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# Transport and Road Research Laboratory

Department of Transport

# Effect of prices on petrol and diesel sales in Kenya

by M A Cundill

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# EFFECT OF PRICES ON PETROL AND DIESEL SALES IN KENYA

by

M A Cundill

## INTRODUCTION

Increases in oil prices since 1973 have had a serious effect on the economies of many developing countries which are dependent upon imported fuels. During 1981 and 1982, a study was carried out by the Overseas Unit of TRRL, working in collaboration with the Ministry of Transport and Communications of the Republic of Kenya, to examine a number of policies for conserving fuel in the transport sector. This report describes the part of that study which examined the effect of price on sales of petrol and light diesel fuel.

## ANALYSES

Simple linear and logarithmic models were used to relate petrol and diesel sales to price, GDP and time. Figures 2 and 4 taken from the report show movements of the variables during this period.

## DISCUSSION AND CONCLUSIONS

For the period 1972–1981, it was found that diesel and petrol sales could be related to time or GDP, but that the GDP relationship was the more stable. For petrol, the elasticity with respect to GDP was 1.24 and for diesel it was rather higher at 1.41.

Petrol price appeared to have a small influence on sales and the best value for the short-term elasticity was around −0.1. For diesel, no significant effect of price on sales could be detected. Petrol price elasticity appeared to be lower (in absolute terms) than in the developed country studies reviewed by Bland (1984). The absence of any observed price response for diesel coincides with Oldfield's findings (1980) on the price elasticity of travel per lorry in the United Kingdom.

One possible explanation for these results is that only privately-owned vehicles are sensitive to fuel price in the short term. It may be that the price elasticity for petrol is somewhat smaller than in most developed countries because privately-owned vehicles account for a smaller proportion of sales. Similarly, the lack of price response for diesel could have arisen because most diesel is sold to company-owned vehicles.

It is to be expected that in the long term, price elasticities will be higher as other changes, especially in the vehicle fleet, occur. Studies carried out elsewhere have suggested higher long-term values, but the time taken to realise these long-term changes could be many years, and one cannot draw any firm conclusions on such long-term changes from the data analysed in this study.

In the short term, adjusting petrol and diesel prices by fuel taxation appears to be an effective way of collecting Government revenue but an ineffective way of regulating fuel sales.

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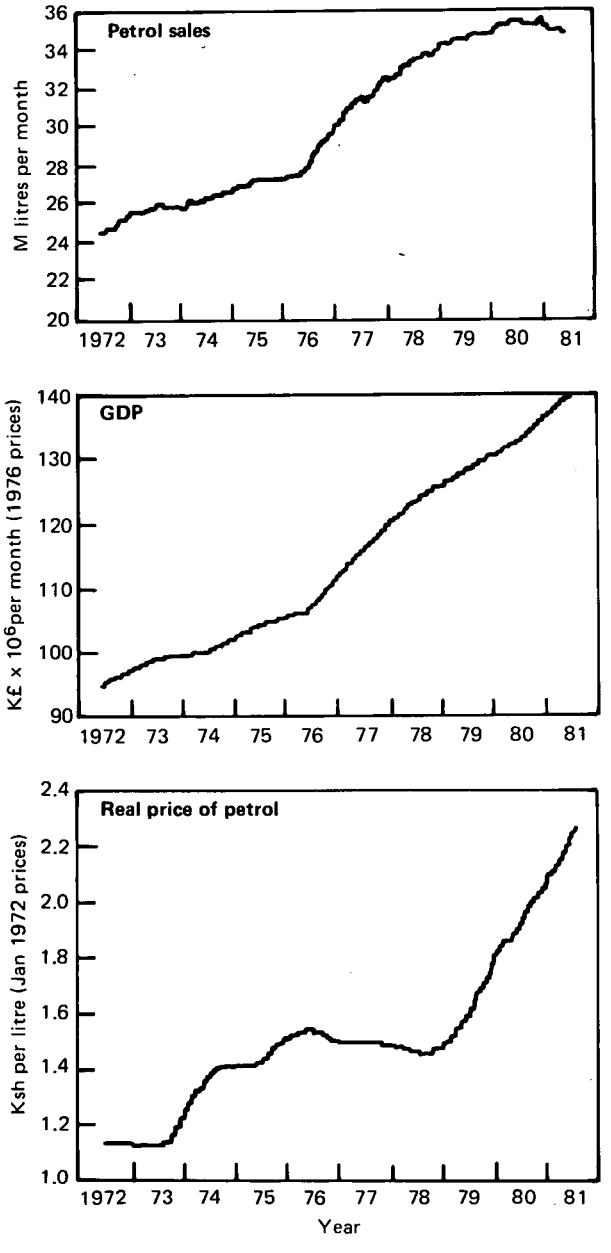


**Fig. 2 Trends in petrol sales, GDP and petrol price**

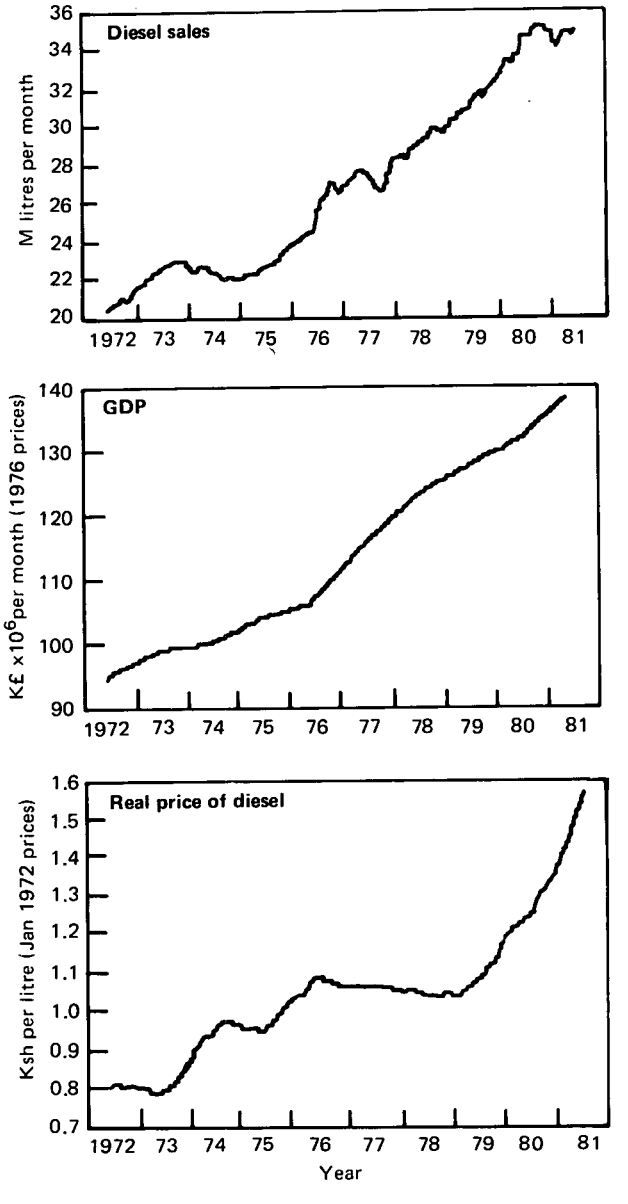


**Fig. 4 Trends in diesel sales, GDP and diesel price**

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**TRANSPORT AND ROAD RESEARCH LABORATORY**
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## RESEARCH REPORT 49

# EFFECT OF PRICES ON PETROL AND DIESEL SALES IN KENYA

**by M A CUNDILL**

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# EFFECT OF PRICES ON PETROL AND DIESEL SALES IN KENYA


## ABSTRACT

To assess the effectiveness of fuel pricing as a means of controlling fuel sales in Kenya, time series analyses were carried out to quantify the effect that changes in price have had on sales of petrol and light diesel fuel between 1972 and 1981. While sales of both products correlated well with time or GDP, it was found that a GDP-based model gave more consistent results and that price had only a small effect on sales. Short-term price elasticity appeared to be around −0.1 for petrol and close to zero for diesel. The difficulty of measuring long-term price elasticity is discussed. It is concluded that taxing fuel is an effective way of collecting revenue but an ineffective way of controlling fuel sales in the short term.


## 1 INTRODUCTION

Increases in oil prices since 1973 have had a serious effect on the economies of developing countries, such as Kenya, which are dependent upon imported fuels. In 1981, over 40 per cent of export earnings were spent on oil imports and the resultant strain on foreign exchange is one of the most serious problems currently facing the economy. Of the oil products consumed domestically, over a half is used by road transport, which is a considerably higher proportion than one would find in most developed countries. The equivalent figure for countries of the EEC, for example, is only 26 per cent (World Bank 1982).

During 1981 and 1982, a study was carried out by the Overseas Unit of the Transport and Road Research Laboratory, working in collaboration with the Ministry of Transport and Communications of the Republic of Kenya, to examine a number of policies for conserving fuel in the transport sector. This report describes a part of that study which examined the effect of price on sales of petrol and light diesel fuel (hereafter referred to simply as diesel).

In a situation where the growth of fuel costs is causing concern, regulation of sales by adjusting the price appears an attractive proposition, especially when compared with alternatives such as fuel rationing, or allowing pumps to run dry. Studies of more developed countries have shown that the short-term price elasticity of demand for petrol is typically around −0.3 (Bland 1984) and for diesel is close to zero (Oldfield 1980). If values are low, then pricing is an attractive way of raising revenue, but an ineffective way of regulating demand.

However it does not necessarily follow that fuel price elasticities will be similar in less developed countries, where fleet mixes and ownership patterns are different and the financial strain of running a vehicle is likely to be more onerous for the average car owner or lorry operator. Relatively little information exists on price elasticities for such countries and hence this analysis was carried out to see what could be deduced from recent time series data on the prices and sales of petroleum products in Kenya.

The analyses presented here were based on data published in the Kenya Statistical Digest (CBS 1973–1983A) and Statistical Abstract (CBS 1973–1983B), supplemented by additional statistics provided by Kenya Shell Ltd and Caltex Ltd.

## 2 BACKGROUND

In Kenya, petrol and diesel fuels are marketed by six major international oil companies—Agip, Caltex, Esso, Mobil, Shell and Total. The companies are free to compete with each other, but the prices of the petroleum products are fixed by Government. They vary slightly from area to area as allowance is made for the cost of inland distribution. All the analyses presented in this report are based on Nairobi fuel prices.

Table 1 shows the price breakdown for diesel and the two grades of petrol, 'premium' and 'regular', in December 1982. Of the total pump price, Government tax accounted for just over 40 per cent for petrol and just under 30 per cent for diesel.

**TABLE 1**

Petrol and diesel price breakdown (Dec. 1982) expressed as a percentage of the Nairobi pump prices

| | Premium Petrol | Regular Petrol | Diesel |
|---|---|---|---|
| Inbound price | 51 | 51 | 62 |
| Tax and duty | 42 | 41 | 29 |
| Inland transport cost | 4 | 4 | 5 |
| Retail margin | 4 | 4 | 5 |
| Pump price† | 100 | 100 | 100 |

Source: Kenya Shell Ltd

†Pump prices in Kenya shillings per litre:
Premium Ksh 8.0, Regular Ksh 7.52, Diesel Ksh 5.48.

Note: Kenyan currency is similar to British pre-decimal currency with one Kenyan pound worth twenty Kenyan shillings. During the study period, the Kenyan pound was worth about 15 per cent more than the pound sterling at official exchange rates.

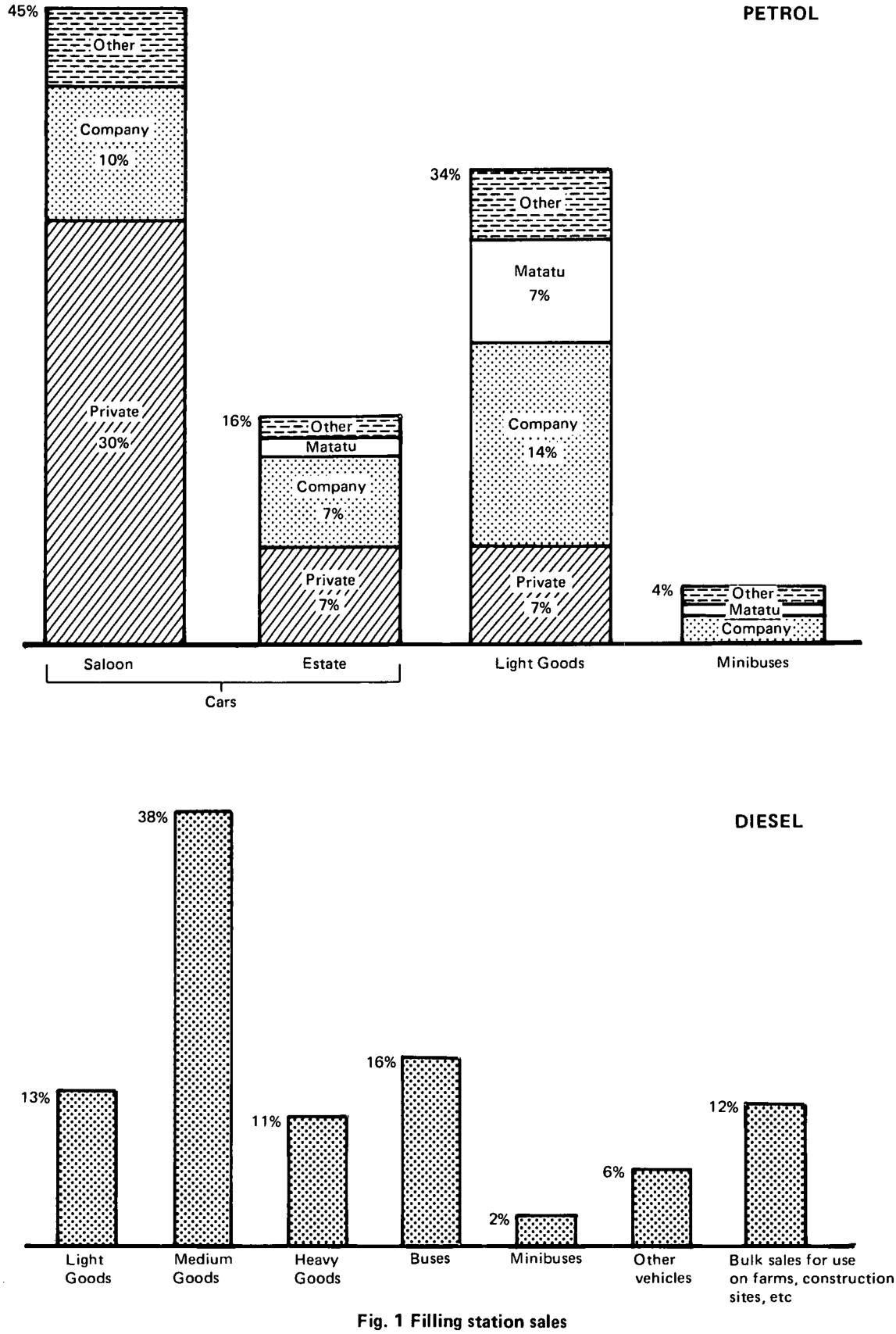


**Fig. 1 Filling station sales**

As an indication of the proportion of petrol and diesel consumed by different types of vehicle and different types of owner, Figure 1 gives the results of a small survey of fuel sales carried out at several filling stations. Filling stations account for about 85 per cent of total petrol sales but only 45 per cent of total diesel sales. The remainder are mostly bulk purchases by large consumers.

According to the Figure, cars accounted for about 60 per cent of petrol consumption and light goods vehicles 34 per cent. Light goods vehicles, however, also accounted for about 13 per cent of diesel consumption; hence, although published data existed on the number of licenced cars and light goods vehicles, it was not possible to determine the total number of petrol or diesel-consuming vehicles.

It is interesting to note that less than half (44 per cent) of petrol sales were to privately-owned vehicles. Company-owned vehicles consumed 33 per cent, matatus (vehicles intermediate between a taxi and a bus used for carrying fare-paying passengers) consumed 10 per cent and other categories (Government, diplomatic, hired vehicles, etc) 12 per cent.

Turning to diesel, the most important vehicle category was 'medium goods', that is, two-axled lorries with twin rear tyres. However, demand was spread over a range of vehicle types with widely varying rates of fuel consumption and hence fuel consumption per vehicle was very sensitive to changes in fleet composition. In contrast to the situation with petrol, the large majority of diesel-consuming vehicles fell in the 'company-owned' category.

The analyses described considered total monthly domestic sales of petrol and diesel for the period January 1972 to December 1981. The analyses were not extended to later years because of concern over the possible effects on sales of other factors, particularly vehicle import restrictions and occasional fuel shortages.

# 3 PETROL SALES

Premium and regular petrol are sold in roughly equal quantities. Premium is the more expensive, its price having ranged between 4 and 14 per cent higher than regular. Published sales figures do not distinguish between the two products and so the analyses have considered total petrol sales. Using annual statistics for sales mix and the monthly price for each product, the weighted average price of petrol was derived. This was deflated by the monthly upper index of consumer prices for Nairobi to produce an average real price of petrol for each month.

Month by month fluctuation in sales averaged 5 per cent but no regular seasonal variation was observed.

The top part of Figure 2 shows sales plotted as a 12-month moving average. Over the first four years, monthly sales grew by about 0.75 megalitres per year. In 1976, growth increased sharply but then it began to decline and by the end of 1981, petrol sales were actually falling. Over the ten years, sales increased by 40 per cent.

The main reason for the growth in consumption was the increase in vehicle population but, as explained in the previous section, there are problems in deriving appropriate disaggregated statistics on vehicle population. Use of the size of the national vehicle fleet as an explanatory variable is also complicated by the possibility that the fleet size may be influenced by fuel price. A number of exploratory analyses were conducted trying to relate sales to published data on vehicle population but the results were disappointing.

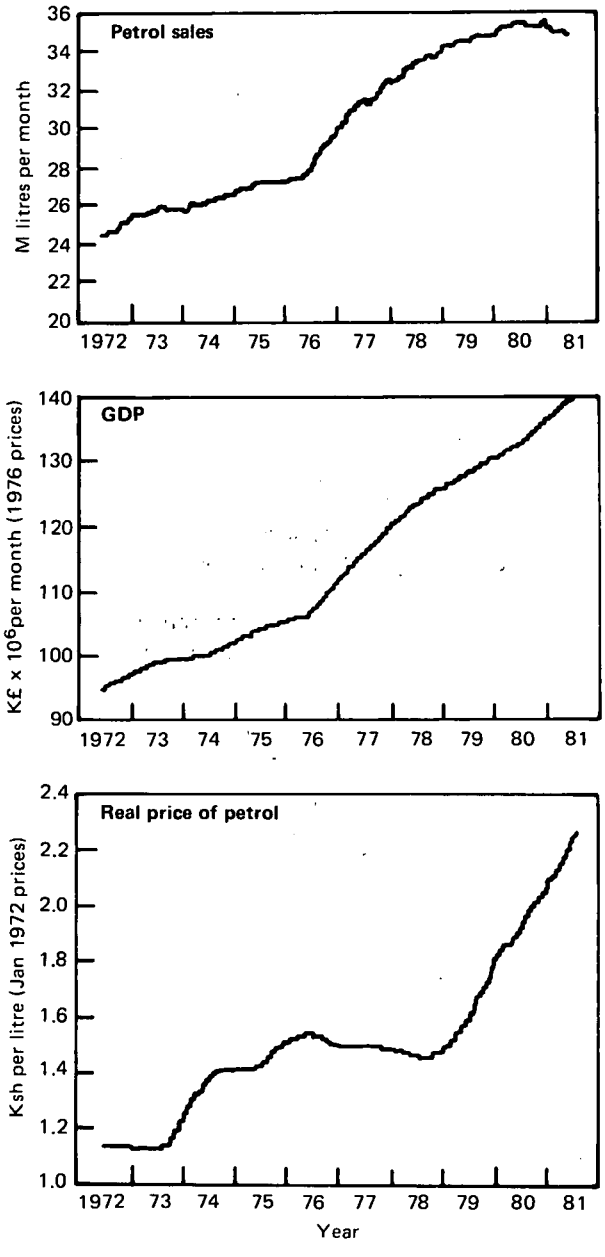


**Fig. 2 Trends in petrol sales, GDP and petrol price**

## TABLE 2

Petrol sales regression analyses

| | Type of Model† | | |
|---|---|---|---|
| | GDP Log-log | GDP Linear | Time Linear |
| a | −2.4 ± 0.3 | −2.4 ± 1.2 | 28.5 ± 1.0 |
| b | 1.24 ± 0.07 | 0.34 ± 0.02 | 0.16 ± 0.01 |
| c | −0.17 ± 0.05 | −4.2 ± 0.9 | −5.3 ± 0.9 |
| $R^2$(120 points) | 0.88 | 0.88 | 0.87 |
| Price elasticity | −0.17 ± 0.05 | −0.21 ± 0.04 | −0.27 ± 0.05 |

†According to equations (1), (2) and (3) respectively
Error ranges are ± 1 standard error

In the models which are described in this report, two variables, GDP and time, were used to explain the underlying growth in sales. GDP at constant prices is shown in the central part of Figure 2. The rise in GDP following the 'coffee boom' of 1976 correlated very well with increasing national fuel sales, but subsequently the relationship weakened, as the fall in growth of petrol sales occurred at a time when there was a continuing rise in GDP.

To show how prices could have influenced demand, the bottom part of Figure 2 gives the real price of petrol, plotted as a 12-month moving average. Up to mid-1976, petrol prices followed an upward trend and then between 1976 and 1979 they fell slightly. Petrol prices rose steeply from 1979 onwards, increasing by over 50 per cent in the following 3 years—at the same time as the growth in sales fell.

It seems as though sales can be related to GDP and price and a regression analysis was carried out using a model of the form

$$\text{Ln (Sales)} = a + b.\text{Ln (GDP)} + c.\text{Ln (Price)} \quad (1)$$

where b is the sales elasticity with respect to GDP and c is the elasticity with respect to price. Sales are measured in megalitres per month, GDP in millions of Kenyan pounds per month at 1976 prices (to conform with the published national statistics) and petrol price in Kenyan shillings per litre at January 1972 prices (the start of the study period). The results are shown in the first column of Table 2.

All the coefficients are statistically significant. The price elasticity of −0.17 ± 0.05 is rather smaller than values derived for more developed countries. It is interesting to note that the elasticity with respect to GDP is greater than unity—a 10 per cent rise in GDP would lead to an increase in sales of 12.4 per cent.

The analysis presented above gives elasticity terms with an indication of their accuracy, but the confidence limits rely on the assumption that the correct form of model has been used. The model was chosen because it is simple, easy to interpret and fits the data reasonably well. However, a more realistic assessment of confidence limits can be gauged by examining the elasticity coefficients derived when other plausible models are fitted to the data.

The simplest alternative is to use a linear model of the form

$$\text{Sales} = a + b.\text{GDP} + c.\text{Price} \quad (2)$$

Although it may appear simpler than (1), it is in some ways less attractive since elasticity is not constant over the range of prices. The results from this model are given in column 2 of Table 2. The model gave as good a fit to the data as the log-log form ($R^2$ is the same) and at the middle of the range of prices, the price elasticity is −0.21 ± 0.04, which is close to the previous value.

It can be argued that GDP is not the most appropriate variable to use to portray growth in sales. It could be that GDP has a good explanatory power chiefly because it is correlated with time and it might be better to use time itself as a proxy variable. This has the further advantage that the resultant model provides a forecasting tool which does not require GDP forecasts.

Using a model of the form

$$\text{Sales} = a + b.\text{Time} + c.\text{Price} \quad (3)$$

where time is a count of the months elapsed since December 1971, gave the values shown in the third column of Table 2. This is almost as good a fit as the two previous models, but at the mid-point, the price elasticity of −0.27± 0.05 is similar though slightly larger than the previous values.

Another way of looking at the accuracy of the models is to examine their time stability—to see how

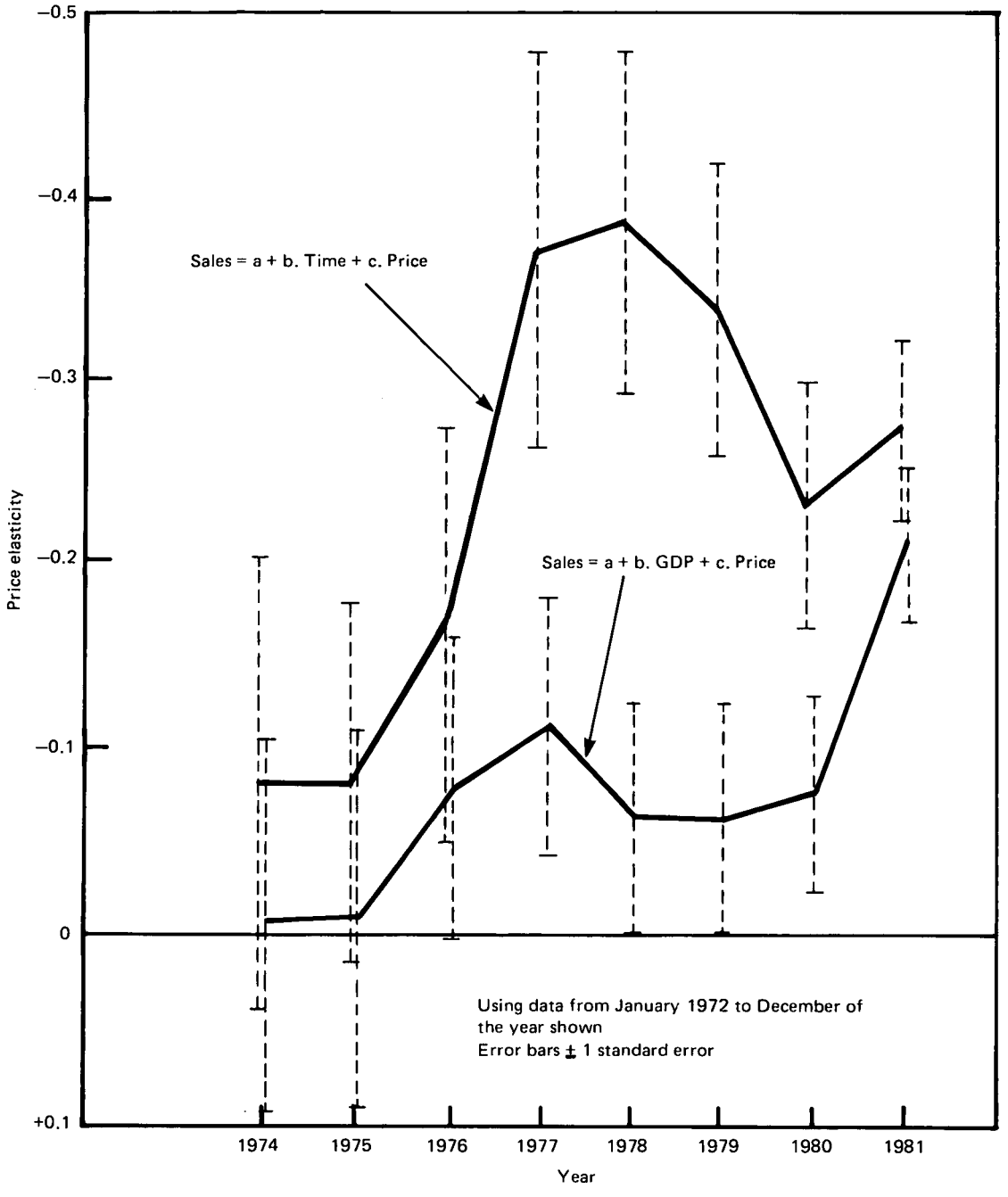


**Fig. 3 Petrol price elasticity based on data for different periods**

the calculated elasticities depend upon the time period chosen for analysis. Figure 3 shows values of the price elasticity when the analysis was confined to data for 1972 to 1974 only, data for 1972 to 1975 only, and so on. (Using data for shorter periods gave inadequate statistical accuracy.) The values were calculated using the linear GDP model (2) and the linear time model (3). The log-log GDP model (1) always produced results close to the linear GDP model and so for simplicity they are not shown.

It can be seen that the calculated elasticities did not remain constant despite the fact that successive analyses incorporate all the data used in earlier ones. The time model always gave higher price elasticities than the GDP model and only in the last year did the GDP model produce a price elasticity very significantly different from zero. As might be expected, over the first few years when GDP was rising uniformly, the elasticities from the two models did not differ significantly. However, following the increase in GDP growth rate in 1976, the elasticities diverged, to reconverge by 1981. The good agreement between models (2) and (3) described earlier seems somewhat fortuitous. If a model had been formulated to relate sales simultaneously to GDP, time and price, it would have produced price elasticities intermediate between those shown in the Figure.

What overall conclusions on price elasticity can be drawn from these results? It has to be recognised that in real life, petrol sales are influenced by a variety of factors, many of which cannot be measured or modelled. The simple models described above have obvious weaknesses and more complex formulations could have been experimented with such as the use of GDP disaggregated by economic sector, lagged relationships, hysteresis effects, price elasticities which increase as prices rise, and so on but it was not felt that the additional complexity was warranted with the data that was available.

The model based on GDP appears preferable to the time-based one since it gave more consistent results. The rise in elasticity for the GDP model in 1981 should be treated with some caution, because of the possible effect of car import controls which were introduced during the year. Probably the most that can be said is that petrol prices do seem to have had some effect on petrol sales, but the effect was small and the elasticity was probably in the region of $-0.1$.

## 4 DIESEL SALES

The study has considered only light diesel fuel, called 'derv' in the United Kingdom and 'gas oil' in Kenya. Unlike petrol, which is consumed almost exclusively by road vehicles, diesel fuel is used by Kenya Railways for their locomotives, by the East African Power and Lighting Company for electricity generation and by industrial users. Statistics on monthly sales to the Railways and the Power and Lighting Company were available and were subtracted from the published figures on total sales. Of the remainder, it was estimated that about 85 per cent was used for transport purposes.

The volume of diesel sales was similar to that of petrol. Month by month fluctuations averaged 8 per cent, rather larger than petrol, but again, no regular seasonal variation was observed. The top part of Figure 4 shows diesel sales plotted as a 12-month moving average. For most of the time, monthly sales increased fairly steadily at a rate of 2 megalitres per year. The main exception to this occurred during 1974 when sales actually fell. Over the ten years, sales rose by 75 per cent.

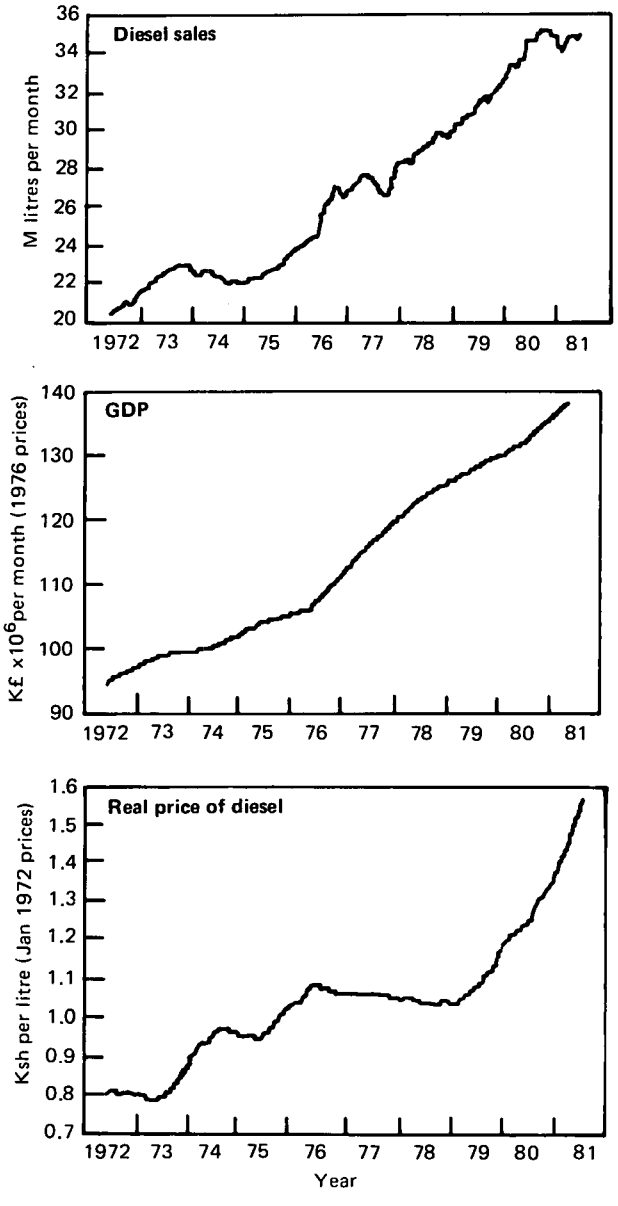


**Fig. 4 Trends in diesel sales, GDP and diesel price**

## TABLE 3

Diesel sales regression analyses

| | Type of Model† | | |
|---|---|---|---|
| | GDP Log-log | GDP Linear | Time Linear |
| a | −3.4 ± 0.6 | −10.8 ± 1.9 | 18.6 ± 1.8 |
| b | 1.41 ± 0.13 | 0.33 ± 0.03 | 0.14 ± 0.01 |
| c | −0.02 ± 0.09 | 0.1 ± 2.1 | −0.26 ± 2.32 |
| $R^2$ (120 points) | 0.81 | 0.80 | 0.78 |
| Price elasticity | −0.02 ± 0.09 | 0.00 ± 0.08 | −0.01 ± 0.09 |

†According to equations (1), (2) and (3) respectively
Error ranges are ± 1 standard error

Also shown in Figure 4 are GDP and the real price of diesel, which has shown similar fluctuations to those of petrol. It is difficult to see by eye any indication that price has influenced sales. Regression analyses were carried out in the same way as those described in the last section and results are given in Table 3.

None of the analyses gave a price elasticity significantly different from zero. The elasticity with respect to GDP was higher than for petrol.

The result of repeating the linear analyses for different time periods is shown in Figure 5. The GDP-based model consistently gave elasticities close to zero while the time-based model was more erratic and yielded elasticities between 0 and −0.4. As with petrol, therefore, it appears that the GDP model was the more reliable indicator of price elasticity. It is concluded that price has had no influence on diesel sales.

# 5 LONG AND SHORT-TERM ELASTICITIES

Following an increase in fuel prices, it will take some time for the full consequences to be felt. In the very short term, vehicle use will be modified—some of the marginal travel will be suppressed, occupancy and load factors will increase, vehicles will be driven in a more fuel-efficient way, and so on. In the longer term, additional changes will take place. For example, as experience has shown, large bus and lorry operators will take steps to reduce fuel consumption by down-rating engines and improving maintenance standards. Some people will scrap their vehicles and some will replace them with others having better fuel efficiency. This last option will probably have the largest single effect. In the long term, therefore, the scope to cut down on fuel use is obviously greater and one would expect to find a higher price elasticity (US Department of Energy 1981).

The models presented so far consider only short-term responses to price change. Models can be formulated to examine both short and long-term effects, but the accuracy with which long-term effects can be measured is poor. This is because fuel consumption is changing over time for a variety of reasons besides fuel price and the extent of these other changes has to be accurately known before it is possible to isolate the effect of price alone. For example, as part of the national policy to encourage the use of more fuel-efficient cars in Kenya, import duties have been progressively increased to penalise vehicles with large engines. Similar policies exist in other countries, for example, Greece (World Bank 1982) and New Zealand (Tanner 1983).

Figure 6 shows approximate import tax levels for Kenya for the last 20 years. Between 1963 and 1980, the total tax (import duty plus sales tax) on a new petrol-driven car rose from 15 per cent to over 80 per cent for a one litre car and from 15 per cent to over 270 per cent for a 2.5 litre car. The increase in annual operating costs arising from changing to a car with a larger engine can now be more dependent upon the levels of car import duty than the price of petrol.

Another point to bear in mind is that most vehicles now on sale are more fuel-efficient than their counterparts of earlier years. For a developing country like Kenya which does not manufacture its own vehicles, this change has been brought about by world-wide increases in fuel price and would have happened regardless of Kenyan fuel prices.

As an alternative to time series analysis, long-term elasticities can be inferred from international cross-sectional analysis. Thomson (1972) and Tanner (1983) have carried out cross-sectional studies by relating average petrol consumption per car to petrol prices in

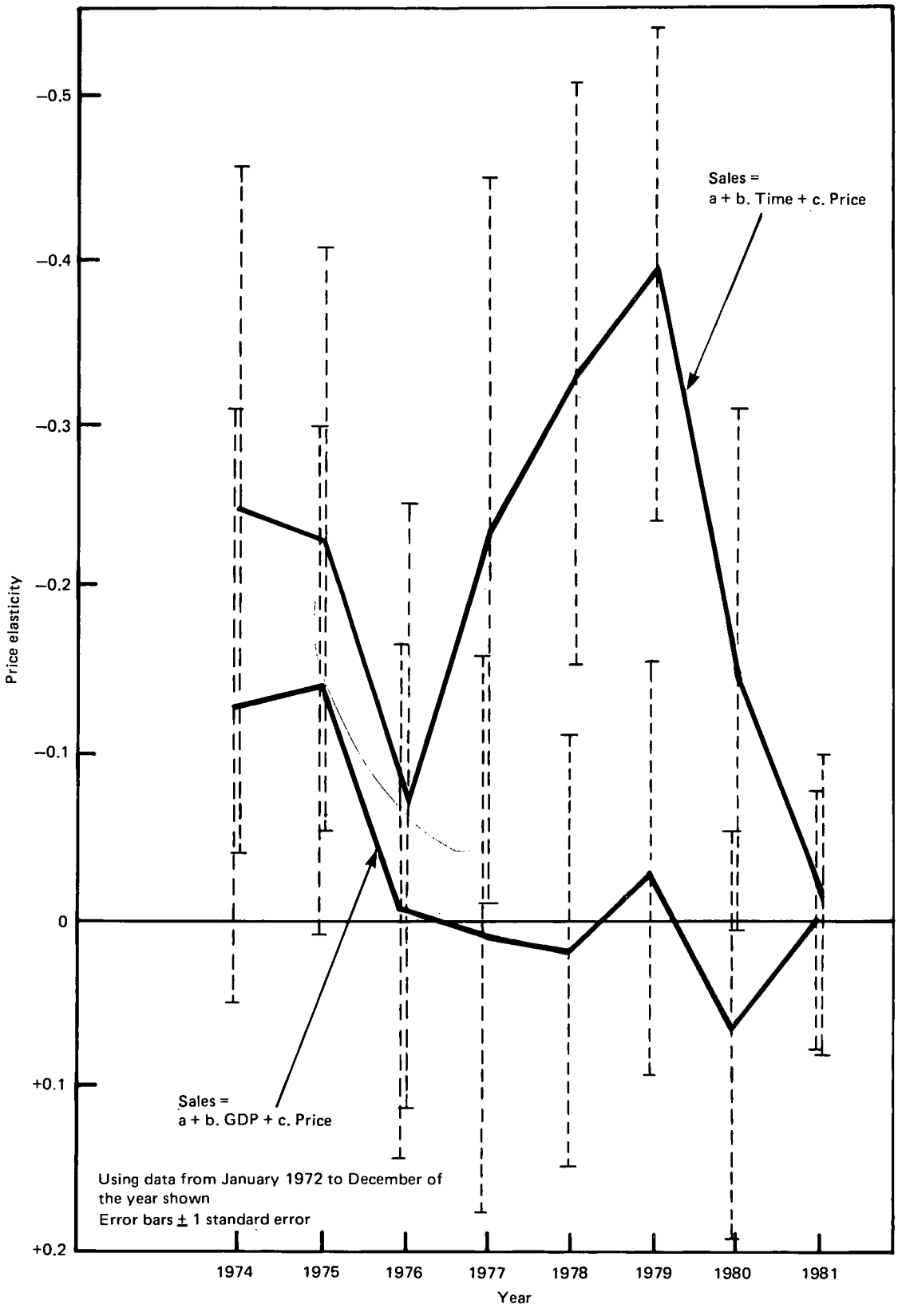


**Fig. 5 Diesel price elasticity based on data for different periods**

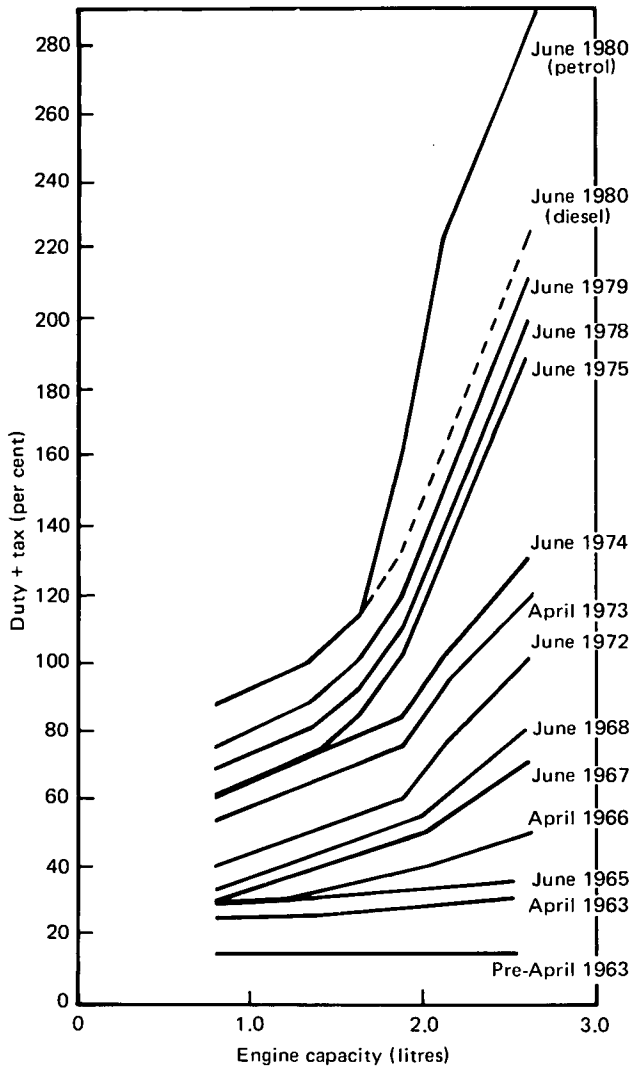


**Fig. 6 Import duty and sales tax on new cars, 1963–1980**

a number of different countries. They measured elasticities close to $-1$, a surprisingly high value when it is considered that petrol is only one of the costs associated with changing vehicle size.

However, there are dangers in assuming that the results of cross-sectional studies give the long-term price response. On the one hand, cross-sectional studies might give an under-estimate since they do not include the effect of stimulated long-term technical improvements in fuel efficiency or the effect of fuel price on vehicle ownership levels. On the other hand, they could be giving an over-estimate because they are often strongly influenced by two or three countries with low fuel prices and there may be other factors besides price which are contributing to the high fuel consumption levels in these countries.

Moreover, the timescale for long-term effects could be many years. The high cross-sectional elasticity stems chiefly from differences in vehicle sizes. If the full effect of a fuel price change on new cars were immediate, it would take over ten years to feel the full effect on fuel sales. But it has also been found that the short-term effect of fuel price on car sales is relatively small (Tanner 1983), implying that the full effect of fuel prices on new car sales is itself mainly a long-term effect. The timescale for long-term effects of fuel prices on fuel sales must be longer still.

# 6 DISCUSSION AND CONCLUSIONS

For the period 1972–1981, it was found that diesel and petrol sales could be related to time or GDP, but that the GDP relationship was the more stable. For petrol, the elasticity with respect to GDP was 1.24 and for diesel it was rather higher at 1.41.

Petrol price appeared to have a small influence on sales and the best value for the short-term elasticity was around $-0.1$. For diesel, no significant effect of price on sales could be detected. Petrol price elasticity appeared to be lower (in absolute terms) than in the developed country studies reviewed by Bland (1984). The absence of any observed price response for diesel coincides with Oldfield's findings (1980) on the price elasticity of travel per lorry in the United Kingdom.

One possible explanation for these results is that only privately-owned vehicles are sensitive to fuel price in the short term. It may be that the price elasticity for petrol is somewhat smaller than in most developed countries because privately-owned vehicles account for a smaller proportion of sales. Similarly, the lack of price response for diesel could have arisen because most diesel is sold to company-owned vehicles.

It is to be expected that in the long term, price elasticities will be higher as other changes, especially in the vehicle fleet, occur. Studies carried out elsewhere have suggested higher long-term values, but the time taken to realise these long-term changes could be many years, and one cannot draw any firm conclusions on such long-term changes from the data analysed in this study.

In the short term, adjusting petrol and diesel prices by fuel taxation appears to be an effective way of collecting Government revenue but an ineffective way of regulating fuel sales.

# 7 ACKNOWLEDGEMENTS

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