THE PEAK IN ROAD PASSENGER TRANSPORT

An Empirical Study

By W. J. Tyson*

I. INTRODUCTION

For some years there has been considerable doubt about the effects of the peak on road passenger transport costs and revenues. One theory has been that the marginal revenues at the peak exceed the marginal costs incurred then, and that the peak thus contributes favourably to an operator's financial position. This seems to be implicit in cases where an existing operator objects to a newcomer running on his route at the peak only, on the grounds that the newcomer would take the most lucrative traffic.¹ More recently, however, it has been argued that the marginal costs of the peak are greater than the marginal revenues obtained then, and that therefore the peak has an adverse effect on an operator's finances. This was one finding of the consultants engaged by the Directing Group of the London Transport Joint Review, although no details of either their methods or their results have ever been published.²

In the light of this and of the reference to the possibility of peak pricing contained in Transport in London,³ it seemed that the question of the peak merited some empirical investigation, especially because the case of London Transport may be atypical as a result of the particularly severe operating problems it faces.

A study was therefore carried out in the Department of Economics at the University of Manchester during 1968 and 1969, with the objects of determining and comparing the long-run marginal costs and revenues resulting from the peak in a road passenger transport undertaking. The undertaking studied was a medium-sized municipal operator running a fleet of 180 vehicles in a predominantly urban area.

Part II of this paper considers in more detail the problem to be studied, and Part III describes the methodology used to derive the cost and revenue estimates and the results obtained. Finally, in the light of these results, some policy conclusions are discussed in Part IV.

*The author wishes to place on record his gratitude to the operator mentioned in the text for his whole-hearted co-operation, and to his colleagues at the University of Manchester, in particular Dr. Norman Lee, who supervised the research, for helpful comments and suggestions.

¹In recent years this argument has normally been used in respect of applications for summer seasonal express services.

²See Transport in London (Cmdn 3686, H.M.S.O., 1969), Appendix, paras. 34–40, for reference to this study and its conclusions.

³Ibid., Appendix, paras. 54 and 65.
II. THE PROBLEM TO BE STUDIED

The main contribution to the study of the peak in road passenger transport up to the present has been Ponsonby’s article published in 1958, which offered no empirical evidence on this question. Apart from this, economists’ attention has been turned towards peak pricing in electricity supply. There is therefore no previously published work to which one may turn for a starting point for further analysis; so the problem must initially be considered at the more basic level of its causes and effects.

Two peaks in demand are faced by road passenger transport operators in the United Kingdom, the twice-daily work peak and the summer seasonal peak. This study deals only with the former, as it is experienced by the majority of stage-carriage operators. The twice-daily work peak is caused by a combination of economic, social and institutional factors, which give rise to a desire on the part of most people to travel to and from work in the same relatively short periods of the day. It is further accentuated by the fact that the pattern of land use in most British towns and cities results in travel being predominantly uni-directional, into the centres in the morning and out in the evening. In the past few years the shortening of the working week and the elimination of much Saturday work has concentrated the journey to work into even shorter periods of the day, especially in the mornings, and into five, not six, days of the week.

Transport operators have always sought to fix their capacity in such a way that peak demands can be met. Thus maximum peak demand always sets the upper limit on capacity, and there is always spare capacity in the off-peaks. Operators’ pricing policy does not, however, seek to reflect the pattern of costs. The overall objective seems to be to equate total costs and total revenues in each accounting period for the undertaking as a whole. This is achieved (with one recent exception) by a uniform scale of charges on all services at all times, regardless of the cost of providing each service in each time period. From a marketing point of view this system does nothing to discourage demand at the peak or to encourage use of the spare capacity in the off-peak. From an economic point of view there is no reason to expect total revenue at the peak to equal total cost. On the grounds that peak and off-peak travel are not close substitutes for one another, they should be regarded as separate products and, as far as possible, costed and priced accordingly.

Furthermore, there is no evidence that the costs of operating additional services

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6 Selne P.T.E. charged an extra 3d. on most fares at the peak in Manchester and Salford from August 1970. It has since modified this policy and extended it to its whole area.

7 The basis of the system is that the fare per mile falls as the distance travelled on the vehicle increases. In effect it comprises a fixed charge plus a rate per mile. By regressing fare paid against distance travelled in the undertaking under study, the two elements were found to be

\[ f = 3.73 + 1.84d \quad (r^2 = 0.985) \]

where \( f \) is fare paid in old pence and \( d \) is distance travelled in miles. The extent to which this reflects accurately the cost of a journey is open to doubt.

8 This argument can be taken one stage further and applied to individual routes within an undertaking.
at the peak are met by the additional revenues obtained from doing so. This is the question on which there has been a difference of opinion in the past, and it is the starting point for the present study.

III. ESTIMATING MARGINAL COSTS AND REVENUES OF THE PEAK

Marginal Costs

The long-run marginal costs of the peak were defined as those costs which were incurred solely to meet peak demands, and which in the long run could be avoided if there were no peaks and if the highest demand was the present maximum off-peak level. To estimate those costs it was first necessary to consider the output savings which would accrue if there were no peaks. In the undertaking under study these would have taken two forms: fewer vehicles would have had to be operated, and some routes could have been operated with single-deck instead of double-deck vehicles.

The former could easily be quantified, but it was impossible to estimate accurately what proportion of the routes could be operated with single-deck vehicles if there were no peak. As it was also felt that the cost difference between the two types of vehicles was now fairly small, it was decided to ignore this effect and concentrate on the costs of operating the additional vehicles at the peak. Of an operational fleet of 153, vehicles running at the peaks only numbered 72, accounting for an annual mileage of 812,000. Allowing for spare vehicles (to cover repairs and breakdowns), it was estimated that if these 72 did not have to be operated, 84 would no longer need to be owned. Thus the long-run total cost of providing and operating 84 vehicles comprised the long-run marginal cost of the peak.

The source of data for the cost estimates was the undertaking’s annual accounts for the financial year in question. It was thought that costs would depend on three factors: the number of vehicles involved, the mileage they operated and the number of road staff (that is, drivers and conductors) necessary to operate them. These three estimates of cost were obtained, termed respectively vehicle cost, running cost and labour cost.

Running cost

Running cost comprised all costs which varied directly with mileage operated, and thus represented the short-run marginal cost of operating any vehicle. Only a figure for the undertaking as a whole could be estimated, although it seems possible that running costs at the peak could be higher than in the off-peak. If this is so, the estimates of the marginal costs of the peak are underestimates, although probably to only a small degree. The estimate obtained was 5.56 pence per vehicle-mile, giving a total cost saving in respect of the vehicles operated at the peaks only (termed part-day vehicles) of £45,910.10

9Two preliminary points need to be made. First, the results are particular to the operator in question; and second, they are for the financial year 1968/69, that is, 1 April 1968 to 31 March 1969.
10For every penny that the cost per vehicle-mile is an underestimate, marginal costs of the peak are underestimates by £8,112.
Vehicle cost

The largest single component of vehicle cost was the capital cost of the vehicles. This could not be derived direct from the undertaking’s accounts, but had to be estimated. The total historic cost of the fleet and of other capital assets was available, and it was assumed that if this sum had to be borrowed the average rate of interest paid would be 7 per cent (this figure was reached after consultation with the undertaking’s principal officers). This gave a cost of capital of £470 per vehicle, which was an underestimate if the true figure should have been based on replacement costs.\textsuperscript{11}

Other costs which varied directly with the number of vehicles in the fleet were those of cleaning and garaging, and the maintenance expenditure which was a function of time rather than of use. It was also felt that the “overhead” expenditures — grouped under the heading “management and general expenses” — would be correlated with fleet size in the long run.

If the fleet were reduced by 84 vehicles it was assumed that all the costs detailed above would in the long run be reduced in proportion to the fall in fleet size. The average saving per vehicle was £1,415 and the total in respect of the part-day vehicles was £118,860. It should be emphasised that the figure of £1,415 was computed on the assumption that the fleet would be reduced substantially, and should not be interpreted as the marginal cost saving which would accrue if the fleet were reduced by only one or two vehicles.

Labour cost

It was realised that estimating the labour cost of operating the part-day vehicles would be complicated, because the level of labour cost per man depends on the amount of overtime worked, which itself depends on the degree of staff shortage. If in the long run it could be argued that if there were no peaks there would be no staff shortage,\textsuperscript{12} all overtime payments made now would be avoided. If, however, it is argued that the relative unattractiveness of the employment would always ensure that there would be some staff shortage, some overtime payments would continue to be made even if there were no peak.\textsuperscript{13} The extreme to which the latter argument could be taken would be to say that if there were no peak the proportionate staff shortage would be the same.

As it was apparent that the final estimate of the marginal cost of the peak would be sensitive to the assumption made about labour cost, estimates were made on the two extreme assumptions: (1) that overtime would be completely eliminated if there were no peak (in other words, that all overtime payments now made are part of the cost of the peak), and (2) that it would be proportionately the same. These were termed Overtime Assumptions 1 and 2 respectively.

\textsuperscript{11}Although replacement costs per vehicle are higher than historic costs, because of technical progress the number of vehicles necessary to replace the present fleet would be less than the number in the fleet now. Thus the difference between the total historic and replacement costs may not be so great as might appear at first sight.

\textsuperscript{12}Because the total labour requirements would be less than the number of drivers and conductors currently employed.

\textsuperscript{13}The rationale of this is that overtime payments are necessary to make the total pay comparable with alternative employments. If staff shortage were reduced, overtime would fall, inducing some men to leave and again increasing staff shortage and overtime. This was the experience of the operator in recent years.
THE PEAK IN ROAD PASSENGER TRANSPORT

W. J. Tyson

Included in the total labour cost was a figure of £280 per man which was the non-wage cost. This included expenditure on uniforms and equipment, national insurance, graduated pension contributions, and the net cost of S.E.T.

The two figures obtained for labour cost were £252,930 and £198,020 on Overtime Assumptions 1 and 2 respectively.

Thus each element of the long-run total cost of operating the additional vehicles at the peak has been estimated in order to give the long-run marginal costs of the peak. The results are summarised in Table 1.

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Long-run Marginal Costs of the Peak</th>
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<tbody>
<tr>
<td></td>
<td>Total £</td>
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<tr>
<td>Overtime Assumption 1</td>
<td></td>
</tr>
<tr>
<td>Running cost</td>
<td>45,910</td>
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<tr>
<td>Vehicle cost</td>
<td>118,860</td>
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<tr>
<td>Labour cost</td>
<td>252,930</td>
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<tr>
<td>Total</td>
<td>417,700</td>
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<tr>
<td>Overtime Assumption 2</td>
<td></td>
</tr>
<tr>
<td>Running cost</td>
<td>45,910</td>
</tr>
<tr>
<td>Vehicle cost</td>
<td>118,860</td>
</tr>
<tr>
<td>Labour cost</td>
<td>198,020</td>
</tr>
<tr>
<td>Total</td>
<td>362,790</td>
</tr>
</tbody>
</table>

In both cases it can be seen that labour cost comprises over half the total cost incurred, vehicle cost not being as significant as may once have been thought. Assuming that in the short run both labour cost and running cost could be avoided, the cost savings would be £298,840 on Overtime Assumption 1 and £243,930 on Overtime Assumption 2. As these assumptions are thought to represent the extreme positions, the estimates presented of both long-run and short-run cost savings can be taken as extremes, with the true figure lying somewhere between the two.

Marginal Revenues

Lack of any detailed data on the distribution of revenue over time meant that the revenue estimates were much less precise than cost estimates. The long-run marginal revenue of the peak was defined as the addition to total revenue which accrues from the provision and operation of additional capacity then. Thus, basically the total revenue of the part-day vehicles had to be measured. This might not, however, be an accurate estimate, because if the additional vehicles at the peak were withdrawn the quality of service as a whole would deteriorate, and the loss in revenue might be greater than the total revenue collected on the part-day vehicles. On the other hand more effective use might be made of the vehicles remaining in service at the peaks, and the loss might then be smaller. No quantitative evidence on this point was
available, and none could be gathered in the course of the study. Therefore the total revenue of the part-day vehicles was used as a proxy for the marginal revenue of the peak.

This revenue was derived from an analysis of the conductors' ticket sales on what was considered a normal day. After certain assumptions to convert a day's total revenue into an annual figure, an estimate was derived which was very close to the true annual total, and it was felt that the distribution over time could be used with a high degree of confidence. This gave an estimate for the total revenue accruing from the operation of the part-day vehicles of £207,250.

**Comparison of Cost and Revenue**

It can therefore be seen that the additional costs incurred solely on account of the peak exceed the additional revenue derived then by an amount which varies between £210,150 and £155,540, and these figures are 50·35 per cent and 42·87 per cent of costs respectively. The policy conclusions which follow from this will be discussed in the next section. At this stage it might usefully be recognised that even in a medium-sized provincial fleet the same basic conclusion was reached as in the London Transport Central Bus Study: that is, that the peak has an overall effect of worsening the undertaking's finances.

**IV. POLICY IMPLICATIONS**

The undertaking under study, therefore, found itself providing a service the total revenue from which was not equalling its total cost. By pursuing its present policy of equating total cost with total revenue, it was overcoming the difficulty because the marginal revenues from the vehicles which operate all day exceed their marginal cost. It may be concluded, therefore, that its financial position would be improved considerably (in the year under question a deficit would have been turned into a surplus) if there were no peak in demand. It seems probable that the bulk of the losses it makes are being incurred because of the peak rather than because of specific unremunerative services, although these may exist as well.\(^{14}\) This accords with the findings published in *Transport in London*:

> (a) the bulk of the Board's deficit cannot be attributed to particular loss-making services; and
> (b) the major factor underlying the Board's deficit is the imbalance between peak and off-peak services.\(^{15}\)

The alternatives available to the undertaking seem to be to continue the present pricing policy, to withdraw the additional services at the peak, and to raise fares at the peak. The implications of each will be discussed in turn.

**Continuation of Present Policies**

If present policies were continued, the total surplus from the vehicles which provide both peak and off-peak services (termed all-day vehicles) would have to be equal to

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\(^{14}\) Another part of the research did establish that there were unremunerative services.

\(^{15}\) Appendix, para. 38.
the deficit incurred in operating the part-day vehicles. Thus users of these vehicles would be cross-subsidising those using the additional vehicles at the peak. Inasmuch as this occurs at the peak, the consequences might not be too serious, as it is almost impossible to distinguish between the two groups of passengers – until they actually board a vehicle it is impossible to identify them. But the cross-subsidy is probably also occurring at the off-peak, and if this is so fares then are higher than they would be if the part-day vehicles did not have to be operated. If demand is in any way price-elastic, the imbalance between peak and off-peak is therefore being accentuated. This leads to a discussion of the possibility of raising fares at the peak.

Raising Fares at the Peak

It is extremely difficult to calculate the total costs of the peak on an avoidability basis, because part of the cost of operating the all-day vehicles is a joint cost of all the outputs (peak and off-peak) they provide. One possible method would be to allocate these joint costs in such a way that the proportion borne in each time period was the same as the proportion of total mileage operated then. Applying the methods outlined above to the determination of the long-run marginal cost of the all-day vehicles, the total cost of the peak was estimated to be £628,800, on the basis of Overtime Assumption 2 and a definition of the peak as the times when the part-day vehicles were in service. This comprised the total cost of the part-day vehicles plus the appropriate proportion of the total costs of the all-day vehicles. Total revenue at the peak fell short of this figure by £72,100. At the off-peak on weekdays, total costs and total revenues were approximately equal; but to equalise them at the peak would entail a fares increase of 17 per cent, assuming a price elasticity of demand of \(-0.25\).

As an alternative to raising fares so as to equate total cost and total revenue at the peak, it might be possible to use the part-day vehicles to provide a service in some way different from that provided by the all-day vehicles. At the moment they provide an identical service, and it would be impractical to charge a higher fare on the part-day vehicles only. If, however, they could provide a faster, more direct service for which a higher fare could be charged, it might thus be possible to make the long-run marginal revenue from their operation equal to their long-run marginal cost.

Thus fares increases at the peak could be used to equate total costs and total revenues then, if the above basis for allocating joint costs were accepted. Or, if the nature of the service provided by the additional vehicles was in some way changed so as to make it possible to charge a higher fare on them, it is conceivable that the long-run marginal costs and revenues could be equalled in this way; but a preliminary study of the magnitudes involved indicated that that would probably not be feasible. Finally, there is the third alternative – withdrawal of services.

Withdrawal of Services

If the above estimates are correct the withdrawal of the additional output at the peak could lead to an improvement in the undertaking’s financial position of at least £155,000. Another effect might, however, be a considerable rise in congestion costs resulting from increased use of private transport. Another possibility therefore seems to be to consider the costs and revenues of each of the part-day vehicles on a marginal basis, and withdraw those vehicles whose contribution to the deficit is greatest. From further research carried out it seemed probable that the part-day vehicles operating
either factory journeys or routes which ran at the peaks only had lower average revenues per mile than the remainder of these vehicles. Thus, if they were withdrawn, it might be possible to reach a position where the long-run marginal cost of the remaining vehicles was equaled by their long-run marginal revenue. Withdrawing only the vehicles mentioned would leave very few people without public transport, the typical result in the town in question being an increase in the number of changes which would have to be made.

V. SUMMARY

The main result of the study reported in this article is that the long-run marginal cost of the peak for at least one road passenger transport operator is greater than long-run marginal revenue. Thus the peak has an adverse effect on the undertaking's financial position, and in the period in question the net loss on the peak was greater than its overall deficit.\textsuperscript{16}

Three alternative policies which could be pursued in this situation were considered – continuation of the present pricing policy, raising fares at the peak and withdrawal of services.

The main consequence of the first policy is an element of cross-subsidy of the peak by off-peak travellers. Given that this is deemed undesirable in the context of present-day transport policy, the course open to the operator seems to be a combination of the second and third policies – raising fares at the peak and withdrawing some of the additional services provided then. The social costs of this are not known; but it was estimated that, if as a result the travel time of all those commuting by car in the town were raised by four minutes per journey, the value of the time loss would exceed the deficit incurred on the peak as a whole (that is, total peak costs minus total peak revenue = £72,100).\textsuperscript{17} Thus the optimal policy might involve some form of subsidy paid to the operator in respect of peak services.

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\textsuperscript{16}How typical this situation is of other undertakings cannot be predicted in general terms. The level of marginal costs at the peak seems from this research to be related to the number of part-day vehicles. Nothing can be said in general terms about the level of long-run marginal revenue in other undertakings.

\textsuperscript{17}This is an approximate calculation based on a number of assumptions.