

COST SAVINGS FROM ONE-MAN OPERATION OF BUSES

By R. H. Brown and C. A. Nash

During recent years the British bus industry has faced severe problems of rising costs and falling traffic (especially off-peak). As a labour-intensive industry¹ which suffers severe staff shortages at the ruling wage rates, it has naturally been much attracted by the possibility of reducing its labour requirements through one-man operation of buses. One-man operation has been used successfully on rural routes for many years, but it is only recently (particularly since the legalising in 1966 of one-man operation of double-decker buses) that it has begun to be used to any great extent on the more heavily used urban routes. It seems worth while, therefore, to try to quantify the cost saving achieved so far in the urban situation.

Various *ex ante* estimates exist of the average potential savings in total cost, such as the National Board for Prices and Incomes figure of 15–20 per cent [2] and Fishwick's estimate of around 14 per cent [3]. In the questionnaire referred to below, we asked municipal undertakings for their own estimates of the average savings from converting a route to one-man operation. Only 13 hazarded a figure, and their estimates ranged from 7.5 per cent to 22.3 per cent, with a mean of 14.7 per cent. The only attempt known to us to measure the benefits from an *ex post* statistical analysis is that of Lee and Steedman [4]. This finds "percentage of annual bus mileage on two-man operation" to be significant, and yields estimates of the savings from one-man operation of over 20 per cent per bus mile converted for any level of one-man operation. However, their work was directed to another end, and the loglinear form of equation fitted—implying as it does a rapidly rising percentage saving per bus mile converted as the latter figure increases—does not seem very appropriate from the point of view of measuring the savings from one-man operation. Lee and Steedman say that they tried linear and loglinear forms, but they do not mention using the semilog form which gave us our best fit. This semilog form implies a constant percentage saving per bus converted, and thus makes it easier to estimate average realised savings.

THE DATA

The basic source of the data used by us was the municipal trading results published annually in *Bus and Coach* for the period 1964–9; additional information was sought by questionnaire from the undertakings direct. Forty-five undertakings provided usable replies; but observations were excluded for any year in which the undertaking

¹For instance, in 1963—the year before the start of the period covered by our survey—48.2 per cent of the total working expense of the Tillings Group of Companies consisted of crew costs. By 1968 this figure had fallen slightly to 47.1 per cent [1].

concerned was operating trolleybuses. This reduced the sample size to 233.

The dependent variable used in the multiple regression analysis was "total working expense per bus mile" (Y), which excludes annual depreciation expense. Arbitrary variations in the accounting treatment of depreciation make this exclusion necessary; thus our measure excludes any capital cost incurred by accelerated replacement of non-convertible buses, as well as the increased capital cost of fitting a bus for one-man operation². Also excluded are the costs of owning a larger fleet, should this be necessary to maintain services (since this will be reflected in a drop in vehicle mileages³), and any effect on revenue of changes in the quality of service provided.

The following independent variables were used:

X_1 *Proportion of fleet fitted for one-man operation*

X_2 *Proportion of fleet consisting of double-decker vehicles*

We should have preferred mileage-related figures for both these variables, since on average both one-man operated buses and single-decker vehicles are probably used more intensively than the fleet average. Thus the savings both from one-man operation and from single-decker operation may be over-estimated (by under-recording the extent of their use).

X_3 *Population of borough or urban district at 1966 sample census*

We needed an indicator of the nature of the area in which the service was being run; population was considered to be the most significant characteristic. ("Average service speed" was also tried, but the data for this was felt to be of varying reliability, and in any case it was found to be statistically insignificant at the 5 per cent level of confidence.)

X_4 *Average annual miles per bus*

This was intended to reflect both the nature of the services and, more important, the degree of peakedness of the traffic. (For the latter we also tried proportion of total fleet in service during the weekday daytime off-peak period; this was statistically insignificant and highly collinear with X_4 .)

X_5 *Index of regional wage differentials*

We were hampered here by the redefinition of the regional boundaries for statistical purposes in 1966, which would have caused a sharp discontinuity in that year had a current index been used throughout. Thus we used for all six years the average figure for 1967-9 of the average hourly earnings of manual workers in "manufacturing and certain other industries" for the region, as a percentage of the U.K. average, as published in the *Abstract of Regional Statistics*. The averaging process involved is not serious, as year-to-year shifts are very slight.

X_6 *Time trend*

As an alternative to the simple time trend finally used, a set of dummy variables to represent individual years was tried, but did not significantly improve the fit.

²If it is assumed that the switch to rear-engined double-deckers would have occurred anyway, to increase safety by facilitating driver control of loading and unloading, this additional cost is very small—Morton [5] estimated it as £200 per bus in 1968.

³The partial correlation coefficient between "proportion one-man operated" and "annual miles per bus" was -0.08.

Initially, we also included fleet size as an explanatory variable. But this was insignificant⁴ at the 10 per cent level of confidence, and was highly collinear with population. Thus fleet size was excluded, but the resulting coefficient on X_3 may represent an amalgam of the two effects.

To achieve an unbiased estimate of the coefficient on X_1 , it is of course particularly important to include all explanatory variables which may be correlated with X_1 . It is hoped that the variables listed above will eliminate most of the bias, but there are still other possible variables which we could not measure: for instance, a low value for the coefficient on X_1 may be associated with a progressive, efficient management.

TABLE 1
Sample Characteristics

Variable	Units	Min.	Mean	Max.	Sigma
Y	d/mile	29.81	43.79	68.14	5.56
X_1	Proportion of fleet	0.00	0.09	0.70	0.13
X_2	Proportion of fleet	0.10	0.86	1.00	0.17
X_3	Hundred thousands	0.18	1.80	10.64	2.10
X_4	Miles/year	19,210	30,750	50,520	4,380
X_5	Proportion of national average	0.91	0.98	1.08	0.04
X_6	Years (1964 = 1)	1.00	3.59	6.00	1.73

RESULTS

The highest value of \bar{R}^2 was achieved when the variables were introduced in the following form⁵:

$$\begin{aligned} \text{Log } Y = & 2.598 - 0.064X_1 + 0.044X_2 + 0.011X_3 \\ & (0.192) (0.023) (0.016) (0.001) \\ & - 0.333 \log X_4 + 0.392X_5 + 0.027X_6 \\ & (0.038) (0.069) (0.002) \\ \bar{R}^2 = & 0.734 \end{aligned}$$

The equation is easier to interpret when antilogged:

$$Y = (396.28) (0.86298)^{X_1} (1.1066)^{X_2} (1.0257)^{X_3} X_4^{-0.333} (2.466)^{X_5} (1.0641)^{X_6}.$$

This suggests an average saving to date from converting to one-man operation of some 13.7 per cent (the 95% confidence interval for the estimate is 9.1%–18.2%), and this result conforms remarkably closely with the *a priori* estimates quoted above. If X_1 – X_5 had remained constant over the period, the equation predicts that costs would have risen by 6.41 per cent per annum, or a total of 36.3 per cent over the period.

In fact, comparing the data for 1964 and 1969 for the 37 corporations which did

⁴The partial correlation coefficient between these variables was 0.82.

⁵Standard errors are given in brackets below the coefficient.

not operate trolley-buses at any point in this period (Table 2), the mean value of total working expense per bus mile rose by some 32 per cent. According to the coefficients of the regression equation, about 2 per cent of this rise was due to a fall in annual vehicle mileages; to date, the swing to one-man operation had resulted in costs being overall some 2½ per cent below what they would otherwise have been, while the swing to single-decker buses had saved some ¾ per cent.

TABLE 2
Time Paths of Variables for 37 Corporations
(Trolleybus operators excluded throughout)

Year	Mean of Variable			
	γ	X_1	X_2	X_4
1964	37.909	0.033	0.881	31,600
1965	39.082	0.035	0.876	31,251
1966	42.315	0.038	0.869	30,948
1967	45.254	0.070	0.868	30,665
1968	47.460	0.110	0.836	30,175
1969	50.046	0.199	0.813	29,716

The Department of Employment and Productivity index of retail prices rose by 23.18 per cent over this period. Thus there has clearly been a substantial rise in the real costs of bus operation, which one-man operation did little to stem. However, these corporations had on average converted only 20 per cent of their buses by 1969; there remained a great potential for savings from this factor, although it should not be assumed that future savings will match those from buses already converted. The proviso is necessary both because, as mentioned above, "number of buses converted" probably underestimates the proportion of mileage run converted, and also because of the possibility that as one-man operation spreads the routes converted may be progressively less suitable.

REFERENCES

- [1] Transport Holding Company: *Annual Report and Accounts*, 1964 and 1968.
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Leeds Polytechnic; University of Southampton