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PERCEIVED AND ACTUAL COSTS OF OPERATING CARS

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ABSTRACT

The perception that drivers have of car operating costs is an important factor in determining modal split characteristics. Theoretical figures derived from discriminant analysis models suggest that drivers perceive only petrol costs, but this has not been corroborated by detailed surveys. This report examines in detail perceived and actual journey to work petrol costs of a sample of London commuters. The perception is also examined of related factors, such as petrol consumption and distance, in an attempt to throw some light on the perception mechanism itself.

Introduction

One of the interesting observations in Quarmby's seminal paper on the choice of mode for the journey to work (Quarmby, 1967) was that, based on the results of the discriminant analysis model, car running costs appeared to be underperceived. Quarmby pointed out that the running cost which gave the best fit was almost exactly equal to the petrol cost of cars averaging 25–35 miles per gallon – mpg (8–12 kilometers per liter – kpl), and he suggested that petrol costs might represent the perceived cost.

However, he also pointed out that little is known about how people cost out the running of their cars and he regretted that his original questionnaire did not ask people directly how much they thought their cars cost to run. In spite of this qualification, the under-perception of running costs by motorists (or the equating of running cost to petrol costs) has been widely accepted, with little direct corroboration or attempt to investigate the perception mechanism.

One notable exception was a study carried out in the United States (Lansing and Hendricks, 1967). The main object of the study was to determine whether people estimated the cost of the journey to work and, if so, how reasonable were the estimates. The authors found, from surveys in metropolitan areas, that while only 25% of people, according to their own report, had ever estimated the operating cost, 90% were prepared to give

some sort of answer. The average and median perceived costs per mile were found to be 5.3 cents and 5 cents, while the objective cost (estimated on the basis of average car consumption and petrol price) was 3.3 cents.

These conclusions, albeit for a country with a markedly different transport culture and significantly lower petrol prices, are clearly at variance with the generally accepted view in the U.K. And yet the issue is not unimportant. In addition to the implications that perception of costs has for modal split, and therefore for present transport policy, it is also an important factor in the formulation of strategies, both technological and organisational, for adapting to a world where oil is too scarce a commodity to be used as fuel for personal transport vehicles.

The objective of the study, then, was to answer three questions:

1. How do car commuters perceive journey costs in general and petrol costs in particular? (Petrol costs are, of course, only one element of full operating costs; the study concentrates on them because of the statement of the hypothesis being examined and because they do constitute the largest and most important element).
2. How do the perceived petrol costs compare with actual petrol costs?
3. What are the perception patterns and mechanisms at work?

The Problem of Perception

Values of perceived costs per mile are obtained, in general, by asking people to estimate the cost of a journey and dividing by the objective estimate of the distance. This is open to the criticism that the figure obtained may not necessarily correspond to the one that has been active in influencing the individual's modal decisions – in this case, his or her continuing decision to drive to work. The interview which establishes the perceived cost may well present the first occasion on which the individual is forced to isolate a single figure as representing the cost of the journey. In such a case, it is possible that the perceived cost which the individual has had "in the back of his or her mind" may not emerge. For example, it is possible that, within certain limits determined by the individual's budget and financial situation (although again, not necessarily explicitly perceived), cost may be no object. The "interview perceived" cost may therefore be of limited relevance.

The seriousness of this problem was confirmed by the survey. Eight of the respondents actually expressed surprise at the figures which they eventually (after much hesitation) gave. They were surprised: "that it [the cost per mile figure] is so low". The inference must be that if the perceived costs can be defined at all for these respondents, they are higher than the figures actually given.

The Estimation of Actual Costs

For the sake of brevity, "actual costs" will be used throughout this paper to mean "objectively measured petrol costs". One of the weaknesses of the work done by Lansing and Hendricks (1967) is that their comparison of objective and perceived costs is at the aggregate level. The objectives of this study rule out such an approach. Determining actual costs for individual cars, however, presented grave difficulties. The resources available ruled out the use of direct metering devices for measuring journey-to-work fuel consumption and so a considerable part of the effort of the study was devoted to establishing an estimating methodology which can be summarised here only very briefly.

There are three main difficulties in estimating objective costs. First, consumption figures for individual makes of car are usually given for general conditions (usually "overall", sometimes also "city" or "constant speed") and so must be adjusted for the specific road conditions in the area being studied. Secondly, these road conditions themselves vary from route to route and day to day. Finally, consumption is affected by factors such as the mechanical condition of the car, driving characteristics and ambient temperature (starting from cold). The estimation procedure employed was based on developing a relationship between fuel consumption curves obtained at the Road Research Laboratory (Everall, 1968) and "overall" consumption figures published by *Autocar*. Individual link speeds and average area speeds for the morning and evening peaks were obtained from the Greater London Council Traffic Survey Section and were checked against figures obtained from respondents' time and distance estimates. Finally, modifications were made to account for the extra fuel used in cold starts (Everall and Northrop, 1973) and for the mechanical condition of the average commuter's car.

Estimates were made of the magnitude of the errors inherent in the various steps (the consumption curves, the *Autocar* data and the average speed data) and of the variability due to driver characteristics and the mechanical condition of the car, and a statistical analysis showed that a reasonable confidence interval (80%) was given by ± 20%.

The Survey

SAMPLE

In all, 60 car-commuters were interviewed. Practical considerations favoured a workplace survey, although there was the obvious danger that such a sample frame might be untypical due to particular road, parking or other conditions. It was decided, therefore, to draw most of the sample from

the workplace frame and a smaller part from a house-to-house survey, to throw into relief any significant conditions or attitudes.

The workplace frame consisted of several Departments of the London Borough of Wandsworth in Wandsworth High Street, London. The Departments chosen employed a wide variety of clerical, accounting, supervisory and managerial staff who did not need to travel in the course of their work and so received no car expenses. A total of 45 people were interviewed on five separate days in mid-summer 1976. Care was taken to ensure that respondents had no prior knowledge of the survey.

The household sample frame consisted of several randomly selected streets in Herne Hill, a suburb in south-east London. Only 15 people were interviewed.

INTERVIEW STRUCTURE

The main object of the interview was to capture the immediate response to the question "How much do you think that it costs you to use your car to travel to work" and then to establish how the figure was derived. Table I gives the list of questions.

The interviewer introduced himself as "conducting a survey on car-commuting" with no mention of costs. Questions 1–10 served not only to capture data but to put the respondent at ease. Questions 12 and 13 had to be kept flexible as the respondent sometimes pre-empted them in answering question 11, or required elucidation (e.g. "Do you mean all costs or just petrol costs?"). Questions 10, 14 and 15 established perception of the components that would be used for calculating costs in the obvious way: distance, mpg (kpl) and the price of petrol. The last two questions were included for general interest.

Results

TWO SAMPLE FRAMES

The main object of having two sample frames was to throw into relief any significant attitudes or conditions that might be specific to one or the other. The results showed that while there were differences in the patterns of perception between the two samples, these were due to differences in parameters such as journey distance and not to location per se. Accordingly, the results are given for the sample as a whole.

JOURNEY LENGTH

The journey length (one-way) distributions are given in Table II. The

TABLE I

List of Questions Asked

1. Name; work telephone number.
2. Do you use the car on a regular basis for driving to work?
   Is it the only car in the household?
3. Do you give anyone a lift on a regular basis?
4. Do you receive any sort of car allowance from the Council/your company?
5. Is the car your own?
   What make and model is it?
   How old is it and how long have you had it?
   How is it serviced?
6. What do you do if the car is not available? When did this last happen?
7. Starting with your own street, can you describe the route you take to work?
8. Where do you park at work?
   How much does it cost?
9. What time do you usually leave home in the morning and work in the afternoon?
   How long do the journeys actually take?
   Do the journey times fluctuate?
10. How far would you say it is, using the route you take, from your home to where you park?
    Have you ever noted the distance from your odometer?
11. How much would you say it costs you to use your car to work?
12. How did you arrive at that figure?
13. How much, then, would you say the petrol costs come to?
14. What grade petrol do you buy?
    How much is it per gallon?
    How often do you buy petrol?
15. How many miles to the gallon do you think your car does, given the road conditions to and from work?
16. If you were to use public transport, how would you travel to work, how long do you think it would take, and how much do you think it would cost?
17. What would you say is the main reason why you drive to work rather than use public transport?

distances were determined from a call-back survey of odometer readings and checked on a 3-inch Atlas.

PETROL BUYING

Three quarters of the entire sample thought of buying petrol as a regular, predominantly weekly, activity. Of the remainder, all but one respondent bought petrol in "regular quantities" (e.g. four or five gallons or £2, £3 or £4-worth of petrol at a time). The distinction between the two groups may

TABLE II

Journey Length (One Way) Distribution

Miles	Wandsworth	Herne Hill	All
0– 3	20	5	25
3– 6	10	5	15
6– 9	7	3	10
9–12	3	1	4
12–15	1	1	2
15–18	4	0	4
Total	45	15	60
Average	5.3 miles	4.7 miles	5.15 miles

be artificial, since when asked "how often is that" most of the latter group replied "about once a week". In other words, nearly all regular commuters seem to have a well-developed routine for buying petrol and are familiar with the amount of petrol they buy, every week or so, and with its grade and price.

JOURNEY TIMES AND SPEEDS

Reported in-car journey times ranged from under five minutes to 65 minutes, with over half the sample in the 10–20 minute range. The times and distances were used to derive average journey speeds and these showed good agreement with the average speed assumptions.

PERCEPTION OF DISTANCE AND CONSUMPTION

Table III shows the comparison of actual and perceived distances. In general, people perceive distance reasonably well, with about one third perceiving "correctly" (see note a in the table) and the remainder over or under estimating, in roughly equal numbers, to within 20 percent.

CONSUMPTION

Although consumption is, strictly speaking, measured in gallons per mile, or equivalent units (liters per km), it is used here in the more popular sense of mpg. "Actual consumption" is used to denote the objectively-determined mpg (kpl) with the cold start not taken into account; and "cold start consumption" the objectively-determined mpg (kpl) incorporating the cold start correction. Figure 1 shows the results. Of the 60 respondents, four had

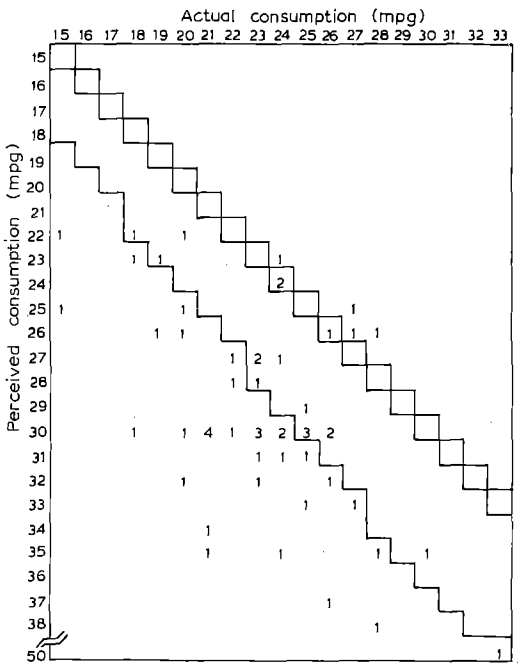
TABLE III

Actual and Perceived Distances

Distance (miles)	Perceived distance[a]			Average difference[b]
	Smaller	Greater	Identical	
0– 3	6	10	9	0.4
3– 6	2	9	4	0.7
6– 9	6	2	2	0.6
9–12	1	0	3	1.5
12–15	0	1	1	3.0
15–18	1	0	3	0.75
All	16	22	22	0.6

[a] Equality was defined as being agreement to within 0.25 mile for distances up to 6 miles, and to within 0.5 mile for distances over 6 miles (10 km).

[b] The average difference was calculated as the average of the absolute differences that exceeded the allowed deviations defined above.



Note: The lower stepped line represents the upper limit of the 80% confidence interval for actual consumption, that is, actual consumption X 1.2.

Fig. 1. Actual perceived consumption (mpg/kpl). Distribution of responses.

no idea of their consumption. The remainder answered the question quite confidently, although only one person had ever made a check.

The majority (49 out of 56) over-perceived mpg (kpl) with the average over-perception being 7 mpg (2.5 kpl) or 30 percent. The perceived figures are, however, close to the published "overall" figures, with the average (absolute) difference being only 2.9 mpg (1.0 kpl) and with 60 percent of figures being within 10 percent of the published ones.

Further analysis showed that most of the perceived figures falling within the actual miles/gallon confidence interval (above the stepped line in Fig. 1) were associated with long journeys and/or small cars – 8.2 miles (13.2 km) and 1142 cc compared with the sample averages of 5.1 miles (8.2 km) and 1205 cc. This is consistent with the above observation, since the longer journeys approximate more to "overall" conditions (being partly along dual carriageway or other fast roads) and since small cars have, in general, "flatter" consumption curves than big ones.

COLD START

Introducing the cold start correction reduces mpg drastically for short journeys (25 percent for a 1.5 mile journey), but less so for longer ones (only 3 percent for a 17 mile journey). The average overperception increases to 40 percent and only 10 respondents, with an average journey distance of 10.1 miles (16.3 km), gave estimates to within 20 percent of the cold start figure.

The results show, then, that mpg (kpl) was overestimated for the sample as a whole by 30–40 percent, with the best estimates coming from long distance commuters. The average overperception for those driving six miles (ten km) or less to work is therefore even higher, as can be seen from Fig. 1.

Finally, in anticipation of examining cost perceptions, the perceived consumption figures were compared with those derived from the perceived cost. For over 70 percent of the sample: perceived mpg (kpl) > actual mpg (kpl) > cost-derived mpg (kpl). This clearly indicates that most of the sample did not use consumption in calculating or estimating the cost.

PERCEIVED AND ACTUAL COSTS: METHOD OF DETERMINATION

Thirty-three respondents derived the cost figure on the (often rather vaguely-articulated) basis of total weekly expenditure, e.g., "Well, I spend about £3 a week on petrol, about half is for travelling to work". Eleven respondents were more definite, attributing specific figures to the work journey, e.g. 1 gallon per week, £1 per day, $\frac{1}{2}$ gallon per day, etc. Finally, seven people

said that they based their figure on consumption (mpg/kpl) and four were uncertain of where they got the figure from.

Thus, most people seem to produce estimates on the basis of a weekly (or at least regular) petrol-purchasing pattern and relatively few base their estimates specifically on mileage and consumption calculations.

PERCEIVED AND ACTUAL COSTS: RESULTS

Figure 2 shows the overall pattern of perceived versus actual costs and perceived versus cold-start costs. The information is summarised in Table IV.

An analysis of the actual and perceived cost distributions reveals two significant relationships: (a) that those who base their estimates on consumption and mileage underestimate costs by about one pence (1p); as one would expect from the findings on consumption perception; and (b) that long-distance commuters perceive costs (and also consumption) fairly accurately, although their cost-perception is not necessarily based on consumption.

The significance of journey distance can be further appreciated by considering the ratios of perceived to cold-start costs for journeys of 0–3, 3–6, 6–9 and over nine miles (14.5 km). The average ratios for these groups, 1.43, 1.46, 1.1 and 0.9, indicate that there may be a certain journey distance threshold beyond which perception is much improved.

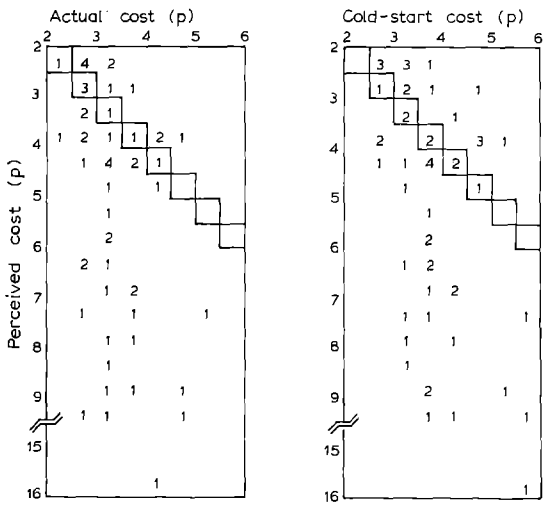


Fig.2. Perceived and actual costs: distribution of responses

TABLE IV

Perceived and Actual Cost Summary

Average perceived cost	5.2p
Average actual cost	3.3p
Average cold-start cost	3.8p
Average over-perception[b] (with respect to actual cost)	2.8p
Average under-perception[c] (with respect to actual cost)	0.6p
Responses	**No. in sample**
Perceived > actual	31
Perceived = actual[a]	18
Perceived < actual	6
Perceived > cold-start	27
Perceived = cold-start[a]	20
Perceived < cold-start	8
Refused to give perceived cost figure	5
Total sample size	60

[a] "=" means within ± 20% of the actual or cold-start figure, as applicable.
[b] i.e., for all respondents giving a figure larger than the objective estimate.
[c] i.e., for all respondents giving a figure smaller than the objective estimate.

Conclusions

MAJOR FINDINGS

The average perceived cost for the sample (5.2p) is significantly greater than the average actual (3.3p) and average cold-start (3.8p) costs. This is so, in spite of the fact that 87 percent of the sample over-estimated consumption, probably by adopting published figures for "overall" road conditions. This inconsistency agrees with the findings that most people do not base their cost estimates on consumption; and such underperception of costs as does occur is almost entirely due to the minority of car commuters who do use consumption in estimating cost. Cost perception does, however, improve significantly with journey distances (although possibly only over a certain threshold of four to six miles) and for journeys of six miles (10 km) or more, journey cost is perceived reasonably accurately.

Most people base their estimate on some notion of how much petrol they buy (on a regular basis) and how much of this is attributable to the

journey to work. The ratio of petrol consumed in commuting to work to total usage was estimated for about half the sample and was found to vary from under 0.2 to 0.85 with the smaller ratios being associated, as one would expect, with shorter distances. Ratios as high as 0.85 are due in part to second cars (whose ownership is itself positively correlated with commuting distance) being used for non-work journeys.

The dominant perceptual mechanism and the wide spread of ratios suggest one reason why cost-perception improves with distance. Short distance commuters over-estimate the journey to work use of the car – probably because it stands out as being regular and twice daily. They typically attribute to the journey to work a third or a half of total petrol expenditure, when it should be only a quarter or a fifth.

Long distance commuters, over six miles (10 km) say, are in a much better estimating position. The journey to work is both considerable in its own right and in relation to overall mileage, and its cost is therefore likely to be accurately estimated through the petrol-buying mechanism.

COMPARISON WITH OTHER STUDIES

While the results agree with those of Lansing and Hendricks (1967) they contradict the generally-held view that drivers underperceive operating costs by equating them to petrol costs (perceived accurately). Where these views are based on direct measurement, the discrepancy may be due to the type of journey in question. Most such studies have been based on inter-urban journeys (where conditions may approximate to those experienced by long-distance commuters, in which case there would be no discrepancy). At any rate, the comment that needs to be made is that cost-perception is a function of journey characteristics and statements must be treated with caution unless suitably qualified.

More puzzling is the agreement between petrol and perceived costs obtained for urban commuting conditions by Quarmby (especially since the agreement is with "overall" petrol costs, which are smaller than actual costs). One explanation is simply that what was true in Leeds 10 years ago may not apply in London now – perhaps thrifty Yorkshiremen are more scrupulous in costing their journeys than spendthrift Londoners! There are, however, arguments against this. The agreement between this study and that of Lansing and Hendricks (which was based on 1963 and 1965 survey data) gives the results a measure of temporal and locational stability. Also the substantial increases in the price of petrol in recent years might be expected to make people more rather than less cost-conscious. And finally, the present average "overall" petrol cost is about 2.5p, so we are talking of a discrepancy not of 10 or 20 percent but 100 percent.

One possible explanation is that the perceived cost figure of 2.0 to 2.5d

(1p) obtained by Quarmby was not sufficiently qualified. It was obtained from running the discriminant analysis model with six car operating cost values from 1d to 3.5d. The value of 2.0 to 2.5d (0.8 to 1.0p) gave the highest multiple correlation coefficient, while satisfying the condition that bus and car cost coefficients should be equal. If all the significant factors in modal choice had been included in the model, the interpretation of the figure as "perceived car operating costs" would be correct [1]. But, in fact, the model did not include any of the quality factors – comfort, dependability, convenience – whose importance in modal choice is now well-established. The figure derived from the model should therefore be interpreted as a "perceived net cost," that is, perceived operating cost modified by the utility or disutility of factors not included in the model (e.g. the 2d could consist of a perceived petrol cost of 3d less a perceived "benefit" in terms of comfort relative to public transport of 1d). Thus, the perceived net cost would be smaller than the perceived operating cost, and the discrepancy between the results obtained would certainly be mitigated.

IMPLICATIONS AND FURTHER RESEARCH

The most obvious implications that the study has indicated are for the journey to work modal split. The over-perception (and even non-perception) of petrol costs offers little promise of persuading car commuters to transfer to public transport on the basis of straight-forward price comparison. The more interesting application is not to short-term modal split, which can or could be controlled through a variety of measures, but to the longer-term and inevitable situation when oil will be scarce as a resource – and petrol too expensive to be used on a large scale in cars. As petrol prices increase, in real terms, over the next two decades how will car-owning households respond? At what point will the price "bite" on different sections of the community and which journeys will be the ones affected first (and which last)? What will be the resulting demands on road space as well as on public transport and what interim policy should be followed to achieve a smooth transition?

These questions are important enough to deserve serious consideration. Some avenues – for example, the development of alternative energy sources and technologies, including electrically driven vehicles – are already receiving considerable attention. But comparatively little is known about some aspects of transport-related behaviour and this study itself suggests various follow-up studies. One would be the evaluation by direct measurement (or a separate development) of the petrol cost-estimating methodology for urban conditions. Another is based upon the suggested perception mechanism, where commuters compensate for the over-perception of journey-to-work costs by under-perceiving, perhaps, the costs of other journeys. Finally, the applica-

bility of the results obtained to urban and suburban commuting must remain somewhat in question until confirmed by similar studies in other locations.

Notes

1 It is important to note that misinterpretation of indirectly-determined operating costs does not necessarily invalidate their use in modelling patterns of movement. They are, in effect, behavioural costs (Quarmby and McIntosh, 1970) and need only be correct in the sense of giving a good empirical fit to observed behaviour. However, an understanding of behavioural figures is necessary if estimates are to be made of their values at some future time, in order to be able to predict future patterns of movement.

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