Energy Policies and Company Cars: An Application of Experimental Design Methods in Economic Research

Occasional Paper

Company cars account for more than a third of new car sales in Australia. Since company cars seem generally larger and less fuel-efficient than average and since they appear to travel greater distances and are replaced more frequently, it seems useful to examine the effectiveness of policies that might have potential fuel conservation effects.

Subject
Series
Date
A to Z
Search
Results
Print
Exit
GO BACK

OPO47

Occasional Paper 47

Energy Policies and Company Cars:

An Application of Experimental Design Methods in Economic Research

Bureau of Transport Economics

ISBN 0 642 06893 3

Printed by Watson Ferguson and Co., Brisbane

FOREWORD

Company cars account for more than a third of new car sales in Australia. Since company cars seem generally larger and less fuel-efficient than average and since they appear to travel greater distances and are replaced more frequently, it seems useful to examine the effectiveness of policies that might have potential fuel conservation effects.

It is this hypothesis that has impelled the author to undertake this study, and the results should be of interest to both government and corporate policy makers. From the fuel conservation standpoint, the results imply that a number of policies could substantially alter company car purchase decisions.

The author makes it clear, however, that fuel conservation effects alone may not be sufficient justification for the implementation of the policy proposals discussed in this report.

The BTE does not necessarily accept all the findings of this report, but I believe that they will contribute in a positive way to the discussion now taking place on fuel management policy.

The author is presently a Research Fellow in Economics at the Australian Film and Television School, North Ryde, NSW.

(R.H. Heacock)
Acting Assistant Director
Planning and Technology Branch

ACKNOWLEDGMENTS

The support provided by Kuring-gai College of Advanced Education, Macquarie University and the Bureau of Transport Economics is gratefully acknowledged. The assistance and encouragement given to me by numerous individual people has been much appreciated, and I would like to specially thank Associate Professor David Hensher and Dr Les Johnson of Macquarie University, and Dr Chris Hall of Kuring-gai College of Advanced Education. My thanks also to all the company executives who participated in the survey, and to Sylvia Butlet and Shirley Lewis who did the typing.

CONTENTS

Page

Page

TABLES

FIGURES

Page

CHAPTER 1
ENERGY CONSERVATION AND COMPANY CARS

1.1 INTRODUCTION: THE ENERGY PROBLEM, CONSERVATION POLICIES AND RESPONSES

One of the major resources scarcity problems facing the World in the 1980s is that of energy. In economic terms the energy problem may be seen as an imbalance between the supply of conventional types of energy and the demand for those types of energy. Thus the major problem centres on petroleum based energy resources.

Australia is rich in energy resources by World standards and is a net energy exporter, however her petroleum reserves are relatively low compared to the rate of consumption. Petroleum provides more than half of all the energy consumed in the Australian economy and almost all the energy consumed in transportation (Australian Transport Advisory Council 1978, National Energy Advisory Committee 1978; Australian Institute of Petroleum 1979a). Approximately two-thirds of this petroleum energy is supplied by domestic production while the remaining one-third is imported. Recent reassessments of reserves and production technologies have suggested that Australia's domestic production of oil is unlikely to decline as soon or as rapidly as previously anticipated (Esso 1980). Australia's self-sufficiency in crude oil is presently expected to fall to 40-50 per cent in 1990 unless significant new reserves are discovered (Australian Institute of Petroleum, Dec. 1980b). However, even if new reserves are found and domestic production maintained at a higher level, the policy of world parity pricing of Australian crude oil will ensure that the price of domestically produced oil will escalate with World prices.

In view of the prospects of escalating prices and uncertainties in the supply of petroleum energy it is important to gain an understanding of the impacts this is likely to have on the economy and society, and to develop appropriate policies in this context.

Of all major sectors of the economy the transport sector is the one which will be most severely affected by rising prices and shortfalls in the supply of petroleum energy. Transportation accounts for almost 60 per cent of all oil consumed in the Australian economy, and is dependent on oil for close to 98 per cent of its energy requirements. (Australian Transport Advisory Council 1978; Esso 1980). For transportation purposes, substitutes to liquid petroleum fuels are not readily available at present, although a number of alternatives are under investigation (Schou 1979, Australian Transport Advisory Council 1978). The high level of dependence on oil and the difficulties of substitution suggest that the conservation of petroleum energy in the transportation sector is of prime importance. It is therefore necessary to identify policies which may encourage conservation of transport energy, and to study the likely impacts of such policies on people and organisations.

An extensive study was undertaken of the existing literature in the areas of energy and transport, conservation strategies, and consumer responses to energy constraints and policies. The findings of this literature survey have been presented in previous publications (Schou 1979, a, b). The major conclusion arising from the literature study is that changes towards smaller more fuel-efficient cars represent the most promising option for the conservation of petroleum energy in the medium term. The five main reasons for this are:

One, the conservation potential of improving the fuel-efficiency of cars is much larger than that of any other policy, because cars presently consume the major share, about 70 per cent, of all the petroleum consumed in transportation (National Energy Advisory Committee 1979, p3).

Two, cars presently operate at efficiencies considerably below that which existing technology could achieve (Lutin 1976; Kirkwood and Lee, Rand Corporation 1975).

Three, gains in fuel efficiency can be achieved without major impacts on the quality of the transport services provided by the car, and without disruption to the travel patterns and transport tasks of individuals and organisations.

Four, introducing improvements in fuel efficiency can reduce total cost of car ownership and operation, this in turn will benefit consumers and will be favoured by market forces (Transportation Research Board 1977).

Five, conservation benefits are achievable within a few years from the introduction of particular efficiency improvements, even though longer lead times are required for full market penetration and maximum fuel savings. This is so because newer cars travel longer average distances than older cars; in Australia some 50 per cent of vehicle kilometres are travelled by cars less than four years old (Hamilton 1978, p33).

Given the substantial energy conservation potential of the car it is of interest and importance to identify policies which would encourage the move towards smaller more fuel-efficient cars. The effectiveness of any policy, or set of policies, will be determined by the responses of car owners and users. It is therefore essential to gain an understanding of how individuals and organisations are likely to respond to particular energy conservation policies.

The literature contains several studies of the responses of individuals and households to energy problems and policies(1). However an important sector of the market for cars and transport energy appears to have been completely overlooked by previous research. This is the company car sector.

1.2 THE RATIONALE FOR STUDYING THE COMPANY CAR SECTOR IN THE CONTEXT OF ENERGY CONSERVATION

In a set of introductory hypotheses about the importance of company cars in the context of energy conservation it was proposed that:

a. Company cars account for a very considerable proportion of the new car market in Australia, and constitute an important part of the total national fleet.

b. Company cars are predominantly larger and less fuel-efficient types of cars.

---

(1) See Schou 1979a and Chapter 2.

c. Company cars travel longer average annual distances than the average for the national fleet.

d. Company cars are replaced more frequently than other cars, this accounts for their greater share of the new car market than of the total national fleet.

The study domain of the company car sector encompasses sedans and station-wagons registered by companies, rather than by private individuals or government. Trucks, utilities and vans were excluded from the study on the grounds that their product and usage characteristics differ substantially from those of sedans and station-wagons. (Throughout this report the term 'car' refers to sedans and station-wagons).

Information obtained from the New South Wales Department of Motor Transport(1) confirmed the first preliminary hypothesis about the importance of company cars. It was found that 44 per cent of new cars and station-wagons registered in NSW in 1978-79 were company cars, but that only about 9 per cent of the total NSW fleet of cars and station-wagons were company cars. This implies that the replacement cycle is considerably shorter for company cars than for the fleet as a whole.

The share of company cars in the new car market is higher in the state of New South Wales than the average for Australia. Data made available by the Ford Sales Company(2) show that company car demand constitutes about 35 per cent of the new car market in Australia. The difference in these market shares could be accounted for by the heavier concentration of industry and commerce in New South Wales as compared with other States, except Victoria.

The very large share of company purchases in the new car market can be expected to have an important influence on the types of cars which are produced by the domestic automobile manufacturers, as well as some influence on imports in particular of luxury cars. In the order of 70 per cent of the

---

(1) Private communication, April 1979.
(2) Private Communication, April 1980.

company car market is supplied by the two major local producers, Ford and GMH, with Ford holding the major share(1). If, as stated in preliminary hypothesis b, company cars are generally larger and less fuel efficient types of cars, then the importance of the company sector in the new car market would tend to encourage the local producers to supply these types of cars to the whole of the market. Examination of the pattern of local automobile production and of automobile imports offers some support for this contention.

No pre-existing data were available to test the preliminary hypotheses in respect of company car type, efficiency, distance travelled and replacement cycles. However data generated by the present study provide strong evidence that company cars are predominantly larger and less fuel efficient types of cars, travelling longer distances and being replaced more frequently than other cars.

The above suggests that the company car sector offers considerable potential for energy conservation through changes to smaller more fuel-efficient cars. It is therefore of particular interest to investigate alternative policies which may be adopted to encourage such changes, and to determine the likely impacts of these policies on company car fleets. This is the subject of the present study.

1.3 SELECTION OF POLICIES FOR ENERGY CONSERVATION IN COMPANY CAR FLEETS

Alternative policies for energy conservation in transportation were examined for the purpose of identifying policies for inducing companies to shift to smaller more fuel-efficient cars. The relevant policies may be divided into three groups:

i. policies which affect the price of petrol
ii. policies which regulate the availability of petrol, and
iii. policies which influence the relative prices of different types of cars, or their relative standing costs(2).

---

(1) Private communication, April and August 1980.
(2) Standing costs do not vary with the level of usage and include such items as registration, insurance and depreciation.

While policies which operate through price or tax incentives are considered the most desirable on efficiency grounds, it seems likely that direct rationing of the supply of petrol will be called for in circumstances of severe shortages.

Four specific policies were selected for detailed study of their likely impact on company car fleets. The policies comprise one which increases the price of petrol, one which limits the availability of petrol and two which discriminate directly against large fuel-inefficient cars through different tax measures(1). The policies selected thus represent the range of policies which could be applied to encourage changes to smaller more fuel-efficient cars.

In selecting these policies, consideration was given to issues of political feasibility and administrative responsibility. Policies which involve subsidies (as opposed to taxes) were considered politically unlikely because of their requirements for government expenditure and thus their implications for government budget deficits. The responsibility for implementing and administering the policies would rest with the State Governments for some and with the Federal Government for others. Petrol price is largely controlled by the Federal Government through excise taxes and its policy of world parity pricing of Australian crude oil. However the State Governments can have some influence via retail licensing fees on petrol outlets, and via bodies such as the New South Wales Prices Commission. Rationing may be imposed at a State level, as experienced in New South Wales during temporary fuel shortages in recent years. Selective taxes on fuel-inefficient cars may be levied by State Governments through registration and insurance charges, while tax deductibility provision for company cars are in the domain of Federal Government responsibility via company taxation.

---

(1) The detailed specification of these policies, and the method of estimating their likely impacts on company car fleets, is discussed in Chapter 4.

On the grounds that some of the policies under investigation could be implemented at a State level it was decided to conduct the data collection for the policy impact study within the state of New South Wales. However the findings of the study can be applied to the other States of Australia as well.

1.4 AIMS OF THE POLICY IMPACT STUDY AND STATEMENT OF THE RESEARCH PROBLEM

The central aims of the study are to:

i. determine the likely impacts of the selected energy conservation policies on the size and composition of company car fleets.

ii. identify the effects of the characteristics of companies and fleets on the policy responses.

iii. demonstrate the application of experimental design methods in economic research.

Given that the policies of interest are not presently applied it is not possible to observe directly the relevant policy responses or to assess the impact of the policies on company car fleets. The approach adopted to overcome this problem involved the application of experimental design methods to the construction of policy scenarios which describe the imposition of the policies at various possible levels. The responses of companies to a range of such policy scenarios were obtained in terms of the numbers of cars of different size classes which companies would intend to keep in their fleets under the circumstances described in the scenarios. Data were also obtained on a variety of company and fleet characteristics which were expected to influence the policy responses of companies. Detailed analysis of the policy responses and the characteristics provides the basis for prediction of the impacts of the policies on the size and composition of company car fleets.

1.5 OUTLINE OF THE REPORT

This section gives a brief outline of the remaining chapters of the report. Chapter 2 surveys the existing literature on the impacts of energy constraints and conservation policies. Although the literature does not contain any previous studies in respect of company cars, there are important areas of literature which have provided background and inspiration for the present research.

Chapter 3 develops the theoretical basis for the study of potential policy impacts. The theories of demand and decision making are discussed, and the applicability of alternative approaches is explored. Theoretical analysis is then employed to derive predictions of company responses to the conservation policies and to derive detailed hypotheses for testing in the empirical research.

Chapter 4 explains the theory and method of experimental design and its application to the construction of policy scenarios for the collection of data on the responses of companies to potential energy conservation policies.

Chapter 5 discusses the design of the survey which was undertaken to obtain the data required for achieving the aims of the study. The survey involved 1000 New South Wales companies and data were collected on the responses of the companies to a range of policy scenarios, as well as on the characteristics of the companies and their fleets.

Chapter 6 presents the results of a detailed statistical analysis of the characteristics of companies and fleets. This analysis offers interesting background information on company car fleets, it confirms the introductory hypotheses about the importance of company cars in the context of energy conservation, and it provides a detailed understanding of the nature of the characteristics variables which constitute important inputs into the central policy impact analysis.

Chapter 7 discusses the methods of statistical analysis and presents the results of the central policy impact analysis. This analysis offers important results in respect of the likely impacts of the selected energy conservation policies on the size and composition of company car fleets, and in respect of the effects of the characteristics of companies and fleets on the policy responses.

Finally Chapter 8 summarises the study and its conclusions.

CHAPTER 2

LITERATURE ON ENERGY PROBLEMS AND POLICIES FOR THE AUTOMOBILE

2.1 INTRODUCTION

A considerable body of literature on energy problems and policies has been established since the oil crisis which affected most parts of the World in 1973-74. No previous studies have dealt specifically with the company car sector in this context, but there are nevertheless parts of the literature which have provided useful background information for the present study. The literature in the areas of energy-efficiencies in transport, effects of energy constraints on travel behaviour, and strategies for energy conservation in the transport sector is reviewed in earlier papers (Schou 1979a and 1979b). The most important conclusion arising from the study of the literature is that changes towards smaller more fuel-efficient cars present the most promising strategy for the conservation of transport energy in the medium term. This chapter focuses on the effects of increases in the price of petrol and increases in the prices or standing costs of cars on the pattern of demand for cars.

2.2 THE EFFECTS OF PETROL PRICE INCREASES AND SHORTAGES OF SUPPLY ON THE PATTERN OF DEMANDS FOR CARS

In response to petrol price increases households or business firms may decrease their consumption of petrol in three ways: i. they may reduce distance driven, ii. they may reduce the number of cars they own or operate, and iii. they may change to smaller more fuel-efficient cars(1).

The literature presents a large number of studies of the effects of petrol price increases and shortages of supply on the travel behaviour of individuals and households. Most of these studies concern the experience in the United States during and immediately after the 1973-74 oil crisis (Becker, Brown and

---

(1) A fourth adjustment process involving the substitution of alternative fuels for petrol is likely to become important in the future.

Schary 1976, Hartgen 1975, Keck, Earlbaum, Milic and Trentacoste 1974, Marshak 1975; Peskin, Schofer and Stopher 1975; Pisarski and DeTerra 1975; Sacco and Hajj 1976; Shinnar 1975; Skinner 1975, Stearns 1976). The findings in respect of short-run changes in travel behaviour and car usage patterns are summarised in Schou (1979a). A few of these studies also reported on the short-run effects on the pattern of demand for automobiles. These findings are reviewed briefly below.

On the basis of studies of individual responses in New York State and Chicago during the energy crisis, Hartgen (1975) reports that total car purchases fell sharply but that no shift was observed to smaller more efficient cars. This occurs with the findings of Milic (1974), Skinner (1975) and Marshak (1975) in respect of the short-run effects of energy constraints on the pattern of demand for automobiles. However Sacco and Hajj (1976), in their study based on South Carolina, reported that the effect of the petrol price increases appeared to be reflected in the buying of more small cars. It is not surprising that the short-term responses of automobile demand were quite conservative bcause of the uncertainty about the likely duration of the energy shortages and the rate of escalation of petrol price. Furthermore the time lags inherent in the turnover of automobiles imply that studies covering time periods of several years are required for any meaningful assessment of the effects on the pattern of demand for automobiles.

There are numerous studies of the demand for automobiles (Australian studies: Industries Assistance Commission 1974; Filmer and Talbot 1975; McDonnell and Defris 1976. Overseas studies: Wykoff 1973; Tanner 1974; Lerman and Ben-Akiva 1976; Blomqvist and Haessel 1978; Lave and Train 1978; Lave 1980; Mogridge 1978). However only a few of these studies segment the demand into different types of cars to allow for the assessment of market share effect of petrol price increases or other policies. Most of the studies only consider petrol price as part of general operating costs, and none are concerned with the effects of petrol supply shortages. The results of the studies which have examined the effects of petrol price increases on the total demand for cars or on the market shares of different types of car are discussed below.

In a study based on aggregate data for Australia, Tulpule (1975) has examined the sensitivity of car ownership forecasts to different petrol price assumptions. For his most severe petrol price assumption ($1.50 per gallon by 1980 increasing by 3c per gallon until 1990) he obtained a maximum of 10 per cent reduction in car ownership compared with his base forecast. Tulpule concludes that rising petrol prices are not likely to have a significant effect on car ownership although they may act to slightly delay the growth of car ownership.

The Industries Assistance Commission (IAC), as part of its 1974 report on the Australian car industry, employed an econometric model of the demand for cars to forecast new car sales from 1974 to 1980. In the base projection it was assumed that the price of petrol would increase at the same rate as the general level of prices until 1980. The effects of the alternative assumption of petrol prices increasing twice as fast as the general level of prices was tested. The model indicated that the total market for new cars would continue to grow but at a reduced rate, thus total sales in 1980 were projected to be about 4 per cent lower than in the base forecast. Sales of small cars were projected to about 3 per cent lower, while sales of medium/luxury cars were projected to be 5 per cent lower, resulting in a slightly increased market share of small cars.

The IAC model embodies a 'structural trend' in the market in favour of smaller cars. Thus even the base forecast projects an increase in the market share of small cars of 17 per cent from 1973 to 1980. It is interesting in this context to examine the actual trend in the Australian car market in the 1970s. In the first half of the 1970s the Australian Bureau of Statistics published annual data on market shares by horse power of new cars registered. Unfortunately the publication of this data series was discontinued in 1976, and it is not possible to follow the trend in the market shares of different size classes after that date. Table 2-1 shows the percentage of new cars in each of three sizes (horse power) categories from 1971 to 1976.

TABLE 2-1 - MARKET SHARES BY HORSE POWER

	17 HP or less	18-27 HP	28 HP or more
1971	32%	17%	51%
1972	30%	14%	56%
1973	34%	12%	52%
1974	36%	14%	50%
1975	40%	15%	45%
1976 (to June)	41%	15%	44%

Source: Chaffin and Hollywood 1976, Australian Bureau of Statistics 1971 to 1976.

The market share of cars with 17 horse power or less increased from 30 per cent in 1972 to 41 per cent in 1976 (an increase of 37 per cent). In the same period the market share of cars with 28 horsepower or more declined from 56 to 44 per cent (a drop of 21 per cent), while the share of cars in the middle group stayed relatively stable. There is no evidence however that this trend has been influenced by petrol prices. In fact the real price of petrol in Australia (the retail price, discounted by the consumer price index) decreased during most of the 1970s up until 1978.

Tanner (1974) has forecast car ownership in the UK to the year 2010, and tested the effects of 'high' and 'low' levels of running costs. According to his results a substantial change in running costs, such as petrol price increases, does not have any significant long term effect on overall car ownership.

In another UK study, Mogridge (1978) has developed a comprehensive model of the car market, and evaluated the effects of petrol price increases on the demand for different size classes of cars. Mogridge found that in the short-run, petrol price has very little effect on the demand for cars, thus confirming the results of the US studies of short-run effects (Hartgen 1975;

Milic 1974, Skinner 1975; Marshak 1975). However in the long-run petrol price increases result in adjustments in car size with smaller cars gaining an increased share of the market. (During and after the oil crisis large cars in the UK depreciated about 15 per cent more per annum than small cars). The size of new cars being bought by households was drastically reduced as a result of the oil crisis. However business purchases which tend to be of new, larger cars reacted more slowly to the crisis. Thus sales of the larger cars stayed relatively constant, and it was the middle ranges that declined the most.

The results obtained by Mogridge (1978) for the UK are consistent with those of the Industries Assistance Commission (1974) for Australia and are reinforced by the results of North American studies (Blomqvist and Haessel 1978; Lave and Train 1978; Wildhorn et al., eds. 1976; US Federal Energy Administration 1974).

Evidence of the long-run influence of petrol price on the size of cars purchased (and produced) may be drawn also from an international comparison of petrol prices and car sizes (Thomson 1973). Such a comparison shows a strong inverse relationship between average car size and the price of petrol. Thus countries which have traditionally had cheap and plentiful supplies of petrol have adopted much larger cars than countries where petrol has been relatively more expensive. This is illustrated by the remarkable difference in the average size of cars between North America and Europe.

2.2.1 The Price Elasticity of Demand for Petrol

A few of the studies reviewed have examined the effects of petrol price increases on both the overall demand for cars and the market shares of different sizes of cars (IAC 1974; Blomqvist and Haessel 1978; Lave and Train 1977; Wildhorn et al. 1976). However the study by Wildhorn et al. is the only one which has simultaneously considered all three adjustment processes whereby the consumption of petrol may be reduced, and reported on the overall impacts of petrol price increases on the demand for petrol. The results of this study are summarised in Table 2-2.

TABLE 2-2 - ADJUSTMENTS TO PETROL PRICE CHANGES: ELASTICITIES

	First Year	Long Run
Car ownership	-0.29	-0.38
Miles per gallon	-0.17	-0.17
Miles per car	-0.37	-0.37
Total	-0.83	-0.92

Source: Wildhorn et al., eds., 1976 p105.

The overall price elasticity of demand for petrol reported by Wildhorn et al. (1976) is considerably higher than that found by most other researchers in the field (Charles River Associates 1976; McGillivray 1976; Ramsey, Rasche and Allen 1975; Mehring 1976; Schou and Johnson 1979). The only Australian study available indicates that the price elasticity of demand for petrol is very much lower for this country (Schou and Johnson 1979). Estimates of the short-run elasticity are in the range of -.02 to -.07(1).

The overall price elasticities of demand for petrol are of interest in the present context as they form a basis of comparison for the elasticities which can be obtained from the present study in respect of the petrol consumption of company cars (See Section 7.4.5).

2.3 THE EFFECTS OF INCREASES IN THE PRICE OF CARS ON THE PATTERN OF DEMAND

Some of the automobile demand studies referenced in the previous section have also reported on the effects of car sales taxes or other forms of car taxes. Tulpule (1975) examined the sensitivity of total car ownership to different

(1) It is acknowledged that the study was undertaken over a time period (1955-1976) where real petrol prices tended to decrease. It is intended to update the study to test whether increasing real prices in the past few years would have altered the results.

sales tax assumptions (ranging from 20 to 35 per cent by 1980). He found that these alternative sales tax assumptions made very little difference to the projected level of car ownership. The maximum reduction in car ownership for the 35 per cent sales tax was only .8 per cent, implying an elasticity of -.02.

In another Australian study, Filmer and Talbot (1975) have reported the elasticity of demand for new cars in respect of increases in purchase price as -.54. Since this result concerns new cars only, it is not directly comparable with Tulpule's results in respect of overall car ownership(1).

Blomqvist and Haessel (1978), in their study of the Canadian car market, found purchase price elasticities of the demand for new cars to be much higher than reported by Filmer and Talbot for Australia. Blomqvist and Haessel distinguish between small cars and large cars and report owner price elasticities of -2.30 for small cars and -1.26 for large cars. The cross elasticity of the demand for new large cars with respect to the price of new small cars is found to be 1.73, while the cross elasticity of the demand for new small cars with repect to the price of new large cars is found to be .86. These results imply that the composition of demand for new cars is quite sensitive to changes in relative car prices, and to policies which influence these.

Lave and Train (1977) have tested the effects of a 10 per cent excise tax on larger cars within the framwork of a model estimating the choice probabilities for ten different classes of cars. Their model indicates that this excise tax would have the smallest effects on the market shares of luxury cars and expensive large cars (presumably because people who buy such cars have little sensitivity to purchase price in the first place). The greatest decrease in market share would be for 'intermediate' cars (about the size of a Ford Fairlane), however the overall effects of the excise tax on the market shares would be very limited. Much larger taxes would be necessary to cause substantial movements. Lave and Train note that a significant excise tax on

---

(1) It should be noted also that a given percentage increase in the sales tax on new cars will result in a much lower percentage increase in their purchase price.

new large cars, could be expected to have the effect of making consumers keep their current large cars for a longer period of time. This is confirmed by the policy models of Wildhorn et al. (1976), which show that an excise tax on new large cars would have the effect of reducing the scrappage rate for existing large fuel-inefficient cars. This response of consumers to selective excise taxes on new 'gas-guzzlers' would act to reduce the effectiveness of such taxes for energy conservation. It therefore appears that a superior strategy would be to levy 'inefficiency-taxes' on an annual basis on all cars below a certain fuel economy standard. The tax policies examined in the present study were designed with this in mind.

CHAPTER 3

THE THEORETICAL BASIS FOR THE STUDY OF POLICY IMPACTS

'The principles of economics are based on postulates about behavioural responses of individuals - and organisations - to changes in the environment' Alchian and Allen 1964, p19.

3.1 INTRODUCTION: THE FUNDAMENTAL HYPOTHESES AND THE POLICY RESPONSE FUNCTIONS

Corresponding to the central aims of the study (as stated in section 1.4) two fundamental hypotheses were formulated:

i. the selected energy conservation policies would have impacts on company car fleets; in particular the policies would induce shifts towards smaller more fuel-efficient cars.

ii. the characteristics of companies and fleets would have important effects on the policy responses.

The central concern then is with the policy responses of companies in terms of changes in the demand for different size classes of company cars(1). Such responses are of crucial importance for determining the likely impacts of the selected policies on the size and composition of company car fleets, and for identifying the effects of various company and fleet characteristics. Thus interest focuses on the policy response functions which may be represented by the following equation:

$$R_{sc} = f\ (\ P\ ,\ CH_c\ )$$

where R_{sc} = Response of company c in terms of dependent variable s, which denotes a given size class of company cars

P = Vector of Policy Variables

CH_c = Vector of Characteristics of company c

---

(1) For the purpse of the empirical study company cars were segmented into three size groups: 'small', 'medium' and 'large'. The segmentation criteria based on product characteristics are detailed in section 4.4.2.

A theoretical framework is required within which to study the policy responses, and on the basis of which to derive detailed hypotheses for empirical testing. The theories of demand and decision making provide a useful framework within which to analyse changes in company car demand patterns in response to the energy conservation policies.

3.2 THEORIES OF DEMAND AND DECISION MAKING

The economic theory of demand provides an appealing basis for explaining and predicting demand responses, and theories of organisational decision making complement the theory of consumer demand in the context where effective demand is exercised at an organisational level.

3.2.1 Revealed Behaviour and Intended Behaviour

The revealed preference approach (Samuelson 1938, 1948, 1950) is adopted as the basis for the study of policy responses, and an extension of the approach is introduced to enable its application in the present study.

Although it became known as the 'revealed preference' approach it is notable that no specific assumptions are made about preferences, and that its only axioms are about behaviour (Samuelson 1948, Little 1949; Green 1971, p121). It could be argued therefore that the conventional terminology is somewhat misleading and that the label 'revealed behaviour' would be more appropriate to the substance of the approach.

Revealed preference theory is based on the two axioms of choice and consistency. The axiom of choice simply states that 'from any set of alternatives, the consumer makes a choice', while the axiom of consistency states that 'if x is chosen from a set of alternatives that includes y, then any set of alternatives from which y is chosen must not contain x' (Green 1971, p121). From these two axioms it is possible to derive all the fundamental results of demand theory (Green 1971, ch 8). The revealed preference approach thus provides a theoretical basis for empirical studies of demand and decision making.

One potential problem in the application of the revealed behaviour approach in the present context, centres on the notion of 'observed behaviour'. If this notion is interpreted in a very literal sense to mean that behaviour must be actually observed before any analysis thereof is possible, then a serious problem arises for prediction of behavioural responses to future situations, or possible policies, which are perceived to differ non-marginally from the present (Hensher and Louviere 1979). The problem is that the relevant responses are not actually observable because the situations or policies of interest do not presently exist, or are not presently imposed at the relevant range of values. It is therefore not possible to rely on presently revealed behaviour or to extrapolate from such behaviour for the purpose of prediction. Since this prediction problem arises from a very strict interpretation of 'observed behaviour' it is possible, by relaxing this interpretation, to extend the applicability of the revealed behaviour approach to future decision contexts. Introducing such an extension to encompass revealed intended behaviour is necessary to enable the study of likely changes in the demand patterns for company cars in response to potential energy conservation policies.

The application of the revealed intended behaviour approach requires data on intended behaviour responses to the potential future policies. In order to obtain such data, policy scenarios were developed describing possible future situations in terms of combinations of the policies at various levels of imposition. Responses to these scenarios were sought in terms of the numbers of cars in different size classes which companies would intend to keep in their fleets under the scenario circumstances. The method of experimental design was applied to the systematic structuring of policy scenarios. Experimental design method and the construction of policy scenarios are the topics of Chapter 4.

3.2.2 Organisational Decision Making

This section briefly outlines the traditional approach to decision theory presents the alternative theories of the behaviour of the firm, and introduces important aspects of the theory of organisational decision making.

Decision theory is a complex body of knowledge developed by mathematicians, statisticians, psychologists and economists attempting to describe systematically how decisions are made, or to prescribe how decisions 'should' be made(1). The traditional approach to the theory of decision making is based on utility and choice theory, and thus shares a common basis with the utility approach to demand theory. It is assumed that the decision unit acts rationally to maximise its overall utility under conditions of certainty, and 'subjective expected utility' under conditions of uncertainty(2).

In the context where the decision maker is a business firm, classical theory assumes that utility is derived from profits, and thus profit maximisation is assumed to be the objective governing the rational behaviour of the firm (Marshall 1920; Machlup 1967). The classical theory of the firm, and its assumption of profit maximisation, has been extensively challenged, on one front, as a result of the increasing dominance of large modern corporations characterised by the separation of ownership and control (Berle and Means 1932), and, on another front, in recognition of the real world complexities hindering rational maximising behaviour.

A plethora of alternative theories have been developed proposing a variety of different motivations such as: sales or revenue maximisation (Baumol 1959), maximisation of managerial utility as a function of residual profits and discretionary expenditure on staff and managerial emoluments (Williamson 1963, 1964, 1967), maximisation of lifetime incomes of managers (Monsen and Downs 1965), maximisation of managerial utility as a function of growth rate and share valuation ratio (Marris 1964), increasing long run profits and growth (Penrose 1959), and assuring autonomy and security of the 'technostructure' through maximisation of the long run rate of growth (Galbraith 1967, 1975).

---

(1) Savage 1954; Edwards 1954, 1961; Edwards and Tversky 1967; Fishburn 1964, 1970; Luce and Raiffa 1957; Luce 1959; Keeney and Raiffa 1976; Rapoport and Wallsten 1972; Green and Wind 1973; White 1969; White and Bowen 1975.

(2) 'Subjective expected utility' (SEU) is comprised of subjectively assessed probabilities of outcomes in some combination (usually multiplied) with their expected utilities (Bernoulli 1954 translation; Von Neumann and Morgenstern 1944; Friedman and Savage 1948; Baumol 1965; Arrow 1951b, Alchian 1953; Edwards 1961).

These theories essentially retain the concept of maximisation from classical theory but modify the content of the maximisation assumption.

The challenge to classical theory on the second front is more fundamental in that the maximisation assumption itself is rejected (Simon 1945, 1955, 1956, 1966, 1967, 1978b; March and Simon 1958; Cyert and March 1963, March and Olsen 1976; March 1978). The alternative theories here are concerned with organisational behaviour and decision making in a world of incomplete information.

The behavioural theory of organisational decision making based on Simon's paradigm of bounded rationality and satisficing offers an appealing conceptual approach to the study of the intended behaviour of organisations in response to the energy policies. Simon argues that limits are imposed upon rationality in decision making by the lack of complete knowledge of the exact consequences of choosing each possible alternative, and by the limited computational capacity of decision makers (1945, 1955, 1956, 1976). The assumption of bounded rationality is therefore introduced to replace the 'omniscient rationality' of classical economic man. Bounded rationality and limited information imply that optimising behaviour is not possible, thus the traditional maximising assumption is replaced by the assumption of satisficing.

In the context of bounded rationality and satisficing Simon has suggested that the pattern of decision making 'is often more nearly a stimulus - response pattern than a choice among alternatives' (1945, p108). The stimulus-response approach, adopted from psychology, lends itself to the study of behavioural responses to changes in the decision making environment, it may be described as a behaviourist approach emphasising the inputs to and output from the decision process. The stimulus-response conceptualisation shares some important features with the revealed behaviour approach to demand theory, in particular both are primarily concerned with behavioural responses to changes in the environment.

The theory of organisational decision making complements the revealed intended behaviour approach in the study of company responses to potential energy policies. The two approaches together provide a useful theoretical basis for the analysis and prediction of the policy impacts on company car fleets.

3.3 THEORETICAL ANALYSIS OF POLICY IMPACTS

Theoretical analysis was applied to derive predictions of company responses to the energy conservation policies selected for investigation. The policies were i. petrol price increases, ii. petrol rationing, iii. inefficiency taxes, and iv. tax deductibility reductions(1). The analysis and prediction centred on the impacts of these policies on the composition and size of company car fleets.

3.3.1 Predicted Effects of Petrol Price Increases

On the assumption of a downward sloping demand curve, the law of demand predicts that, ceteris paribus, an increase in the price of petrol will lead to a decrease in the consumption of petrol. However the prediction of the magnitude and timing of the decrease in consumption is more difficult. Theory suggests that the price elasticity of demand will tend to be low for commodities which are considered to be necessities and which do not have ready substitutes, and existing empirical evidence points to a very low short-run price elasticity of demand for petrol (Schou and Johnson 1979).

Prediction of the magnitude and timing of the changes in demand for petrol requires an understanding of the adjustment mechanisms. Reductions in the consumption of petrol by company car fleets may result from changes towards more fuel-efficient car, decrease in the number of cars, substitution of alternative fuels, or changes in car usage patterns. The adjustments through changes in the composition and size of company car fleets are the main interests of the present study, and other possible sources of adjustment will be dealt with only briefly.

Increases in the price of petrol could encourage some substitution towards more fuel-efficient cars in the medium term. However, expenditure on petrol represents only part of the operating costs of company cars, and it is expected that substantial price increases would be required to cause even a moderate shift in the composition of company fleets. The extent of any shift

---

(1) The four policies are specified in detail in section 4.4.1.

is likely to be influenced by a variety of different characteristics of companies and fleets. The timing of adjustment effects through changes in the composition of company car fleets is likely to be determined by the replacement cycle of fleet cars. It seems that a period of five years or so would be an appropriate time span for the study of medium term adjustments.

The petrol consumption of company car fleets could be reduced through a reduction in the size of fleets, that is a decrease in the total demand for company cars. However adjustments to total fleet size would be based on considerations of the overall costs and benefits to the company of the cars in its fleet, and reductions in fleet size are unlikely to be significant.

The third option for reducing the demand for petrol involves the substitution of alternative fuels such as LPG and diesel. However due to technological constraints and transition costs substitutes are not readily available and the cross elasticity of demand for substitutes in respect of petrol price increases is predicted to be very low.

Finally changes in usage patterns of company cars could bring about reductions in petrol consumption. The possible changes include decreases in distances travelled, as well as improved driving behaviour and improved maintenance. The extent to which adjustment is likely to take place through decreases in distances travelled depends on the perceived marginal benefits of the marginal mileage, and the relationship of these benefits to marginal costs. There may be scope for substitution of telecommunications for some company car travel. While it is quite difficult to predict the extent to which this would reduce average distance travelled per car, substitution of telecommunications for business travel could lead to under-utilisation of fleet cars ('excess capacity') and to reduction in fleet size. Company cars may be considered as factors of production viz. inputs into the production of services and satisfaction (Becker 1965, Becker and Michael 1973), and their efficient allocation and utilisation is likely to be of considerable importance to a company. Therefore the average distance travelled by company cars is expected to be fairly unresponsive to petrol price increases.

Some reduction in petrol consumption of company car fleets could occur through inducement of petrol conserving driving behaviour and through improved maintenance. However these effects are particularly difficult to predict. Driving behaviour is largely outside the domain of organisational decision making, and increased maintenance may not be economical from an overall cost-saving point of view.

In summary, the impacts of petrol price increases on company car fleets are predicted to be moderate. Substantial price increases would lead to some changes toward smaller more fuel-efficient cars in the medium term, but reductions in fleet sizes are predicted to be minimal.

3.3.2 Predicted Effects of Petrol Rationing

The impacts of petrol rationing on company car fleets are likely to be more direct and more severe than the impacts of petrol price increases although the magnitude of the effects would clearly depend on the particular levels of imposition of the two policies. Petrol rationing is a constraint on the supply of petrol imposed on a per car per time basis. If the constraint is set a level lower than the present petrol consumption for company cars, then companies will be forced to adjust to the rationing constraint by reducing petrol consumption per car. This adjustment may take place through the mechanisms discussed in the previous section.

In the short run reduction in distances travelled and inducement of petrol conserving driving behaviour is likely. In the medium term substitution of alternative fuels for petrol, and substitution of more efficient fleet cars for the less efficient ones is predicted. If the petrol rationing is imposed on a per car basis the impact on total fleet size is likely to be minimal. In extreme cases of rationing total fleet size may even increase if companies consider it worth-while keeping extra cars in order to obtain extra petrol rations.

3.3.3 Predicted Effects of an Inefficiency Tax and of Reduced Tax Deductibility

The inefficiency tax under study is an annual tax on 'petrol-inefficient' cars, defined as cars returning less than ten kilometres per litre of petrol. Similarly the reduced rates of tax deductibility of expenses associated with company cars would apply only to such 'petrol-inefficient' cars. The inefficiency tax would have the effect of increasing the standing-costs of large inefficient cars relative to the types of cars which meet the efficiency criterion of the policy. The policy of reduced tax deductibility would increase effective capital costs as well as standing and operation costs of inefficient cars.

Both of these policies are predicted to induce some substitution of small fuel-efficient cars for large inefficient ones. The extent of this substitution would depend on the levels of imposition of the policies and on the characteristics of companies and fleets. The impact on total fleet size is likely to be negligible because companies can avoid the cost increases of the policies without reducing fleet size.

The effects on usage patterns of company cars are predicted to be minimal. The inefficiency tax is a lump sum per annum tax and thus would not affect output, viz. distance travelled (and driving behaviour). The reduced tax deductibility of expenses associated with company cars may have a very slight effect of reducing the distance travelled by fuel-inefficient cars, insofar as the effective milage costs have been increased.

3.3.4 Importance of the Characteristics of Companies and Fleets

It was hypothesised that the characteristics of companies and fleets would have important effects on th responses of companies to the energy conservation policies (fundamental hypothesis ii, section 3.1). Policy responses are expected to differ considerably between companies due to differences in business environment and differences in a variety of relevant characteristics. Information on company and fleet characteristics is therefore important to the explanation and prediction of policy responses. In addition such information may enable the identification of groups of companies ('market segments') with similar response patterns.

The specific characteristics which were hypothesised to influence the policy responses were as follows: industry type, company size, fleet size, proportions of small, medium and large cars in a fleet, ratio of management cars to field cars, average distance travelled, fuel-efficiency, extent of company payment of petrol expenses, usage of alternative fuel sources, replacement cycles, methods of acquisition, structure of organisational decision making with respect to company cars, and the perceived importance of a variety of purposes and features of company cars.

The effects of particular characteristics on the policy responses are somewhat more difficult to predict from economic theory than are the policy effects themselves. However speculation as to the likely influence of the characteristics provides a source of detailed hypotheses which are empirically testable.

3.4 SPECIFICATION OF DETAILED HYPOTHESES FOR THE STUDY OF POLICY IMPACTS

Detailed research hypotheses were formulated on the basis of the theoretical analysis of the policy impacts on the composition and size of company car fleets, and on the basis of speculation as to the effects of the characteristics of companies and fleets on the policy responses. The detailed hypotheses represent expansions from the two fundamental hypotheses which were stated at the beginning of this chapter. Thus the hypotheses fall in two main groups, the first one being concerned with the impacts of the four selected energy policies, and the second with the effects of the characteristics. All the hypotheses are stated on the assumption of ceteris paribus.

Group I Hypotheses about the Policy Impacts

1. The policy impacts on the composition of company car fleets would be substantial, while the impacts on the size of fleets would be minimal.

2. Each of the four policies would result in shifts from large cars to small ones, the effects on medium sized cars varying with the type and level of the policies.

3. The impacts of the rationing policy would be much more significant than the impacts of the price and cost oriented policies.

4. Very substantial increases in the price of petrol (in the order of 50 to 100 per cent) would be required to have any significant impact on fleet composition or size.

5. The inefficiency tax would induce substitution to small fuel-efficient cars, but would have no impact on total fleet size.

6. The policy of reducing tax deductibility for company cars which do not meet certain fuel economy standards would induce substitution to cars which do meet the standards. (Similar to the inefficiency tax this policy discriminates directly against large fuel-inefficient cars). The impact on total fleet size would be negligible.

Group II Hypotheses about the Characteristics Effects

7. Companies in some industries such as manufacturing, wholesale and retail, transport and communications, and community services would be more likely to move towards smaller cars than would companies in other industries such as rural and mining, building and construction, finance and property, and business and professional services.

8. Small companies would be more likely to change to smaller cars than would medium size and large companies.

9. The effects of fleet size would be similar to the effects of company size; thus small fleets are likely to be more responsive to the policies.

10. Previous experience with small fleet-cars is likely to increase the propensity to adopt yet more small cars. The higher the present proportion of small cars (short of 100 per cent) the higher the propensity to shift further to small cars, and the higher the present proportion of large cars the greater the inclination to retain those types of cars.

11. The larger the ratio of management cars to field cars in a company fleet, the less likely are shifts to small cars.

12. The longer the average distance travelled, the higher the propensity to shift to smaller cars.

13. The higher the present fuel efficiency, the greater the inclination to move to yet more of the fuel-efficient cars. (Similar to the effects of present experience with small fleet-cars).

14. The greater the proportion of fuel expenses paid by the company, the higher the propensity to change to smaller more fuel-efficient cars.

15. The higher the proportion of cars in a fleet using fuels other than petrol, the less likely are shifts to smaller cars.

16. The shorter the replacement cycle for company cars, the greater the shift to smaller cars in a medium term period of about five years.

17. The higher the proportion of fleet cars which are leased, rather than purchased by the user company, the less would be the change in fleet composition.

18. The more choice given to employees in respect of type of car, the less likely is a change to smaller cars.

19. Companies in which decision making in respect of company cars is highly concentrated at the top levels of the decision structure, are more likely to move to small cars than are companies in which middle managers and other car users are important in the decision making.

20. Companies which consider status and 'perk' oriented attributes of company cars to be important are less likely to move to smaller cars than are companies which consider operation and cost attributes to be relatively more important.

The hypotheses specified in this section served as an important basis for defining the information requirements of the study. Data collected in the questionnaire survey enabled the empirical testing of the hypotheses about policy impacts and characteristics effects, thus contributing to the achievement of the overall objectives of the study.

CHAPTER 4
THE METHOD OF EXPERIMENTAL DESIGN AND THE CONSTRUCTION OF POLICY SCENARIOS

4.1 INTRODUCTION: INTENDED BEHAVIOUR RESPONSES TO POLICY SCENARIOS

This chapter presents the theory and method employed in the collection of the data on intended behaviour responses to possible energy conservation policies. Given that the policies of interest are not presently applied, or are not applied at the relevant range of levels, it is not possible to rely on actual present behaviour for observations of responses to these policies. It is necessary to develop hypothetical, but plausible, scenarios which describe the imposition of the relevant policies at various levels, and to obtain responses in terms of intended behaviour in the decision environments described in the scenarios.

The revealed intended behaviour responses to an appropriate range of policy scenarios can be employed in the prediction of the effects of policies which may be considered for introduction in the future. Provided that the policy scenarios are realistic and unambiguously formulated, it is reasonable to expect a close relationship between the intended behaviour responses and actual future behaviour under circumstances as represented by the scenarios. There is some evidence in the literature that a predictive relationship exists between expressed intended behaviour and real behaviour (Louviere, Wilson and Piccolo 1977, Louviere and Levin 1978, Louviere and Baker 1979, Hensher and Louviere 1979). It is not possible at this stage to test empirically the strength of the predictive relationship in the present study, since this would require the actual imposition of the policies of interest and the observation of actual responses.

In order to enable the collection of meaningful intended behaviour responses, it is necessary to systematically structure policy scenarios. This may be accomplished by the application of experimental design methods. The following section introduces the experimental design approach and outlines its previous applications in economic research.

Section 4.3 discusses selected aspects of experimental design theory. Section 4.4 details the specification of the policy variables and the response variables for the empirical design. Section 4.5 develops the experimental design policy scenarios employed in the major empirical study, while section 4.6 briefly describes the scenario design of the pilot study.

4.2 EXPERIMENTAL METHOD IN ECONOMICS AND PUBLIC POLICY

Experimental design techniques represent tools of data collection and analysis commonly employed in psychology, in physics, and in agricultural and industrial research (Winer 1962; Cochran and Cox 1957; Roscoe 1975). However experimental methods are quite new in economics which has traditionally relied on data obtained by observation of present and past behaviour (ex post facto). Actual experimentation has traditionally been viewed as a tool not applicable to economic research, because of the difficulties of experiments involving people and complex systems. In an exception to this view Orcutt (1964, 1970) has advocated the use of social experimentation to collect basic data for public policy, and in the last decade interest in social experimentation has grown among economists involved in public policy. This interest has been particularly evident in the United States where efforts to rationalise decision making at the Federal level brough economists into important government posts and 'made them painfully aware of how little their traditional data sources allowed them to say about the likely effects of policy changes' (Rivlin 1974 p346). Furthermore, a tight Federal budget and a widespread disillusionment with promises of rapid social change made expensive, new, untested social programs look unattractive and made experimentation seem a more sensible alternative (Rivlin 1974).

Economic experiments in public policy have been conducted in the areas of income maintenance, health insurance, housing allowances and electricity pricing (Aigner and Morris 1979; Conlisk and Watts 1979; Morris 1979; Ferber and Hirsch 1979; Newhouse et al. 1979; Manning et al. 1979; Aigner 1979b). These socio-economic experiments differ from the classical experiments in psychology and agriculture by their cost, size and administrative complexity. Thus it has been necessary to adopt various modifications to the sampling and modelling techniques of classical experimental design in order to make these practicable. The central goal of the large-scale economic experiments has been to obtain good data to increase knowledge of complex policy issues and to improve the basis for public policy formulation and implementation. Thus far only a few major public policy experiments have been completed and it is therefore too early to assess conclusively the value of such experiments in economics.

The present study represents a unique application of experimental design techniques in the context of survey research. It may be seen as a compromise between the usual economic approach of employing data based on past and present behaviour, and actual experimentation requiring the policies of interest to be implemented for an experimental subgroup of the study population. Data on present or past revealed behaviour would be inadequate for predicting the effects of the potential policies under study, while data from actual experimentation would be unobtainable as such experimentation is clearly outside the powers of an independent researcher. The present study thus attempts to combine the most desirable aspects of each approach, and it attempts to demonstrate that experimental design techniques may be usefully applied in economic research to generate data on the likely effects of policies, without necessarily incurring the costs and administrative problems of actual experimentation.

4.3 PROPERTIES OF EXPERIMENTAL DESIGNS

It has been argued in the literature that experimental design research is the most highly developed and formalised approach to establishing cause-and-effect relationships (Roscoe 1975, p189). Ex post factor research employing observed, non-controlled, independent variables involves the danger that the effects or responses observed may be caused by variables other than the independent variables the effects of which the researcer wanted to study. The experimental design approach seeks to overcome this problem by allowing the researcher to manipulate systematically the independent variables of interest, and assess directly the effects on the dependent variable. Given an appropriate experimental design, the effects of several different independent variables may be investigated simultaneously, and yet the effects of each independent variable on the dependent variable may be estimated independently (Aigner 1979a; Cochran and Cox 1957; Hays 1963; Roscoe 1975; Winer 1962). In the present context this means that the four policies, and different levels of these policies may be combined in experimental design policy scenarios allowing for the investigation of policy interaction effects while at the same time permitting independent estimation of the effects of each policy at each level on the revealed intended behaviour responses.

The following sections introduce the experimental design theory necessary for the development of an optimal experimental design.

4.3.1 Factorial Designs

From the numerous different types of experimental designs discussed in the statistical literature (for example Cochran and Cox 1957; Hays 1963; Winer 1962) factorial designs appear to be the type best suited for the construction of policy scenarios. Factorial designs offer the desirable properties of simultaneous, but independent, estimation of policy effects and policy interaction effects. In a factorial design the effect of each variable is studied across different levels of the other variables and thus the information obtained will be applicable over a corresponding range of possible situations (Winer 1971, p309). Kerlinger and Pedhazur (1973, p156) have hailed factorial designs as examples of 'efficiency, power and elegance' which 'expediously accomplish scientific experimental purposes'. However the practical application of factorial designs may fall somewhat short of this ideal in situations where more than a very small number of variables and levels of variables are to be investigated. This is so because it becomes necessary to compromise a full factorial design in order to make it practically feasible.

In a full factorial design the variable-combinations (scenarios in the present case) encompass all combinations which can be formed from the variables under study, that is each level of each variable is combined with each level of every other variable. Thus for example a study in which there are two independent variables each having three levels (or values) would require 3^2 variable-combinations. Generalising this to p variables and q levels q^p combinations would be involved. As the number of variables or the number of levels within variables increases, the number of combinations required by a full factorial design increases very rapidly. (For example a study of four variables at four different levels would require 4^4, that is 256, combinations, and a study of sixteen variables at only two levels would require 2^{16}, viz. a staggering 65 536 combinations).

If responses are to be obtained from n subjects for each variable-combination in a study of p variables at q levels, a sample size of $n \times q^p$ would be necessary, or each subject would be required to respond to q^p variable-combinations. In any practical application there is clearly a quite low limit to the number of responses which it would be reasonable to require from any one individual, and there is a limit on the feasible sample size. Thus in studies where several variables are to be investigated at several levels, some method is needed for reducing the number of variable-combinations to be included in the design. The following section introduces such a method.

4.3.2. Fractional Factorials, Split Designs and Repeated Measures

The technique of fractional factorials is aimed at reducing the dimensions of a factorial design to practicable proportions while retaining as many of its desirable properties as possible. A fractional factorial design employs only a fraction of the number of variable-combinations of a full factorial design, but retains the number of independent variables and the levels of these variables. The fraction employed depends on the original design dimensions as well as on the requirements of the particular study in respect of the variable effects and interaction effects which it is desired to estimate independently. The necessary cost incurred in adopting a fractional design is that some of the interactions become confounded and can not be independently estimated (Cochran and Cox 1957 ch 6A; Winer 1962 ch 8). However if these interactions can be assumed to be negligible relative to the main effects of the independent variables considered separately, then this does not present a problem(1). It is feasible by controlling the variable sequencing in the design specification to determine which interactions it will be possible to estimate from a given fractional design (Hahn and Shapiro 1965; Winer 1962 ch 8). Thus one may select for estimation those interactions which theoretical considerations would suggest to be significant.

The selection of a suitable fractional factorial design may be accomplished with the assistance of a catalogue of design plans as provided in Hahn and Shapiro (1966) and Cochran and Cox (1957). Unfortunately it is not always possible, given the number of variables and levels of variables which are to be investigated, to select a fractional design with the desirable properties of allowing independent estimation of the main effects and the interaction effects of interest, while at the same time reducing the design dimension to a tractable size. Thus in some cases an acceptable trade-off between practicability of design application and ability to estimate the effects of interest cannot be achieved by the technique of fractional factorials alone. One approach to overcoming this problem is to develop an appropriate split design, consisting of component designs which individually are of practicable size and which may be combined in such a way as to allow the estimation of overall effects. This may be achieved by including each variable in each component design but only at a sub-set of the levels to be studied, and by holding a base-level of each variable constant across designs to ensure comparability of the effects of the other levels which differ between designs.

The design developed for the present study was a split design consisting of three fractional factorial component-designs with repeated measures on subjects. In a repeated measurements design each subject is asked to respond to each variable combination within the design or component-design (Winer 1962 chs 4 and 7; Roscoe 1975 ch 22). Repeated measurements offer the important

---

(1) As a rule the main effects will account for the most significant share of the total variation in the dependent variable, two way interactions will account for less; and higher order interactions (interactions of more than two variables) will account for only a negligible amount of variance. (Cochran and Cox 1957 ch 6A; Louviere and Hensher 1981).

advantage of increasing the number of observations (responses) obtained from a given sample of subjects. This in turn offers compelling practical advantages of economy and administrative efficiency.

4.4 VARIABLE SPECIFICATION

4.4.1 Selection and Specification of Policy Variables

The specific energy conservation policies to be examined were selected from a number of possible policies directed at the conservation of petroleum energy in transportation. For each of the four policy variables, four levels (or values) were specified to enable examination of the effects of each policy variable at several possible levels. These levels may be designated as:

0	1	2	3
'the present'	'mild'	'medium'	'tough'

'The present' is taken as an anchor point and the other policy levels increase progressively in severity.

The specification of the policy variables and levels is detailed below:

PP: A policy of increasing the price of petrol; increases are in real terms as compared with the present petrol price (which is taken as the actual price paid by the company at the time of the survey).

Levels:	-	('present')
	25%	('mild')
	50%	('medium')
	100%	('tough')

PR: A policy of petrol rationing, rationing levels are per week per car.

Levels:	no limit	('present')
	60 litres	('mild')
	40 litres	('medium')
	20 litres	('tough')

IT: A policy of imposing a selective tax on fuel-inefficient cars. This inefficiency tax would be imposed annually on every car returning less than 10 kilometres per litre(1) and would not be tax deductible as part of the operation cost of the car.

Levels:	Nil	('present')
	\$50 per year per car	('mild')
	\$100 per year per car	('medium')
	\$200 per year per car	('tough')

TD: A policy of changing the tax deductibility provisions such as to disallow fuel deductibility of costs for cars returning less than 10 kilometres per litre. The percentage of costs which would be tax deductible are shown as the levels of this policy.

Levels	100%	('present')
	75%	('mild')
	50%	('medium')
	Nil	('tough')

By means of experimental design methods these four policies at their four respective levels were combined into policy scenarios in such a way as to allow the estimation of their effects on intended behaviour responses.

---

(1) 10 kilometre per litre = 28.2 miles per gallon, and 'returning less than 10 kilometres per litre' is equivalent to 'consuming more than 10 litres per 100 kilometres'. There may be differences of opinion as to the preferred unit of measurement, but this is not of importance to the substance of the study as one measure may be readily converted into another for the purpose of interpreting the results.

4.4.2 Specification of The Dependent Variables, Market Segmentation on Characteristics Criteria

The focus of the study is on the likely impacts of the policies on the size and composition of company car fleets. Thus intended behaviour responses need to be obtained from companies in terms of the number of cars of different size categories which the company would intend to keep if circumstances were as described in a given policy scenario. This in turn requires the segmentation of the car makes and models on the market into distinct size categories.

The few previous studies which have segmented the automobile market into size classes have all employed different criteria for classification (overseas studies: Blomqvist and Haessel 1978, Kulash 1975; Lave and Train 1975; Mogridge 1978; Whorf 1975; Australian studies: Chaffin and Hollywood 1976; Industries Assistance Commission 1974). Since no commonly accepted, well defined categories could be found it was necessary to devise segmentation criteria and define car size classes independently for the purpose of the present study.

In the spirit of Lancaster's characteristics approach to demand theory (Lancaster 1966b and 1971), the cars on the market were categorised into small, medium, or large on the basis of a set of objective characteristics. The characteristics employed for the classification were: curb weight, engine size, number of cylinders, and fuel economy. Information on these characteristics was obtained from the National Roads and Motorists Association for all the major car makes and models on the Australian market (NRMA 1979). The cars were then classified as small, medium or large according to the following criteria:

Small:
- Weight less than 1000 kilograms
- engine size less than 1.8 litres
- 4 cylinders
- fuel economy greater than 10 kilometres per litre

Medium:
- Weight of 1000 to 1200 kilograms
- engine size in the range of 1.8 to 2.5 litres
- generally 4 cylinders
- fuel economy in the range of 8 to 10 kilometres per litre

Large: . Weight greater than 1200 kilograms
. engine size greater than 2.5 litres
. 6 or more cylinders
. fuel economy less than 8 kilometres per litre

In cases where the application of all four criteria resulted in ambiguous classification, priority was given to the weight, followed by the engine size and the number of cylinders. The fuel economy criteria is considered to be somewhat less precise because of difficulties in objective measurement.

The size classes as defined above may be illustrated by the following examples of makes and models of cars on the Australian market.

Small: Toyota Corolla, Datsun 120Y, GMH Gemini, Ford Escort, Chrysler Galant.

Medium: Toyota Celica, Datsun 180B and 200B, GMH Torana (4 cylinder), Ford Cortina, Chrysler Sigma.

Large: GMH Commodore, Kingswood and Statesman, Ford Falcon, Fairmont and Fairlane, Chrysler Valiant and Regal, BMW, Volvo, Mercedes, Jaguar.

Companies were asked to indicate the number of cars which they would intend to keep in each of the three size-classes in response to sets of policy scenarios. Obtaining the policy responses in terms of the absolute numbers of cars in each size-class allowed for the investigation of changes in overall company car demand, as well as changes in the market shares of small, medium and large cars.

4.5 CONSTRUCTION OF THE POLICY SCENARIOS

On the basis of the experimental design method discussed in section 4.3, the policy variables specified were arranged into sets of policy scenarios such as to allow estimation of the effects of the policy variables on the dependent variables.

4.5.1 Problems of a Full Factorial Design

The overall design involves 4 policy variables each at 4 levels; thus it would be described as 4^4 design, and a full factorial design would require 256 different policy scenarios to be considered. A design of this dimension would be impractical if not impossible to implement, and it would clearly be unreasonable in a repeated measures context to request each subject to respond to anywhere near this number of different policy scenarios.

The approach which was taken towards creating a tractable design, which would still allow estimation of the main policy effects of interest, was two-fold. First the overall design was split into three component-designs, second the dimension of each component-design was reduced by the use of fractional factorial designs.

4.5.2 The Strategy of Split Design

The policy scenarios in each component-design were constructed so as to incorporate all four policy variables but only at two levels each. The three component-designs each incorporated 'the present' as the base level of each of the four policy variables. The second level of the policy variables within each design was allocated in such a way as to create a 'mild', a 'medium' and a 'tough' set of policy scenarios as illustrated in Figure 4-1.

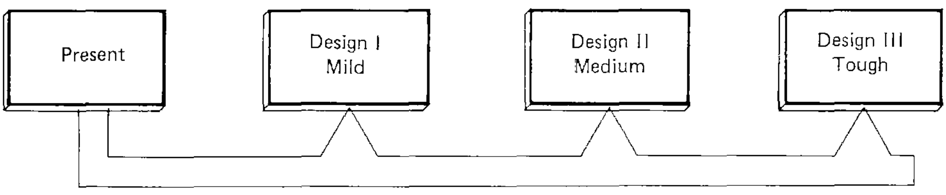

Figure 4.1
The connection between the three component-designs

This scheme of allocation of policy variables and levels to component-designs provided comparability of policy effects across the designs via the common base level. Investigation of policy effects over the three sets of scenarios expanded the range of applicability of the information collected, and it allowed for possible threshold effects to be identified.

The systematic division of the overall 4^4 design into three component-designs served as the first step towards creating a practicable research design. Given that each component-design incorporated four policy variables each at two levels the overall design may b described as a '3 x 2^4' design. A full factorial design would require 2^4, that is 16, different policy scenarios within each of the three designs. The use of repeated measures would require each subject to respond to each of the policy scenarios within a design. In this context it was judged that 16 policy scenarios were too many to expect each respondent to consider seriously. Evidence to support this judgement was drawn from information theory and from numerous experiments in psychology which suggest that the accuracy with which people assess information declines quite rapidly as the number of information elements to be processed is increased beyond some fairly small number. It has been argued in a well known article by Miller (1956) that this number is seven, plus or minus two. In order to reduce the information requirements on each subject to within this range, use was made of fractional factorial techniques.

4.5.3 Properties of the Fractional Factorial Designs

With the assistance of the Hahn and Shapiro (1966) design catalogue the dimension of each component-design was systematically reduced from 2^4 to 2^{4-1}. Thus only 8 different policy scenarios were required within each design.

In a 2^{4-1} fractional factorial design all the main effects of the policy variables can be estimated independently, as there is no confounding with the interaction effects. In addition, three of the six two-factor interactions can be estimated from the design (Cochran and Cox 1957, ch 6A; Hahn and Shapiro 1966). The three interactions for estimation were 'petrol price by inefficiency tax', 'petrol price by tax deductibility', and 'inefficiency tax by tax deductibility'. These interactions were selected for two reasons, first the price and tax policies were considered more likely to be implemented on a permanent basis than the rationing policy, and second it was expected that the interaction terms involving the rationing policy would be significant only on account of the dominating effects of rationing.

All higher order interactions, involving combinations of three or all four policy variables, are confounded in the fractional design and cannot be estimated. However this is not a source for concern since such higher order effects are unlikely to be significant (Louviere and Hensher 1981) and are quite difficult to interpret meaningfully.

The method employed for combining policy variables and levels into policy scenarios, such as to allow all main effects and the selected interaction effects to be estimated, was based on the Hahn and Shapiro (1966) design index and design master plan number two. The latter provided the guide for allocation of policy variables and levels to the eight policy scenarios in each component-design.

Table 4-1 indicates the detailed allocation system adopted

Each row of Table 4.1 represents a different policy scenario, viz. possible future situation with respect to the policy variables under investigation. Each subject was asked to evaluate the likely effects of each of the eight policy scenarios in one component-design on the dependent variables. More specifically the subjects were asked to respond to each scenario by indicating the number of small, medium and large cars which their company would keep in the company fleet if circumstances over the next five years or so were as described by that scenario.

The detailed plan of the scenario design shown in Table 4.1 was applied identically to each of the three component-designs in order to ensure comparability of the estimated effects. The overall design then is illustrated in Table 4-2.

TABLE 4.1 - THE SYSTEM FOR COMBINING POLICY VARIABLES AND LEVELS INTO SCENARIOS

Policy Variables		PP	PR	IT	TD
Scenario	1	X	0	X	0
	2	X	0	0	X
	3	0	0	X	X
	4	0	0	0	0
	5	X	X	X	X
	6	X	X	0	0
	7	0	X	X	0
	8	0	X	0	X

where: PP = Petrol Price rises

PR = Petrol Rationing

IT = Inefficiency Tax

TD = Tax Deductibility reductions

0 indicates that the particular policy is at its base level of 'the present'

X indicates that the particular policy is applied at some level different from 'the present'.

TABLE 4-2 - THE OVERALL DESIGN OF THE POLICY SCENARIOS

Design		Mild I				Medium II				Tough III			
Policy Variables		PP	PR	IT	TD	PP	PR	IT	TD	PP	PR	IT	TD
	1	1	0	1	0	2	0	2	0	3	0	3	0
SCENARIOS	2	1	0	0	1	2	0	0	2	3	0	0	3
	3	0	0	1	1	0	0	2	2	0	0	3	3
	4	0	0	0	0	0	0	0	0	0	0	0	0
	5	1	1	1	1	2	2	2	2	3	3	3	3
	6	1	1	0	0	2	2	0	0	3	3	0	0
	7	0	1	1	0	0	2	2	0	0	3	3	0
	8	0	1	0	1	0	2	0	2	0	3	0	3

where: 1,2, and 3 in the body of the Table indicate the mild, medium, and tough level, respectively, of the particular policy.

Tables 4-3, 4-4 and 4-5 show the policy scenarios with the actual policy variables and levels, and accompanying instructions as employed in the final survey. The 'present' was included immediately above the set of experimentally designed scenarios to serve as a reference point for respondents and at the same time provide built-in consistency check on responses. The latter is so because scenario number four in the design consists of policy levels identical to the 'present' and thus a comparison of the responses to these two sets of circumstances will provide a test on the extent to which scenario responses are consistent with actual behaviour.

The three component-designs were assigned randomly to an equal number of companies in the sample of the main survey.

TABLE 4-3 - SPECIFICATION OF MILD POLICY SCENARIOS

This question is of crucial importance to the study
Please consider your answers carefully

The question presents a number of energy policy scenarios which may become relevant to decision making in respect of company motor vehicles over the next five years or so. The scenarios have been simplified by including only four variables which are considered to be representative of the types of policies which may be introduced. These four variables are as follows:

Petrol price - where an increase in real terms of 25% is considered.

Petrol rationing - where rationing to 60 litres per week per car is considered.

Petrol inefficiency tax - which could be imposed annually on every car getting less than 10 kilometres per litre (10 km/L = 28.2 mpg), and which would not be tax deductible. This tax is considered at the level of $50 per year per car.

Tax deductibility provisions - which could be changed to allow full deduction of costs only for cars getting at least 10 kilometres per litre; for less fuel efficient cars it is considered that tax deductibility may be reduced to 75%.

(As a guide, the average fuel economy of some typical cars has been estimated in NRMA road tests as follows: Datsun 120Y - 12.9km/L, Chrysler Sigma Scorpion - 10km/L, GMH HZ Kingswood SL - 7.3 km/L, Ford ZH Fairlane - 4.9km/L)

I would like you to respond to each of the scenarios below by indicating the number of vehicles which your company would most likely decide to have in each size class if circumstances were as described by that scenario. (Assuming that the activities of your company were otherwise unchanged).

The scenarios need to be considered in relation to the present situation as described in the first row of the table below. Please enter there the present petrol price in your company (in cent/litre and to one decimal place) and the size class composition of your fleet as of 30 June 1979. The size classes are the same as in Question 2.

	SCENARIOS				NUMBER OF VEHICLES		
	Petrol Price	Rationing (litres per week)	Inefficiency Tax	Tax Deductibility	Small	Medium	Large
Present	____	no limit	nil	100%	____	____	____
1	+ 25%	no limit	$50	100%	____	____	____
2	+ 25%	no limit	nil	75%	____	____	____
3	present	no limit	$50	75%	____	____	____
4	present	no limit	nil	100%	____	____	____
5	+ 25%	60 litres	$50	75%	____	____	____
6	+ 25%	60 litres	nil	100%	____	____	____
7	present	60 litres	$50	100%	____	____	____
8	present	60 litres	nil	75%	____	____	____

TABLE 4-4 - SPECIFICATION OF MEDIUM POLICY SCENARIOS

This question is of crucial importance to the study
Please consider your answers carefully

The question presents a number of energy policy scenarios which may become relevant to decision making in respect of company motor vehicles over the next five years or so. The scenarios have been simplified by including only four variables which are considered to be representative of the types of policies which may be introduced. These four variables are as follows:

Petrol price - where an increase in real terms of 50% is considered.

Petrol rationing - where rationing to 40 litres per week per car is considered.

Petrol inefficiency tax - which could be imposed annually on every car getting less than 10 kilometres per litre (10 km/L = 28.2 mpg), and which would not be tax deductible. This tax is considered at the level of $100 per year per car.

Tax deductibility provisions - which could be changed to allow full deduction of costs only for cars getting at least 10 kilometres per litre; for less fuel efficient cars it is considered that tax deductibility may be reduced to 50%.

(As a guide, the average fuel economy of some typical cars has been estimated in NRMA road tests as follows: Datsun 120Y - 12.9km/L, Chrysler Sigma Scorpion - 10km/L, GMH HZ Kingswood SL - 7.3 km/L, Ford ZH Fairlane - 4.9km/L)

I would like you to respond to each of the scenarios below by indicating the number of vehicles which your company would most likely decide to have in each size class if circumstances were as described by that scenario. (Assuming that the activities of your company were otherwise unchanged).

The scenarios need to be considered in relation to the present situation as described in the first row of the table below. Please enter there the present petrol price in your company (in cent/litre and to one decimal place) and the size class composition of your fleet as of 30 June 1979. The size classes are the same as in Question 2.

SCENARIOS					NUMBER OF VEHICLES		
	Petrol Price	Rationing (litres per week)	Inefficiency Tax	Tax Deductibility	Small	Medium	Large
Present	____	no limit	nil	100%	____	____	____
1	+ 50%	no limit	$100	100%	____	____	____
2	+ 50%	no limit	nil	50%	____	____	____
3	present	no limit	$100	50%	____	____	____
4	present	no limit	nil	100%	____	____	____
5	+ 50%	40 litres	$100	50%	____	____	____
6	+ 50%	40 litres	nil	100%	____	____	____
7	present	40 litres	$100	100%	____	____	____
8	present	40 litres	nil	50%	____	____	____

TABLE 4-5 - SPECIFICATION OF TOUGH POLICY SCENARIOS

This question is of crucial importance to the study
Please consider your answers carefully

The question presents a number of energy policy scenarios which may become relevant to decision making in respect of company motor vehicles over the next five years or so. The scenarios have been simplified by including only four variables which are considered to be representative of the types of policies which may be introduced. These four variables are as follows:

Petrol price - where an increase in real terms of 100% is considered.

Petrol rationing - where rationing to 20 litres per week per car is considered.

Petrol inefficiency tax - which could be imposed annually on every car getting less than 10 kilometres per litre (10 km/L = 28.2 mpg), and which would not be tax deductible. This tax is considered at the level of $200 per year per car.

Tax deductibility provisions - which could be changed to allow full deduction of costs only for cars getting at least 10 kilometres per litre; for less fuel efficient cars it is considered that tax deductibility may be abolished (0%).

(As a guide, the average fuel economy of some typical cars has been estimated in NRMA road tests as follows: Datsun 120Y - 12.9km/L, Chrysler Sigma Scorpion - 10km/L, GMH HZ Kingswood SL - 7.3 km/L, Ford ZH Fairlane - 4.9km/L)

I would like you to respond to each of the scenarios below by indicating the number of vehicles which your company would most likely decide to have in each size class if circumstances were as described by that scenario. (Assuming that the activities of your company were otherwise unchanged).

The scenarios need to be considered in relation to the present situation as described in the first row of the table below. Please enter there the present petrol price in your company (in cent/litre and to one decimal place) and the size class composition of your fleet as of 30 June 1979. The size classes are the same as in Question 2.

	SCENARIOS				NUMBER OF VEHICLES		
	Petrol Price	Rationing (litres per week)	Inefficiency Tax	Tax Deductibility	Small	Medium	Large
Present	____	no limit	nil	100%	____	____	____
1	+100%	no limit	$200	100%	____	____	____
2	+100%	no limit	nil	0	____	____	____
3	present	no limit	$200	0	____	____	____
4	present	no limit	nil	100%	____	____	____
5	+100%	20 litres	$200	0	____	____	____
6	+100%	20 litres	nil	100%	____	____	____
7	present	20 litres	$200	100%	____	____	____
8	present	20 litres	nil	0	____	____	____

4.6 THE SCENARIO DESIGN OF THE PILOT STUDY

While the body of the present chapter has been concerned with the design of the policy scenarios for the main survey, this section will briefly explain the design employed in the pilot study.

The pilot design may be summarised as a 3^{3-1} fractional factorial design with repeated measures on 9 scenarios. That is the design incorporates three independent variables each at three levels:

A: petrol price, where increases in real terms of 20 per cent, 50 per cent and 100 per cent were considered

B: petrol availability, where the levels to be considered were: easy (as we are used to), moderate (sporadic shortages at petrol stations, average queuing times of ten minutes) difficult (widespread shortages, average queuing times of thirty minutes).

C: a 'petrol-guzzler tax' which would be imposed annually on every car getting less than 10 kilometres per litre (28.2mpg), and which would not be tax deductible. The levels of this tax considered were $20, $50 and $100 per year per car.

A full factorial design on these three variables at three levels would involve 3^3, that is 27, different scenarios. As this was considered unreasonable in a repeated measures context, a 1/3 fraction of the factorial design was employed thus requiring subjects to respond to only 3^{3-1}, ie 9 scenarios. At this reduced dimension it would still be possible to estimate all main effects independently, however the ability to estimate interactions has been completely sacrificed (Hahn and Shapiro 1966).

The specification of the car size classes, in terms of which the policy responses were obtained, was also somewhat different from that of the final study. There were four different size classes specified as percentages of the company fleet, that is: % small, % medium, % large, and % luxury. The definition of the size classes was provided by a list of examples and was thus rather less precise than the classification adopted in the final study. (See the pilot study questionnaire in appendix A.)

CHAPTER 5
THE SURVEY APPROACH TO DATA COLLECTION

5.1 OBJECTIVES OF THE SURVEY AND INTRODUCTION TO SURVEY RESEARCH

As an integral part of the study, a survey was undertaken of some 1000 New South Wales companies. The objective of this survey was to collect the data required for testing the hypotheses and meeting the overall aims of the study. Thus data was collected on i. the numbers of small, medium and large cars which the companies would intend to keep in their fleets under the circumstances described by the policy scenarios, and ii. the company and fleet characteristics which were expected to influence the responses to the policies. The survey served the important purpose of providing new policy oriented data in the increasingly important area of energy conservation and management.

The design of a survey requires consideration to be given to a wide range of issues including: definition of the survey population, sample selection, method of data collection, questionnaire design, survey administration, and role of a pilot survey. These issues are to a large extent interdependent and in the survey design process many decisions are simultaneous rather than sequential. This is illustrated in Figure 5-1, which also shows the place of the survey design in the context of the complete research sequence.

The literature on survey research provided some assistance in the design of the survey(1). However the design requirements of each study differ and call for an independent approach. This chapter outlines the approach adopted in the present study.

---

(1) In particular the following references were drawn upon: Erdos 1970; American Marketing Association 1977; Brown 1967; Deming 1960; Franzen and Lazersfeld 1945; Henley 1976; Jones 1979; Kimball 1961; Kish 1967; Linsky 1975; Moser and Kalton 1972; Scott 1961; Watson 1965; Walizer and Wienir 1978; Yates 1965.

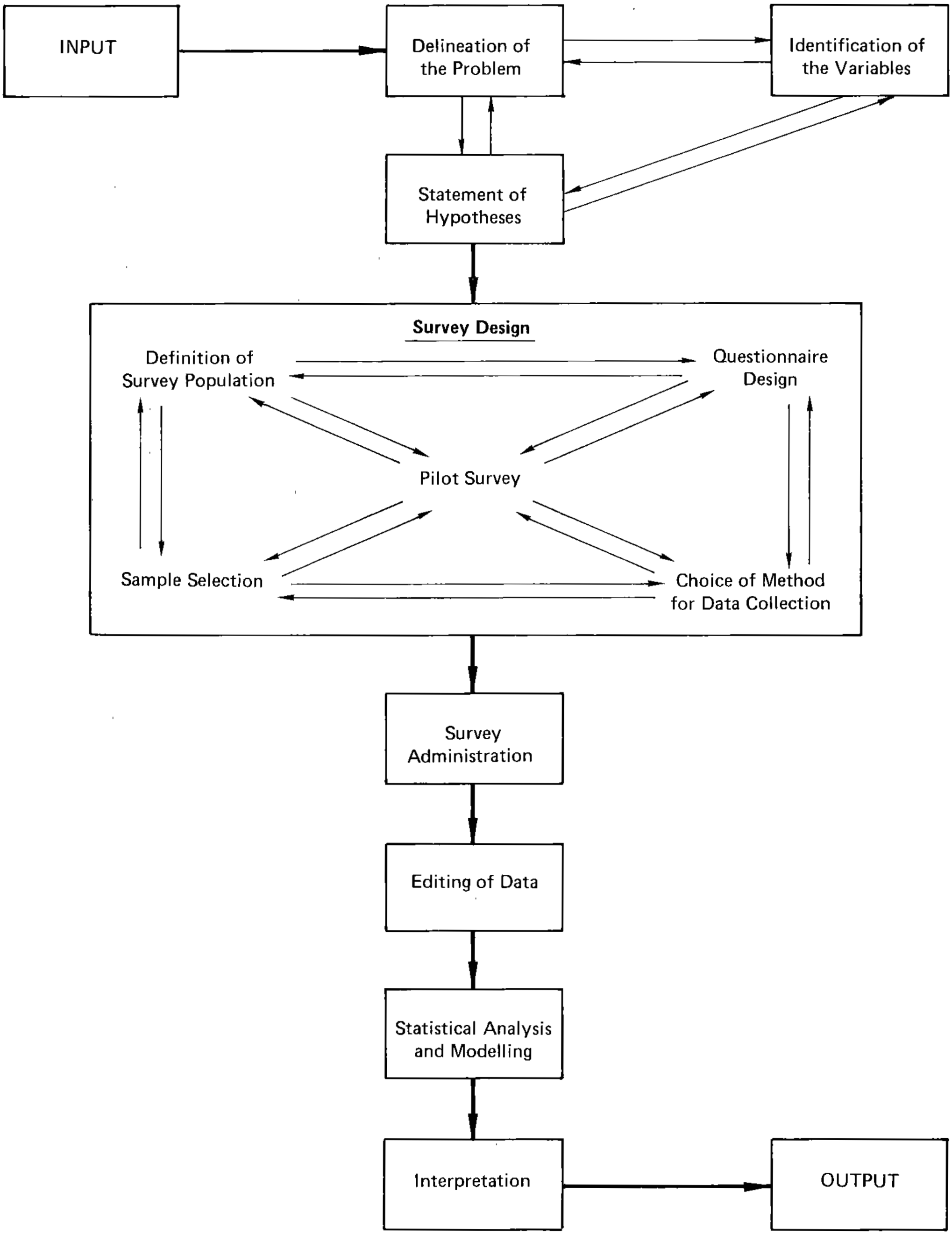

Figure 5.1
Model of the survey research

5.2 THE PILOT SURVEY

A pilot survey of 100 organisations was undertaken for the purpose of pre-testing all aspects of the survey design and administration. The questions in the pilot survey (see Appendix A) were exploratory in nature and intended to identify issues and to test the availability of particular pieces of information. Many of the questions were open ended and designed to elicit information which could be used in the construction of fully specified questions for the main survey. In particular two completely open-ended questions were included for the purpose of identifying the important purposes and features of company cars. One half of the pilot sample received a questionnaire with these particular open-ended questions, while the other half was asked to assign importance ratings to prestated purposes and features.

The pilot sample included a few Government Departments and Authorities in order to test the feasibility of obtaining the relevant information on car fleets from such organisations. It was established that, while government bodies do operate substantial car fleets, decisions in respect of these fleets are not usually made at the level of the individual organisation, but are subject to wider governmental influence. Therefore information about the likely responses to the energy policies under study could not be obtained from the individual organisations.

Of the 100 pilot questionnaires 26 were returned, however only 17 had adequately completed the final section of the policy scenarios. This indicates the need for changing the position of the policy scenarios (from page seven of the form) and for reducing the total number of questions asked. Careful editing suggested where improvements could be made, where information requested was generally not available and where misunderstandings tended to occur. A preliminary statistical analysis was applied to ascertain the sample distributions on some key characteristics. No obvious biases in the sample could be detected.

The information and experience gained in the pilot survey provided valuable inputs into the design of the main survey. The remaining parts of the chapter discuss the most important aspects of the main survey design.

5.3 THE DEFINITION OF THE SURVEY POPULATION AND THE SELECTION OF THE SAMPLE

The objectives of the study broadly define the survey population as companies which operate car fleets. On the grounds that very small companies were considered unlikely to operate car fleets of any significant size (if at all), the survey population excluded companies employing less than ten people. The survey population was geographically delineated to the state of New South Wales, because several of the policies under investigation could be introduced at a state level. This delineation also allowed for more intensive sampling withine one state.

A comprehensive listing of the companies in the survey population was found in the KOMPASS Business Directory (1979) which contains information on about 5000 NSW companies of all types and sizes. On the criteria of accuracy and completeness the KOMPASS Directory constituted a very good sampling frame. However one shortcoming for the present purpose was that it contained no information on company fleets, and thus some companies which do not operate company fleets may have been inadvertently included in the sample(1).

For budgetary reasons it was not feasible to collect information from the whole of the survey population, and it was determined to select a sample of 1000 companies for the main survey. The objective of the sampling was to select a representative segment of the survey population thus allowing generalisations to be made from the sample to the population.

The sampling method employed to select companies from the frame was an approximation to simple random sampling. The statistical advantages of simple random sampling are well documented in the literature (Yates 1965; Kish 1967; Deming 1960; Moser and Kalton 1972; Walizer and Wienir 1978). The standard method of generating a fully random sample involves the use of random number tables, and requires every unit in the sampling frame to be assigned a unique number. Acknowledging that the sample ultimately obtained would be partially

---

(1) An attempt was made to obtain a listing of companies and company car registrations from the NSW Department of Motor Transport. However this foundered on the refusal of the NSW Privacy Committee to grant authorisation for the release of the information.

determined by which companies chose to respond, the procedure of assigning a number to every one of the approximately 5000 entries in the sampling frame did not seem justified. The alternative procedure adopted, simply involved the random selection of about one fifth of the companies on each page of the KOMPASS Directory, excluding companies with less than ten employees.

5.4 THE DATA COLLECTION METHOD AND THE QUESTIONNAIRE DESIGN

A mail questionnaire survey was employed to collect the information from the selected companies. The choice of the mail survey method, over the alternatives of personal interviewing or telephone interviewing, was based on considerations of which method would be the most appropriate to the study, provide the most reliable and complete results, and be accommodated within the available budget and time frame.

The major advantages of mail surveys are: the possibility of a wider distribution, the flexibility for the respondents to complete the questionnaire when convenient and to search out information, the absence of interviewer bias, and substantially lower costs. There is some evidence that, provided the questions are unambiguous and well set out, the self-administered questionnaire approach will give more accurate and complete responses, and be more cost effective, than interviewing (Brög and Newmann 1978).

The design of the questionnaire is of crucial importance to the quality of data obtained. Questions must be clear and unambiguous in order to elicit precise and complete answers. The questionnaire as a whole must be well structured and professionally presented, appealing to respondents, and minimise editing requirements.

> 'A good questionnaire appears as easy to compose as does a good poem. The end product should look as if effortlessly written by an inspired child - but it is usually the result of long, painstaking work.'
> Erdos 1970, p37.

The main survey questionnaire is presented in appendix A. The questionnaire consisted of a total of fifteen questions; the first twelve and the last two of which sought information on company and fleet characteristics, while question thirteen (on page three) sought the central responses to the policy scenarios. The last page of the questionnaire provided space for respondents' comments, and (optionally) for the name and address of respondents interested in attending a seminar or receiving a summary of the study findings.

5.5 SURVEY ADMINISTRATION, RESPONSE RATE AND DATA PREPARATION

The questionnaires, cover letters and pre-addressed, stamped return mail envelopes were mailed to the General Managers of the selected companies on 11 July. Unfortunately a mail dispute erupted two days later and most of the 1000 survey mailings were held up for about three weeks! The implication of this was that the relevant company executives received the questionnaires after the return date stipulated in the cover letter. This no doubt caused a considerable reduction in the rate of response(1).

The response rate for the main survey was about 22 per cent. In total, 216 questionnaires were returned. In addition about 25 letters and phone calls were received from companies which did not operate car fleets or did not have the required information available. (A similar number of mailings were returned because the company had left the address or ceased operations).

The quality of the returned questionnaires was generally very high, judging by the standards of completeness and consistency. The responses were subjected to a set of manual edit checks, designed to improve the clarity of answers and to facilitate data processing. The data were key punched directly from the questionnaires onto 80 column cards. This direct data transfer circumvented the usual step of transcribing data onto coding sheets before punching, and it thus eliminated one important source of errors. The punched and verified data were subjected to comprehensive machine edit checks by means of a computer program written for this purpose, and data files were prepared for the analysis.

---

(1) An attempt was made to carry out some follow-up contact by telephone, however time and cost constraints did not permit an extensive follow-up campaign.

CHAPTER 6
CHARACTERISTICS OF COMPANIES AND FLEETS

6.1 INTRODUCTION: OBJECTIVES OF THE CHARACTERISTICS ANALYSIS

In the questionnaire survey, data were collected on the intended policy responses of companies, and on a variety of company and fleet characteristics which were expected to influence these policy responses. The data on the characteristics of companies and fleets were subjected to a detailed statistical analysis(1). The objectives of this analysis were:

i. to provide interesting background information about company car fleets.

ii. to test the introductory hypotheses that company cars are predominantly the larger and less fuel-efficient types of cars, travelling longer annual distances and being replaced more frequently than the average for the total national fleet.

iii. to provide a detailed understanding of the nature of the characteristics variables which constitute important inputs into the central policy impact analysis.

The results of the characteristics analysis are presented in section 6.2, and section 6.3 reports on a factor analysis performed on the perceived importance of purposes and features of company cars.

6.2 PROFILE OF THE CHARACTERISTICS OF COMPANIES AND FLEETS

6.2.1 Industry Type and Company Size

The sample comprised a total of 216 companies distributed across eight industry groups and six company size categories, as shown in Tables 6-1 and 6-2.

---

(1) This analysis was performed by means of the BMD-P2D Detailed Data Description program (Dixon & Brown 1979).

TABLE 6-1 - INDUSTRY TYPE DISTRIBUTION OF COMPANIES

Industry Type	Companies of each Industry Type Number	Percentage
Rural and Mining	14	6.5
Manufacturing	111	51.4
Building and Construction	17	7.9
Wholesale and Retail	50	23.1
Transport and Communication	15	6.9
Finance and Property	14	6.5
Business and Professional Services	24	11.1
Community Services and Entertainment	3	1.4
Total	248	114.8(a)

(a) A number of companies indicated that they belonged to more than one industry groups, thus the total percentage adds to more than 100.

TABLE 6-2 - SIZE DISTRIBUTION OF COMPANIES

Size of Company(a)	Companies in each Size Category Number	Percentage	Cumulative
Less than 20	54	25.0	25.0
20-49	33	15.3	40.3
50-99	31	14.3	54.6
100-499	63	29.2	83.8
500-999	17	7.9	91.7
1000 or more	18	8.3	100.0
Total	216	100.0	

(a) In terms of number of employees.

The whole range of industry types and company size groups appears to be well represented by the sample. However the proportion of companies in the 'less than 20 employees' group is expected to be considerably lower than the corresponding population proportion. This is so because the sample purposely excluded companies with less than ten employees, on the grounds that these very small companies were unlikely to keep company car fleets.

6.2.2 Size and Composition of Company Car Fleets

The company car fleets in the sample consisted of a total of 12 031 cars. This figure represents just under ten per cent of all cars (including station-wagons) which were registered by companies in New South Wales in 1979(1).

The size of fleets covered ranged from 1 car to 1050 cars with a mean of about 56, a median of 15, a mode of 5, and a standard deviation of 129. The distribution of fleet sizes has a strong positive skew, that is values are heavily concentrated towards the low end of the range. The percentage of fleets and the percentage of cars in each of a number of fleet size categories is shown in Table 6-3.

It is interesting, though not surprising, to note the large disparity between the percentage of fleets and the percentage of cars in each fleet size category. Thus while fleets of less than 50 cars account for 75 per cent of the total number of fleets, they only account for about 18 per cent of the total number of cars. At the other end of the range fleets of more than 500 cars constitute less than 2 per cent of the fleets but account for about 28 per cent of all the cars in the sample.

---

(1) Figures made available by the New South Wales Department of Motor Transport (in private communication) indicated that 135 471 cars and station-wagons were registered by companies in NSW in 1979.

TABLE 6-3 - THE DISTRIBUTION OF FLEETS AND CARS ACROSS FLEET SIZES

	Percentage of Fleets		Percentage of Cars	
Fleet size	Percentage	Cumulative	Percentage	Cumulative
less than 10	40.3	40.3	3.3	3.3
10-24	21.3	61.6	6.0	9.3
25-49	13.4	75.0	8.6	17.9
50-99	10.2	85.2	12.9	30.8
100-500	12.9	98.1	41.3	72.1
more than 500	1.9	100.0	27.9	100.0

Of the 12 031 cars in the sample only 8 per cent were classed(1) as small, about 22 per cent were classed as medium size, and the remaining 70 per cent were classed as large. The present distribution of the fleet cars across the three car size categories is illustrated in Figure 6-1.

Within each of the three size categories the frequency of fleets with a small number of cars is far greater than the frequency of fleets with a large number of cars. Thus the distribution within each of the three car size categories has a strong positive skew, as would be expected from the distribution of total fleet sizes. The dominance of large cars in the company fleets is further illustrated by the fact that 63 per cent of the fleets did not contain <u>any</u> small cars, while only 10 per cent of fleets contained no large cars. These results lend strong support to the introductory hypothesis that company cars are predominantly of the larger (and less fuel-efficient) type of car, (introductory hypothesis b, section 1.2).

An additional aspect of fleet composition concerned the shares of management cars and field cars in each size class. This is shown in Table 6-4.

---

(1) The definition of each size class was stated on the questionnaire, and is discussed in section 4.4.2.

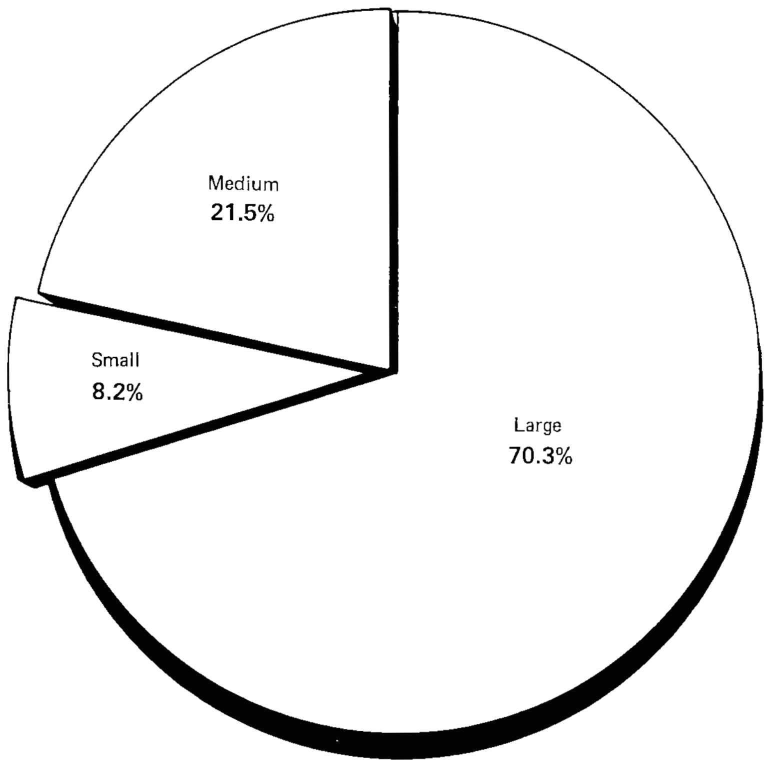

Figure 6.1
Frequency of small, medium and large cars in the fleets at present

TABLE 6-4 - THE PERCENTAGE OF MANAGEMENT CARS AND FIELD CARS CATEGORISED AS SMALL, MEDIUM AND LARGE

	Percentage of Cars			
	Small	Medium	Large	Total
Management Cars	1.0	6.9	33.5	41.4
Field Cars	7.1	14.6	36.9	58.6
Total	8.1	21.5	70.4	100.0

It is clear that very few management cars are small (or medium size), while a somewhat larger share of the field cars are in the smaller size classes.

6.2.3 Distance Travelled

The average annual distances driven by the company fleets ranged from 7000 to 50 000 kilometres for management cars, and from 10 000 to 80 000 kilometres for field cars. The mean distance for management cars was 20 510 kilometres (with a standard deviation of 6678) while the mean distance for field cars was considerably greater at 33 838 kilometres (with a standard deviation of 13 650). The average distances driven are approximately normally distributed.

It is interesting to compare these distances to the average annual distance for the total Australian fleet of cars and station-wagons. According to Australian Bureau of Statistics (1980) the average for the total national fleet is 15 100 kilometres. About 70 per cent of the management car fleets and no less than 95 per cent of the field car fleets were driven average annual distances in excess of the national average. These figures lend strong support to the introductory hypothesis that the average distances driven by company cars exceed those of private cars, thus contributing to the greater total petrol consumption of company cars (introductory hypothesis c, section 1.2).

6.2.4 Fuel Economy, and Policy Implications

The average fuel economy reported for management cars in the fleets range from 3.5 to 16 kilometres per litre(1) with a mean of 6.8. The corresponding figures for field cars were 5 to 15.5 kilometres per litre and a mean of 7.4. Thus field cars generally tend to be more fuel efficient than management cars. The average fuel economies of the fleets were approximately normally distributed.

The average fuel economy for all Australian cars has been estimated at 8.3 kilometres per litre (National Energy Advisory Committee 1978 p10). The average fuel economy for all company cars (7.1) is about 14 per cent less than this, lending further support to the hypothesis that company cars tend to be larger and less fuel-efficient types of cars (introductory hypothesis b, section 1.2).

In the context of the energy policies it is interesting to note that 92 per cent of the companies reported average fuel economies of less than 10 kilometres per litre. This is the threshold level below which the inefficiency tax and the reduced tax deductibility policies would be imposed. Thus only about 8 per cent of companies are likely to remain unaffected by the policies (even the company fleets which on average satisfy the efficiency standard may include some cars which do not.)

In relation to the petrol rationing policy, which is expressed in terms of litres per week per car, it is useful to examine the average petrol consumption per week per car for the current company fleets. These figures were computed from the data on average distances driven and the data on average fuel economies. The mean petrol consumption per week per car was 63.8 litres for management cars and 88.9 litres for field cars. It is possible from the distributions of these two variables to predict the percentage of the company fleets which would be affected by the rationing levels considered, that is, the percentage of management cars and field cars respectively which presently consume in excess of 60, 40 and 20 litres per week. These figures are shown in the following table.

---

(1) x kilometres per litre = 100/x litres per 100 kilometres.

TABLE 6-5 - THE PERCENTAGE OF CARS AFFECTED BY EACH RATIONING LEVEL

	Management Cars	Field Cars
60 litres per week	50%	80%
40 litres per week	81%	94%
20 litres per week	98%	100%

It is to be expected that the higher the present levels of petrol consumption the more severe would be the effects of the rationing policy on a company.

The policy of increasing petrol prices would have the greatest absolute effects on the companies with the greatest total petrol consumption (attributable to any or all of large fleets, high annual distances, high average petrol consumption). However the importance of the increased petrol costs are likely to vary with the financial situation of individual firms and it is difficult to predict a priori which firms would be the most responsive to petrol price increases.

6.2.5 Petrol Price, and the Extent of Company Payment of Fuel Expenses

The actual petrol price paid by companies varied from 19.9 to 29.5 cents per litre, with a mean of 26.9, a standard deviation of 2.8 and a negatively skewed distribution. It is interesting that nearly 90 per cent of companies reported paying less than the maximum retail price for petrol, which at the time of the survey was 29.5 cents per litre in New South wales. This indicates that companies tend to have special discount or supply arrangements sheltering them to some extent from retail price increases. This situation had been anticipated, and therefore the petrol price increases in the policy scenarios were expressed as percentage increases from the actual petrol price paid by individual companies, rather than in terms of absolute retail prices.

The majority of the companies reported that they pay all fuel expenses for cars in their fleets. About 80 per cent of the companies paid all the fuel expenses incurred by their management and field cars, 15 per cent paid between three-quarters and all of such expenses, while only 5 per cent of companies covered less than three-quarters of fuel expenses of their fleets. The overall share of fuel costs covered by the company did not appear to differ significantly between management cars and field cars, although some companies pay different proportions of fuel expenses for different categories of cars.

6.2.6 Alternative Fuels

The usage of fuels other than petrol for company car fleets was very limited at the time of the survey. Only 3 per cent of the companies reported some use of LPG(1) for cars in their fleets and a similar proportion reported some use of diesel. In total only .8 of one per cent of the cars covered by the study were run on LPG, and .4 of one per cent of the cars on diesel(2). However several companies (about 10 per cent) commented that they were considering moves towards LPG.

Information was collected specifically on LPG and diesel because these were considered to be the two alternative fuels most likely to be used in company fleets.

6.2.7 Replacement Cycles and Acquisition Methods

The time periods between replacement of company cars ranged from 2 years to 6 years, with an overall mean of just over 3 years (38 months), a standard deviation of about 10 months, and a distribution approximating the normal distribution. The replacement cycle tends to be somewhat shorter for field cars than for management cars. Table 6-6 shows the cumulative percentage of companies reporting replacement cycles of less than or equal to the number of years shown for management cars and field cars respectively.

---

(1) Liquid Petroleum Gas.
(2) If the study had included trucks and other vehicles there would no doubt have been a greater proportion of these run on diesel.

TABLE 6-6 - REPLACEMENT CYCLES OF COMPANY CARS

	Cumulative Percentage of Companies	
Replacement Cycle	Management Cars	Field Cars
2 years or less	10.0%	16.9%
3 years or less	63.3%	74.3%
4 years or less	89.0%	93.4%
5 years or less	98.6%	99.5%

The replacement cycle of company cars indicates the likely time lags in changing the size class composition of the fleet.

The average replacement cycle of just over 3 years implies that the average age of the company cars is about 19 months (if it is assumed that the number of cars is roughly the same at each stage of the cycle). This compares with an average age of about 5 1/2 years for all Australian cars (Hamilton 1978, p33), providing strong support for the introductory hypothesis that company cars are replaced much more frequently than other cars and therefore account for a far greater share of the new car market than of the total national fleet (introductory hypothesis d, section 1.2).

The most common method of acquisition for the company cars was outright purchase. About 74 per cent of the 12 031 cars covered were purchased by the user company, 25 per cent were leased, and less than 1 per cent were acquired through hire purchase. In terms of companies, 65 per cent purchased some or all of their fleet cars, 56 per cent engaged in some leasing arrangements, while only 9 per cent of companies had acquired any cars by hire purchase. Many of the companies used more than one method of acquisition, and thus the last set of percentages adds to much over 100.

6.2.8 Extent of Employee Choice of Car, and Relative Importance of Decision Makers

The extent of choice allowed to employees with respect to the type (make and model) of 'their' company cars differs considerably between different levels of employees. Five categories of employees were considered (senior executives, middle managers, junior executives, sales representatives, and service staff/technicians) and two degrees of choice (unrestricted choice and choice within a range specified by company policy). Table 6-7 indicates the overall percentage of employees in each category who were given each degree of choice.

TABLE 6-7 - EXTENT OF EMPLOYEE CHOICE OF CAR

Level of Employees	Unrestricted Choice	Choice within Specified range	No Choice (or not applicable)
Senior executives	32%	67%	1%
Middle managers	2%	48%	50%
Junior executives	1%	19%	80%
Sales representatives	2%	43%	55%
Service staff/technicians	3%	15%	82%

As would be expected, senior executives are generally given more discretion in choice of company car than any other category of employee. It appears that sales representatives are given almost as much choice as middle managers, and considerably more choice than junior executives. However particular caution is necessary in the interpretation of these figures because it is not possible from the data to distinguish 'no choice' from 'not applicable' and non response. Thus the relatively low choice percentages for junior executives and technicians may to some extent reflect that many of the companies did not have any employees in these categories.

The decision making process in respect of company cars varies with the size and structure of the company. In order to determine the relative importance of various decision makers in the process, rankings were obtained on an importance scale (1 = most important, 2 = second most important, etc). Table 6-8 shows the average and absolute importance rankings of the relevant decision makers.

It is evident that decisions on company cars are generally determined at a very high level in the organisation, usually involving the managing director and the general manager. The decision role of company car users appears to be fairly limited.

TABLE 6-8 - IMPORTANCE RANKINGS OF DECISION MAKERS

	Average(a) Ranking	Absolute(b) Ranking
Managing director	1.3	1
Board of directors	2.0	3
General Manager	1.8	2
Chief accountant	3.1	5
Transport/purchase manager	3.3	6
Personnel manager	2.1	4
Middle managers	3.6	7
Suppliers sales consultant	6.0	9
Independent consultant	6.8	10
Company car users	4.0	8

(a) This is the average ranking for each decision maker across non-zero values in the sample.
(b) The absolute rankings are derived directly from the values of the average rankings.

6.2.9 Purposes and Features of Company Cars

The perceived importance of a whole range of purposes and features of company cars was measured on a five point scale ranging from not important to very important, for management cars and field cars respectively.

Company cars were generally considered essential for conducting company business, this was particularly so in the case of field cars. Management cars are also to a large extent considered as an important fringe benefit, a part of the remuneration package, and as a means of providing transport of suitable standard. The companies tended not to consider company cars important as means of projecting the company image, as status symbols, or as means of gaining tax savings. The image and status type variables are no doubt more important in some types of companies(1) than in others, however, there may have been some reluctance on the part of these companies to state so.

The features of company cars which were considered the most important by the companies were reliability, comfort, performance and safety. Fuel economy was considered more important for field cars than for management cars, which is not surprising given the greater average distances driven by field cars. Variables such as new car price, resale value, and maintenance and insurance costs were considered quite important (concentration on ratings 3 and 4) for all cars, but slightly more important for field cars. It is interesting that size of car in itself was considered to be relatively unimportant (with ratings concentrating at the centre of the importance scale and below).

In view of the large number of purposes and features variables (ten purposes and ten features rated for both management and field cars, giving a total of forty ratings by each company) it was considered impractical to attempt to test the effects of each of these variables separately. In this context a factor analysis served a very useful purpose.

---

(1) Ford Sales Company of Australia Limited has suggested that image and status type variables are very important in the case of tobacco companies, breweries, cosmetic companies and large retailing companies (personal communication).

6.3 FACTOR ANALYSIS OF THE PERCEIVED IMPORTANCE OF THE PURPOSES AND FEATURES OF COMPANY CARS

In order to summarise the data on the perceived importance of purposes and features of company cars, and to enable the use of these data as inputs into the policy impact analysis, a factor analysis was performed on this part of the data set(1). Factor analysis is a method for reducing a large number of variables to a smaller number of presumed underlying factors. Factor analysis summarises the initial variables by identifying how they are similar and how they are different, and derives factors from the intercorrelations among variables (Kerlinger and Pedhazur 1973, ch 13, Schilderinck 1977 ch 2).

The results of the factor analysis reducing the forty purposes and features variables to three factors are summarised in Table 6-9. The figures in this table reveal some interesting relationships. All purposes and features of field cars load mainly onto factor one, although the variables indicating remuneration, fringe benefit and status as purposes of field cars also load fairly highly onto factor two, which contains the main loadings of the corresponding variables for management cars. The purposes and features of management cars separate into two groups between factors two and three. Factor two comprises the status and 'perk' oriented variables, while factor three comprises what may be described as operation and cost oriented variables.

In view of this pattern of factor loadings the three factors may be interpreted as the 'field car', the 'status', and the 'operation' factor, respectively. The results of the factor analysis lend support to the hypothesis that field cars and management cars are seen to perform quite different roles within the company fleet. It was on the basis of this hypothesis that certain data were collected separately for the two categories of company cars. The factor scores of each company on each factor were used as inputs into the multiple regression analysis of the policy impacts, in order to test the influence of the factors on policy responses.

---

(1) The program employed was the BMD-P4M Factor Analysis Program (Dixon and Brown 1979).

TABLE 6-9 - FACTORING OF PURPOSES AND FEATURES

Variable Name	No.	Factor 1	Factor 2	Factor 3
FBUS	47	.882	.000	.000
FRELIAB	68	.862	.000	.000
FCUSTM	49	.805	.000	.000
FSAFETY	70	.793	.000	.334
FFUEL	67	.770	.000	.255
FCOMF	69	.768	000	.000
FNEWPRIC	71	.764	.000	.000
FINSUR	73	.741	.000	.333
FRESALE	76	.732	.000	.339
FSPARE	75	.731	.000	.358
FSIZE	72	.668	.000	.000
FCOMP	53	.652	.483	000
FSTAND	51	.633	.000	.000
FPRESTI	74	.619	.381	.000
FREMUN	55	.614	.517	.000
FPRING	52	.606	.512	.000
FIMAGE	50	.572	.307	.000
FSTATUS	56	.557	.532	.000
FTRNSP	48	.546	.366	.000
FTAX	54	.518	.481	.000
MFRING	42	.000	.740	.000
MSTATUS	46	.000	.739	.000
MREMUN	45	.000	.736	.000
MCOMP	43	.000	.687	.000
MTAX	44	.000	.638	000
MPRESTI	64	.000	.618	.000
MIMAGE	40	.000	.545	.317
MTRNSP	38	.000	.520	.301
MSPARE	65	.299	.000	.734
MSAFETY	60	.000	.326	725
MRELIAB	58	.000	.000	.704
MINSUR	63	.270	.000	678
MRESALE	66	.288	.250	.631
MFUEL	57	.000	.000	.628
MCUSTM	39	.000	.000	.606
MBUS	37	.000	.000	604
MSIZE	62	.269	.342	.583
MCOMF	59	.000	.440	.506
MSTAND	41	.000	.454	.406
MNEWPRIC	61	.000	.313	452

The interpretation of the variable names is provided via the matching variable numbers below

a. Purposes of Company Motor Vehicles:

	Management Cars	Field Cars
Essential for conducting company business	37	47
Provide employee transport	38	48
Contact with customers	39	49
Project company image	40	50
Provide transport of suitable standard	41	51
Fringe benefit	42	52
Competitive necessity to attract and keep good staff	43	43
Tax savings	44	54
Part of remuneration package	45	55
Status symbol, sign of corporate success	46	56

b. Features of Company Motor Vehicles:

	Management Cars	Field Cars
Fuel economy	57	67
Reliability	58	68
Comfort and performance	59	69
Safety	60	70
New car price	61	71
Size, number of seats	62	72
Maintenance and insurance costs	63	73
Suitable prestige value	64	74
Price and availability of spare parts	65	75
Resale value	66	76

6.4 SUMMARY

The characteristics analysis reported in this chapter has confirmed that company cars are generally of the larger and less fuel-efficient type of cars, travelling longer average distances and being replaced more frequently than the average for the total Australian fleet. The majority of company cars are purchased by the user company, and only a very small proportion are operated on fuels other than petrol. The companies, which represent the full range of industry types and company sizes, usually pay less than the retail price for petrol, and pay most of the fuel expenses incurred by the cars in their fleets. Decisions in respect of company cars are usually made at a very high level in the management structure. Decision makers tend to perceive the importance of purposes and features related to field cars differently from the purposes and features of management cars, in the latter case a distinction is made between status and 'perk' oriented variables, on the one hand and operation and cost oriented variables, on the other.

The characteristics of companies and fleets were hypothesised to have important effects on the responses of companies to the energy conservation policies under study (fundamental hypothesis ii, section 3.1) and thus the characteristics variables served as valuable inputs into the central policy impact analysis.

CHAPTER 7
IMPACTS OF THE POLICIES ON COMPANY CAR FLEETS

7.1 INTRODUCTION

7.1.1 Objectives of the Policy Impact Analysis

The objective of the policy impact analysis is to derive results in respect of:

i. the likely impacts of the energy conservation policies on the size and composition of company car fleets, and
ii. the effects of the characteristics of companies and fleets on the policy responses.

7.1.2 The Nature of the Data

The data set contains two distinct types of data, each directed at serving one part of the study objective. The two types are referred to as: i. the policy impact data, and ii. the characteristics data. The characteristics data were described in the previous chapter, and the policy scenarios for obtaining the policy impact data were developed in chapter 4.

The policy impact data were obtained as responses to sets of policy scenarios, presenting combinations of different levels of the four policy variables. For each of the eight scenarios (in each of the three component designs) information was obtained on the number of small, medium and large cars, which a company would intend to keep in its fleet if the circumstances were as described in a given scenario. Responses to the policy scenarios may be interpreted as revealed intended behaviour, and as measures of the likely impacts of the policies on the size and composition of company car fleets.

7.1.3 The Statistical Methods of the Policy Impact Analysis

Statistical methods of multivariate analysis were used to determine the impacts of the policies, and to identify the effects of the characteristics of companies and fleets.

Alternative methods of analysis were explored. Analysis of variance is the technique which has traditionally been employed to analyse experimental design data. However regression analysis may also be applied to experimental data (Kerlinger and Pedhazur 1973; Roscoe 1975).

It can be shown that the analysis of variance and the analysis of regression are mathematically equivalent. Analysis of variance is a special case of regression on only categorical variables, and analysis of covariance is equivalent to regression on both categorical and numerical variables (Wonnacott and Wonnacott 1972, pp314-318). Regression analysis is a more general and flexible method, applicable to a wider range of types of data. It is the most powerful, and also the most appropriate, method of analysis in cases where the independent variables include both categorical and continuous variables, and where a multiplicity of factors external to an experiment need to be accounted for. The regression method can be applied to analyse data from very complex experimental designs, including fractional factorials and repeated measures as employed in this study, and the procedure is not hampered by unequal cell frequencies which cause complications in the analysis of variance (Kerlinger and Pedhazur 1973, chs 1, 6 and 9; Roscoe 1975, chs 44 and 45).

The multiple regression approach was adopted for the comprehensive analysis of the experimental policy impact data and the characteristics data. However analysis of variance was applied in a preliminary examination of the responses to the policy scenarios. This analysis of variance is reported in section 7.2, while the main regression analysis is discussed and its results presented in sections 7.3 and 7.4.

7.2 ANALYSIS OF VARIANCE OF POLICY RESPONSES

7.2.1 Overall Impacts of the Policy Scenarios

An indication of the overall impacts of the policy scenarios on the size and composition of company car fleets can be obtained from an examination of the cell means of the intended behaviour responses in respect of the number of small, medium, and large cars which companies would intend to keep under each scenario. These cell means were computed by analysis of variance(1) and are presented in Table 7-1.

The average response figures provide some very important results; they show that the policy scenarios would have substantial impacts on the composition of company car fleets, while the impacts of fleet size would be negligible. The average number of large cars would be reduced considerably, and the numbers of small and medium sized cars would be increased to compensate. The average total number of cars stays remarkably stable and is not significantly affected by even the most severe policy scenarios.

A separate statistical analysis(2) revealed that less than ten per cent of companies would consider any reduction in the size of their fleets under any of the scenario circumstances. It was also confirmed that the average reduction in fleet size would be less than one.

These results are consistent with expectations based on the theoretical analysis of the policy effects, and they confirm the hypothesis that companies would respond to the energy policies by changing to smaller more fuel-efficient cars, and that decreases in fleet size would be minimal (hypothesis 1, section 3.4).

While it is not possible to distinguish the effects of the individual policies directly from the average response pattern, it is apparent that the effect of the rationing policy is dominant. (This dominance is manifested by the very considerable shifts in the average fleet composition under the scenarios which include the imposition of rationing). This is also consistent with a priori expectations, and it lends support to the hypothesis that the impacts of petrol supply constraints would be far more severe than the impacts of price and cost related policies (hypothesis 3, section 3.4).

---

(1) The BMD-P2V computer program was employed for this part of the analysis (Dixon and Brown 1979).

(2) By means of the BMD-P2D Detailed Data Description Program (Dixon and Brown 1979).

TABLE 7-1 - AVERAGE RESPONSES TO THE POLICY SCENARIOS

	SCENARIOS				NUMBER OF VEHICLES			
	Petrol Price	Rationing (litres per week)	Inefficiency Tax	Tax Deductibility	Small	Medium	Large	Total
Present	______?	no limit	nil	100%	6.1	16.4	34.1	56.6
1	+ X%	no limit	$X	100%	11.9	24.0	20.7	56.6
2	+ X%	no limit	nil	X%	13.8	26.5	16.0	56.3
3	present	no limit	$X	X%	13.2	26.6	16.8	56.6
4	present	no limit	nil	100%	6.1	19.0	31.5	56.6
5	+ X%	X litres	$X	X%	25.0	21.9	9.0	55.9
6	+ X%	X litres	nil	100%	24.4	21.4	10.3	56.1
7	present	X litres	$X	100%	23.9	18.4	12.9	55.2
8	present	X litres	nil	X%	24.9	20.4	9.9	55.2

where: X indicates the imposition of a given policy at some level determined by the component-design ('mild', 'medium' or 'tough', see section 4.5.2) of the policy scenarios. The cell means are based on 193 fully completed responses.

It is of some interest to compare the average responses for the 'present' with those for scenario number four. Scenario number four consists of policy levels identical to the present, and therefore such a comparison provides a built in check on the consistency of the scenario responses and actual behaviour. There appears to be some degree of inconsistency in the responses indicated by the disparities between the two sets of cell averages. However this disparity may be explained by the time lags involved in changing the composition of the fleets(1); thus it is quite reasonable for a company to indicate that a composition different from the existing one would be chosen under circumstances similar to the present, as the existing fleet composition was determined under previously existing circumstances (which would have involved lower petrol prices). Of the fully completed responses to the policy scenarios 77 per cent were in fact consistent in the sense of providing identical responses for the 'present' and for scenario number four.

In order to determine whether there were any significant differences in the response patterns of the inconsistent cases as compared with the consistant cases, a separate analysis of variance was performed grouping the cases by consistency. The results of this analysis showed that the differences in the response patterns of the two groups were not significant, at the five per cent level for the F-test. (The F-ratios for each of the three dependent variable comparisons were: .96 for small cars, 1.1 for medium cars and .17 for large cars). It is therefore unnecessary to make any distinction between consistent and inconsistent cases for the purpose of the central policy impact analysis.

7.2.2 Impacts of the Policy Scenarios by Level of Policies

In order to obtain some preliminary indications of how the responses vary with the levels of the policy variables, analysis of variance was applied to the experimental design data grouped by component-design. The results of this analysis are presented in Table 7-2. (The cell means are based on the fully completed responses matrices for each of the three component designs, the effective sample sizes being 60, 60 and 73 respectively).

---

(1) The average replacement cycle for company cars in the sample was just over three years (see section 6.2.7).

TABLE 7-2 - AVERAGE RESPONSE TO THE THREE SETS OF POLICY SCENARIOS

SCENARIOS					NUMBER OF VEHICLES			
MILD	Petrol Price	Rationing (litres per week)	Inefficiency Tax	Tax Deductibility	Small	Medium	Large	Total
Present	____?	no limit	nil	100%	5.9	18.6	65.6	90.1
1	+ 25%	no limit	$50	100%	11.8	36.9	41.3	90.0
2	+ 25%	no limit	nil	75%	13.8	46.8	29.8	90.4
3	present	no limit	$50	75%	14.2	47.7	28.0	89.9
4	present	no limit	nil	100%	7.7	31.0	51.4	90.1
5	+ 25%	60 litres	$50	75%	28.1	40.8	20.9	89.8
6	+ 25%	60 litres	nil	100%	27.8	38.7	23.4	89.8
7	present	60 litres	$50	100%	24.4	31.0	31.5	86.9
8	present	60 litres	nil	75%	26.4	37.3	23.2	86.9
MEDIUM	Petrol Price	Rationing (litres per week)	Inefficiency Tax	Tax Deductibility	Small	Medium	Large	Total
Present	____?	no limit	nil	100%	4.9	9.0	31.2	45.1
1	+ 50%	no limit	$100	100%	13.1	20.3	11.3	44.7
2	+ 50%	no limit	nil	50%	12.9	20.6	11.3	44.8
3	present	no limit	$100	50%	12.8	20.3	11.8	44.9
4	present	no limit	nil	100%	7.6	16.1	21.2	44.9
5	+ 50%	40 litres	$100	50%	24.0	16.5	3.4	43.9
6	+ 50%	40 litres	nil	100%	23.9	16.1	4.8	44.8
7	present	40 litres	$100	100%	23.4	15.5	5.2	44.1
8	present	40 litres	nil	50%	24.5	15.6	4.3	44.4
TOUGH	Petrol Price	Rationing (litres per week)	Inefficiency Tax	Tax Deductibility	Small	Medium	Large	Total
Present	____?	no limit	nil	100%	2.6	8.9	27.2	38.8
1	+100%	no limit	$200	100%	10.9	16.4	11.5	38.8
2	+100%	no limit	nil	0	14.9	14.8	8.6	38.3
3	present	no limit	$200	0	12.9	14.6	10.9	38.4
4	present	no limit	nil	100%	3.6	11.7	23.5	38.8
5	+100%	20 litres	$200	0	23.2	10.7	3.8	37.7
6	+100%	20 litres	nil	100%	22.8	11.4	4.1	38.3
7	present	20 litres	$200	100%	23.9	10.5	4.0	38.4
8	present	20 litres	nil	0	24.0	10.4	3.6	38.0

The figures in Table 7-2 show a substantial disparity between the component-designs in the average total fleet size and in the corresponding cell means for the numbers of small, medium and large cars. A disparity of this magnitude (as between the 'mild' version, on the one hand, and the 'medium' and 'tough' versions, on the other) was quite unexpected, given that the component designs had been allocated randomly to sub-samples of the same survey population. A separate analysis(1) revealed that four of the largest five fleets in the sample belonged to the 'mild' sub-sample. Because of the highly skewed distribution of the fleet size variable(2), these few very large fleets have introduced the imbalance in the mean fleet sizes between the three sets of policy scenarios. The implication of this is that the analysis of variance performed in terms of absolute numbers of small, medium and large cars cannot provide any meaningful indication of how the pattern of responses vary across different levels of the policy variables. The disparity in the absolute figures introduces into the analysis a significant component of variance which is unrelated to the policy measures, and which is sufficiently large to override the variance attributable to changes in the levels of the policy variables. Furthermore the highly skewed distributions of each of the dependent variables(3) invalidate the F-test of significance of the differences in responses between the three component designs.

The most effective method of overcoming these problems was to weight the responses by fleet size, and transform the absolute numbers of small, medium and large cars into percentage fleet-shares. Alternative approaches of i. excluding the largest three or four fleets from the analysis, and ii. introducing fleet size as a covariate in the analysis were considered, but found to have serious shortcomings. Thus i. involves exclusion of the observations which are numerically the most important and yet does not provide an accurate basis for comparing policy effects across levels, and ii. involves the adjustment of cell means for the covariate effect which causes difficulties for the interpretation of scenario effects.

---

(1) By means of a small Fortran program written for the purpose.
(2) See section 6.2.2.
(3) A separate statistical analysis by the BMD-P2D descriptive statistics program established that the distributions of the likely numbers of cars were highly skewed, similar to the distributions of the actual present numbers of cars (see section 6.2.2).

In view of the result that the impact of the policy scenarios on fleet size is negligible there is very little loss of information incurred by the transformation to percentage figures. The transformed dependent variables have distributions approximating the normal distribution thus allowing for valid statistical significance testing. The results of the analysis of variance in terms of the percentages of small, medium and large cars in the fleets are presented in Table 7-3.

The figures in Table 7-3 indicate that the magnitude of the shift in the fleet composition increases substantially as the policy levels increase from the 'mild' levels to the 'medium' levels. However it is not readily apparent whether the magnitude of the shift in the composition increases as the policy levels increase from 'medium' to 'tough'. There is still some disparity in the average 'present' fleet composition between the three designs, and this tends to distort the apparent effects of the changes in the policy levels. In order to establish the extent to which the policy impacts increase with the levels of the policy variables, it is necessary to account for the differences in the 'present' fleet compositions. It is possible by means of simple but tedious calculations(1) from the average response figures to derive changes in the percentages of small, medium and large cars induced by changes in the levels of the policy variables. However this task is more efficiently performed by the regression of the average policy responses on the policy variables(2).

---

(1) The calculations involve averaging the value of each response variable for each level of each policy and then taking the difference between the average value of the response when a policy is imposed at a given level and when it is not imposed at all (the 'present'). For example the likely effect of a 25 per cent increase in the price of petrol on the average fleet share of small cars may be calculated as:

$$((21.9 + 22.1 + 41.7 + 39.1)/4) - ((22.1 + 17.9 + 38.7 + 40.0)/4) = 1.6$$

This procedure provides estimates of the likely effects of one policy, independent of the effects of any of the other policies. This independence is assured by the orthogonal nature of the experimental design, thus when averaging the response for one policy at one level, the effects of other policies and levels are neutralised because an equal number of 'imposed' and 'not imposed' levels are included.

(2) The results of this aggregate regression analysis are reported in section 7.3.2.

TABLE 7-3 - PERCENTAGE FLEET-SHARES UNDER SCENARIOS

SCENARIOS					NUMBER OF VEHICLES		
MILD	Petrol Price	Rationing (litres per week)	Inefficiency Tax	Tax Deductibility	Small	Medium	Large
Present	____?	no limit	nil	100%	12.3	26.6	61.1
1	+ 25%	no limit	$50	100%	21.9	40.2	37.9
2	+ 25%	no limit	nil	75%	22.1	43.7	34.2
3	present	no limit	$50	75%	22.1	46.3	31.6
4	present	no limit	nil	100%	17.9	34.6	47.5
5	+ 25%	60 litres	$50	75%	41.7	39.5	18.8
6	+ 25%	60 litres	nil	100%	39.1	40.0	20.9
7	present	60 litres	$50	100%	38.7	39.3	22.0
8	present	60 litres	nil	75%	40.0	39.4	20.6
MEDIUM	Petrol Price	Rationing (litres per week)	Inefficiency Tax	Tax Deductibility	Small	Medium	Large
Present	____?	no limit	nil	100%	13.0	30.2	56.8
1	+ 50%	no limit	$100	100%	27.0	42.3	30.7
2	+ 50%	no limit	nil	50%	31.3	41.0	27.7
3	present	no limit	$100	50%	31.5	39.9	28.6
4	present	no limit	nil	100%	17.1	36.3	46.6
5	+ 50%	40 litres	$100	50%	57.9	33.5	8.6
6	+ 50%	40 litres	nil	100%	55.3	34.9	9.8
7	present	40 litres	$100	100%	55.0	34.8	10.2
8	present	40 litres	nil	50%	57.7	32.9	9.4
TOUGH	Petrol Price	Rationing (litres per week)	Inefficiency Tax	Tax Deductibility	Small	Medium	Large
Present	____?	no limit	nil	100%	7.8	29.5	62.7
1	+100%	no limit	$200	100%	28.5	40.8	30.7
2	+100%	no limit	nil	0	32.7	39.4	27.9
3	present	no limit	$200	0	26.6	40.6	32.8
4	present	no limit	nil	100%	12.0	33.0	54.1
5	+100%	20 litres	$200	0	55.5	30.4	14.1
6	+100%	20 litres	nil	100%	53.6	32.3	14.1
7	present	20 litres	$200	100%	56.1	28.5	15.4
8	present	20 litres	nil	0	55.3	31.0	13.7

For the purpose of determining the relative significance of the effects attributable to the policy variables and to inherent differences between respondents, a second type of analysis of variance(1) was performed. It was found that the effects attributable to differences between respondents were highly significant and dominated the effects atrributable to the policy variables. The significance of the differences between respondents is an interesting and important result. It confirms the second of the two fundamental hypotheses of the study, namely that the characteristics of companies and fleets have important effects on the policy responses. This means that the variability in the policy responses cannot be adequately explained by the policy variables alone, and that the differences in the inherent characteristics of companies and fleets must be accounted for in a comprehensive analysis. However the analysis of variance method is not suited to dealing with a multiplicity of such characteristics which represent factors external to the experiment. It can only effectively analyse a very small number of external factors.

The analysis of variance has provided some important results in respect of the impacts of the policy scenarios on the size and composition of car fleets. It has confirmed the hypothesis that the policies would induce shifts towards smaller more fuel efficient cars, and it has established that the policy effects on the size of company fleets would be negligible. Finally it has demonstrated the importance of the effects of the characteristics of companies and fleets on the policy responses. However a detailed and comprehensive analysis of the impacts of the individual policies and the effects of the specific characteristics of companies and fleets requires a more general and flexible approach. Multiple regression analysis provides such an approach.

---

(1) This second type of analysis of variance employed the BMD-02V program for the analysis of factorial designs. This program, which belongs to an older series of BMD programs, is most inflexible. It requires data inputs to be in a very specific form, it is unable to sort or select cases, it assumes a full factorial design, and it does not provide F-tests of significance directly, leaving these to be hand calculated for all the relevant comparisons.

7.3 MULTIPLE REGRESSION ANALYSIS OF THE POLICY IMPACTS AND THE EFFECTS OF COMPANY AND FLEET CHARACTERISTICS

7.3.1 Regression Techniques and Assumptions

Multiple regression is a powerful method of analysing the collective and separate contributions of several independent variables to the variability of a dependent variable. It is well suited to accomplishing the objectives of the detailed analysis of policy impacts and characteristics effects.

The multiple regression model is based on a hypothesised relationship between the variables of interest, and the specification of this relationship is based on theoretical considerations. The estimation of the parameters of the regression model rests on a set of assumptions about the nature of the disturbance terms (residuals) and the independent variables. Thus it is assumed that the disturbance terms are random variables with expected values of zero, constant variance, zero covariance, that they are uncorrelated with the regressors (the independent variables), and that there is not perfect multicollinearity among the regressors (Kelejian and Oates 1974, chs 2 and 4; Maddala 1977 chs 7 & 8). On the basis of this set of assumptions ordinary least squares estimation is applied to derive estimates of the parameters of the regression model. It can be shown that these estimates possess the desirable statistical properties of being unbiased minimum variance estimates (Kelejian and Oates 1974 ch 2). One additional assumption about the disturbance terms is introduced in order to permit statistical testing of the significance of the estimated parameters. Thus it is assumed that the disturbance terms are normally distributed (Kelejian and Oates 1974 ch 3). Analysis of the residuals of the regression model estimation provides a useful method of checking the validity of certain assumptions underlying the model. For example analysis of the residuals may reveal departures from normality, existence of heteroscedastic residuals or non linear relationships. It may also assist in detecting omitted variables or outliers in the data (Maddala 1977 pp83-88). Where such problems are detected a number of techniques are available for modifying the estimation procedure or transforming the variables to obtain the best estimates possible under the circumstances (Maddala 1977 chs 10, 12 and 13).

Two sets of regression models were developed for the present analysis, first a set of simple aggregate models, and second a set of comprehensive disaggregate models. The aggregate models and the results of their estimation are presented in the following section.

7.3.2 Aggregate Analysis of Policy Impacts

The purpose of the aggregate regression analysis was to estimate the average impacts of each of the four policies on the composition of company car fleets. The results of the aggregate analysis also provide the basis for an interesting comparison with the results of the disaggregate analysis.

The set of aggregate regression models may be represented by the following equations:

$$APCSMALL_s = a_0 + a_1 PP_s + a_2PR_s + a_3IT_s + a_4 TD_s + u_s$$

$$APCMEDIUM_s = b_0 + b_1 PP_s + b_2PR_s + b_3IT_s + b_4 TD_s + u_s$$

$$APCLARGE_s = c_0 + c_1 PP_s + c_2PR_s + c_3IT_s + c_4 TD_s + u_s$$

where: $APCSMALL_s$, $APCMEDIUM_s$, and $APCLARGE_s$ are the average percentages of small, medium and large cars in the fleets under policy scenario s(1)(2).

PP_s = petrol price under scenario s

PR_s = petrol rationing under scenario s

---

(1) The average percentage figures employed in the aggregate regression analysis were obtained in the analysis of variance by level of policies. See Table 7-3.

(2) It should be noted that the regression estimation of only two of these three models would be sufficient to obtain the required results. This is so because the corresponding coefficients (eg a_1, b_1 and c_1) must add to zero in order for the total of the percentage shares to remain at 100 per cent, and thus the estimates for the third model could be obtained by simple addition and subtraction.

IT_s = inefficiency tax under scenario s

TD_s = tax deductibility under scenario s

a, b and c = coefficients of the policy variables

(i = 0, 1, 2, 3, 4)

u_s = the disturbance term under scenario s

These models were estimated(1) for all policy scenarios together as well as for each component-design separately. The results of these estimations are presented in Table 7-4, and the significance, direction and magnitude of the average policy impacts are discussed.

The t-values of the estimates coefficients in Table 7-4 show that the rationing variable is highly significant (at the one per cent level) in all but one model, while the price and tax variables fail to be statistically significant in most of the estimations. Despite the number of low t-values, the coefficient of multiple determination, R^2, tends to be quite large. High R^2 values are not unusual where estimation is based on aggregated data. This is because aggregation averages out much of the variation in the data, leaving a smaller amount of variation to be explained by the regression model.

The signs of the coefficients are generally consistent with expectations based on theoretical considerations of the directions of the policy-induced changes in fleet composition. Thus each of the policies would decrease the percentage of large cars and increase the percentage of small cars. (The imposition of the petrol price policy and the inefficiency tax implies an increase in the values of these variables, to the contrary the imposition of petrol rationing and tax deductibility reductions implies a decrease in the values of these variables.) The percentage of medium sized cars would decrease in response to

(1) The computer program employed in the estimation was the BMD-P1R Multiple Regression Program (Dixon and Brown 1979).

TABLE 7-4 - AGGREGATE POLICY EFFECTS ON SIZE CLASS COMPOSITION OF COMPANY CAR FLEETS

	Petrol Price		Petrol Rationing		Inefficiency Tax		Tax Deductibility		
	Coefficient	t-value	Coefficient	t-value	Coefficient	t-value	Coefficient	t-value	R^2
All scenarios									
APCSMALL	.020	(.51)	-.574	(-9.65)	.003	(.14)	-.033	(-.87)	.85
APCMEDIUM	/ .010	(.54)	.156	(5.71)	-.0002	(-.04)	-.001	(-.40)	.63
APCLARGE	-.029	(-.61)	.418	(5.62)	-.002	(-.10)	.034	(.71)	.66
Mild scenarios									
APCSMALL	.060	(3.15)	-.942	(-39.52)	.027	(2.83)	-.084	(-4.40)	.99
APCMEDIUM	.038	(.37)	.083	.63	.038	(.73)	-.148	(-1.42)	.51
APCLARGE	-.100	(-.85)	.860	(5.88)	-.064	(-1.09)	.232	(1.98)	.93
Medium scenarios									
APCSMALL	.051	(.92)	-.744	(-10.74)	.025	(.90)	-.120	(-2.16)	.98
APCMEDIUM	.039	(1.40)	.146	(4.25)	.014	(1.00)	.006	(.20)	.88
APCLARGE	-.089	(-1.09)	.598	(5.81)	-.039	(-.94)	.115	(1.39)	.93
Tough scenarios									
APCSMALL	.051	(1.12)	-.503	(-6.61)	.017	(.72)	-.050	(-1.09)	.94
APCMEDIUM	.022	(1.14)	.135	(4.14)	.005	(.47)	-.015	(-.75)	.86
APCLARGE	-.073	(-1.24)	.367	(3.75)	-.021	(-.71)	.064	(1.09)	.85

the rationing policy but increase in response to the price and tax policies, and thus the direction of changes in the percentage of medium sized cars depend on the levels and combinations of the policy impositions.

The magnitude of the policy impacts may be predicted from the coefficients of the regression models for levels of the policy variables within a reasonable range of extrapolation from the policy levels employed in the estimation. Interpreting the coefficients in the usual way, a one unit change in the independent variable will lead to a change in the dependent variable of the magnitude indicated by the coefficient of the independent variable, ceteris paribus. Thus for example a one unit increase in the petrol price variable will lead to a .06 unit increase in the average percentage of small cars. Given that the petrol price variable is measured in percentage units, it follows that a 25 per cent increase in petrol price will lead to a 1.5 unit increase in the average percentage of small cars. Table 7-5 shows the predicted changes in the average perentage of small, medium and large cars in response to the policies at the levels of imposition considered directly in the policy scenarios. The coefficients employed in this prediction were the ones estimated for each component design separately, thus allowing the identification of potential threshold effects and differences in response patterns across policy levels.

It is evident from these figures that the impacts of rationing on the average fleet composition greatly exceed the impacts of any of the other policies at the particular levels of imposition considered. Thus for example the introduction of rationing at the level of 60 litres per week per car would have the likely effect of decreasing the average percentage of large cars in company fleets by 17.2 units, that is from the present 70 per cent to about 53 per cent. The same policy would increase the percentage share of small cars by 18.8 units, which is from 8 per cent at present to about 25 per cent. It is notable that the impacts of the most severe rationing level of 20 litres per week per car appear not to be consistently greater than the impacts of the 40 litres per week rationing level. A possible reason for this is that many companies considered a 20 litre ration too severe to enable their full adoption. This explanation is supported by the comments of respondents.

TABLE 7-5 - PREDICTED CHANGES IN AVERAGE FLEET COMPOSITION

Policy Variable and Level	APCSMALL	APCMEDIUM	APCLARGE
Petrol price increase(a)			
25%	+ 1.5	+ 1.0	- 2.5
50%	+ 2.6	+ 1.9	- 4.5
100%	+ 5.1	+ 2.2	- 7.3
Petrol rationing(b)			
60 litres per week per car	+ 18.9	- 1.7	- 17.2
40 litres per week per car	+ 29.7	- 5.8	- 23.9
20 litres per week per car	+ 30.3	- 8.1	- 22.2
Inefficiency tax			
$50 per year per car	+ 1.3	+ 1.9	- 3.2
$100 per year per car	+ 2.5	+ 1.4	- 3.9
$200 per year per car	+ 3.4	+ 1.0	- 4.4
Tax Deductibility			
75%	+ 2.1	+ 3.7	- 5.8
50%	+ 4.3	+ 1.6	- 5.9
Nil	+ 6.7	- .3	- 6.4

(a) The increase in petrol prices are taken from the base of the average price of 26.9 cents paid by the companies at the time of the survey.
(b) The rationing impacts are calculated from the base of the actual average fuel consumption of about 80 litres per week for the 12 031 cars in the sample.

The aggregate analysis has provided interesting results in respect of the average impacts of each of the policies on the composition of company car fleets. However the aggregate models do not allow for the investigation of the effects of company and fleet characteristics. This is so because the characteristics have been averaged out in the aggregation process. Disaggregate analysis is required to determine the characteristics effects simultaneously with the policy impacts.

7.3.3 Disaggregate Analysis of Policy Impacts and Characteristics Effects

The disaggregate analysis allows the full utilisation of the information contained in the data set by performing the analysis at the level of the individual observation. This provides for the detailed investigation of the policy impacts and the effects of the characteristics of individual companies and fleets on the policy responses. Disaggregate models are superior to aggregate ones for the purposes of detailed analysis and prediction. The following sections discuss the specification of the variables and the development of the models for the disaggregate analysis.

7.3.3.1 Specification of Variables

The dependent variables of the disaggregate policy impact were the percentage shares of small, medium and large cars which companies would intend to keep in their fleets under the circumstances described in the policy scenarios. Given that the totals of the fleet shares must add to 100 per cent, the estimation of two of the three regression model would be sufficient to derive all the coefficient estimates. Nevertheless computer estimation of all three models offers the most efficient method of obtaining all the required results.

Examination of the raw response variables in terms of the absolute numbers of small, medium and large cars showed that each of these variables had a strongly positively skewed distribution. Employing these raw responses as dependent variables would violate the regression model assumptions of normally distributed, constant variance residuals, and would therefore invalidate the standard statistical significance tests of the parameter estimates. This problem was effectively overcome by the transformation of the response variables into percentage of fleet figures. Kuh and Meyer (1955) have shown that ratio (or percentage) models are more appropriate than regression models based on undeflated values in applications with cross section data where the influence of size-variable is distorting the estimation of other parameters. Given that policy impacts on the size of fleets were shown to be negligible there is virtually no loss of information entailed in the transformation of the dependent variables from absolute numbers to percentages (see section 7.2.1).

It was originally planned to estimate a model employing fleet size under the policy scenarios as the dependent variable for the purpose of identifying the impacts of the policies on the size of fleets. However since fleet size hardly varies at all there is little point in attempting to identify its sources of variation.

The independent variables of the disaggregate models fall in two groups; first the experimental design policy variables and second the variables describing the characteristics of companies and fleets. The basic policy variables were petrol price, petrol rationing, inefficiency tax, and tax deductibility(1). In order to allow for the testing of higher order (quadratic) effects and policy interaction effects, additional independent variables were generated from the basic linear policy variables. Quadratic terms were generated for each policy variable by means of a transformation procedure termed the method of orthogonal polynomials (Robson 1959; Hays 1963 ch 16; Winer 1962, p178). The purpose of this method is to ensure independence of the linear and quadratic effects in model estimation, thus avoiding the problem of multicollinearity. The transformation procedure was based on the following formula from Robson (1959 p189):

$$Q(X_A) = x_i - \frac{1}{n} \Sigma x_i^2 - (x_i - \bar{x}) \frac{\Sigma x_i (x_i - \bar{x})}{\Sigma (x_i - \bar{x})}$$

where: X_A = policy variable A

x_i = the i^{th} level of the policy variable

$\bar{x}$ = the mean value of the policy levels

n = the number of levels of the policy variable

---

(1) The policy variables were specified in detail in section 4.4.1.

Independent variables to capture potential policy interaction effects were generated by simple multiplicative transformations for the estimable interactions(1). Thus the following interaction terms were generated: 'petrol price by inefficiency tax', 'petrol price by tax deductibility', and 'inefficiency tax by tax deductibility'.

The characteristics variables were specified in a number of different ways depending on their nature and purpose. The two fundamental characteristics of companies, type of industry and size of company, were entered as 0-1 dummy variables. The type and size categories containing the greatest number of companies were selected as base cases and not entered as dummies but embodied in the constant term of each model. Thus the base categories were the industry type 'manufacturing' and the size group 'less than 20 employees'.

The remaining characteristics were specified as continuous variables and a number of transformations were performed generating ratios and composite variables. Ratios were generated deflating variables by fleet size in cases where the undeflated variables were highly correlated with fleet size, or had highly skewed distributions (causing the residuals to depart significantly from the normal distribution and thus invalidating the standard statistical tests of significance). Ratio transformations served effectively to overcome these problems, and the variables generated can be readily interpreted as proportions of the cars in company fleets. Variables specified in this way were the proportions of small, medium, and large cars in the fleets, the proportions of fleet cars operated on LPG and diesel, the proportions which were purchased, leased, and hire-purchased, and the proportion of cars for which the company pays all fuel expenses. One additional ratio variable was generated to measure the ratio of management cars to field cars.

In the cases where the characteristics of management and field cars, entered separately, were found to be insignificant the average for the whole fleet was generated by simple transformations. These variables were: the distances travelled, the fuel economies, the replacement cycles and the fuel expense coverage.

---

(1) Three of the total of six two-factor interactions may be estimated from the experimental design. See section 4.5.3.

A final type of specification of the characteristics variables was represented by the three factors generated in the factor analysis of the purposes and features of company cars(1). These factors were labelled the 'field car', the 'status', and the 'operation' factor, respectively.

This completes the specification of the variables employed in the disaggregate policy impact models.

7.3.3.2 Model building, Parameter Estimation and Hypothesis Testing

The disaggregate analysis of the impacts of the energy conservation policies on company car fleets was based on a set of multiple regression models. The aims of this analysis were to estimate the impacts of the policies on the composition of company car fleets, to test for the existence of higher order effects and policy interactions, and to test the hypotheses(2) about the effects of the characteristics of companies and fleets on the policy responses. Accordingly, the disaggregate models were built around a central core consisting of the basic four policy variables, and expanded from that core by introducing firstly the quadratic terms and the interaction terms, and secondly the characteristics variables.

The core models are represented by the following equations:

$$PCSMALL_{fs} = a_0 + a_1PP_s + a_2PR_s + a_3IT_s + a_4TD_s + u_{fs}$$

$$PCMEDIUM_{fs} = b_0 + b_1PP_s + b_2PR_s + b_3IT_s + b_4TD_s + u_{fs}$$

$$PCLARGE_{fs} = c_0 + c_1PP_s + c_2PR_s + c_3IT_s + c_4TD_s + u_{fs}$$

where: $PCSMALL_{fs}$, $PCMEDIUM_{fs}$ and $PCLARGE_{fs}$ are the percentage shares of small, medium and large cars in company fleet f under scenario s.

(1) See section 6.3.
(2) See section 3.4.

PP_s = petrol price under scenario s

PR_s = petrol rationing under scenario s

IT_s = inefficiency tax under scenario s

TD_s = tax deductibility under scenario s

a_i, b_i, c_i = coefficients (i = 0,1,2,3,4)

u_{fs} = the disturbance term for company f under scenario s.

The comprehensive models are summarised in the next set of equations:

$$\begin{aligned} PCSMALL_{fs} &= a_0 + a_1PP_s + a_2PR_s + a_3IT_s + a_4TD_s \\ &+ a_5QPP_s + a_6QPR_s + a_7QIT_s + a_8QTD_s \\ &+ a_9PP_s * IT_s + a_{10}PP_s * TD_s + a_{11}IT_s * TD_s \\ &+ a_{12}CH1_f + a_{13}\ CH2_f + \text{----------} + a_mCH_{nf} + u_{fs} \end{aligned}$$

$$\begin{aligned} PCMEDIUM_{fs} &= b_0 + b_1PP_s + b_2PR_s + b_3IT_s + b_4TD_s \\ &+ b_5QPP\ _s + b_6QPR_s + b_7QIT_s + b_8QTD_s \\ &+ b_9PPs * IT_s + b_{10}PP_s * TD_s + b_{11}IT_s * TD_s \\ &+ b_{12}CH1f + b_{13}CH2f + \text{----------} + b_m\ CH_{nf} + u_{fs} \end{aligned}$$

$$\begin{aligned} PCLARGE_{fs} &= c_0 + c_1PP_s + c_2PR_s + c_3IT_s + c_4TD_s \\ &+ c_5QPP_s + c_6QPR_s + c_7QIT_s + c_8QTD_s \\ &+ c_9PP_s * IT_s + c_{10}PP_s * TD_s + c_{11}IT_s * TD_s \\ &+ c_{12}CH1f + c_{13}CH2f + \text{----------} + c_mCH_{nf} + u_{fs} \end{aligned}$$

where: $PCSMALL_{fs}$, $PCMEDIUM_{fs}$, $PCLARGE_{fs}$, PP_s, PR_s, IT_s, TD_s and u_{fs} are defined as for the core models.

QPP, QPR, QIT and QTD are the quadratic terms for the policy variables.

PP * IT, PP * TD and IT * TD are the interaction terms of the policy variables.

$CH1_f$, $CH2_f$ . . . . CH_{nf} represent the characteristics 1 to n of company f.

a_i,b_i,c_i are the coefficients (i= 0,1,2,...m, where m is the total number of independent variables).

The results of the estimation of these core models and expanded models are presented and discussed in the following section.

7.4 RESULTS OF THE DISAGGREGATE POLICY IMPACT ANALYSIS

7.4.1 Basic Policy Impacts on the Composition of Company Car Fleets

Table 7-6 presents the results of the estimation of the core models stating the percentages of small, medium and large cars as functions of the four basic policy variables. The computer program employed in this estimation was the BMD-P1R Multiple Regression Program (Dixon and Brown 1979). A special 'strung out' structure of the data input file was required in order to estimate simultaneously the effects of the experimental design policy variables and the effects of the characteristics variables external to the design. The data for each company contained eight sets of policy variables and eight sets of dependent response variables (from the repeated measures scenario design) but only one set of characteristics variables. Thus in order to estimate the effects of the characteristics variables on the policy responses it was necessary to repeat the former for each set of repeated measures. Given that there were 216 companies in the data set, the expanded data file contained 1944 observations (viz. 216*(8+1)) when including 'the present', and 1728 observations when excluding 'the present'.

TABLE 7-6 - BASIC POLICY IMPACTS ON FLEET COMPOSITION

Policy Variables	PCSMALL coef.	t-ratio	PCMEDIUM coef.	t-ratio	PCLARGE coef.	t-ratio
PPRICE	.045	1.94	.021	.92	-.065	-2.97
RATION	-.591	-16.12	.133	3.77	.458	13.16
INEFTAX	.013	1.12	.006	.58	-.019	-1.77
TAXDUCT	-.050	-2.16	-.015	-.66	.065	2.95
R^2	.162		.008		.133	
F-ratio	84.16		3.62		69.79	
Constant	73.06		28.24		-1.30	
Observations	1728		1728		1728	

The estimated coefficients of the basic policy variables all have the correct sign according to expectations based on the theoretical analysis. Thus increases in the percentage share of small cars in company fleet would result from increases in petrol prices, decreases in petrol rations, imposition of an inefficiency tax, and decreases in tax deductibility of expenses related to company cars. The impacts on the percentage share of large cars would be of the same order of magnitude but in exactly the opposite direction. The percentage of medium sized cars would be decreased as a result of the rationing policy, but would tend to be increased (although not significantly) by the remaining policies. These results confirm the fundamental hypothesis about the policy impacts (section 3.1.1).

The t-ratios of the estimated coefficients show that the rationing variable is highly significant in all three models, the petrol price and tax deductibility variables are significant (at the five percent level for the t-test) in the models for PCSMALL and PCLARGE and the inefficiency tax fails to be significant (at the five percent level) in any of the models.

The coefficient of multiple determination, R^2, is very low in all models, and extremely low in the case of PCMEDIUM. This indicates that the proportion of the total variation in the dependent variables which is accounted for by the four basic policy variables is only .16, .008 and .13 respectively. In the context of a disaggregate data set containing a large amount of variation, it is not surprising that very low R^2 are obtained in that the estimation of the models employed only the four basic policy variables. It is clear that additional explanatory variables are required to account for a greater proportion of the variation in the dependent variables. This is consistent with the results of the analysis of variance (reported in section 7.2.2), which showed that the variation due to difference in the inherent characteristics of companies exceeded the variation attributable to the policy variables.

Despite the low R^2 values the F-tests show that the estimated core models for PCSMALL and PCLARGE are highly significant, and that even the model for PCMEDIUM is significant at the one percent level.

It is evident from the R^2 values and the F-ratios of the three models that the variation in PCMEDIUM is much more difficult to explain and predict than the variation in the other two dependent variables. This is as expected on the grounds that the policy impositions cause shifts from large cars to small cars, and in this process the percentage share of medium sized cars may be either increased or decreased depending on the types and levels of the policies.

It is instructive to compare the results of the disaggregate core models with the results of the aggregate models estimated on the average response data for all scenarios (see table 7-4). The coefficients in the aggregate models tend to be statistically insignificant except in the case of the rationing variable, and yet the R^2 of the aggregate models are considerably greater than those for the corresponding disaggregate models. The differences in the performance of the two sets of models illustrate the differences in the types of results which are commonly obtained in analysis based on aggregate as against disaggregate data. In the aggregate data the variation attributable to differences between subjects has been averaged out, thus removing the variation which is usually the most difficult to explain. In contrast, the disaggregate data contain all the variation due to differences in the inherent characteristics of companies and fleets, and it would be unreasonable to expect the basic policy variables by themselves to account for more than a small part of this total variation.

7.4.2 Higher Order Policy Effects and Policy Interactions

In the first stage of the expansion from the disaggregate core models the quadratic policy terms and the policy interaction terms were introduced and tested. Table 7-7 presents the results of the estimation of the policy impact models including all policy terms.

The quadratic effect of rationing is statistically significant (at the one percent level) in the models for PCSMALL and PCLARGE, the quadratic effect of the tax deductibility policy is significant only in the model for PCLARGE, and none of the remaining quadratic effects are significant. The coefficients of the significant quadratic terms have the same signs as the corresponding linear terms, implying that the higher order effects reinforce and strengthen the basic policy effects (except in the case of the PCMEDIUM model).

TABLE 7-7 - HIGHER ORDER POLICY EFFECTS AND POLICY INTERACTION EFFECTS ON FLEET COMPOSITION

Policy Variables	PCSMALL coef.	PCSMALL t-ratio	PCMEDIUM coef.	PCMEDIUM t-ratio	PCLARGE coef.	PCLARGE t-ratio
PPRICE	.050	1.81	.017	.62	-.066	-2.59
RATION	-.493	-11.74	.147	3.63	.345	8.82
INEFTAX	.019	1.42	.004	.28	-.023	-1.85
TAXDUCT	-.004	-1.58	-.007	-.26	.051	2.01
QPPRICE	-.001	-.63	-.001	-.75	.001	1.50
QRATION	-.013	-4.39	-.002	-.61	.015	5.44
QINEFTAX	-.000	-.06	-.000	-.69	.000	.72
QTAXDUCT	-.001	-1.45	-.001	-1.04	.002	2.57
PP * IT	-.001	-2.42	-.000	-.64	.002	2.62
PP * TD	.000	1.10	.001	1.27	0.001	-2.52
IT * TD	.001	2.63	.000	.20	-.002	-3.07
R^2	.190		.015		.196	
F-ratio	37.11		2.35		38.39	
Constant	48.06		37.36		14.56	
Observations	1728		1728		1728	

The interaction between the petrol price increases and the inefficiency tax is statistically significant (at the one per cent level) in the models for PCSMALL and PCLARGE, as is the interaction between the inefficiency tax and the tax deductibility policy. The petrol price by tax deductibility interaction is significant only in the case of PCLARGE and finally none of the interactions are significant in the PCMEDIUM model. The significant interaction effects indicate that the introduction of the policies in combination would have impacts on the fleet composition over and above the impacts attributable to each policy variable in isolation. Thus for example the introduction of the inefficiency tax in combination with the tax deductibility policy would result in a greater shift towards small cars than could be predicted from each of the policies separately. The existence of significant interaction effects clearly has implications for policy making.

While the expanded policy models have assisted in identifying some significant higher order policy effects and policy interactions, the overall explanatory power of the models has been improved only slightly. It is evident that additional explanatory variables are required to account for the variability of the policy responses of companies. This purpose is served by the introduction of the variables describing the characteristics of companies and fleets.

7.4.3 Results of the Comprehensive Analysis of Policy Impacts and Characteristics Effects

The set of fully expanded policy impact models state the percentage shares of small, medium, and large cars as functions of the policy variables (including higher order and interaction terms) and the characteristics variables. These comprehensive models serve the objectives of: i. confirming the impacts of the policy variables on the composition of company car fleets in light of information about the characteristics of companies and fleets, and ii. identifying the effects of these characteristics on the policy responses of companies. The results of the estimation of the comprehensive models of policy impacts and characteristics effects are presented in Table 7-8.

TABLE 7-8 - POLICY IMPACTS AND CHARACTERISTICS EFFECTS ON THE COMPOSITION OF COMPANY CAR FLEETS

Explanatory Variables(a)	PCSMALL coef.	PCSMALL t-ratio	PCMEDIUM coef.	PCMEDIUM t-ratio	PCLARGE coef.	PCLARGE t-ratio
PPRICE	.067	2.650	.024	.944	-.091	-4.242
RATION	-.483	-12.308	.167	4.205	.316	9.468
INEFTAX	.026	2.064	.002	.137	-.028	-2.590
TAXDUCT	-.064	-2.517	-.014	-.557	.078	3.625
QPPRICE	-.000	-.398	-.000	-.235	.000	.748
QRATION	-.014	-5.273	-.005	-1.691	.019	8.218
QINEFTAX	.000	.141	-.000	-1.143	.000	1.196
QTAXDUCT	-.001	-.611	-.001	-1.334	.002	2.309
PP*IT	-.001	-2.432	-.000	-.570	.001	3.541
PP*TD	.000	.989	.001	1.537	-.001	-2.995
IT*TD	.001	3.487	.000	.140	-.001	-4.270
RURAL	-17.040	-4.609	6.089	1.626	10.953	3.485
BUILD	-5.232	-1.603	.307	-.903	5.538	1.996
SALE	-6.636	-3.443	5.090	2.607	1.545	.943
TRNSPCOM	-6.192	-1.964	-.032	-.010	6.222	2.321
FINPROP	-8.531	-2.334	-.233	-.063	8.758	2.819
BUSIPROF	2.556	.803	-4.931	-1.529	2.370	.876
COMSERV	12.044	1.215	1.679	.167	-13.723	-1.629
SIZE35	-.296	-.107	-.965	-.343	1.261	.534
SIZE75	-5.153	-1.681	3.390	1.092	1.761	.676
SIZE300	5.181	2.089	3.628	1.444	-8.808	-4.179
SIZE750	25.847	7.392	-6.009	-1.696	-19.835	-6.673
SIZEGTM	25.040	5.405	-1.687	-.360	-23.348	-5.929
FLEETSIZ	-.023	-.779	.009	.031	.014	.370
PPSMALL	52.448	9.829	-45.001	8.227	-7.446	-1.642
PPLARGE	-20.443	-6.288	-40.667	3.643	61.110	22.114
RATIOMF	-.894	-2.756	-.017	-.052	.911	3.304
AVDIST	.125	1.266	.087	.875	-.212	-2.532
AVKMPL	1.423	2.152	-.312	-.466	-1.111	-1.976
PLPG	-7.330	-1.343	1.817	1.920	5.513	3.090
PDIESEL	-4.625	-2.349	-1.223	-1.109	5.847	2.893
PFCOV	10.784	3.607	3.831	1.507	-14.616	-4.825
AVRPLCM	-.181	-2.067	.135	1.484	.046	.604
PLEASE	-1.167	-.162	6.410	3.317	-5.243	-3.233

TABLE 7-8 - POLICY IMPACTS AND CHARACTERISTICS EFFECTS ON THE COMPOSITION OF COMPANY CAR FLEETS

Explanatory Variables(a)	PCSMALL coef.	PCSMALL t-ratio	PCMEDIUM coef.	PCMEDIUM t-ratio	PCLARGE coef.	PCLARGE t-ratio
FACTOR1	10.862	5.491	-1.135	-.567	-9.727	-5.785
FACTOR2	-2.221	-2.260	-.817	-.351	3.038	3.053
FACTOR3	-1.091	-1.056	3.897	2.661	-2.805	-2.997
R^2	.43		.22		.53	
F-ratio	27.48		10.25		40.60	
Constant	64.47		-4.12		-20.24	
Observations(b)	1389		1389		1389	

(a) All variables are defined in Table 7-8a.
(b) The estimation of these models is based on 1389 observations; each completed scenario response providing a set of eight observations, less the ones that have missing values on any of the modelling variables.

TABLE 7-8a - DEFINITION OF THE VARIABLES IN THE POLICY IMPACT MODELS

Name	Definition
PCSMALL	the percentage of small cars in company fleet under scenarios
PCMEDIUM	the percentage of medium size cars in company fleet under scenarios
PCLARGE	the percentage of large cars in company fleet under scenarios
PPRICE	petrol price
RATION	petrol rationing
INEFTAX	inefficiency tax
TAXDUCT	tax deductibility
QPPRICE	the quadratic term for petrol price
QRATION	the quadratic term for petrol rationing
QINEFTAX	the quadratic term for inefficiency tax
QTAXDUCT	the quadratic term for tax deductibility
PP*IT	the interaction of petrol price and inefficiency tax
PP*TD	the interaction of petrol price and tax deductibility
IT*TD	the interaction of inefficiency tax and tax deductibility
RURAL	rural and mining
BUILD	building and construction
SALE	wholesale and retail
TRNSPCOM	transport and communications
FINPROP	finance and property
BUSIPROF	business and professional services
COMSERVE	community services
SIZE35	20-49 employees
SIZE75	50-99 employees
SIZE300	100-499 employees
SIZE750	500-999 employees
SIZE6TM	1000 or more employees
FLEETSIZ	fleet size
PPSMALL	the present proportion of small cars in a fleet
PPLARGE	the present proportion of large cars in a fleet
RATIOMF	the ratio of management cars to field cars
AVDIST	average annual distance travelled by cars in a fleet
AVKMPL	average fuel economy of cars in a fleet
PLPG	the proportion of cars run on liquid petroleum gas
PDIESEL	the proportion of cars run on diesel
PFCOV	the proportion of cars for which the company pays all fuel costs
AVRPLCM	the average replacement cycle for cars in a fleet
PLEASE	the proportion of cars that are leased
FACTOR1	The 'field car' factor on purposes and features
FACTOR2	the 'status and perk' factor for management cars
FACTOR3	the 'operation and cost' factor for management cars

Substantial improvements in the explanatory power of the models are achieved by the introduction of the variables describing the characteristics. Thus the proportions of the variation in the dependent variables which are accounted for by the comprehensive models have been increased to .43, .22 and .53 from .19, .015 and .196 respectively. In view of the disaggregate nature of the underlying data set the overall performance of the comprehensive models appears very good.

The introduction of the explanatory characteristics variables into the policy impact models have generally strengthened the significance of the coefficients of the policy variables, while leaving their signs unchanged.

Thus the results obtained in the models estimated on the policy variables only are confirmed and strengthened in the light of information about the characteristics of companies and fleets. The hypotheses advanced about the policy impacts have thus all been supported by empirical evidence (Hypotheses 2, 3, 4, 5 and 6, section 3.4).

The results in respect of the characteristics effects are interpreted and discussed below.

The Effects of Industry Type

The coefficients of the industry type dummy variables express the effects of each of the industry types as differences from the base case of manufacturing companies. (The number of dummy variables introduced as independent variables must be one less than the number of categories in the classification; the remaining dummy is embodied in the constant term of each model and become the standard against which differences between industry groups are assessed).

As compared with companies in the manufacturing industry, companies in the rural and mining industries have a significantly lower propensity to change to small cars, as do companies in wholesale and retail, finance and property, transport and communication, and building and construction. Companies in wholesale and retail are most likely to adopt medium size cars. Companies in business and professional services do not differ significantly from companies in manufacturing in respect of their propensity to change to small cars. Finally the community services sector is the least likely of all to retain large cars.

These results are generally consistent with the hypothesised effects of industry type on the policy responses, with the exceptions that companies in transport and communication are less inclined to move to smaller cars than had been expected, and companies in business and professional services are somewhat more likely to adopt small cars than had been expected (Hypothesis 7, section 3.4).

Effects of Company Size

The coefficients of the company size dummy variables express the effects of each company size class in terms of differences from the base case of companies with less than 20 employees. In comparison with these companies of less than 20 employees, companies in the size group 20 to 49 employees do not differ significantly in their policy responses. Medium sized companies of 50 to 99 employees have a lower propensity to change to small cars than do either smaller or larger companies (although this difference is significant only at the 9 per cent level). Companies in the size groups of more than 100 employees have a significantly higher propensity to adopt small cars, than do companies in the smaller size groups. In particular the very large companies (of 500 to 999, and 1000 and more employees) are the most inclined to change to small cars for their fleets. This effect of company size had not been expected and it refutes the hypothesis that smaller companies are the most likely to move to smaller cars (Hypothesis 8, section 3.4). An explanation which can be offered for the observed effect is that large companies are more likely to have professionally managed fleets and therefore adjust more readily to the increased costs and contraints involved in the policy scenarios.

Effects of Fleet Size

The estimated coefficient of the fleet size variable is insignificant, indicating that the size of company fleets do not have any significant effect on the policy responses. Fleet size effects appear to be fully accounted for by the company size variables, thus effectively disproving the hypothesis in respect of those effects (Hypothesis 9, section 3.4).

Effects of Fleet Composition

The existing composition of company car fleets has highly significant effects on the composition which companies would intend to adopt in response to the policy scenarios. The greater the present share of a particular car size class in the fleet, the greater would be the share of that size class under the scenario circumstances. Thus companies which already have experience with smaller fleet cars have a significant propensity to adopt yet more of them. On the other hand, companies which have very high present fleet shares of large cars have a highly significant propensity to retain those types of cars. These results lend strong support to the hypothesis which proposed these effects of the present size class composition of company car fleets (Hypothesis 10, section 3.4).

Effect of the Management to Field Car Ratio

The ratio of management cars over field cars has a significant effect on the policy responses; the higher this ratio, the less likely are shifts to small cars. This supports the hypothesis advanced as to this effect (Hypothesis 11, section 3.4).

Effects of Distance Travelled

The coefficients of the distance variable show that the greater the average annual distance travelled by cars in a fleet the more likely are moves away from large cars, although the increase in the likelihood of adopting small cars is not statistically significant. This is consistent with the hypothesis that companies with fleet cars travelling very high average distances would be the most affected by the policies which impose increased costs and constraints on company car usage (Hypothesis 12, section 3.4).

Effects of Present Fuel Efficiency

The present fuel economy of company car fleets has a positive effect on the fleet share of small cars under the scenario circumstances. That is, the better the present average fuel economy, the more likely are shifts to small, fuel-efficient cars. This is consistent with the effects of the present fleet composition, and it confirms that companies which already have relatively fuel-efficient cars in their fleets are inclined to adopt yet more small cars, while companies with low fuel economy fleets are inclined to retain their large cars (Hypothesis 13, section 3.4).

Effects of Alternative Fuel Usage

The usage of LPG and diesel in company car fleets has the effect of increasing the propensity to retain large cars. The usage of LPG also has some effect of increasing the share of medium sized cars, while the usage of diesel in particular has a significant effect of increasing the likelihood of adopting small cars. These findings lend support to the hypothesis that the greater the usage of fuels other than petrol the less would be the responsiveness to the petrol conservation policies (Hypothesis 14, section 3.4). It should be noted though that the very limited number of companies (about six per cent of the sample) which reported any current usage of alternative fuels renders these results somewhat tentative.

Effects of Company Payment of Fuel Expenses

The extent to which companies pay the fuel costs incurred by their fleet cars has a significant effect on expected fleet composition. Thus the greater the proportion of the fleet cars for which the company pays all fuel costs (for business as well as private travel) the greater the propensity to move to smaller more fuel-efficient cars. This confirms the hypothesis that the companies which pay all fuel costs are more responsive to the policies than the companies which do not (Hypothesis 15, section 3.4).

Effects of Replacement Cycles

The average replacement cycle for cars in company fleets has some effect on the responsiveness of companies to the policy scenarios. Thus the shorter the replacement cycle the greater will be the shift to small cars (although the effects on the fleet shares of medium and large cars are not statistically significant). This lends some support to the hypothesis as to the effect of the replacement cycles in the context of the study period of about five years (Hypothesis 16, section 3.4).

Effects of the Method of Acquisition

The method of acquisition of company cars has a significant effect on the likely fleet-shares as between large and medium sized cars. The higher the proportion of fleet cars that are leased (rather than purchased or hire-purchased by the user company) the greater would be the shift away from large cars to medium sized ones. It is interesting to note that leasing appears to have the effect of decreasing the fleet-share of small cars, although this effect is not statistically significant. These results are consistent with the hypothesis that the impacts of the policies on fleet composition would be less where leasing is the dominant method of acquisition (Hypothesis 17, section 3.4).

Effects of Purposes and Features Factor Scores

The three factors summarising the perceived importance of a wide range of purposes and features of company cars have some very interesting effects on the policy responses. The 'field car' factor (FACTOR1) has the highly significant effect of increasing the shift to small cars from large ones (and from medium sized ones to a lesser extent). The 'status' factor (FACTOR2) has the effect of decreasing the inclination to shift to small cars, while the 'operation' factor (FACTOR3) increases the likelihood of moves from large to medium sized cars. This implies that companies which rate the purposes and features of field cars highly would be far more likely to change to small cars, than would companies which consider the status and perk oriented attributes to be very important. Finally companies which perceive the operation and cost oriented attributes of management cars as highly important are likely to move to medium size cars but not right down to small ones.

These results lend considerable support to the hypothesis advanced with respect to the effects of the perceived importance of the purposes and features of company cars on the policy responses (Hypothesis 20, section 3.4).

Summary of Characteristics Effects

The results of the comprehensive analysis of policy impacts and characteristics effects have provided strong support for the fundamental hypothesis that the characteristics of companies and fleets will have important effects on their responsiveness to the energy conservation policies under study.

It was found that the companies in some sectors such as manufacturing, business and professional services, and community services are more likely to move to small cars than companies in rural and mining, finance and property, transport and communications, and building and construction, and finally that companies in wholesale and retail are likely to change to medium size cars but not to small ones. It was found that large companies of more than 100 employees are the most inclined to move to smaller cars, and in particular that very large companies of more than 500 employees have a very high propensity to shift to small cars.

In respect of fleet characteristics it was found that the propensity to change to smaller more fuel-efficient cars is greater for each of the following: (a) greater present proportions of small and medium size cars in a fleet; (b) lower ratio of management to field cars; (c) longer distances travelled; (d) higher present fuel efficiencies, (e) less usage of alternative fuels; (f) higher proportions of fuel expenses paid by the company; (g) more frequent replacement cycles; (h) lower proportions of fleet cars being leased and finally[1] (i) greater perceived importance of field car attributes and operation and cost oriented attributes, and less perceived importance of status and perk oriented attributes.

7.4.4 Predicted Changes in Fleet-Shares

On the basis of the final policy impact models (Table 7-8), fleet-shares of small, medium and large cars can be predicted for any level of the policy variables (within a reasonable range of extrapolation from the levels used in the estimation of the models).

---

(1) The effects of the extent of employee choice and the decision making structure on the policy responses could not be tested because the data on these two characteristics departed significantly from the normality assumption of the regression model.

The disaggregate nature of the models allows for the prediction of the fleet composition of individual companies or selected groups of companies. This ability to predict the policy impacts on particular companies is an important asset of disaggregate policy models, and the results of such predictions are likely to be of interest to both government and corporate policy makers.

The predicted impacts on the overall fleet-shares of small, medium and large cars were derived for each of the policies and levels specifically considered in the scenarios. The changes in fleet-shares were calculated from the estimated coefficients of the policy variables (see Table 7-8) including the relevant quadratic and interaction terms. The impacts of each policy on the fleet-shares were estimated on the assumption that the other policies remained constant at their present levels. Thus, for example, the change in the fleet-share of large cars in response to increases in petrol price, ceteris paribus, was calculated as follows:

$$\Delta\ \text{PCLARGE} = c_1\ \Delta\ \text{PP} + c_5\ \Delta\ \text{QPP} + c_9\ \Delta\ \text{PP*IT} + c_{10}\ \Delta\ \text{PP*TD}$$

where: Δ PCLARGE = change in fleet-share of large cars

PP = Petrol Price (defined in units of percentage increase from 'the present')

QPP = The Quadratic Petrol Price term, generated by the transformation formula shown in section 7.3.3.1.

IT = Inefficiency Tax (assumed to remain constant at its present level of $0)

TD = Tax Deductibility (assumed to remain constant at its present level of 100 per cent)

The impact of a 25 per cent increase in petrol price, ceteris paribus, is then predicted as:

$$\Delta\ \text{PCLARGE} = (-.091*25) - (0*1964.25) - (.001*25*0) - (.001*25*100) = -4.8$$

Given that the mean present fleet-share of large cars is 70.3 per cent, the result would be a decrease in that share to 65.5 per cent. (The mean petrol price actually paid by the companies at the time of the survey was 26.9c per litre, thus an increase of 25 per cent would imply a petrol price of 33.6c per litre).

Table 7-9 shows the predicted changes and the resulting overall fleet-shares for each of the policies.

TABLE 7-9 - PREDICTED CHANGES IN FLEET-SHARES

Policies	PCSMALL Change	PCSMALL Share	PCMEDIUM Change	PCMEDIUM Share	PCLARGE Change	PCLARGE Share
Present	-	8.2	-	21.5	-	70.3
<u>Petrol Price</u>						
+ 25%	+1.7	9.9	+3.1	24.6	-4.8	65.5
+ 50%	+3.3	11.5	+6.2	27.7	-9.5	60.8
+ 100%	+6.7	14.9	+12.4	33.9	-19.1	51.2
<u>Petrol Rationing</u>(a)						
60 litres p.w.	+20.9	29.1	+.6	22.1	-21.5	48.8
40 " "	+30.5	38.7	-2.7	18.8	-27.8	42.5
20 " "	+40.2	48.4	-6.0	15.5	-34.2	36.1
<u>Inefficiency Tax</u>						
$50	+6.3	14.5	+0.1	21.6	-6.4	63.9
$100	+12.6	20.8	+0.2	21.7	-12.8	57.5
$200	+25.2	33.4	+0.4	21.9	-25.6	44.7
<u>Tax Deductibility</u>						
75%	+3.6	11.8	+2.3	23.8	-5.9	64.4
50%	+5.9	14.0	+3.5	25.0	-9.3	61.0
nil	+8.5	16.7	+3.6	25.1	-12.1	58.2

(a) The rationing impacts are calculated from the base of the actual average petrol consumption of about 80 litres per week for the company cars in the sample.

The predicted fleet-shares show the dominating impacts of the rationing policy relative to the price and tax policies at these particular levels of application. Each of the policies would result in a shift from large cars to small ones, and in most cases the share of medium size cars would also increase. The petrol price increases would result in the greatest increase in the share of medium size cars, but only a relatively modest increase in the share of small cars, even for the 100 per cent increase in the petrol price. The rationing policy would result in a very substantial shift away from large cars and (at its more severe levels) also some move away from the medium size cars. In the case of the inefficiency tax, decreases in the fleet-share of large cars would correspond very closely to increases in the share of small ones, with the share of medium sized cars barely changing. This is presumably because very few medium size cars would meet the fuel economy standard (10 kilometres per litre) required to avoid the tax. However the tax deductibility policy, which is subject to the same fuel economy threshold, would result in some increase in the share of the medium size cars.

The fleet-share changes predicted from the final disaggregate models generally exceed those which could be predicted from the aggregate models (see Section 7.3.2, Tables 7-4 and 7-5). This is mainly attributable to the quadratic effects and the policy interactions which are included only in the disaggregate models.

The policy response functions implied by the predicted fleet-shares are illustrated in Figure 7-1.

Elasticities of the fleet-shares in respect of each of the policies can be obtained from the predicted changes in fleet composition. Given that the policies differ non-marginally from the present and span a wide range of possible levels, arc elasticities appear to be the most appropriate measures for the policy responsiveness of the fleet-shares. The elasticities vary continuously along the response functions, and the figures obtained depend on the range over which the elasticities are measured and the direction in which changes are assumed to occur. The arc elasticities of the fleet-shares in respect of each of the policies were calculated over the ranges between each set of adjacent policy levels (including 'the present') by means of the formula:

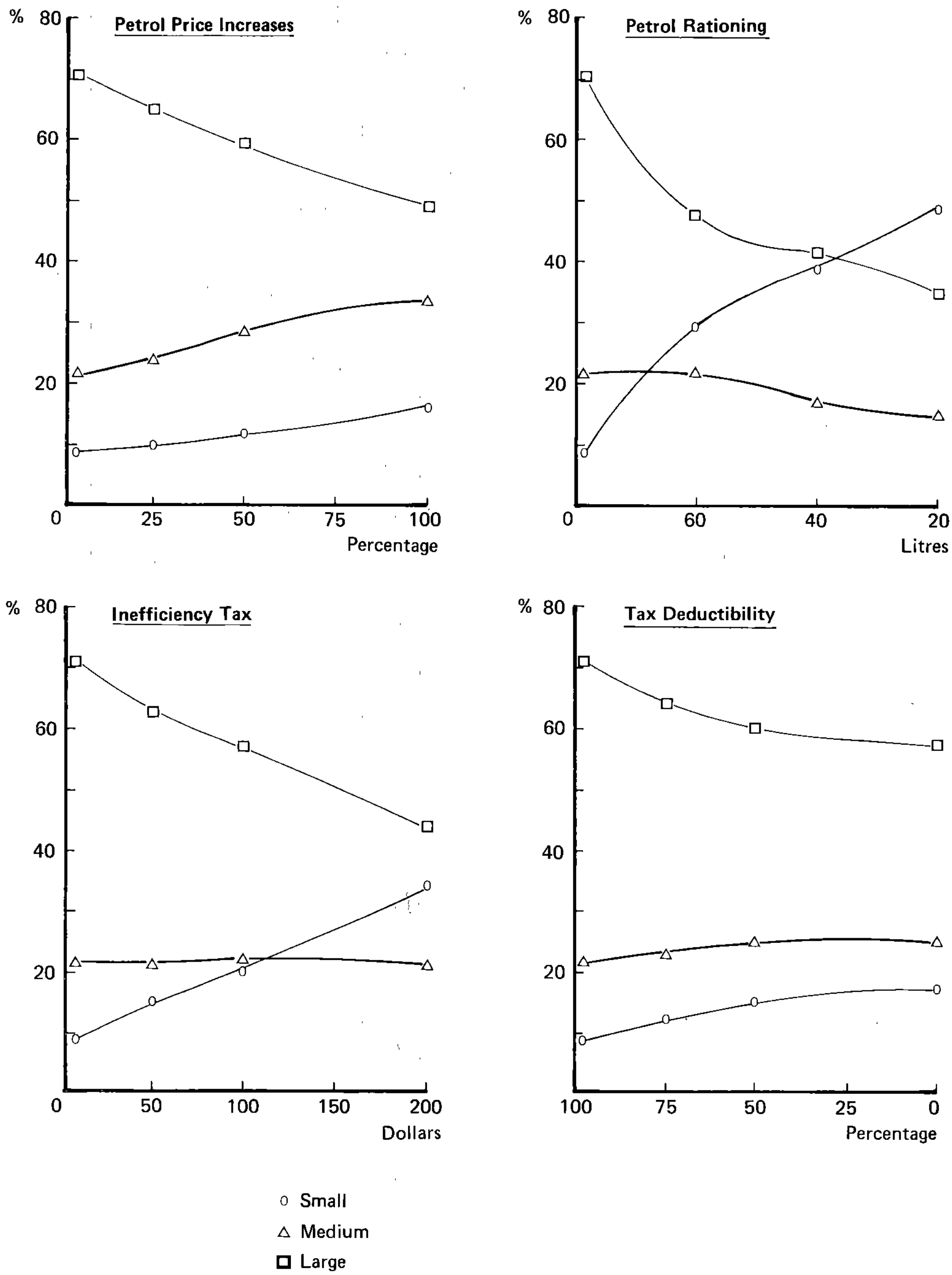

Figure 7.1
Policy response functions in terms of fleet-shares

$$R(FS)(PV) = \frac{\%\text{ change in FS}}{\%\text{ change in PV}}$$

where: FS represents a particular Fleet-Share, and
PV represents a particular Policy Variable

The percentage changes were calculated from the base of the mildest policy level progressing to the more severe ones, assuming this to be the most likely direction of change in the policy variables. (Elasticities calculated at the arc mid-point, averaging changes in both directions, would differ somewhat from the ones obtained here.) As an example, the arc elasticity of the fleet-share of small cars in respect of petrol price, when petrol price increases by 25 per cent from the mean 'present' value of 26.9 cents, is calculated as:

$$E(S)(PP) = \frac{(1.7/8.2) * 100\%}{25\%} = .83$$

If petrol price was to change from 'present + 25%' (33.64 cents) to 'present + 50%' (40.6 cents), the fleet-share of small cars would increase from 9.9% to 11.5%, thus the arc elasticity over this range would be:

$$E(S)\ (PP) = \frac{((11.5 - 9.9)/9.9)}{((40.6 - 33.6)/33.6)} = .78$$

Table 7-10 presents the arc elasticities of the fleet-shares of small, medium and large cars in respect of each of the policies and for each progressive change in the policy levels.

The elasticities provide useful summary measures of the relative responsiveness of the fleet-shares to the policies. However caution is required when interpreting the elasticities. In particular it is important to note that the ranges over which the changes in fleet-shares are measured differ both between and within policies. Thus policies which have greater absolute effects on fleet-shares are not necessarily associated with greater elasticities. The estimated fleet-shares provide a more direct, and for some purposes more useful, basis for the prediction of the policy impacts on company car fleets.

TABLE 7-10 - FLEET-SHARE ARC ELASTICITIES

Policies	PCSMALL	PCMEDIUM	PCLARGE
Petrol Price Present (26.9 cents)			
+ 25%	83	.005	-.33
+ 50%	.78	.60	-.34
+100%	.91	.69	-.49
Petrol Rationing 'Present' (80 l.p.w.)(a)			
60 litres per week	10.20	.11	-1.22
40 " " "	.99	-.45	-.39
20 " " "	.50	-.35	-.30
Inefficiency Tax Present (nil)(b)			
$50 p.a.	.22	.003	-.05
$100 p.a.	.43	.005	-.10
$200 p.a.	.61	.009	-.22
Tax Deductibility(c) Present (100%)			
75%	1.76	.43	-.34
50%	.56	.15	-.16
nil	.19	.004	-.05

(a) 80 litres per week is the actual average petrol consumption of the company cars in the present situation of no rationing.
(b) The arc elasticities with respect to the inefficiency tax can not be obtained from the base of 'the present' (which is nil and can not be divided with). Instead this is calculated for the middle of the arc.
(c) As the absolute value to the companies of the tax deductibility is not known, the elasticities with respect to this policy are calculated in terms of the raw percentages.

7.4.5 Price Elasticity of Demand for Petrol by Company Cars

On the basis of the predicted fleet-shares (Table 7-9), it is possible to gain rough estimates of the energy conservation implications of alternative policies. Clearly, the greater the shift to smaller more efficient cars, the greater will be the potential energy savings attainable by a given policy. The average annual petrol consumption for cars in each of the three size classes can be calculated from information on the average fuel economies and the average distances driven. The total annual petrol consumption by company cars in New South Wales can then be obtained by transforming the fleet-share figures into numbers of cars, multiplying the number of cars in each size category with the average annual petrol consumption for that class, and finally summing across the three size classes. In this way the total annual petrol consumption of company cars in New South Wales was estimated to be in the order of 544.9 million litres at present. The petrol saving attainable by a given policy is calculated as the difference between the total consumption at present and the total consumption under that policy.

The effects of increases in the price of petrol on the consumption of petrol were calculated, and elasticity estimates were derived. It was found that the price elasticity of demand for petrol by company cars is in the order of .08 at present, rising to .14 as petrol price increases up to 100 per cent. It is interesting to note that these estimates are of the same order of magnitude, and only slightly higher, than the ones obtained by Schou and Johnson (1979) in respect of the overall demand for petrol in Australia (see Section 2.2.1).

CHAPTER 8
SUMMARY AND CONCLUSIONS

The company car sector was identified as offering a considerable potential for the conservation of petroleum energy through changes to smaller more fuel-efficient cars. Company cars account for more than one-third of the new car market in Australia, and as much as 44 per cent of that market in New South Wales. It was proposed that company cars are generally larger and less fuel-efficient types of cars, travelling longer average distances and being replaced more frequently than the average for the total Australian car fleet.

The literature on the effects of energy problems and policies was examined with view to establishing the effects of different policies on the pattern of demand for cars. Four specific policies were selected for detailed study of their likely impacts on the size and composition of company car fleets. These policies were: i. increasing the price of petrol, ii. rationing the supply of petrol, iii. imposing a selective tax on cars below a certain fuel economy standard (10 kilometres per litre), and iv. reducing tax deductibility for cars which do not meet this standard.

The aims of the study were: i. to determine the likely impacts of the selected energy conservation policies on the size and composition of company car fleets, ii. to identify the effects of the characteristics of companies and fleets, and iii. to demonstrate the application of experimental design methods in economic research.

Given that the policies of interest are not presently applied, it is not possible to observe directly the policy responses relevant to assessing the impacts of the policies on company car fleets. The approach adopted in overcoming the problem involved the application of experimental design methods to the construction of policy scenarios which describe future situations in terms of combinations of the policies at various possible levels. The responses of companies to a range of such policy scenarios were sought in terms of the numbers of small, medium and large cars which companies would intend to keep in their fleets if circumstances were as described in the scenarios. Obtaining the policy responses in terms of absolute numbers of cars in the different size-classes allowed for the investigation of changes in overall demand for company cars as well as changes in the market shares.

The theoretical approach to the analysis of the policy responses was based on revealed preference theory. In order to accommodate the study of policy responses which can not be actually observed, the revealed preference approach was extended to encompass revealed intended behaviour. The theory of organisational behaviour was drawn upon to complement the revealed preference approach in the context where effective demand and decision making is exercised at an organisational level. Theoretical analysis was applied to derive predictions of policy responses and to establish detailed hypotheses for testing in the empirical research.

The approach of experimental design policy scenarios and intended behaviour responses provided an appealing framework for the study of the likely impacts of potential policies. Experimental design methods are relatively new to economics, and their application in the context of survey research is novel.

The intended behaviour responses to the policy scenarios were obtained in a survey of 1000 New South Wales companies. The survey also collected data on a variety of company and fleet characteristics which were hypothesised to have significant effects on the policy responses.

Preliminary to the policy impact analysis, the characteristics data were subjected to a detailed descriptive analysis. This analysis provided interesting background information on the company car sector, tested the introductory propositions about company cars, and provided a thorough understanding of the nature of the characteristics variables which constituted important inputs into the central policy impact analysis. It was confirmed that company cars are generally larger, less fuel-efficient types of cars, travelling longer average distances and being replaced more frequently than the average for the total Australian fleet. This evidence illustrates the energy conservation potential of the company car sector.

In respect of other characteristics it was found that the majority of company cars were purchased by the user company rather than leased, and that only a very small proportion were operated on fuels other than petrol. The companies, which represented the full range of industry types and company sizes, usually paid less than the retail price for petrol, and paid most of the fuel expenses for the company cars. Decisions in respect of company cars were generally made at a very high level in the management structure. A factor analysis, performed on the perceived importance of a wide range of purposes and features of company cars, showed that decision makers tend to perceive the purposes and features of field cars quite differently from those of management cars, and that in the latter case a distinction is made between status and 'perk' oriented variables, on the one hand, and operation and cost oriented variables, on the other.

The policy impact analysis generated the results in respect of the likely impacts of the energy conservation policies on the size and composition of company car fleets, and the effects of the characteristics of companies and fleets on the policy responses. Analysis of variance was applied in a preliminary examination of the responses to the policy scenarios, and multiple regression analysis was employed in the comprehensive analysis of policy impacts and characteristics effects.

It was found that the policy impacts on the size of company car fleets, and thus on the overall demand for company cars, would be negligible. However the impacts on the composition of demand would be substantial with companies changing to smaller more fuel-efficient cars. The impact of rationing was found to dominate the impacts of the price and tax policies at the levels of application specifically considered. The rationing would result in a very substantial shift away from large cars and (at its more severe levels) also some move out of the medium size category. The petrol price increases would cause the greatest increase in the fleet-share of medium size cars, but a relatively little increase in the share of small cars. The inefficiency tax would cause a greater shift from large cars to small ones than any of the other policies except for rationing. The resulting fleet-share of medium size cars would remain almost unchanged by the inefficiency tax. Finally, the tax deductibility reductions would induce some changes from large cars to small and medium size ones.

The analysis confirmed the importance of the effects of company and fleet characteristics on the policy responses. It was found that industry type and company size have highly significant effects on the propensity of companies to change to smaller cars. Thus companies in some sectors such as manufacturing, business and professional services, and community services are more likely to move to small cars than companies in rural and mining, finance and property, transport and communications, and building and construction. Companies in wholesale and retail are likely to change to medium size cars but not to small ones. Very large companies are the most inclined to change to small fleet cars, while medium size companies (of 50 to 99 employees) are the least inclined to do so.

In respect of other characteristics effects it was found that the propensity to change to smaller more fuel-efficient cars is greater for each of the following. (a) greater present proportions of small and medium size cars in a fleet; (b) lower ratio of management to field cars; (c) longer distances travelled, (d) higher present fuel efficiencies; (e) less usage of alternative fuels; (f) higher proportions of fuel expenses paid by the company; (g) more frequent replacement cycles; (h) lower proportions of fleet cars being leased and finally (i) greater perceived importance of operation and cost oriented attributes, and lesser perceived importance of status and perk oriented attributes.

The results of this study are expected to be of interest to both government and corporate policy makers. From the point of view of energy conservation policy, the results imply that increases in petrol prices, brought about through the oil parity pricing policy or by other means, will encourage some moves towards smaller more fuel-efficient cars. However a direct tax on cars which do not comply with a certain fuel economy standard would have far greater effects on fleet-shares. An annual inefficiency tax would be relatively easy to administer, for example though registration charges, and could readily be extended beyond company car fleets to apply to all inefficient cars. Selective reductions in tax deductibility for inefficient cars would encourage some changes to smaller cars. However differential rates of tax deductibility are likely to be more difficult to administer than a direct annual inefficiency tax. The rationing policy would be the most effective in inducing shifts to smaller cars. However rationing would involve some serious costs of disrupting the operation of companies and the whole economy, and such a policy is unlikely to be implemented except for situations of severe supply shortages.

In the area of corporate policy the study is of relevance to the efficient management of company car fleets under energy constraints, and it has important implications for the automobile industry faced with large potential shifts in the pattern of demand in a very important sector of the market.

APPENDIX A

SURVEY QUESTIONNAIRES AND LETTERS

Main Survey questionnaires
3 versions differing on question 13

Main Survey Cover Letter

Pilot Questionnaire;
2 versions differing on questions 11 and 12

TO THE GENERAL MANAGER OR A SENIOR EXECUTIVE
INVOLVED IN DECISION MAKING IN RESPECT OF COMPANY MOTOR VEHICLES

The following questions refer to cars and station wagons only
(please do not include utilities, panel vans or trucks)

1. How many cars plus station wagons are there in the company fleet? (please write the total number as of 30 June 1979) ____

2. How many of these vehicles belong to each of the 3 size classes indicated below?

Small: (Characterised roughly by: weight less than 1000 kg or engine size less than 1.8 litres, 4 cylinders, and fuel economy exceeding 10 kilometres per litre. For example: Toyota Corolla, Datsun 120Y, GMH Gemini, Ford Escort, Chrysler Galant) ____

Medium: (Characterised roughly by: weight of 1000 to 1200kg or engine size 1.8 to 2.5 litres, mostly 4 cylinders, and fuel economy in the range of 8 to 10 kilometres per litre. For example: Datsun 180B and 200B, Toyota Celica, Ford Cortina, GMH Torana(4), Chrysler Sigma) ____

Large: (Characterised roughly by: weight above 1200 kg or engine size above 2.5 litres, 6 or more cylinders, and fuel economy beneath 8 kilometres per litre. For example: GMH Commodore, Kingswood and Statesman, Ford Falcon and Fairlane, Chrysler Valiant and Regal, BMW, Jaguar, Mercedes, Volvo) ____

3. Within each size class, please classify the vehicles roughly into:

	Small	Medium	Large
a. Management or executive cars	____	____	____
b. Field or sales representative cars	____	____	____

4. What is the average distance driven per car per year (to the nearest thousand kilometres) by

a. Management of executive cars? ____000 km
b. Field or sales representative cars? ____000 km

5. What is the average fuel economy for

a. Management or executive cars? ___mpg or ____km/litre
b. Field or sales representative cars? ___mpg or ____km/litre

6. To what extent does the company cover fuel costs?
Please indicate below the number of Management Cars and Field Cars for which the company covers the stated percentage (or percentage range) of fuel costs

	Number of Management Cars	Number of Field Cars
0%	____	____
1% - 25%	____	____
26% - 50%	____	____
51% - 75%	____	____
76% - 99%	____	____
100%	____	____

7. How many of the company motor vehicles are presently run on LPG? ____
Diesel? ____

8. What is the average replacement cycle, in months, for

   a. Management or executive cars? ____
   b. Field or sales representative cars? ____

9. How are the cars and station wagons for the company fleet acquired? (please indicate the <u>number</u> of the present vehicles which were acquired by each of the following methods)

   a. purchase outright ____
   b. hire purchase ____
   c. lease ____

10. Below are listed some purposes and features which are thought to be relevant to decisions on the types of vehicles to be acquired for the company fleet. How important is <u>each</u> of these purposes and features to your company at present? Please indicate the importance for Management Cars and Field Cars, respectively, by assigning a number out of 1, 2, 3, 4, 5, where 1 indicates 'not important' and 5 indicates 'very important' as on the following scale:

not important 1 2 3 4 5 very important

a. <u>Purposes</u> of Company Motor Vehicles:

	Management Cars	Field Cars
Essential for conducting company business		
Provide employee transport		
Contact with customers		
Project company image		
Provide transport of suitable standard		
Fringe benefit		

Competitive necessity to attract and keep good staff

Tax savings

Part of remuneration package

Status symbol, sign of corporate success

b. Features of Company Motor Vehicles:

Fuel economy

Reliability

Comfort and performance

Safety

New car price

Size, number of seats

Maintenance and insurance costs

Suitable prestige value

Price and availability of spare parts

Resale value

11. How many employees in each of the following categories are given a choice of type of car?

	Choice within a specified range	Unrestricted choice
Senior executives	____	____
Middle managers	____	____
Junior executives	____	____
Sales representatives	____	____
Technicians, service staff	____	____

12. Who is involved in decision making in respect of company motor vehicles? Please rank those involved in the order of their importance in the decision making process (1 = most important)

Managing director
Board of directors
General manager
Chief accountant
Transport, purchase managers
Middle managers
Suppliers sale's consultant
Independent consultant
Company car users
Other, please specify

____

13. This question is of crucial importance to the study
Please consider your answers carefully

The question presents a number of energy policy scenarios which may become relevant to decision making in respect of company motor vehicles over the next five years or so. The scenarios have been simplified by including only four variables which are considered to be representative of the types of policies which may be introduced. These four variables are as follows:

Petrol price - where an increase in real terms of 25% is considered.

Petrol rationing - where rationing to 60 litres per week per car is considered.

Petrol inefficiency tax - which could be imposed annually on every car getting less than 10 kilometres per litre (10 km/L = 28.2 mpg), and which would not be tax deductible. This tax is considered at the level of $50 per year per car.

Tax deductibility provisions - which could be changed to allow full deduction of costs only for cars getting at least 10 kilometres per litre; for less fuel efficient cars it is considered that tax deductibility may be reduced to 75%.

(As a guide, the average fuel economy of some typical cars has been estimated in NRMA road tests as follows: Datsun 120Y - 12.9km/L, Chrysler Sigma Scorpion - 10km/L, GMH HZ Kingswood SL - 7.3km/L, Ford ZH Fairlane - 4.9km/L)

I would like you to respond to each of the scenarios below by indicating the number of vehicles which your company would most likely decide to have in each size class if circumstances were as described by that scenario. (Assuming that the activities of your company were otherwise unchanged).

The scenarios need to be considered in relation to the present situation as described in the first row of the table below. Please enter there the present petrol price to your company (in cent/litre and to one decimal place) and the size class composition of your fleet as of 30 June 1979. The size classes are the same as in Question 2.

SCENARIOS					NUMBER OF VEHICLES		
	Petrol Price	Rationing (litres per week)	Inefficiency Tax	Tax Deductibility	Small	Medium	Large
Present	_____	no limit	nil	100%	_____	_____	_____
1	+ 25%	no limit	$50	100%	_____	_____	_____
2	+ 25%	no limit	nil	75%	_____	_____	_____
3	present	no limit	$50	75%	_____	_____	_____
4	present	no limit	nil	100%	_____	_____	_____
5	+ 25%	60 litres	$50	75%	_____	_____	_____
6	+ 25%	60 litres	nil	100%	_____	_____	_____
7	present	60 litres	$50	100%	_____	_____	_____
8	present	60 litres	nil	75%	_____	_____	_____

13. This question is of crucial importance to the study
Please consider your answers carefully

The question presents a number of energy policy scenarios which may become relevant to decision making in respect of company motor vehicles over the next five years or so. The scenarios have been simplified by including only four variables which are considered to be representative of the types of policies which may be introduced. These four variables are as follows:

Petrol price - where an increase in real terms of 50% is considered.

Petrol rationing - where rationing to 40 litres per week per car is considered.

Petrol inefficiency tax - which could be imposed annually on every car getting less than 10 kilometres per litre (10 km/L = 28.2 mpg), and which would not be tax deductible. This tax is considered at the level of $100 per year per car.

Tax deductibility provisions - which could be changed to allow full deduction of costs only for cars getting at least 10 kilometres per litre; for less fuel efficient cars it is considered that tax deductibility may be reduced to 50%.

(As a guide, the average fuel economy of some typical cars has been estimated in NRMA road tests as follows: Datsun 120Y - 12.9km/L, Chrysler Sigma Scorpion - 10km/L, GMH HZ Kingswood SL - 7.3km/L, Ford ZH Fairlane - 4.9km/L)

I would like you to respond to each of the scenarios below by indicating the number of vehicles which your company would most likely decide to have in each size class if circumstances were as described by that scenario. (Assuming that the activities of your company were otherwise unchanged).

The scenarios need to be considered in relation to the present situation as described in the first row of the table below. Please enter there the present petrol price to your company (in cent/litre and to one decimal place) and the size class composition of your fleet as of 30 June 1979. The size classes are the same as in Question 2.

SCENARIOS					NUMBER OF VEHICLES		
	Petrol Price	Rationing (litres per week)	Inefficiency Tax	Tax Deductibility	Small	Medium	Large
Present	_____	no limit	nil	100%	_____	_____	_____
1	+ 50%	no limit	$100	100%	_____	_____	_____
2	+ 50%	no limit	nil	50%	_____	_____	_____
3	present	no limit	$100	50%	_____	_____	_____
4	present	no limit	nil	100%	_____	_____	_____
5	+ 50%	40 litres	$100	50%	_____	_____	_____
6	+ 50%	40 litres	nil	100%	_____	_____	_____
7	present	40 litres	$100	100%	_____	_____	_____
8	present	40 litres	nil	50%	_____	_____	_____

13. This question is of crucial importance to the study
Please consider your answers carefully

The question presents a number of energy policy scenarios which may become relevant to decision making in respect of company motor vehicles over the next five years or so. The scenarios have been simplified by including only four variables which are considered to be representative of the types of policies which may be introduced. These four variables are as follows:

Petrol price - where an increase in real terms of 100% is considered.

Petrol rationing - where rationing to 20 litres per week per car is considered.

Petrol inefficiency tax - which could be imposed annually on every car getting less than 10 kilometres per litre (10 km/L = 28.2 mpg), and which would not be tax deductible. This tax is considered at the level of $200 per year per car.

Tax deductibility provisions - which could be changed to allow full deduction of costs only for cars getting at least 10 kilometres per litre; for less fuel efficient cars it is considered that tax deductibility may be abolished (0%).

(As a guide, the average fuel economy of some typical cars has been estimated in NRMA road tests as follows: Datsun 120Y - 12.9km/L, Chrysler Sigma Scorpion - 10km/L, GMH HZ Kingswood SL - 7.3km/L, Ford ZH Fairlane - 4.9km/L)

I would like you to respond to each of the scenarios below by indicating the number of vehicles which your company would most likely decide to have in each size class if circumstances were as described by that scenario. (Assuming that the activities of your company were otherwise unchanged).

The scenarios need to be considered in relation to the present situation as described in the first row of the table below. Please enter there the present petrol price to your company (in cent/litre and to one decimal place) and the size class composition of your fleet as of 30 June 1979. The size classes are the same as in Question 2.

SCENARIOS					NUMBER OF VEHICLES		
	Petrol Price	Rationing (litres per week)	Inefficiency Tax	Tax Deductibility	Small	Medium	Large
Present	____	no limit	nil	100%	____	____	____
1	+100%	no limit	$200	100%	____	____	____
2	+100%	no limit	nil	0	____	____	____
3	present	no limit	$200	0	____	____	____
4	present	no limit	nil	100%	____	____	____
5	+100%	20 litres	$200	0	____	____	____
6	+100%	20 litres	nil	100%	____	____	____
7	present	20 litres	$200	100%	____	____	____
8	present	20 litres	nil	0	____	____	____

14. Which industry group does your company predominantly belong to?

Rural and Mining	1
Manufacturing	2
Building and Construction	3
Wholesale and Retail	4

15. What is the size of your company in terms of the number of employees in NSW?

Less than 20	1
20 - 49	2
50 - 99	3
100 - 499	4

Transport and Communication	5	500 - 999	5
Finance and Property	6	1000 or more	6
Business and Professional Services	7		
Community Services and Entertainment	8		

COMMENTS RELATING TO THE SURVEY TOPIC (for example, what, if anything, has your company done or considered doing in order to control the fuel costs of operating the company fleet in view of rapidly escalating petrol prices?)

FEEDBACK

If you are interested in receiving a summary of the findings of this study in due course (about December) or if you might like to attend a seminar to discuss the study at Kuring-gai College of Advanced Education in October, you may provide your name, position, company name, address and phone number in the space below. Please note that this is entirely optional.

THANK YOU VERY MUCH FOR YOUR PARTICIPATION

Please return the completed form in the attached stamped and addressed envelope to:

Miss Kirsten Schou
'Project Energy and Transport'
Department of Economic Studies
Kuring-gai College of Advanced Education
Box 222 PO
LINDFIELD NSW 2070

To the General Manager

Dear Sir,

I would like to invite the participation of your company in a survey on energy constraints and the company car.

In view of rapidly escalating petrol prices and possible supply shortages in the years to come, and given the fact that a substantial proportion of petroleum consumed in this country is consumed by the motor car, it is of some interest and importance to study how automobile owners are likely to be affected by energy constraints.

Company ownership of motor cars constitutes an important share of total car ownership and a very significant share of the new car market. Therefore this study is concerned with the likely impact of energy constraints, and of government policies to deal with these, on decisions in respect of company motor vehicles. I expect that the results may be of interest and use to your company.

Your company has been selected from a listing of business firms operating in New South Wales. Any information provided will be kept strictly confidential and used for research and statistical purposes only. Please note that I do not require your name or the name of your company to be stated on the survey form unless you are interested in receiving a summary of the research findings in due course, or if you might be interested in attending a seminar which will be held at Kuring-gai College of Advanced Education in October to discuss the study.

If you do not feel that you have the time to complete the survey form yourself, I would like you to delegate this to someone in your organisation who is involved in decision making in respect of company motor vehicles.

I would very much appreciate the assistance of yourself or your delegate in completing the form and returning it to me in the enclosed addressed and stamped envelope before Friday, 27 July.

If you would like any further information you may telephone me on (02) 439-7147 or leave a message on (02) 467-9397.

Yours sincerely,

Kirsten Schou
Department of Economics

TO THE MANAGING DIRECTOR

Section 1

This section contains a number of questions relating mainly to company motor vehicles.

1. Which industry group does your company mainly belong to?

Agriculture and Forestry	1
Mining	2
Manufacturing	3
Electricity, gas and water	4
Building and Construction	5
Wholesale and Retail	6
Transport and Communication	7
Finance and Property	8
Community Services and Entertainment	9
Other (please specify)	0

____

2. Size of company in terms of number of employees in NSW

Less than 20	1
20-49	2
50-99	3
100-499	4
500-999	5
1000 or more	6

3. Location of company head office.

Sydney Metropolitan Area	1
Newcastle or Wollongong	2
elsewhere in NSW	3
outside NSW	4
outside Australia	5

THE FOLLOWING QUESTIONS REFER TO CARS AND STATION WAGONS ONLY.
PLEASE DO NOT CONSIDER UTILITIES, PANEL VANS OR TRUCKS.

4. How many cars and station wagons are there in the company fleet? (eg, if there are 10 cars and 40 station wagons write 50).

____

5. How many of these vehicles belong to each of the following size classes?

Small light	Light medium
Corolla 1200	Alfasud
Datsun 120Y	Audi Fox
Escort	Celica 1600
Fiat 127	Corona/Celica 2000
Galant	Centura
Lancer	Cortina 4
Gemini	Cortina 6
Torana	Datsun 180B
Honda Civic 1200	Fiat 128
Honda Civic 1500	Mazda RX2/RX3/1600
Leyland Mini	Mazda 929/121
Mazda 1300/808	Renault 15/16/17
Renault 12	Torana 6
Subaru	Torana 8
VW 1.6 Litre	Passat 1.6 Litre
VW Golf	Others
... Total Small Light	... Total Light Medium

Large	Luxury
Datsun 240K	Alfetta/2000/Montreal
Datsun 260C/260Z	BMW
Falcon 6	Fiat 124/130
Falcon 8	Fiat 132
Fairlane	Ford Ltd/Landau
Holden 6	Jaguar/Daimler
Holden 8	Lancia
Statesman	Mercedes 230/240/250/280
Mazda RX4	Mercedes 350/450/600
Toyota Mk II	Peugeot
Crown Custom/Super	Rover
Triumph 2500/Dol/Sprt	Saab
Valiant 6	Triumph Stag
Valiant 8	Volvo 242/244/245
Chrysler	Volvo 264
	Others
... Total Large	... Total Luxury

6. How many of the cars and station wagons in the fleet are usually garaged at company premises over night?

______

7. How many of the cars and station wagons in the fleet are assigned (allocated) to one individual employee and usually garayed at a private address?

______

8. Of the following general categories of employees please indicate roughly the percentage which presently has company cars allocated and the number of cars which are allocated in each category.

	percentage of employees	number of cars
Senior executives	______	______
Middle managers	______	______
Junior executives	______	______
Sales representatives	______	______
Others (please specify)		
______ ________		

9. How many employees in these categories are given a choice in remuneration between a car or a higher salary

Senior executives	____
Middle managers	____
Junior executives	____
Sales representatives	____
Others	____

10. How many employees in these categories are given a choice of

	make of car	model of car
Senior executives	______	______
Middle managers	______	______
Junior executives	______	______
Sales representatives	______	______
Others	______	______

11. The purposes served by company motor vehicles have been suggested to include the following. How important is each of these purposes (and any others which you may care to add) to your company at present? Please indicate the importance for Management cars and Field cars respectively by assigning a number out of 1, 2, 3, 4, 5, where 1 indicates 'not important' and 5 indicates 'very important' as on the following scale:

not important	1	2	3	4	5	very important

	Management cars	Field cars
Provide employee transport	______	______
Project company image	______	______
Part of remuneration package	______	______
Competitive necessity (to attract and keep good staff)	______	______

Reward for good service	______	______
Status symbol sign of corporate success	______	______
Other please specify	______	______
______________	______	______
______________	______	______

9. How many employees in these categories are given a choice in remuneration between a car or a higher salary?

Senior executives	______
Middle managers	______
Junior executives	______
Sales representatives	______
Others	______

10. How many employees in these categories are given a choice of

	make of car	model of car
Senior executives	______	______
Middle managers	______	______
Junior executives	______	______
Sales representatives	______	______
Others		

11. What are seen as the main purposes served by company motor vehicles in your organisation?

12. The following list contains some features of motor vehicles which are thought to be important to companies in deciding on the types of vehicles to be acquired for the company fleet. How important is each of these features (and any others which you may care to add) to your company at present? Please indicate the importance for Management cars and Field cars respectively by assigning a number out of 1, 2, 3, 4, 5, where 1 indicates 'not important' and 5 indicates 'very important' as on the following scale:

not important	1	2	3	4	5	very important

	Management cars	Field cars
Resale value	________	________
Fuel economy	________	________
Comfort	________	________
Performance	________	________
Number of seats	________	________
New car value	________	________
Maintenance, Insurance cost	________	________
Other (please specify)	________	________

____

____

13. Are there any other important considerations for determining the composition of the fleet as between different types of vehicles, or for determining company policy on motor vehicles in general?

14. How are cars and station wagons for the company fleet acquired? Please indicate the number of cars which were acquired by each method:

purchase outright ________

hire purchase ________

lease without maintenance ________

fully serviced lease ________

other, please specify ________

12. Please list the characteristics or features of company motor vehicles which are considered as important to your company in deciding on the types of vehicles to be acquired respectively for:

management cars field cars

13. Are there any other important considerations for determining the composition of the fleet as between different types of vehicles, or for determining company policy on motor vehicles in general?

14. How are cars and station wagons for the company fleet acquired? Please indicate the number of cars which were acquired by each method:

purchase outright	________
hire purchase	________
lease without maintenance	________
fully serviced lease	________
other, please specify	________

15. What is the discount which the company usually obtains on the various size classes of cars? (size classes as in question 5 and discount to the nearest whole percent)

	discount
small	________%
medium	________%
large	________%
luxury	________%

16. What is the average replacement-cycle, in months, of:

a. Management or executive cars ________

b. Field or sales representatives ________

17. What percentage of repair and maintenance costs is presently covered by the company?

a. Management or executive cars ________%

b. Field or sales representatives cars ________%

18. Is there a charge for parking vehicles at the place of employment during working hours?

yes	1
no	2

18a. If 'yes' does the company cover this parking charge for employees?

yes, fully	1
yes, partially	2
no	3

19. To what extent does the company cover fuel costs? Please indicate below the number of Management cars and Field cars for which the company covers the stated percentage (range) of fuel costs

	Management cars	Field cars
0%	________	________
1%-25%	________	________
26%-50%	________	________
51%-75%	________	________
76%-99%	________	________
100%	________	________

20. Does your company have fuel available on company premises in the form of a

petrol pump?	yes	1	-	no	2
diesel pump?	yes	1	-	no	2
LPG supply?	yes	1	-	no	2

20a. If the company does have a petrol pump, what is the current cost of petrol from the pump?

________cent/litre

21. What was the annual fuel cost to the company of running the fleet in the latest financial year for which figures are available?

$________

21a. What was the closing date of the financial year used above? (eg if June 1978, write 0678)

____

22. What was the approximate annual fuel consumption of the fleet of cars and station wagons in that year? Please estimate to nearest thousand.

______000litres

23. What was the average distance driven in that year (to the nearest thousand kilometres) by

   a. Management or executive cars ________000 kilometres

   b. Field or sales representatives cars ______000 kilometres

24. What is the average fuel economy (in whole numbers) for

   a. Management cars _____ km/L or _____mpg

   b. Field or sales representatives cars _____ km/L or _____mpg

25. Are any of the company motor vehicles run on fuel other than petrol?

yes	1
no	2

25a. If yes, how many vehicles are run on

Diesel	________
LPG	________
other (please specify)	________

26. Has the company considered converting (further) part(s) of the fleet to run on alternative fuels?

yes	1
no	2

26a. If 'yes', please detail

27. What, if anything, has the company done/is considering doing to control fuel costs of operating the fleet in view of rapidly escalating petrol prices?

Section 2

This section contains a number of hypothetical decision scenarios which may become relevant to decisions in respect of company motor vehicles over the next decade or so.

The scenarios have been simplified by including only 3 variables:

1. petrol price - where increases in real terms of 20 per cent, 50 per cent and 100 per cent are considered

2. petrol availability - which may be:
   easy - as we are used to
   moderate - sporadic shortages at petrol stations, average queuing time 10 minutes
   difficult - widespread shortages, average queuing time 30 minutes.

3. A 'petrol-guzzler tax' - which would be imposed annually on every car getting less than 10 km/L (28.2 mpg), and which would not be tax deductible for the company. Such a tax is considered at \$20 p.a., \$50 p.a., \$100 p.a., per car.

(As a guide the average fuel economy of some typical cars has been estimated as follows: Corolla SE-12.3km/L; Capella 4 door-12.3km/L; Cortina 4 door L-10.5km/L; Kingswood - 9.1km/L; Fairlane 500-6.0km/L).

In view of the present composition of your company's fleet of cars and station wagons between the four size classes in Question 5, I would like you to respond to the following hypothetical decision scenarios by indicating the composition of fleet which your company would most likely adopt if circumstances were as indicated in each scenario.

The scenarios need to be considered in relation to the present situation which may be described by: (please fill in missing information)

Present petrol price to your company?	______cent/litre
Present petrol availability	easy
Present 'petrol guzzler-tax'	none

Present composition of fleet as indicated in question 5, as percentage of fleet (to nearest whole per cent)

small	medium	large	luxury
____%	____%	____%	____%

Scenarios				% Composition of Fleet			
	Petrol Price Increase	Avail-ability	'Guzzler Tax' per car	small	medium	large	luxury
1	50%	moderate	$50	____	____	____	____
2	50%	difficult	$20	____	____	____	____
3	50%	easy	$100	____	____	____	____
4	100%	moderate	$100	____	____	____	____
5	100%	difficult	$50	____	____	____	____
6	100%	easy	$20	____	____	____	____
7	20%	moderate	$20	____	____	____	____
8	20%	difficult	$100	____	____	____	____
9	20%	easy	$50	____	____	____	____

General comments on survey topic or survey form

Feedback

If you are interested in receiving a summary of the findings of this study in due course (about December) or if you would not mind me possibly getting in touch with you about the survey, you may if you wish provide your name, position, company name, address and phone number in the space below. Please note that this is entirely optional.

THANK YOU VERY MUCH FOR YOUR PARTICIPATION

Please return the form to Miss Kirsten Schou
Project Energy and Transport
Department of Economic Studies
Kuring-gai College of Advanced Education
Box 222
Lindfield 2070 NSW

APPENDIX B

SAMPLE VALIDATION

Industry type and company size provided the only characteristics which could be compared with any existing population data. Access was gained to information on the industry type classifications of industrial companies listed on the Sydney Stock Exchange in 1974 (data collected for the CODAT data base, Hall 1975). This data allowed for some comparison of industry type distributions of companies, although the population of listed industrial companies differed in a number of ways from the sampling population. Thus for example mining companies are not listed with the industrials, and companies involved in finance and property tend to be relatively over-represented in the Stock Exchange Listing. The industry classification of the listed companies were summarised into industry groups comparable with the sample grouping. The percentage of companies in each industry group is shown in Table B-1 for the sample and for the listed companies.

TABLE B-1 - INDUSTRY TYPE DISTRIBUTIONS OF THE COMPANIES IN THE SAMPLE COMPARED WITH THE COMPANIES IN THE INDUSTRIALS LISTING OF THE SYDNEY STOCK EXCHANGE IN 1974

Industry Groups	Percentage of Companies in the sample(a)	Percentage of Listed Companies
Rural and Mining	5.6	2.2
Manufacturing	44.8	43.7
Building and Construction	6.8	4.9
Wholesale and Retail	20.2	10.9
Transport and Communication	6.1	6.9
Finance and Property	5.6	23.0
Business and Professional Services	9.7	6.7
Community Services and Entertainment	1.2	1.7
Numbers of Companies	216	870

(a) Compared with the figures presented in table 6-1 the sample percentages have been adjusted to add up to 100 by dividing each percentage with 1.148.

In the case of most of the industry groups the sample percentage is of a similar order of magnitude to the percentage of listed companies. Where considerable disparities occur (as in the cases of rural and mining, finance and property and wholesale and retail) these appear to be accounted for by the differences between the sampling population and the population of listed companies.

The available evidence indicates that the companies in the sample represent the full range of industry types in the underlying population of New South Wales companies. Furthermore the sample proportions of companies in the different industry groups appear to be representative of the corresponding population proportions.

Information on the numbers of New South Wales manufacturing establishments in various size classes is provided by the Australian Bureau of Statistics (ABS 1969, 1978). There are however a number of problems which prevent any direct comparison of these figures with the sample data. ABS statistics relate only to manufacturing establishments while the sample covers the full range of industry types. Some difficulties in comparison also arise from the fact that the ABS size groupings are less detailed than the ones employed in the present study. Thus the most up-to-date ABS figures (June 1978) provide no size-class breakdown for companies employing more than 100 people. The ABS figures for 1969 do provide a more detailed classification of large establishments, but on the other hand they provide less detailed breakdown of small establishments (and it is also difficult to ascertain the extent to which these figures have become outdated).

Another difficulty which obstructs the comparison of the size class distributions of companies in the sample with the ABS statistics is that the latter are based on 'establishments', which means that they include entities which are not companies and therefore not strictly part of the sampling population. The inclusion of establishments which are not companies is likely to increase the proportion of entities in the smallest size-categories. Given, furthermore, that the sampling population excluded companies employing less than ten people one would expect that the proportion of companies in the smallest size-groups would be much lower in the sample than in the population of enterprises. Conversely the sample proportions of larger companies would be expected to be consistently higher than the corresponding establishment proportions. These expectations are confirmed by comparison of the figures presented in table B-2.

TABLE B-2 - COMPANY SIZE DISTRIBUTION IN THE SAMPLE COMPARED WITH ESTABLISHMENT SIZE DISTRIBUTION IN THE POPULATION

Size of Company or Establishment	Percentage of Companies or Establishments		
	Companies in the Sample	Establishments 1969	Establishments 1978
Less than 10	-	56.4	45.6
10-19	-	-	21.8
10-49	-	31.1	-
Less than 20	25.0	-	
20-49	15.3	-	17.0
50-99	14.3	5.8	7.2
100-499	29.2	5.8	-
500-999	7.9	.5	-
1000 or more	8.3	.3	-
100 or more	-	-	8.4

The population statistics required for an accurate evaluation of the degree of sample representativeness do not exist, however the information at hand does not suggest any significant differences between the companies in the sample and those in the relevant study population. This in turn allows valid generalisation of the study results from the sample to the population.

APPENDIX C

CONTENT ANALYSIS OF RESPONDENTS' COMMENTS

In the survey questionnaire respondents were invited to comment on the survey topic and to describe what, if anything, their companies had done or were considering doing in order to control the fuel costs of operating the company fleet in view of rapidly escalating petrol prices. The responses provided to these open ended questions contained a great variety of interesting information. As a means of summarising this information an informal content analysis was undertaken. The individual statements were categorised into four groups relating to: i. Cars and Engines, ii. Fuels, iii. Usage Administration and iv. 'Miscellaneous'. Within each group similar statements were classed together and their frequencies recorded. The results of this informal content analysis are presented below:

<u>Cars and Engines</u>	Frequency
. Change to four cylinder vehicles from six to eight cylinders	20
. Move to smaller vehicles	18
. Deleted V-8 vehicles	8
. Presently conducting studies of the economics of small vs large cars	5
. Move from large to medium sized vehicles	4
. Change fleet from 4 medium and 21 large vehicles to 19 medium and 6 large	1
. Move from 5.8 litre V8's and 4.2 litre 6's to 2.2 and 2 litre vehicles	1
. Using medium sized vehicles only	2
. Move from medium to small vehicles	1
. Change to vehicles with better miles per gallon ratio	2
. Field cars only changed to four cylinders	5
. Smaller cars for sales representatives when carrying size is not essential	4

. Changed to four cylinders five years ago for city representatives but not country representatives	1
. Limited engine capacity to 3.3 litres for representatives and 4.2 litres for executives	1
. Limited engine capacity to 4.3 litres	1
. Limit 6's to 3.3 litres except for executives	1
. Encourage executives to move from 6 cylinders to 4 cylinders by offering airconditioning	1
. Turbo-charging four cylinder vehicles for senior management	1
. Change from GMH to Toyota, except for top management	1
. Changed from Chargers to Coronas	1
. Sold Mercedes Benz and bought Honda Prelude	1
. Sold Ford Fairlane at loss and purchased Peugeot	1
. Half the fleet changed to four cylinder vehicles and the others converted to LPG	1
. Sold old V6s and purchased new V8s (as they give better efficiency)	1
. Prestige vehicles give acceptable economy (18-25 mpg) as well as low maintenance costs and high efficiency in relation to five passengers	1
. Have considered small vehicles but the low resale value of larger cars has made it uneconomical	1
. Presently using large cars rather than small ones because of better financial terms	1
. Consider present fleet cars to be medium and not large and find them most economical especially on long trips	1
. Small cars are not as comfortable on long trips	1
. Large cars are necessary for carrying stock on field trips	1
. Vehicles are essential and policy would only change from larger cars if there was rationing	2
. Field vehicles are a necessary part of business and it is very difficult to cut back mileage	1
. Reduced fleet size	2

Fuels

. Converted vehicles to LPG	5
. Considering conversion to LPG	14
. Current study of possibility of converting to LPG CNG or electric cars	4
. LPG was shown to be unsuitable through study as conversion costs are high and its availability limited	4
. LPG should be more readily available and the initial conversion cost reimbursed	1
. Will use LPG when available	1
. LPG is not practical for the older yard vehicles, but may cease the pilfering of petrol	1
. Changed to Compressed Natural Gas (CNG)	1
. Considering CNG	1
. Trucks converted to diesel	1
. Considering diesel	1
. Considering electric vehicles	1
. Converting cars to run on lower octane petrol	1
. Install 2000 gal petrol tanks on company premises	1
. Introduction of own petrol bowsers and direct supply from oil companies	1

Usage and Administration of Fleets

. Revision of sales representatives routes and delivery routes	9
. Rescheduling of sale cycles	1
. Consider more telephone selling	1
. Eliminate unproductive and unprofitable cars	1
. Utilise courier services	1
. Reallocate service staff closer to home	1
. Tighter control and restrictions on private use of vehicles	5

. Eliminate free week-end petrol for sales representatives	1
. Fixed petrol allowance	1
. Incentive schemes for reduced petrol consumption	4
. Employees to pay petrol costs for their own usage	3
. Employees to pay all petrol costs	1
. Employees have choice of car or a fixed car allowance	3
. Greater use of public transport, particularly during petrol strikes	1
. Lack of reliable public transport prevents reducing the number of cars in fleet	1
. More attention to car maintenance	3
. Constant review of cost control procedures	1

Miscellaneous

. Current fuel expenses are a relatively insignificant cost, thus it is the availability of fuel that affects policy formulation	5
. Fuel costs are becoming as important as vehicle prices although safety and comfort are necessary considerations	4
. Restrictions on mobility are more important than high mileage	2
. Envisage no problems	1
. Company car problems avoided as executives lease vehicles from their own family companies	2
. Re-examine executive remuneration package	2
. Executive remuneration packages dictated by market and difficult to change	2
. Company supplies materials to GMH, Ford and Chrysler and therefore chooses cars from these three manufacturers	1
. Considering deleting power steering and air conditioning	1
. Considering modifications to pollution control equipment	2
. Evaluating electronic ignition systems	1

- Purchasing vehicles with better carburation 1
- Will review situation when replacement is due 1

BIBLIOGRAPHY

Aigner D.J. (1979a)
'A brief introduction to the methodology of optimal experimental design' Journal of Econometrics vol II no 1 pp7-26.

Aigner D.J. (1979b)
'Sample design for electricity pricing experiments: Anticipated precision for a time-of-day pricing experiment' Journal of Econometrics vol II no 1 pp195-211.

Aigner D.J. and Morris C.N. (1979)
Editors' Introduction to Special Issue on Experimental Design in Econometrics Journal of Econometrics vol II no 1 p1-5.

Albertson L.A. (undated)
Telecommunications as a Travel Substitute, Some psychological, Organisational and Social Aspects, Telecommunication Society of Australia, NSW Monograph No. 8.

Alchian A.A. (1953)
'The meaning of utility measurement' American Economic Review vol 43 no 1 pp26-50.

Alchian A.A. and Allen W.R. (1964)
Exchange and Production : Competition, Coordination and Control, Wadsworth Publishing Company, Belmont, California.

American Marketing Association (1977)
Special Issue: Recent Developments in Survey Research Journal of Marketing Research vol 14 August.

Arrow K.J. (1951a)
Social Choice and Individual Values, Wiley, New York.

Arrow K.J. (1951b)
'Alternative approaches to the theory of choice in risk-taking situations' Econometrica vol 19 no 4 pp404-437.

Arrow K.J. (1958)
'Utilities, attitudes, choice: a review note' Econometrica vol 26 pp1-26.

Australian Bureau of Statistics (1969)
Manufacturing Establishments, Selected Items of Data, Canberra, June.

Australian Bureau of Statistics (1978)
Census of Manufacturing Establishments, Canberra, June, Ref. no. 8203.1

Australian Bureau of Statistics (1980)
Survey of Motor Vehicle Usage, Australia. Twelve months ended 30 September 1979 (Preliminary), Canberra, September, Ref. no. 9202.0.

Australian Bureau of Statistics (1971 to 1980)
Motor Vehicle Registrations, Canberra, annual.

Australian Institute of Management (1979)
National Executive Salary Survey, Australian Institute of Management, an annual survey.

Australian Institute of Petroleum Ltd. (1980a)
Oil and Australia, the Figures behind the Facts, An Annual Publication.

Australian Institute of Petroleum Ltd. (1980b)
Petroleum Gazette, Monthly Magazine of the Oil Industry.

Australian Transport Advisory Council (1978)
Transport and Energy Overview, Commonwealth/State Transport Secretariat, Dept. of Transport, Canberra, Sept. 26.

Baumol W.J. (1959)
Business Behaviour, Value and Growth, Macmillan, New York.

Baumol W.J. (1965)
Economic Theory and Operations Analysis, Prentice Hall, Englewood Cliffs, New Jersey.

Becker B.W., Brown D.J. and Schary P.B. (1976)
'Behaviour of car owners during the gasoline shortage', Traffic Quarterly vol 30 pp469-483.

Becker G.M., De Groot M.H. and Marschak J. (1963)
'Stochastic models of choice behaviour' Behavioural Sciences vol 8 pp41-55.

Becker G.S. (1962)
'Irrational behaviour and economic theory' Journal of Political Economy vol 70 no 1 pp1-13.

Becker G.S. (1965)
'A theory of the allocation of time' The Economic Journal vol 75 pp493-517.

Becker G.S. and Michael R.T. (1973)
'On the new theory of consumer behaviour' Swedish Journal of Economics Dec. pp378-396.

Berle A.A. and Means G.C. (1932)
The Modern Corporation and Private Property, Harcourt, Brace & World, New York. (rev. ed. 1967).

Bernoulli D. translation from Latin by Sommer L. (1954)
'Exposition of a new theory of the measurement of risk' Econometrica vol 22 no 1.pp23-36.

Blaug M. (1964)
Economic Theory in Retrospect, Heinemann, London. (Second Edition 1968) Chapter 9 'Marshallian economics: utility and demand'.

Blomqvist A.G. and Haessel W. (1978)
'Small cars, large cars, and the price of gasoline' Canadian Journal of Economics vol 11 no 3.

Brög W. and Neumann K.H. (1978)
The interviewee as a human being: A critical contribution to the discussion of methods in empirical social research, Social data, Munich, West Germany.

Brown A. and Deaton A. (1972)
'Models of consumer behaviour: a survey' Economic Journal vol 82.

Brown R.V. (1967)
'Evaluation of total survey error' Journal of Marketing Research vol 4 pp117-127.

Chaffin M. and Hollywood D.H. (1976)
Forecasting car ownership, The Shell Company of Australia Ltd., Head Office, Melbourne.

Charles River Associates (1976)
Price Elasticity of Demand for Transportation Fuels, Report prepared by Charles River Associates (Cambridge, Massachusetts) for the Office of Transportation Research, Federal Energy Administration, Washington, D.C.

Chelson M. (1975)
'Improving Automobile Fuel Efficiency: The Impacts on Industry and the Economy' Proceedings - Sixteenth Annual Meeting Canadian Transportation Research Forum TRF XVI (I) pp16-26.

Christie B. (1974)
Telecommunication: An alternative to the business trip, Communications Studies Group, University College London and London School of Economics (unpublished).

Claffey P.J. (1977)
Passenger Car Fuel Conservation, USA National Technical Information Service, PB 265369.

Cochran W.G. and Cox G.M. (1957)
Experimental Designs, John Wiley & Sons, New York (2nd Edition).

Conlisk J. and Watts H. (1979)
'A model for optimising experimental designs for estimating response surfaces' Journal of Econometrics vol 11 no 1 pp27-42.

Cooke P.N.C. (1978)
The Company Car, Gower Press.

Cot D.R. (1958)
Planning of Experiments John Wiley, New York.

Cyert R.M. and March J.G. (1963)
A Behavioural Theory of the Firm, Prentice-Hall, Englewood Cliffs, New Jersey.

Davidson D., Suppes P. and Siegel S. (1957)
Decision-Making: An Experimental Approach, Stanford University Press.

Day L.H. (1973)
'An assessment of travel/communications substitutability' Futures October pp559-572.

Deaton A. and Muellbauer J. (1980)
Economics and Consumer Behaviour, Cambridge University Press.

Deming W.E. (1960)
Sample Design in Business Research, John Wiley & Sons, New York.

Difiglio C. (1975)
'Analysis of fuel economy excise taxes and rebates' Special Report 169 Transportation Research Board, Washington.

Dixon W.J. and Brown M.B. eds (1979)
BMDP - 79, Biomedical Computer Programs P-Series, University of California Press.

Dyckman R.R. and Salomon R. (1972)
'Empirical utility functions and random devices: an experiment' Decision Sciences vol 3 no 1 pp1-13.

Economic Research Unit (1975)
Energy and Transport in Australia 1975-2005 A report prepared for the Commonwealth Bureau of Roads, Melbourne, June.

Edwards W. (1954)
'The theory of decision making' in Edwards, W. and Tversky, A. Eds. (1967) Decision Making, Penguin.

Edwards W. (1961)
'Behavioural decision theory' in Edwards, W. and Tversky, A. Eds. (1967) Decision-Making, Penguin.

Edwards W. and Tversky A. (Eds) (1967)
Decision Making, Penguin.

Emery F.E. ed. (1969)
Systems Thinking, Penguin.

Endersbee L.A. (1979)
'The transport fuel dilemma, patterns of consumption we cannot sustain', Search vol 10 no 1-2.

Energy Authority of New South Wales (1979)
Report on Energy Conservation in Motor Vehicles, ISBN 0-7240-4883-g, September.

Erdos P.L. with Morgan A.J. (1970)
Professional Mail Surveys, McGraw-Hill.

Erlbaum N.S., Hartgen D.T. and Cohen G.S. (1977a)
'Automotive energy forecasts: impact of price, availability and efficiency', Planning Research Unit Preliminary Research Report 133, New York, Department of Transportation, Albany.

Erlbaum N.S., Cohen G.S. and Hartgen D.T. (1977b)
'Automotive energy forecasts: impact of carpooling, trip chaining, and auto ownership', Preliminary Research Report 134, Planning Research Unit, New York State Department of Transportation, Albany, December.

Esso Australia (1980)
Australian Energy Outlook, An Esso Report.

Farrell M.J. (1954)
'The demand for motor-cars in the United States', Journal of the Royal Statistical Society Series A vol 117 no 2 pp171-193.

Federal Chamber of Automotive Industries (1978)
Uniform Code of Practice for Passenger Car Fuel Consumption Reduction Joint Statement by the Minister for Transport P.J. Nixon and the Minister for National Development K.E. Newman. Canberra, 4 July.

Ferber R. (1973)
'Consumer economics: a survey' Journal of Economic Literature vol 11 no 4 pp1303-1342.

Ferber R. and Hirsch W.Z. (1979)
'Social experimentation and economic policy' Journal of Econometrics vol 11 no 1 pp77-116.

Filmer R. and Talbot S. (1975)
'Long run and short run models of motor vehicle demand', Fifth Conference of Economists, Brisbane, August.

Fishburn P.C. (1964)
Decision and Value Theory, John Wiley, New York.

Fishburn P.C. (1970)
Utility Theory for Decision Making, John Wiley, New York.

Ford Sales Company of Australia Ltd. (1980)
Data released in private communication with the Manager for Special Markets.

Franzen R. and Lazersfeld P.F. (1945)
'Mail questionnaire as a research problem' Journal of Psychology, vol 5 no 20 p317.

Friedman M. and Savage L.J. (1948)
'The utility analysis of choices involving risk' Journal of Political Economy vol 56 pp279-304.

Galbraith J.K. (1967)
The New Industrial State, Penguin.

Galbraith J.K. (1975)
Economics and the Public Purpose, Penguin.

Gale D. (1960)
'A note on revealed preference' Economica vol 27.

Georgescu-Roegen N. (1950)
'The theory of choice and the constancy of economic laws' Quarterly Journal of Economics vol 64 pp125-138.

Georgescu-Roegen N. (1954)
'Choice, expectations, and measurability' Quarterly Journal of Economics vol 68 pp503-34.

Gershynu J. (1976)
'The choice of scenarios' Futures December.

Green H.A.J. (1971)
Consumer Theory, Penguin.

Gremion C. (1972)
'Towards a new theory of decision making?' International Studies of Management and Organisation, Summer.

Hahn G.J. and Shapiro S.S. (1966)
A Catalog and Computer Program for the Design and Analysis of Orthogonal Symmetric and Asymmetric Fractional Factorial Experiments, Information Science Laboratory Technical Report No. 66-C-165, General Electric Company, Corporate Research and Development, Schenectady, New York.

Hall C.B. (1980)
Information derived from the CODAT Data Base, private communication, December.

Hamilton R.B. (1978)
'Mobility and the individual' Paper presented to Society for Social Responsibility in Science National Conference on Energy and People - Social Implications of Different Energy Futures, Canberra 7-9 Sept. 1978.

Hartgen D.T. (1975)
Individual Travel Behaviour under Energy Constraints Preliminary Research Report 86, Planning Research Unit, New York State Department of Transportation, Albany, July.

Hays W.L. (1963)
Statistics for Psychologists, Holt, Rinehart and Winston.

Henderson J.M. and Quandt R.E. (1958)
Microeconomic Theory, McGraw-Hill New York.

Henley J. (1976)
'Response rate to mail questionnaires with return deadline' Public Opinion Quarterly vol 40 no 3 pp374-375.

Hensher D.A. and Louviere J. (1979)
'Behavioural intentions as predictors of very specific behaviour' Transportation vol 8 pp167-182.

Hicks J.R. (1946)
Value and Capital, Oxford University Press.

Hicks J.R. (1956)
A Revision of Demand Theory, Oxford University Press Oxford.

Hirst E. (1976)
'Transportation energy conservation policies' Science vol 192.

Horowitz A.J. (1978)
'The subjective value of time spent in travel' Transportation Research vol 12 pp385-393.

Houthakker H.S. (1950)
'Revealed preference and the utility function' Economica vol 17 no 66 pp159-74.

Industries Assistance Commission (1974)
Passenger Motor Vehicles, Etc. IAC Canberra July.

Institution of Engineers, Australia (1977)
Recommendations for An Energy Policy for Australia Including the Working Papers of the Task Force on Energy discussed at the Conference on Energy, Canberra July 1977, Special Publication, October 1977.

Jones W.H. (1979)
'Generalising mail survey inducement methods: population interactions with anonymity and sponsorship' Public Opinion Quarterly vol 43 no 1 pp102-111.

Juster F.T. (1970)
'Microdata, economic research, and the production of economic knowledge' American Economic Review Papers and Proceedings vol 60 no 2 pp138-148.

Katona G.K. (1953)
'Rational behaviour and economic behaviour' Psychological Review vol 60 pp307-318.

Keck C.A., Earlbaum N.S., Milic P.L. and Trentacoste M.F. (1974)
Changes in Individual Travel Behaviour during the Energy Crisis, 1973-74 Preliminary Research Report 67, Planning Research Unit, New York State Department of Transportation, Albany, August.

Keeney R.L. and Raiffa H. (1976)
Decisions with Multiple Objectives Preferences and Value Tradeoffs, John Wiley and Sons, New York.

Kelejian H.H. and Oates W.E. (1974)
Introduction to Econometrics, Principles and Applications, Harper International Edition, Harper & Row.

Kerlinger F.N. and Pedhazur E.J. (1973)
Multiple Regression in Behavioural Research, Holt Rinehart and Winston, New York, London, Sydney.

Kimball A.E. (1961)
'Increasing the rate of return in mail surveys' Journal of Marketing vol 25 no 6 pp63-64.

Kirkwood T.A. and Lee A.D. (1975)
A Generalised Model for Comparing Automobile Design Approaches to Improved Fuel Economy. Rand Corporation, California, January.

Kish L. (1967)
Survey Sampling, John Wiley and Sons New York.

Klein L.R. (1953)
A Textbook of Econometrics, Row, Peterson and Co., Evanstan.

Kneebone D.C. and Wilkins J.K. (1977)
'Energy conservation and transport'. Report of Working Party 9 of the Task Force on Energy in Recommendations for an Energy Policy for Australia Institution of Engineers, Australia, Special Publication, October.

KOMPASS Business Directory Vol 2 (1979)
Sponsored by Australian Chamber of Commerce, Confederation of Australian Industry, Metal Trades Industry of Australia. Approved by the Department of Trade and Resources, and the Department of Industry and Commerce. Published by Peter Isaacson Publications Pty. Ltd., Victoria.

Koo A.Y.C. (1963)
'An empirical test of revealed preference theory' Econometrica vol 31 no 4 pp646-664.

Koo A.Y.C. and Hasenkamp G. (1972)
'Structure of revealed preference: some preliminary evidence'. Journal of Political Economy vol 80 no 4 pp724-743.

Koo A.Y.C. and Schmidt P. (1974)
'Cognitive range in the theory of revealed preference' Journal of Political Economy vol 82 pp174-179.

Kozmetsky G. et. al. (1978)
'Impacts of an auto-weight limitation on energy, resources and the economy'. Policy Sciences vol 9 no 1 pp97-120.

Kuh E. and Meyer J.R. (1955)
'Correlation and regression estimates when data are ratios' Econometrica vol 23 pp400-416.

Kuhn T. (1962)
Structure of Scientific Revolutions University of Chicago Press.

Kulash D.J. (1975)
'Forecasting Long-run automobile demand', Special Report 169 Transportation Research Board, Washington.

Lancaster K.J. (1966a)
'Change and innovation in the technology of consumption' American Economic Review vol 56 no 2 pp14-23.

Lancaster K.J. (1966b)
'A new approach to consumer theory' Journal of Political Economy vol 74 no 2 pp132-57.

Lancaster K.J. (1971)
Consumer Demand, A New Approach, Columbia University Press, New York and London.

Lane J.E. (1977a)
Some possible implications of rising petroleum fuel prices for road transport, Australian Road Research Board, Report AIR 000-69.

Lane J.E. (1977b)
Petrol prices, vehicle usage and road user charges, Australian Road Research Board, Report AIR 000-90.

Latsis S.J. (ed.) (1976)
Method and Appraisal in Economics, Cambridge.

Lave C.A. and Train K. (1978)
A Disaggregate Model of Auto-Type Choice Transportation Research Fall/Winter.

Lave C.A. (ed.) (1980)
'Automobile choice and its energy implications' (Special Issue) Transportation Research vol 14a nos 5-6.

Leach G. (1973)
'The impact of the motor car on oil reserves' Energy Policy vol 1 no 3 pp195-207.

Lerman S.R. and Ben-Akiva M. (1976)
Disaggregate behavioural model of automobile ownership Transportation Research Record 569.

Lesourne J. (1977)
A Theory of the Individual for Economic Analysis vol 1 North-Holland Publishing Company.

Linsky A. (1975)
'Stimulating responses to mailed questionnaires: a review' Public Opinion Quarterly vol 39 no 1 pp82-101.

Little I.M.D. (1949)
'A reformulation of the theory of consumer's behaviour' Oxford Economic Papers vol 1.

Loasby B.J. (1976)
Choice, Complexity and Ignorance: An Inquiry into Economic Theory and the Practice of Decision Making, Cambridge Univerity Press, Cambridge.

Lopez D.A. and Gray P. (1977)
'The substitution of Communication for Transportation: a case study' Management Science vol 23 no 11 pp1149-1160.

Louviere J.J. and Levin I.P. (1978)
'Functional measurement analysis of spatial and travel behaviour', Advances in Consumer Research vol 5 Illinois: Association for Consumer Research.

Louviere J.J. and Baker J. (1979)
Assessing Trade-offs in Plan Evaluation: A Behavioural Approach, Technical Report 108, Institute of Urban and Regional Research University of Iowa.

Louviere J.J., Wilson E.M. and Piccolo J.M. (1977)
Applications of psychological measurement and modelling to behavioural transport demand analysis, Research paper 2, Institute for Policy Research, University of Wyoming.

Louviere J.J. and Hensher D.A. (1981)
Demand for International Air Travel: Behavioural Models of Preferences and Choices with Particular Emphasis on the Impact of Alternative Fare Structures, Bureau of Transport Economics, Occasional Paper (forthcoming).

Luce R.D. (1959)
Individual Choice Behaviour, John Wiley & Sons, New York.

Luce R.D. and Raiffa H. (1957)
Games and Decisions: Introduction and Critical Survey John Wiley & Sons, New York.

Lutin J.M. (1976)
'Energy savings for work trips: analysis of alternative commuting patterns for New Jersey' Transportation Research Record 561 pp23-36.

Machlup F. (1967)
'Theories of the firm: marginalist, behavioural, managerial' American Economic Review vol 57 no 1 pp1-33.

Maddala G.S. (1977)
Econometrics, McGraw-Hill.

Manning I. (1978)
'The price of petrol and future urban transport' Paper presented at Urban Research Unit Seminar, Australian National University.

Manning W.G. Jr, Mitchell B.M. and Acton J.P. (1979)
'Design of the Los Angeles peak-load pricing experiment for electricity' Journal of Econometrics vol 11 no 1 pp131-194.

March J.G. and Simon H.A. (1958)
Organisations, Wiley, New York.

March J.G. and Olsen J.P. eds. (1976)
Ambiguity and Choice in Organisations, Bergen Universitetsforlaget.

March J.G. (1978)
'Bounded rationality, ambiguity, and the engineering of choice' The Bell Journal of Economics vol 6 no 2.

Marris R.L. (1964)
The Economic Theory of 'Managerial' Capitalism, Macmillan, London.

Marshak S. (1975)
'Response of Automotive Market to Energy Saving Ideas' Special Report 169 Transportation Research Board, Washington, pp12-13.

Marshall A. (1920)
Principles of Economics, Macmillan, 8th Edition.

McDonell J.S. and Defris L.V. (1976)
'Demand for new motor vehicles - using Australian consumer sentiment measures to explain and predict consumer behaviour' Australian Economic Review no. 36 pp56-64.

McGillivray R.G. and Kemp M.A. (1974)
'Alternative Strategies for Reducing Gasoline Consumption by Private Automobiles' Transportation Research vol 8 pp349-361.

McGillivray R.G. and Olsson M.L. (1975)
Estimates of Automobile Gasoline Savings Due to Some Conservation Strategies Working Paper 1216-5, October 1975 The Urban Institute, Washington.

McGillivray R.G. (1976)
'Gasoline use by automobiles' Transportation Research Record 561.

McKitterick T.E.M. (1974)
'The effect of energy price changes on transport' National Westminster Bank Quarterly Review August p49-60.

Mehring J. (1976)
'Potential Effect of Transport Fuel Price Increases on Energy Consumption' Proceedings - Seventeenth Annual Meeting Canadian Transportation Research Forum XVII(1) p1-6.

Milic P.L. (1974)
Changes in Individual Travel Behaviour during the Energy Crisis, 1973-74. with Keck C.A., Earlbaum N. and Trentacoste M.F.: Preliminary Research Report 67, Planning Research Unit, New York State Department of Transportation, Albany, August.

Miller G.A. (1956)
'The magical number seven, plus and minus two: some limits on our capacity for processing information' Psychological Review vol 63 pp81-97.

Mishan E.J. (1961)
'Theories of consumer behaviour: a cynical view' Economica N.S. vol 28 pp1-11.

Miyazaki T. (1977)
Urban Transport Options for Energy Conservation Unpublished consultant's report written for the OECD - Group of Experts on Traffic Policies for the Improvement of the Urban Environment. Paris, December.

Mogridge M.J.M. (1978)
'The effct of the oil crisis on the growth in the ownership and use of cars' Transportation vol 7 no 1 pp45-68.

Monsen J. Jr and Downs A. (1965)
'A theory of large managerial firms' Journal of Political Economy vol 73 pp227-236.

Morris C. (1979)
'A finite selection model for experimental design of the Health Insurance Study' Journal of Econometrics vol 11 no 1 pp43-62.

Moser C.A. and Kalton G. (1972)
Survey Methods in Social Investigation, Heinemann Educational Books Limited, London.

Mosteller F. and Nogee P. (1951)
'An experimental measurement of utility' Journal of Political Economy vol 59 no 5 pp371-404.

Munro J.M. and Constable G.A. (1974)
'Energy Use in Canadian Transportation: The Patterns of Future Adjustment' Proceedings - Fifteenth Annual Meeting Canadian Transportation Research Forum XV(1) pp589-602.

Ramsey J., Rasche R. and Allen B. (1975)
'An analysis of the private and commercial demand for gasoline' Review of Economics and Statistics vol 57 no 4 pp502-507.

Nakamura M., Uemura T., Nishi T. and Shiomi N. (1977)
'A system analysis of effectiveness of energy saving measures in transport' in Visser E.J. (ed) Transportation Decisions in an Age of Uncertainty, Martinus Nighoff, The Hague.

Namboodiri N.K. (1972)
'Experimental designs in which each subject is used repeatedly' Psychological Bulletin vol 77 no 1 pp54-64.

National Energy Advisory Committee (1978)
Proposals for An Australian Conservation of Energy Program NEAC Report No. 1 Australian Government Publishing Service, Canberra, September.

National Energy Advisory Committee (1979)
Efficient use of Liquid Fuels in Road Vehicles NEAC Report No. 8, Australian Government Publishing Service, Canberra, July.

National Roads and Motorists Association, NRMA (1979)
The Open Road, Sydney, June.

New South Wales Department of Motor Transport (1979)
Figures released in private conversation with the Assistant Superintendent of the Management Services Banch of NSW DMT.

Newhouse J.P. et. al. (1979)
'Measurement issues in the second generation of social experiments: The Health Insurance Study' Journal of Econometrics vol 11 no 1 pp117-130.

Nicholas Clark & Associates (1975a)
Transport & Energy in Australia, Part 1 - Review Report prepared for the Bureau of Transport Economics, Occasional Paper No. 2, Australian Government Publishing Service, Canberra, June.

Nicholas Clark & Associates (1975b)
Transport & Energy in Australia Part 2 - Consumption by Categories Report prepared for the Bureau of Transport Economics, Occasional Paper No. 4, Australian Government Publishing Service, Canberra, August.

Nicosia F.M. (1969)
Consumer Decision Processes, Prentice-Hall, Englewood Cliffs, New Jersey.

O'Flaherty C.A. (1977)
'Energy, technology and movement' in Resolving Conflicts in Transport, Chartered Institute of Transport, Australian Council Melbourne.

O'Muircheartaigh C.A. and Payne C. (1977)
The Analysis of Survey Data, Vol 1 Exploring Data Structures; vol 2 Model Fitting, John Wiley & Sons.

Orcutt G.H. (1964)
Data Needs for Computer Simulation of Large-Scale social systems, Proc. of the Conf. on Computer Methods in the Analysis of Large-Scale Social Systems, Joint Center for Urban Studies, Mass. Institute of Technology and Harvard University, Cambridge Mass.

Orcutt G.H. (1970)
'Basic data for policy and public decisions: technical aspects. Data, research and Government' American Economic Review Papers and Proceedings vol 60 no 2 pp132-137 May.

Orcutt G.H., Watts H.W. and Edwards J.B. (1968)
'Data aggregation and information loss' American Economic Review vol 58 pp773-787.

Organisation for Economic Cooperation and Development (1977)
Energy Problems and Urban and Suburban Transport Road Research Programme, Report of Research Group T12, OECD, Paris, April.

Orski C.K. (1974)
'The potential for fuel conservation: the case of the automobile' Transportation Research vol 8 pp247-258.

Penrose E.T. (1959)
The Theory of the Growth of the Firm Blackwell, Oxford.

Peskin R.L., Schofer J.L. and Stopher P.R. (1975)
The Immediate Impact of Gasoline Shortages on Urban Travel Behaviour US Department of Transportation, April.

Pfanzagl J. (1965)
'A general theory of measurement - application to utility' in Luce R.D., Bush R.R. and Galanter E. (eds) Readings in Mathematical Psychology, Vol II, John Wiley; New York & Sydney.

Pisarski A.E. and DeTerra N. (1975)
'American and European transportation responses to the 1973-1974 oil embargo' Transportation vol 4 pp291-312.

Radford K.J. (1975)
Managerial Decison Making, Reston Publishing Company, Reston Virginia.

Richter M.K. (1966)
'Revealed preference theory' Economica vol 34.

Rivett B.H.P. (1975)
'Behavioural problems of utility theory' in White D.J. and Bowen K.C. (eds) The Role and Effectiveness of Theories of Decision in Practice, Hodder and Stoughton, London; and Crane, Russab & Co. Inc. New York.

Rivlin A.M. (1974)
'Allocating resources for policy research: How can experiments be more useful?' American Economic Review vol 64 no 2 pp346-354.

Robson D.S. (1959)
'A simple method for constructing orthogonal polynomials when the independent variable is unequally spaced' Biometrics June pp187-191.

Roscoe J.T. (1975)
Fundamental Research Statistics for the Behavioural Sciences, second edition, International Series in Decision Processes, Holt, Rinehart and Winston, New York, Sydney.

Saaty T.L. (1977)
'Scenarios and priorities in transport planning: application to the Sudan' Transportation Research vol 11 Pp343-350.

Sacco J.F. and Hajj H.M. (1976)
'Impact of the energy shortage on travel patterns and attitudes' Transportation Research Record 561 Pp1-11.

Samuelson P.A. (1938)
'A note on the pure theory of consumer's behaviour' Economica vol 5.

Samuelson P.A. (1947)
Foundations of Economic Analysis, Harvard.

Samuelson P.A. (1948)
'Consumption theory in terms of revealed preference' Economica vol 15 N.S. pp243-253.

Samuelson P.A. (1950)
'The problem of integrability in utility theory' Economica vol 17 pp355-385.

Samuelson P.A. (1952)
'Probability, utility and the independence axiom' Econometrica Oct. pp670-78.

Samuelson P.A. (1967)
'Problems of methodology' American Economic Review vol 53 no 2 pp231-237.

Savage L.J. (1954)
The Foundations of Statistics Wiley.

Schilderinck J.H.F. (1977)
Regression and Factor Analysis in Econometrics, Martinus Nijhoff Social Sciences Division, Leiden, The Netherlands.

Schipper L. (1976)
'Another look at energy conservation' American Economic Review Papers and Proceedings of 91st meeting, May.

Schou K. (1979a)
'Energy and transport: strategies for energy conservation in urban passenger transport' Environment and Planning A vol 11 no 7 pp767-780.

Schou K. (1979b)
'Transport energy issues: evaluation of conservation measures' Fifth Australian Transport Research Forum, Planning Transport - Issues & Myths, Forum Papers, Sydney, April.

Schou K. and Johnson L.W. (1979)
'The short-run price elasticity of demand for petrol in Australia' International Journal of Transport Economics vol 6 no 3 pp357-364.

Scott C. (1961)
'Research on mail surveys' Journal of the Royal Statistical Society vol 124 pp143-205.

Seidel M.R. (1978)
'Gas-saving taxes: a comparison' Resources and Energy vol 1 no 1 pp93-107.

Sen A.K. (1970)
Collective Choice and Social Welfare, Holden-Day, San Francisco.

Sen A.K. (1971)
'Choice functions and revealed preference' Review of Economic Studies vol 38.

Sen A.K. (1973)
'Behaviour and the concept of preference' Economica vol 40 pp241-259.

Shepherd A. (1976)
The Urban Transport Problem, Notes from a seminar given at the University of NSW on 28 September (Faculty of Arts Seminar).

Shinnar R. (1975)
'The Effect of the Energy Crisis on the Private Car in the US' Transportation Research vol 9 no 2/3 pp87-95.

Simon H.A. (1945)
Administrative Behaviour, A Study of Decision-Making Processes in Administrative Organisation; The Free Press, Macmillan. Third Edition 1976.

Simon H.A. (1955)
'A behavioural model of rational choice' Quarterly Journal of Economics vol 59 pp99-118.

Simon H.A. (1956)
'Rational Choice and the structure of the environment' Psychological Review vol 63 pp129-139.

Simon H.A. (1957a)
Models of Man, Social and Rational, John Wiley & Sons Inc. New York.

Simon H.A. (1957b)
'The compensation of executives' Sociometry vol 20 pp32-55.

Simon H.A. (1960)
The New Science of Management Decision Making Revised Edition 1977, Prentice-Hall, Englewood Cliffs, New Jersey.

Simon H.A. (1965)
'The new science of management decision' in Welsch L.A. and Cyert R.A. (eds) (1970) Management Decision Making, Penguin, pp13-29.

Simon H.A. (1966)
'Theories of decison-making in economics and behavioural science', Surveys of Economic Theory 3, American Economic Association and Royal Economic Society, Macmillan.

Simon H.A. (1976)
'From substantive to procedural rationality' in Latsis S.J. (ed.) Method and Appraisal in Economics, Cambridge.

Simon H.A. (1978a)
'On how to decide what to do' The Bell Journal of Economics vol 6 no 2.

Simon H.A. (1978b)
'Rationality as a process and as product of thought' American Economic Review vol 68 no 2 pp1-16.

Skinner L.E. (1975)
The Effect of Energy Constraints on Travel Patterns: Gasoline Purchase Study, US Department of Transportation, July.

Slutsky E.E. (1915)
'On the budget of the consumer', reprinted in Readings in Price Theory, (American Economics Association), Irwin.

Stearns M.D. (1976)
'The Behavioural Impacts of the Energy Shortage: Shifts in Trip-making Characteristics', Transportation Research Record 592.

Swalm R.O. (1966)
'Utility theory - insights into risk taking' Harvard Business Review vol 44 pp123-136.

Tanner J.C. (1974)
Forecasts of Vehicles and Traffic in Great Britain, Department of the Environment, London.

Taylor D.W. (1965)
'Decision making and problem solving' in Welsch, L.A. and Cyert R.A. (eds) 1970. Management Decision Making Penguin.

Thomson J.M. (1973)
The Limitation of the Use of Cars in Urban Areas, Organisation for Economic Co-operation and Development, Paris.

Transportation Research Board (1975)
Strategies for Reducing Gasoline Consumption through Improved Motor Vehicle Efficiency, Special Report 169, Transportation Research Board, Washington.

Transportation Research Board (1977)
Energy Effects, Efficiencies, and Prospects for various Modes of Transportation, National Cooperative Highway Research Program, Synthesis of Highway Practice 43 Washington D.C.

Tulpule A.H. (1975)
Forecasts of Vehicle Ownership and Traffic in Australia, Working Paper, Commonwealth Bureau of Roads, Melbourne, April.

Tversky A. (1967)
'Additivity, utility and subjective probability' Journal of Mathematical Psychology vol 4 no 2 pp175-202.

US Federal Energy Administration (1974)
Project Independence Report on Energy Conservation: Transportation Sectors. Prepared by Interagency Taskforces for the FEA, Washington, November.

von Neumann J. and Morgenstern O. (1944)
Theory of Games and Economic Behaviour, Princeton University Press, Princeton. (Second edition 1947).

Walizer M.H. and Wienir P.L. (1978)
Research Methods and Analysis - Searching for Relationships, Harper & Row, Publishers Inc., New York.

Watson J.J. (1965)
'Improving the response rate on mail research' Journal of Advertising Research vol 5 no 2 pp48-50.

Welsch L.A. and Cyert R.M. (eds.) (1970)
Management Decision Making, Penguin.

White D.J. and Bowen K.C. (eds.) (1975)
The Role and Effectiveness of Theories of Decision in Practice Hodder and Stoughton, London; and Crane, Russak & Co. Inc. New York.

Whorf R.P. (1975)
Policy-Oriented Modelling of new Automobile Sales and Fuel Consumption, Special Report 169, Transportation Research Board, Washington.

Wildhorn S. et. al. (eds.) (1974)
How to Save Gasoline: Public Policy Alternatives for the Automobile Rand Corporation, R-15-60-NSF, Ballinger Publishing Company, Cambridge, Mass.

Williamson O.E. (1963)
'A model of rational managerial behaviour' in Cyert R.M. and March J.G. (eds) A Behavioural Theory of the Firm, Prentice-Hall, Englewood Cliffs, New Jersey.

Williamson O.E. (1964)
The Economics of Discretionary Behaviour: Managerial Objectives in a Theory of the Firm, Prentice-Hall, Englewood Cliffs, New Jersey.

Williamson O.E. (1967)
The Economics of Discretionary Behaviour, Markham, Chicago.

Winer B.J. (1962)
Statistical Principles in Experimental Design, McGraw-Hill, New York.

Wonnacott T.H. and Wonnacott R.J. (1972)
Introductory Statistics for Business and Economics, Wiley International Edition, John Wiley & Sons.

Wykoff F.C. (1973)
'A user cost approach to new automobile purchases' Review of Economic Studies vol 40 no 123 pp377-390.

Yates F. (1965)
Sampling Members for Census and Surveys, Griffen and Company, London.