction.

This paper presents the results of research into the influence of two factors under the control of system management on the wage rate of vehicle drivers. Since the total wage bill (including benefits) of vehicle drivers is a large percentage of total operating costs in most transportation firms, controlling the wage rate is of considerable importance in controlling costs and in the profitability of various services. The two factors considered were (1) size of the vehicle, which is especially important in respect to variations in the type and quality of service (e.g., frequent departures or calls with small vehicles versus less frequent service with larger vehicles) and (2) size of the organization (private firms or government agency) immediately providing the service.

The empirical part of this paper is based on a study of wage rates among various carriers of passengers within urban areas. These included both publicly-owned carriers usually operating at a deficit, and privately-owned carriers that operated at a (positive) profit. While such carriers represent only a small portion of transportation, regardless of what measure is used, there is considerable indirect evidence that the results may apply to other types of carriers as well—other modes as well as freight carriers. Therefore after presentation of the results of the analysis of the urban passenger carriers, implications and conclusions are discussed in more general terms.

2. ANALYSIS OF URBAN PASSENGER CARRIERS

This study was motivated by a desire to find ways of reducing the deficit of

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urban transit changes. One aspect dealt with product or "service-price" changes that might increase revenue, while another examined means of reducing costs. The latter naturally included driver wages and benefits, since according to the American Public Transit Association (1981, pp. 45-48), driver wages represent 75 to 85 percent of the expense of vehicle operations (transportation expense). And the cost of vehicle operations accounts for approximately 50 percent of the total transit operating expense. In this context, identifying the impact of factors which contribute to lower driver labor prices can provide ways by which costs and hence deficits can be reduced. Addressing this problem is necessary if transit is to become more efficient and able to adapt to changing public transportation needs.

2.1 Rationale for the Study

The rationale fo rthe study, in the sense of the reasons why it was expected that there would be significant wage rate differences among different urban transportation passenger carriers and that these might vary in a consistent manner with certain technological and organizational features of those carriers, are somewhat complex, They draw on prior literature in diverse fields, each of which has its own concepts and jargon, all of which makes concise presentation difficult. Here we shall attempt to present only a glimpse of this, as the results and interpretation are far more interesting. We shall treat the technological and organizational parts separately.

By technological differences we refer to differences in vehicles operated, specifically vehicle size. Although it is common in transportation cost studies to assume that drivers of different size vehicles in the same firm will be paid at the same rate (e.g., see Andrle et al., 1981), there are many reasons to expect that the wage rate would increase with vehicle size, **ceteris paribus.** For one, the difficulty of driving the vehicle usually increases with size, demanding greater skill. Also, the average load (passengers or goods) usually increases with vehicle size, increasing the liability. Thus such variation would be expected, and on occasion such differences have been noted in the literature (e.g., Levinson et al., 1971, for over-the-road trucks; and Walters, 1979, regarding jitneys and buses in developing nations). But there does not appear to have been developed any specific relationship for this effect.

Turning to characteristics of the organization, labor economists and others have observed variations in the wage rate for the same job in the same city or labor market. Institutional labor theories tend to explain this on the basis of different settings in which the wage rate for the same job is established (e.g., Dunlop, 1978). At the risk of oversimplifying, such theories say that the level of wages in a cluster of (related) jobs in a firm are basically defined by a "key rate." The key rate is determined by factors both internal to the firm and external to it, such as the rate in other firms for the same "key" job. Influencing it in any firm might be the overall profitability of that firm, its market power or monopoly position, and the degree of unionization, among other factors. Its market power and ability to obtain subsidies for money-losing services, would seem to be particularly relevant for transportation.

The same job, such as driving a truck or passenger carrying vehicle, may appear in a job cluster associated with a keyrate in two very different types of firms. In this case, the wage rate for that job may be very different between the firms, as examples in institutional labor treatises illustrate. This then leads to the hypothesis that organizational characteristics can influence wage rates significantly. Again, examples of such differences appear occasionally for transportation jobs and firms (e.g., Dunlop, 1978, 59, using local truck driver wages for 1951; and Johnson et al., 1982, for taxis in 1981), but there appears to have been no research into the general pattern of influence of organizational features.

These and similar considerations led to the posing of two questions:

1. What is the influence of organizational characteristics?
2. What is the influence of vehicle size on the driver wage rate?

These questions are expressed in general terms, but the actual analysis was specific and limited, due to the usual time limitations and the difficulty of obtaining data. Since our immediate interest was in urban transit, we focused on urban passenger carriers—trains, taxis, charter buses, airport and other specialized scheduled services, etc. Alos, the few instances of prior research that even touched on differences due to organizational factors suggested that organization was a key factor (e.g., Johnson et al., 1982, Feibel and Walters, 1980). Thus we focused on various measures of organization site, along with vehicle size, in the empirical work.

3.0 INTERFIRM VARIATIONS IN WAGE RATES

This portion of the research investigated the general question of the effect of organizational characteristics of transportation firms on driver wage rates. Driver wage rates of different passenger transportation firms in the Philadelphia area were selected for analysis. A single area was chosen to avoid the complicating factor of geographical wage differentials, and also because data gathering for this phase was difficult. The wage rates observed varied considerably among the firms, as did the mix of sizes of vehicles and firm characteristics.

The underlying theory (or hypotheses) presented earlier suggest that the overall wage level of drivers in a firm, as might be measured by the average, should depend on firm size and average vehicle size. This wage rate could then be adjusted upward or downward to reflect differences between specific vehicle sizes and the average size. In this section we develop relationships for this average wage, the adjustments being treated in the next section.

3.1. The Model

For this analysis, various models were explored. All models, however, were linear in form, as below:

$$w_i = \alpha + \beta s_i + \gamma r_i \qquad (3.1)$$

where:

w_i = average wage rate for firm;

s_i = average vehicle size for firm; seats (or places if standees allowed)

r_i = firm size, measured by either total annual revenue, fleet size, annual revenue vehicle-miles, or annual passengers carried.

α, β, γ = parameters to be estimated

This form was originally thought of as an initial form which would then be modified based on preliminary results. However, it fit the data so well, and no other form could be suggested on a priori grounds, that it was not modified. We turn now to the data and results.

3.2. The Data

The data were obtained from passenger carriers in the Philadelphia area covering a range of transportation firms and vehicle sizes. Properties selected included a variety of services: mass transit, charter bus, school bus, airport limousine, airport bus, taxi and commuter rail service.

The sample size was smaller than expected due to difficulty in obtaining data. Only the data from the regional mass transit company was readily available from the UMTA Section 15 Reporting System. Data for other transportation firms were obtained from the Pennsylvania Public Utilities Commission and the firms themselves. Unfortunately, virtually the same companies that would not supply data for this research did not file complete reports with the Public Utilities Commission. These were usually small firms.

Firm sizes vary with the type of operation and the measure of firm size used. Sample ranges for each measure are presented in Table 3.1.

Vehicle size was measured by vehicle capacity. Seating capacity was used in all cases except mass transit, where capacity included standing room. The val-

TABLE 3.1

RANGES OF FIRM SIZES

Measure (Per Year)	Taxi	Airport Limousine	School or Charter Bus	Mass Transit
Revenue, $1000	53-1604	295-840	360-4596	276,741
Fleet, units	2-61	9-36	10-40	1984
Passengers, 1000	12-354	75-269	286-526	275,460
Vehicle-miles, 1000	95-1604	513-1623	226-3620	40,978

Source: Pennsylvania Public Utilities Commission reports for 1980. Commuter rail comitted for lack of comparability.

ues for vehicle size vary considerably, typical values measured in persons being: taxis—5, airport shuttles—11, charter buses—45 to 49, school buses—50 to 60, regional mass transit (surface only—bus and streetcar)—66, commuter rail—262.

For the wage rates, mileage wage rates are used and are calculated as total annual driver wages and benefits divided by annual revenue vehicle miles. These were used as for all carriers but the regional transit authority this was the only form of available data. Because a mileage wage rate is used, an adjustment is necessary for those systems which operate at speeds substantially different from the average operating speed for other systems. Fortunately, except for the regional transit agency, the transportation firms included in the sample typically had average operating speeds of twenty miles an hour, so the use of hourly or mileage rates would have little effect. The transit wage rate was adjusted in inverse proportion to its speed relative to the system.

3.3. Results

Fifteen different models were estimated, the variations consisting of different firm size variables and inclusion/exclusion of commuter rail, which presented problems in the definition of firm size. The results were all similar, as to parameter magnitudes (for the same variables) and as to degree of fit. One example is presented below:

$$w_i = 0.19746 + 0.00345 s_i + 0.11057 \times 10^{-8} r_i \quad (3.2)$$

$$(0.02388) \quad (0.0075 \times 10^{-3}) \quad (0.2913 \times 10^{-9})$$

$$t = (8.268) \quad (3.802) \quad (3.795)$$

$$R^2 = 0.84304 \qquad F = 32.22591$$

$$df = 13 \qquad SEE = 0.06469$$

This is with r_i equal to total annual revenue in dollars. The fit is quite good. As a consequence of such good fits, no other functional form was explored.

3.4. Interpretation

The overall significance of the equation, as indicated by the R^2 value and the standard error of the estimate, and of the regression coefficients, as indicated by the t statistics, demonstrates the degree of fit to the data. The particular model chosen for any further investigation will depend on the availability of data. With the chosen equation a mileage wage rate can be estimated based on the separate or combined influence of vehicle size and firm size. As expected, the regression coefficients are positive, indicating an increase in wage rates accompanying any increase in firm size and/or vehicle site.

The effect of the independent variables on mileage wage rates over a typical range of values is examined through equation (3.2), by example, which uses total operating revenue (r_i) as the measure of firm size. The values used for r_i are typical for the type of operations listed. The results are presented in Table 3.2.

Table 3.2 is organized to compare predicted wage rates for a range of vehicle sizes and firm sizes. In column 1 of the table, the predicted mileage wage rates associated with using different vehicle sizes within a large transit agency are listed. Moving across each row, for each vehicle size, one can compare the predicted wage rate within the large transit agency with the wage rate associated with different organizations. Similarly, using columns 2 through 5 and moving downward to the last row, one can evaluate the wage changes associated with operating larger vehicles in each type of firm. However, to assess the complete effect of vehicle size variations we must adjust average firm wage rate w; for specific vehicles in the firm, the topic of the next section.

4. INTRAFIRM ADJUSTMENT FOR VEHICLE SITE

In this analysis, the variation of driver wage in a firm with the size of vehicle operated is examined. The investigation used data on urban transit systems.

In the analysis to follow, all wage rates are mileage wage rates, to conform with the prior analysis. Nevertheless, the results would not have been substantially different, because there is generally little variability in the operating speeds of different vehicle types within a firm. (See Krouk and Morlok, 1983, 23-26 for details.)

4.1. The Model

Although a number of different models were explored, the most plausible one based on **a priori** considerations is that wage rates should be adjusted to vehicle size by an increment to a base wage that is proportional to vehicle site. Such a relationship is:

TABLE 3.2

COMPARISON OF ESTIMATED WAGE RATES FOR VARIOUS TYPICAL VEHICLES AND DIFFERENT ORGANIZATIONS

Wages in $/mile	Firm Size — Total Operating Revenue, r_i, $1,000/yr.				
Average Vehicle Size, s_i, places	275,000 (Large transit company)	250 (Taxi company)	400 (Airport service)	800 (Charter bus company)	1,200 (Private transit company)
5 (taxi)	.5188	.2150	.2152	.2156	.2160
11 (van)	.5404	.2357	.2359	.2363	.2367
25 (minibus)	.5878	.2840	.2842	.2846	.2850
45 (charter bus)	.6568	.3530	.3532	.3536	.3540
66 (transit vehicle)	.7292	.4254	.4256	.4260	.4265

$$\frac{w_{ij}}{w_i} = \epsilon + \delta \frac{s_{ij}}{s_i} \quad (4.1)$$

where:

w_{ij} = wage rates for vehicle j within firm i, $/vehicle-mile

w_i = average wage rate for firm i, $/vehicle-mile

s_{ij} = vehicle capacity for vehicle j within firm i, passengers

s_i = average vehicle capacity for firm i, passengers

ϵ, δ are parameters with $\epsilon = (1 - \delta)$, which means when $s_{ij} = s_i$, $w_{ij} = w_i$.

This can be rewritten as:

$$\frac{w_{ij} - w_i}{w_i} = \delta \frac{s_{ij} - s_i}{s_i} \quad (4.2)$$

In addition, it is important to note that the mileage wage rate measures used in these models is automatically normalized to compensate for varying wage levels associated with the geographical differences of different firms. This adjustment occurs by virtue of using a ratio of the wage rates.

4.2. Data

Transit data were obtained from financial and operating data found in the UMTA Section 15 Reporting System (see Morin, 1981) for eighteen U.S. transit firms, of various size, operating more than one vehicle type. Many more than eighteen firms operate vehicles of different sizes, but data on only eighteen of those could be used because of incompleteness of reporting by other systems.

4.3. Results

Regression of equation (4.2) produced the following results:

$$\frac{w_{ij} - w_i}{w_i} = 0.28456 \frac{s_{ij} - s_i}{s_i}$$

(.05570)

t = (5.109)

R^2 = .42032

SEE = .17260

F = 26.103

df = 36

This model, as well as others used, indicate that in the transit industry there are wage differentials associated with different vehicle sizes. As expected, drives wage rates are lower for smaller vehicles. In fact, the slope of approximately 0.28 in this model indicates that, for example, wage rates would be reduced approximately 14 percent by using a vehicle half the size of the average vehicle for the firm (0.28 x 0.5).

5. SIGNIFICANCE AND IMPLICATIONS OF RESULTS

The results of the two analyses suggest that driver wage (and benefit) rates are substantially influenced by both organizational characteristics and vehicle technological characteristics. Specifically, for the same vehicle technology, the wage rate can vary by a factor or two, and further adjustments for vehicle size variation within the firm can be of the order of 15 percent (for a vehicle range of 2:1). What are the implications for the provision of transportation service? The primary implications can be grouped into three areas: (1) cost reduction, (2) improving quality features of service offered, and (3) offering entirely new services. The discussion will attempt to generalize from the specific empirical studies of the carriage of passengers in urban areas to other contexts.

5.1. Cost Reduction

In an increasingly competitive environment, as is found by many types of transport firms as a result of recent regulatory reform legislation—including air, bus, rail freight and truck lines—pressure to reduce costs will undoubtedly increase. While this will be felt across all aspects of the business, it presumably will be especially acute in lines of business that had previously been cross-subsidized by other lines of business. Often-cited examples are small package freight, and lightly-trafficed services or routes. One strategy for reducing costs that is suggested by the preceding analysis is to reorganize such services so that they are provided by small, essentially independent organizations. Such organizations would benefit from lower labor costs, reducing their total costs. Depending upon the situation, it might be desirable to maintain identification of this service with the original (presumably larger) carrier, in which case appropriate symbols could be continued in use and service could be coordinated as to connections, through routing, prices, etc., as appropriate.

Various features of this strategy already exist. The spinning off of particular services is exemplified by new short line railroads, and commuter air lines. Many of the latter also illustrate the continued identification and coordination of service with a parent carrier, as in the case of service offered under the banner of Allegheny Airlines, to mention one. What we are suggesting is that such arrangements do not represent something that is necessarily exceptional or atypical, but rather that this is a general strategy that should be considered by transport management to provide services that otherwise could not be provided profitably.

Naturally there may be resistance to such a strategy, particularly from unions representing existing employees of the parent firm. Such opposition might preclude the strategy. However, even in the highly unionized transit industry examples of such arrangements exist (one will be described in Sec. 5.3). If the alternative is no service, and the spin-off benefits the parent by interlined traffic, unions may find the strategy in their interest.

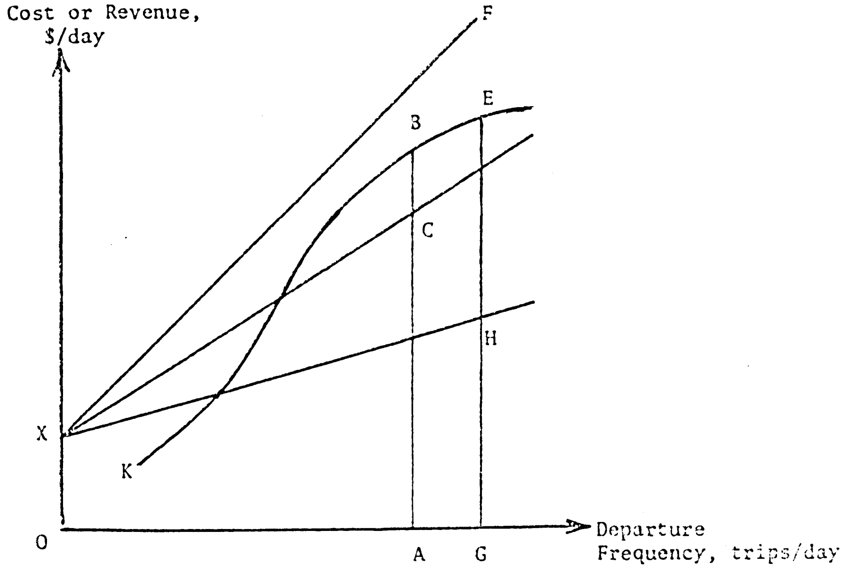
5.2. Improving Quality of Service

Along with pressure to reduce costs, the increasingly competitive environment may make it desirable to improve service quality in order to maintain or improve market position. In general the implications of the wage relationships for improving service quality are derived from both a general lowering of wage rates and the lowering of wages as a result of using smaller vehicles. Space restrictions limit the presentation to an example for one carrier type, although similar arguments could be made for other modes.

The example chosen is that of a scheduled passenger carrier along one route. It could be air, bus, rail, or water; the focus on a single route makes for brevity with little loss of generality. The example is presented with reference to Figure 5.1.

The figure shows a demand function KBE expressed in terms of revenue received (passenger trips multiplied by average fare, presumed to be held constant) as a function of frequency of vehicle departures on the routes. Also, the figure shows a cost curve XC for the base case of a (relatively) large firm operating large vehicles and having to pay (relatively) high driver wage rates. A profit maximizing firm would choose frequency A and have a profit CB. If the organizational structure and technology used were modified to permit substantial reductions in the costs of each vehicle trip, as by provision of service by a smaller and/or use of smaller vehicles, then the cost function might appear as XH. In this case, there is a profit at the previously considered level of frequency A. But the frequency should be increased to G in order to maximize

EFFECT OF WAGE RATE REDUCTION ON SERVICE QUALITY OPTIONS



Notes: Slope of KBE at B is identical to that of XC. Slope of KBE at E is identical to that of XH. The reduction in cost represented by the shift from XC to XH is deliberately increased in magnitude for clarity.

FIGURE 5.1

profit. Thus the service quality is improved (by the increase in frequency, the one service variable included here), and the carrier is better off due to the greater profit.

Of course, other considerations could be brought into the analysis, such as capacity constraints related to vehicle size, and facility capacity where that might be binding. Examples of this are presented in Morlok (1978, 711 ff), and these would not alter the general conclusions.

More generally, other level of service features should also be considered, although in general the lower cost of labor would be expected to enable higher quaity of service at the same cost per unit of traffic (passenger or ton of freight) or some trade-off that provides a combination of lower cost and improved service.

5.3. New Services

The considerations for new service are similar to those for improved service above. Referring again to Figure 5.1, one can imagine a situation in which, for a given price (freight rate or passenger fare), the cost curve lies above the revenue curve at all levels of service. This is illustrated there by line XF. Such a relationship may hold for any price level, so the service is inherently unprofitable and presumably would not be offered (unless forced by regulation). On the other hand, if costs were reduced to XH, then of course it would be profitable and could be offered.

The point is that cost reductions of the type we modeled earlier can have the effect of opening up new opportunities to provide service at a profit. These may include services of a type not previously offered by anyone. In particular, services that are inherently very labor (driver) intensive may be possible. These probably include services that are very tailored to the needs of each shipment or traveler, and in that sense offer a very high quality.

One recent example of this is in the provision of a new paratransit service for elderly and handicapped in Philadelphia. The regional transit authority was directed to provide this new service. One option was to provide this directly with its own drivers operating the vans used for this service. But this would have led to drivers' wages that were very high, slightly less than the wages of drivers of large buses. Instead, they contracted for provision of the service by small private firms, whose wage rates are about half those of the bus drivers, thereby reducing the cost of the service almost proportionately. This was done just as our study was nearing completion, and provided an excellent test of our hypotheses and relationships. Although we were provided only approximate wage rates for reasons of confidentiality, they were close to the values the models estimate.

6. CONCLUSIONS

There is clearly room for considerably more research into the general topic of effects of characteristics of organizations and technology used on labor costs, and more generally, on the costs of other factors of production. Some of the areas of inquiry that seem most important to us are enumerated below:

1. While organization size is correlated with wage rates, other features that apparently are correlated with size must play a part. An urgent need is to identify these, to more fully understand the relationships.
2. Related to this, is an attempt to understand these phenomena in terms of not only institutional theories of wage determination, but also neoclassical economic theory.
3. Empirical research for other modes of transportation is clearly suggested. An investigation of the stability of wage patterns over time is also suggested.
4. This research indicates that the design of systems should embrace not only the physical design that is now treated but also simultaneously consider the design of appropriate organizations for each technology.

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