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IMPORT PENETRATION IN THE U.K. PASSENGER CAR MARKET: A CROSS SECTION STUDY FOR 1975

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This paper is circulated for discussion purposes only and its contents should be considered preliminary.

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1. Introduction

The British Motor Industry has had its share of troubles recently. After the 1972-3 boom demand slumped considerably as a result of both the world recession and the increase in oil and petrol prices. Costs have climbed rapidly and until 1975 British firms failed to increase prices by enough to cover these increased costs. Despite this, import penetration increased. In 1970 and 71 British firms held about 86% (by numbers) of the U.K. car market. This fell to 72% in 1973 and 74 and by 1975 was down to 67%.* At the same time the industry failed to offset this increase in import penetration by increases in exports. Our share of the world car market had fallen.

A number of explanations have been offered for this phenomenon. For instance, the Central Policy Review Staff made the following criticisms.

i) The British Industry did not have enough models in the mini range.

ii) Some British models give less value for money than imported models, especially when the extras included in the list price are taken into consideration.

iii) Some British models are dated.

iv) Although in the earlier period British models had a price advantage this was eroded by price increases.

v) British built cars have a reputation for poor quality and reliability.

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* Society of Motor Manufacturers & Traders

vi) Rationalisation of dealer franchises by British firms has provided a source of dealers for imported cars.*

In this paper we present 2 sets of estimates for the sensitivity of consumers' demand to factors such as these. The first set, concerns long-term factors affecting the distribution of market shares among models. The second set is concerned more with recent shifts in the structure of demand, no doubt mainly because of the increase in the cost of motoring. Both sets of results are based on an analysis of model sales during the first nine months of 1975.

2. The Economic Model

Motor cars are combined with other inputs to provide services to the household. The exact nature of the services the household demands will depend on its income, family composition, and tastes. Different models of car combine characteristics and price in different amounts, so that households vary in their choice of most suitable model according to income, family composition and tastes. A given household is more likely to buy a particular model:

a) the more effectively it is able to provide the sort of services the household requires.

b) the cheaper these services are provided.

Within the car market there is a distribution of households according to income, family composition and tastes. The sales of any particular model will then depend on:

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* Central Policy Review Staff

a) the density of the market for the sort of service the model most effectively provides

b) the number, or density, of other models competing in the same region of the market

c) the value for money offered by the model in question relative to its near competitors.

Insofar as purchasers have imperfect information about all the models available advertising may affect their choice amongst fairly similar competing models.

The distribution of characteristics of models offered for sale will follow to some extent the distribution of market demand i.e. more models will tend to be offered in the most popular parts of the market. The choice of models will therefore be greater in these parts of the market and the slope of the demand curve for the individual model will be less steep. Assuming that car manufacturers have free entry to all parts of the market and that a full monopolistic competition equilibrium prevails then the less popular segments of the market will be characterised by lower sales per model, and larger mark up over marginal costs.

In general terms the demand for a particular model can be expressed as

$$Q_i = f(P_i, X_i, A_i, M) \qquad (1)$$

P_i = price of model i

X_i = a list of attributes of the model or conditions surrounding its sale

A_i = the extent to which the model is advertised

M = total size of the market

Since we are studying a single time period M is fixed and is ignored in what follows.*

Estimation of equation (1) as it stands would face certain difficulties. One of these is that the number of items in the list of X is potentially very large so that the loss of degrees of freedom becomes a problem. Another is that the columns of the matrix $[P \quad X]$ would be quite strongly related to each other and multicollinearity would be a major problem.

However, the considerations mentioned in our economic analysis help us to specify more strictly the form of the equation.

The list of attributes matter for two different and quite independent reasons. First, in combination with price it defines the relative value for money that a model presents (in comparison with rivals which have similar attributes). Second, the list of attributes defines the segment of the market in which a particular model is sold.

The first of these considerations implies that, instead of taking price and a list of attributes as the explanatory variables we ought to use a single variable, quality-adjusted price (see Cowling & Cubbin, 1971).

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* Strictly speaking we should also include the prices and characteristics of competing models in the specification of the demand function. These are also constant for a given year. Our conclusions would have to be modified if the market were to change drastically.

This should allow us to keep a larger number of degrees of freedom. The second consideration, that of defining a market segment, requires only a small number of characteristics.

If we adopt these suggestions equation (1) now becomes

$$Q_i = g\ \{(P_i - X_i\beta),\ X_i^o,\ A_-\} \qquad (2)$$

where X^o is a subset of the characteristics X, sufficient to define the market segment of each model and $(P - X\beta)$ is the quality-adjusted price of each model.

$X\beta$ is the average price one would expect to pay for a car with the particular set of characteristics X. P is the price actually charged by the seller. The smaller is P relative to $X\beta$ the better is the value for money offered by that particular model, taking into account the quality characteristics X. For this reason $(P - X\beta)$ is referred to as the quality-adjusted price (see Cowling and Rayner (1970), Cowling and Cubbin (1971) for earlier applications of this term).

The β coefficients are estimated by regressing price on the X characteristics for the sample of cars offered for sale. The coefficient β_j represents the extra price asked on average for one extra unit of characteristic j. $X_i\ \beta$ is the "predicted" level of price for car i and $(P_i - X_i\ \beta)$ is the actual level of P_i minus its predicted level $(P_i - X_i\ \beta)$ is, therefore, simply the residual from the least squares regression of P on X.

Unfortunately the initial purchase price does not represent the total cost of motoring. Fuel, insurance, and maintenance need to

be taken into account as well. Fuel and insurance costs, however, will vary as a matter of course from one segment of the market to another. In considering value for money what is important is the level of these costs relative to cars with similar characteristics. This can be allowed for by regressing these other costs on our set of characteristics and using the residual as a measure of the relative economy of the car in question.

A rational household buying a car would aggregate its capital and running costs in arriving at the choice of model to buy. However, the relative importance of these different factors will vary from household to household according to mileage anticipated, rate of discount applied, extent of no claims bonus. In the aggregate, therefore, the relative importance of each of these costs is not known a priori. They are therefore allowed to enter separately into the statistical analysis.

3. Statistical considerations

We formulated our statistical model in two ways and accordingly estimated two sets of regressions, the difference being the dependent variable which in one case was sales and in the other the rate of change of sales between 1974 and 1975. The estimates obtained using sales have an interpretation as long run coefficients since the regression analysis seeks to explain differences in the levels of sales in terms of differences in the levels of car characteristics. The other specification is not merely a first difference form of the levels equation since it uses the same independent variables to explain the change in sales. The estimates in this case therefore tell us something about the factors inducing changes in the pattern of sales during the period. Given the cross sectional nature of the data this specification is legitimate and we can interpret the coefficients to a large degree as changes in the coefficients of the long run relationship which took place in the period.

The emphasis in specifying the explanatory variables used was on allowing various hypotheses to be tested rather than on building a full econometric model of the car market. In particular we have not sought to explain total sales and our results do not allow any forecasts to be made for the industry as a whole. Likewise no attempt has been made to treat cars explicitly as a consumer durable and explain sales in terms of a stock adjustment model. Our approach was simply to provide an equation which could reasonably be identified with the demand side, and which could be used to make statements about market shares of different models and manufacturers.

A list of all the variables used and their definitions is given in Appendix (1). The functional form chosen was linear in the cases of

most variables, the exceptions being price, advertising, number of dealers and sales (new registrations) which were all replaced by their logarithms. The log of price was used to facilitate the estimation of the elasticity and the logs of the other variables were used because they showed a considerable degree of skewness over the sample, which might imply a heteroscedasticity problem. Respecifying the equation in terms of the logs of these variables, while to some extent altering the relationship being estimated, might be expected to reduce this problem and so ensure more efficient estimates.*

Three price variables were used: the list price (log of list price), the average miles per gallon and the insurance group. Since these all vary quite widely across different models according to quality differences, even within our group of family saloons, we would not expect to estimate pure price effects using them as explanatory variables. Variation in one of these price variables would be the sum of variation due to quality differences (more powerful cars are more expensive) and that due purely to price holding quality constant (value for money). To the extent that the market is divided into segments according to quality we might find it difficult to estimate the effect of a pure price difference using these variables as they stand. In the analysis, therefore, they were adjusted for quality differences by running a set of preliminary regressions on quality characteristics and taking the residuals. These regressions are reported in Appendix (2).

A potential source of bias in the least squares procedure is the possible simultaneity between some of the variables. If the level of

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* See Goldfeld & Quandt, (1972) Ch.3.

Our results are given in Tables I and II. The regressions reported in both tables are based on three groups of models: all models in the sample (a list of models used is given in Appendix (3)), British produced models only and imported models only. In no case is it possible to say that the respective regression results based on British models only and imports only are different on the basis of a Chow test.* In view of this the emphasis is placed, for purposes of inference, on the results obtained using all models although the results for the two subgroups are retained for descriptive purposes.

Two samples of imported models were used, containing 51 and 23 observations respectively. The larger sample (which we call the "SMMT" sample) consists of those popular saloons for which new registrations data is published by the SMMT for both 1974 and 1975. The smaller sample (the "Which?" sample) is a subset of the "SMMT" sample for which it is possible to obtain data on reliability from "Motoring Which?". Thus all the equations based on the "Which?" sample contain an extra independent variable, "Av Off Rd", which is an estimate of the average number of days in a year that a car is off the road due to breakdown or servicing taken from a survey of "Motoring Which?" readers.

It might be expected that, with up to as many as twelve independent variables, multicollinearity might present a serious problem in testing hypotheses. Inspection of the correlation matrix, however, reveals no pair of variables which are obviously collinear and, while this does not rule out possible higher order multicollinearity involving more than two variables, it is perhaps not being too optimistic to regard the problem as small. Multicollinearity is unlikely to be a problem particularly in view of the diversity of models considered, covering a wide range of quality characteristics, manufacturers and countries of origin.

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* See Fisher

advertising depends on the sales of a particular model during the current period or, as seems likely in the sales equation, if the size of dealer network depends on sales then there might be expected to be simultaneous equations bias. This problem has been ignored on the grounds that such bias might, in this case, reasonably be assumed to be small since its magnitude depends on the instability of the equation to be estimated relative to that of other simultaneous equations in the system.* Since in our case we are using a large set of explanatory variables we might argue that specifying the equation in this way reduces the error variance and hence minimises the inconsistency due to simultaneity. Against this, however, we should point out that some of the samples used are quite large and therefore there might be some payoff to using a simultaneous equation method rather than least squares.

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* Suppose the equation is written as

$$Y_i = \beta X_i + \gamma Z_i + U_i$$

and in addition we have

$X_i = \alpha Y_i + V_i$, then the least squares estimate of β has an asymptotic bias of plim $\hat{\beta} - \beta = (\alpha - \beta) \dfrac{\sigma_U^2}{\sigma_U^2 + \sigma_V^2}$. (Rao and Miller p.197). Thus the size of the bias depends directly on the ratio σ_U^2/σ_V^2 and, if we can reduce σ_U^2 by better specification of the equation, we may reasonably ignore any simultaneity problems (always assuming of course that Y_i is only one factor among many influencing X_i and therefore σ_V^2 can be regarded as large).

TABLE I

Dependent variable log Q75	All models		British models only		Imports only	
	1	2	3	4	5	6
Constant	1.93	3.98	1.38	0.43	12.58	6.83
	(2.25)	(5.83	(0.71)	(0.19)	(2.87)	(4.28)
Delivery	0.01	-0.04	0.009	-0.01	-0.08	-0.07
	(0.36)	(-1.47)	(0.26)	(-0.29)	(-0.94)	(-1.63)
Guarantee	0.05	0.04			-0.08	0.04
	(1.28)	(1.18)			(-1.30)	(0.94)
Yrs.Intro.	-0.01	0.02	-0.02	-0.009	-0.008	0.03
	(-0.40)	(0.87)	(-0.57)	(-0.23)	(-0.18)	(0.73)
Range	0.06	0.06	0.09	0.11	-0.03	0.04
	(2.45)	(2.83)	(3.25)	(4.18)	(-0.87)	(1.16)
Insurance Group*	-0.28	-0.29	-0.37	-0.40	0.42	-0.33
	(-1.50)	(-2.12)	(-1.60)	(-1.45)	(1.39)	(-2.17)
MPG*	0.01	0.08	0.09	0.05	-0.20	0.13
	(0.26)	(1.86)	(1.32)	(0.69)	(-2.69)	(2.48)
Log Price*	-2.05	0.26	-0.82	0.28	-5.08	0.45
	(-2.0)	(0.40)	(-0.55)	(0.17)	(-3.9)	(0.59)
Log No. of dealers	1.0	0.41	1.09	1.10	-0.36)	0.0008
	(5.54)	(3.07)	(3.77)	(3.19)	(-0.61)	(0.003)
Log Advertising	0.19	0.44	0.21	0.12	0.04	+0.41
	(2.0)	(5.78)	(0.95)	(0.47)	(0.32)	(4.08)
No.of Extras	-0.05	-0.13	0.01	0.10	0.17	-0.20
	(-0.61)	(-1.93)	(0.14)	(1.12)	(1.31)	(-2.30)
Av.off Road	-0.29		-0.28		-0.78	
	(-2.94)		(-2.0)		(-3.54)	
N	40	68	17	17	23	51
R^2	0.83	0.80	0.93	0.88	0.80	0.63
ESS	6.441	20.447	0.745	1.245	1.695	14.871
F	12.73	22.66	7.51	5.52	3.97	6.89
df	75	57	6	7	11	40

* denotes quality adjusted.

(t values in parentheses)

4. Results

The price elasticity in equation 1 (Table I), based on the complete "Which?" sample is about -2, although the estimate is quite sensitive to changes in the sample and specification. The value obtained using the "Which?" sample of imports only, for example (equation 5) is -5 and highly significant while that obtained using the "SMMT" sample (equation 6) is insignificant with the wrong sign*. Taking as plausible an estimate between -2 and -5 would give a value rather lower than those previously reported**. A possible explanation of

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* A possible reason for the insignificance of price is the inclusion in the sample of cars imported from Eastern Europe, which all have extremely low quality adjusted prices without correspondingly high sales. Treating these as outliers by using a dummy variable (1 for Moskvitch, Lada, Wartburg, Skoda, 0 otherwise) had the effect of making the coefficient on price negative but still statistically insignificant.

** Cowling and Cubbin (1971) and Cubbin (1975) both obtained values of the long run price elasticity in the range -7 to -8. These were based on a partial adjustment hypothesis estimated by OLS using a pooled sample of time series and cross section data. To the extent that there was any unexplained cross sectional variation (picked up by the error term), the coefficient of the lagged dependent variable is likely to have been biased upwards and therefore the rate of adjustment underestimated. We might therefore expect these figures for the long run elasticity to be on the high side. For a discussion of the use of panel data to estimate dynamic equations, see Nerlove (1965).

this is that the period 1974/75 was one of rapid price change and, if the consumers adjust only slowly due to imperfect information about prices and the fact that the stock of vehicles can only be changed slowly in response to changed market conditions, we might expect the estimate of the long run elasticity to be low.

In terms of explaining short term changes (Table II) the estimate appears more stable with a value for both the complete "Which?" sample and imports only of about -1.3. As an estimate of the short term elasticity this is also rather lower than previously reported values*. Now the price variable is adjusted for differences in quality between models and is a residual from a previous regression of the log of list price on various characteristics, using all 68 observations in the "SMMT" sample. The average residual for British models is 0.04 and that for imports is -0.01 which implies that, defining price in this way, British cars in the sample were approximately 4% dearer than average while imports were 1% cheaper. Therefore, other things being equal, this estimate of the price elasticity would suggest a sales disadvantage for British models, relative to a model with a value of "log price" of zero, of $1.3 \times 4 = 5.2\%$ and give an advantage to importers of $1.3 \times 1 = 1.3\%$.

The variable "MPG", a measure of fuel economy (average miles per gallon adjusted for quality differences in the same way as price), appears to have had a significant effect in the short term (Table II) with a

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* Cowling and Cubbin (1971) and Cubbin (1975) obtained estimates around -2.

TABLE II

Dependent variable Δ log Q	All models		British models only		Imports only	
	1	2	3	4	5	6
Constant	-0.05	+1.61	-2.01	-2.30	2.33	+3.33
	(-0.13)	(+4.15)	(-2.23)	(-2.50)	(0.79)	(+3.62)
Delivery	-0.015	-0.02	0.005	-0.115	-0.008	-0.020
	(-0.96)	(-1.20)	(0.345)	(-0.725)	(-0.16)	(-0.793)
Guarantee	-0.008	+0.015			-0.01	+0.011
	(-0.92)	(+0.75)			(-0.28)	(+0.430)
Yrs. Intro.	-0.014	+0.001	-0.003	-0.001	-0.059	-0.011
	(-1.04)	(+0.10)	(-0.230)	(-0.04)	(-2.34)	(-0.538)
Range	-0.01	-0.016	-0.006	+0.003	-0.045	-0.024
	(-0.92)	(-1.30)	(-0.456)	(+0.024)	(-2.36)	(-1.33)
Insurance Group*	-0.03	+0.076	+0.028	+0.019	0.034	+0.027
	(-0.31)	(+0.98)	(+0.26)	(+0.164)	(0.199)	(+0.030)
MPG*	+0.03	+0.062	+0.044	+0.034	-0.033	+0.0916
	(+1.34)	(+2.46)	(+1.46)	(+1.11)	(-0.69)	(+2.95)
Log Price*	-1.25	+0.289	-0.771	-0.438	-1.39	+0.446
	(-2.61)	(+0.79)	(-1.12)	(-0.653)	(-1.47)	(+1.031)
Log No. of dealers	-0.062	-0.424	+0.200	+0.204	-0.27	-0.685
	(-0.78)	(-5.52)	(+1.49)	(+1.45)	(-0.88)	(-5.03)
Log Advertising	+0.14	+0.21	+0.12	+0.09	0.16	+0.184
	(3.22)	(+4.70)	(+1.13)	(+0.85)	(2.51)	(+3.20)
No. of Extras	+0.036	-0.014	+0.018	+0.046	0.072	-0.026
	(1.03)	(-0.360)	(+0.43)	(+1.21)	(1.05)	(-0.513)
Av. off Road	-0.09		0.08		-0.11	
	(-1.98)		(1.30)		(-0.63)	
N	40	67	17	17	23	50
R^2	0.61	0.47	0.69	0.60	0.85	0.56
ESS	1.411	6.52	0.162	0.21	0.417	4.82
F	3.98	5.04	1.33	1.17	4.65	5.11
df	28	56	6	7	10	39

* denotes quality adjusted.
(t values in parentheses).

coefficient in excess of 0.3. Other things being equal an extra mile per gallon of fuel economy would mean increased sales during 1974/75 of over 3%. Within the group of imported models only the effect seems somewhat ambiguous with the value of the coefficient being sensitive to the sample used. The smaller "Which?" sample attributes no significance to petrol consumption while the variable "Yrs.Intro." (the number of years since the model's introduction) is highly significant with a negative coefficient (equation 5). It would appear from this, therefore, that people who purchased imported cars belonging to this sample were substituting newer and, to some extent, cheaper models. This does not mean that MPG is unimportant as an explanatory variable but reflects the fact that the models in this group gave better than average fuel economy, the mean being 0.51 compared with a mean for all imports in the "SMMT" sample of -0.17. Looking at the results for this larger sample (equation 6) MPG is significant with a coefficient larger than that obtained using the sample of all models. The estimate of the long run elasticity given in Table I is very sensitive to changes in the sample used and we can argue that this effect is underestimated because of incomplete adjustment following a period of rapid increase in petrol prices.

In terms of their ability to compete with imports on fuel economy it seems that British produced models are in a relatively favourable position using our measure of MPG (mean value of 0.37) when compared with the larger sample of imports (mean value -0.17) although not when compared with the smaller "Which?" sample.

TABLE III

Averages of explanatory variables

	British Models	Imported Models	
		"SMMT" sample	"Which?" sample
Delivery (weeks)	3.5	3.8	3.6
Guarantee (months)	12	9.2	8.6
Yrs.Intro.	6.8	4.9	5.3
Range	7.9	4.3	4.9
Ins.Group*	-0.14	0.0004	-0.22
MPG*	0.37	-0.17	0.51
log price*	0.04	-0.01	0.001
No.of dealers	1315	282	316
Advertising (£000's)	403	106	142
No.of extras	3.4	3.5	3.3
Av.off Road (days per year)	2.9	-	1.4

* Measured as the residual from the regression of the variable on quality characteristics (see Appendix 2).

Delivery in any case does not seem to be an area in which British models perform badly, the average being 3.5 weeks as against the average for imports slightly higher at 3.8.*

The variable "guarantee" was also generally insignificant although in Table I it tended to have the right sign and a stable coefficient. We might have expected to observe a significant effect of an index of the quality of after sales serve had we made allowance for the recent increased competition in this area but this occurred in the later part of 1975, after the period covered by our sales data.

The variable "No.of extras" was insignificant in every equation in Table II and in the regressions reported in Table I tended to have the opposite sign to that expected. This can perhaps be taken to reflect a preference by consumers for models which include fewer items as standard in the purchase price. Looking at the results for imported models only, however, there does seem to be some ambiguity about this, the "SMMT" sample showing a strong negative effect while the "Which?" sample indicates a strong (although statistically insignificant) positive coefficient. An interesting feature is that in those equations in which this variable is significantly negative price is insignificant, possibly indicating that "No. of extras" is picking up a price effect. This can be explained in terms of the definition of our price variable which, as described above, is the residual from a regression of the log of list price on a set of quality characteristics (see Appendix (2)) after an adjustment has been made for extras fitted at the factory, as standard items, on the basis of what these items would have cost if fitted to a basic model after purchase. Earlier estimated price-quality relations in which the list price was not

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* This contradicts the results of the 1974 Survey of Consumers reported by the CPRS p.95. It is conceivable that our data from What Car contains relatively optimistic estimates by retailers and manufacturers of British cars.

Our third price variable, "Insurance group", appears to have had no perceptible effect in explaining short term changes in 1974/75 (Table II) but to be significant in the equations in Table I. As with "MPG" the significance level appears to depend on the sample of imported models used, although the value of the coefficient is fairly stable at about -0.3. As with "MPG" also the implication of this variable for the competitive position of British models depends on which imports are considered. The average insurance group (quality adjusted) for British cars is -0.14 while that for the large sample of imports is about zero. The mean value for the smaller "Which?" sample of imports is, however, -0.22 implying a slight advantage for the average model in this group over the average British model of, perhaps, 3% of sales in the long run. This figure is, of course, somewhat arbitrary and depends critically on precisely which models are included in both the British group and the imported group, but it does indicate a possible reason for the apparent unimportance of this variable in equation 5, based on the "Which?" sample of imports.

Five quality variables which are frequently identified as being important in explaining the growth of imports are delivery, reliability, product range, guarantee period and the number of extra items fitted as standard. Of these "Delivery" was statistically insignificant in all regressions although it did tend to have the expected negative sign. This is perhaps not surprising in view of the excess capacity in the motor industry during 1975 but it would seem to put recent publicity about the importance of lost production through strikes in the British industry into proper perspective.

reliability is an area where British models are at a particular disadvantage, the average number of days off the road being 2.9 compared with the average for imports in the "Which?" sample of 1.4. The estimated coefficient reported in Table II is -0.1, which would put the average British model at a relative sales disadvantage of 15% in the short run. The implication of this result is that during 1974/75 consumers were tending to substitute imports after having identified reliability as a particular source of weakness in British cars, the statistical significant of this variable in Table II indicating that its importance had not been perceived for a sufficiently long period for complete adjustment to have occurred. The coefficient is quite high being about -0.29 for the complete "Which?" sample and is higher still using imports only. It appears from these results that, if the reliability figures are based on an unbiased sample, then sales are particularly sensitive to differences in reliability and that this factor is especially important in explaining import penetration in the UK market.

The fifth variable in this group "Range", defined as the number of variants on the basic model which are available, is one whose effect is favourable to British producers. In Table II it appeared to have no effect but was highly significant in the equations reported in Table I, with a stable coefficient of 0.6. This indicates a long run effect of increasing the choice of model type (for example introducing an extra variant on the Allegro) of about 6% of sales. For the sample of British

adjusted in this way gave ridiculously high shadow prices for the individual extras (a radio was over £200, for example, in one equation). The difference in price between a model with a particular extra item and one without, with all other quality characteristics identical, is therefore much smaller if price is adjusted in the way outlined above than if it is unadjusted. If this is indicative of a larger markup on cars with more extras than consumers would show a marked preference for models with fewer extras. An interesting feature of the "Which?" sample, however, was the (small) negative correlation between "Log Price" and "No.of extras" suggesting that within this group there was no extra markup on models with more factory-fitted items. This partly explains why both these variables had the expected signs when this sample was used.

The lack of any significant positive coefficient for this variable and the implication of a negative effect means that British produced models on the average have a slight advantage over cars in the larger group of imports although not when compared with the smaller group. The average number of extras included in the purchase price of British vehicles is 3.4 as against 3.5 for all imports and 3.3 for the smaller "Which?" group.

The fourth quality variable is a measure of reliability, "Av.off Road", an estimate of the average number of days a particular model is off the road for repairs and servicing in a year. It was only available for a restricted set of imports although all British models were included in the sample. This variable was statistically significant in both types of equations. In terms of their ability to compete effectively with imports

only British cars. The estimate of the long run elasticity was much more uncertain being between 0.19 and 0.44. This figure is unlikely to be very reliable, however, since, as with dealers, we expect advertising expenditure to be higher for models and manufacturers with higher sales and therefore we should be aware of some possible bias (see Schmalensee, pp. 9-11). Our short run estimates in Table II are not subject to this simultaneity problem because of the inclusion of the previous year's sales.

The final explanatory variable, "Yrs. Intro", was included in order to test the hypothesis that consumers prefer newer models. This is advanced by the CPRS as a reason for the success of Japanese cars in the U.K., although no evidence is presented.* This variable was insignificant, however, except in Table II, equation 5, the latter perhaps tending to confirm the hypothesis as far as it relates to changes occuring within 1974/75. The general insignificance of this variable suggests that the age of a model is perhaps not a serious factor. This insignificance could also be explained in terms of this variable being a proxy for the model's reputation or the stock of goodwill built up by experience over a period of years. This would imply a positive coefficient, and, if the two effects are present simultaneously, a value close to zero.

Finally, it should be pointed out that we included engine size

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* p.67.

models only the coefficient was larger and more highly significant while it was insignificant using imports only. Thus, in terms of the range of variants on a basic model type, British manufacturers (with an average range of 7.9) were at a clear advantage over importers (whose average range was only 4.3).

Of the remaining variables, the one representing the size of the distribution network, "Log. no. of dealers", was, perhaps not surprisingly, highly significant in the regressions reported in Table I, with an estimated elasticity of 1. This figure is probably unreliable, however, because of possible simultaneity bias due to a long run dependence of the number of dealers on sales. Large sales of a particular model indicates the need for a large network of dealers to provide specialised after sales service. Looking at the figures obtained using only British cars the estimate is about the same and highly significant, probably a reflection of the pattern of sales and dealer networks prevailing before imports were a serious threat. The estimate based on the larger sample (equation 2) but with the reliability variable omitted is lower due to the high correlation (0.57) between these variables. It is interesting to note that using imports only gave no significance to this variable suggesting that when people have decided to buy a foreign car the availability of specialist dealers is not a very important consideration in the choice of model. This may be a reflection of the importance of distribution networks to the fleet market, as noted by the CPRS.* They estimate that this accounts for about 20% of the market with company-sponsored purchases representing a further 20%.

Advertising was highly significant both in explaining recent changes and the level of sales. The short term elasticity was between 0.15 and 0.23 and was fairly constant in different samples but lower using

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* p. 60

5. Implications of the Results

We can now use these results to make some rough calculations and to draw some policy conclusions for firms selling to the British car market. We shall concentrate first on the long run determinants of sales, as given by Table 1. We obviously cannot dismiss the importance of delivery dates or of guarantee period, despite the perverse result amongst the reduced sample of imports when reliability is taken into account. It is a different matter for the age of the model, which seems to make little difference. It is possible that this is because the relationship is not monotonic, and the most popular age of a design might be four or five years, at which point all the bugs have been ironed out. However it is also possible that old designs are not unpopular. The reason for introducing new models might then be in order to use new and cheaper production techniques (c.f. the Morris Minor and the Marina) or simply because the managers find it exhilarating to produce new models.

On the other hand, allowing for a wide range of choices within a particular model does attract more customers. Thus the Ford policy seems to pay off in terms of sales. Whether it pays off in terms of profits depends on the cost penalty of doing this.

It is possible to analyse the profitability of such quality variation as follows. The first-order condition for profit maximisation with respect to a quality characteristic, Z, may be written as follows.

$$\mu_Z \left\{ \frac{P - MC}{P} \right\} = \frac{1}{P} \frac{\partial AC}{\partial Z}$$

as an explanatory variable in some early regressions, on the grounds that this was an index of quality and to omit it would result in a misspecification. It was never significant, however, and engine size was dropped from the set of independent variables before the regressions reported in Tables I and II were run.

where P = price of output

MC = marginal cost

$\frac{\partial AC}{\partial Z}$ = the effect on average cost of a unit change in Z

$\mu_Z = \frac{Q}{Z} \cdot \frac{1}{Q}$, the proportional increase in sales when Z is increased by one (infinitesimally small) unit. The bracketed term on the left-hand side of the equation is known as the price-cost marginal and in a profit maximising firm producing a differentiated product will be greater than or equal to the reciprocal of the long-run price elasticity of demand (ignoring the sign). The largest estimate of the long run price elasticity of demand so far reported is around 8 (Cubbin, p.47) and therefore the minimum value for the price-cost margin ought to be 12½%, and we should be surprised if it were much more than 20%. Adding one more to the list of variants on a model should generate extra profits on increased sales of between 0.25% (= 0.06 x 0.125) and 2.2% (=0.11 x 0.2). Therefore taking the most pessimistic assumption about elasticity and price-cost margin a new model should not be added to the range unless it adds to overall average cost less than three-quarters of one per cent of the wholesale price. On the most optimistic assumptions (for a model with a price-cost margin of 20% and where the higher value for μ_Z can be assumed) the extra variant should be added on if it adds less than 2.2% to average costs.*

Similar calculations have been made for different "quality" strategies and these are reported in Table IV. The table should be interpreted as giving relative orders of magnitude only since the sensitivity of the market to different quality changes may vary slightly from segment to segment and from model to model. It should also be remembered that

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* For a firm producing similar models μ_Z should be adjusted to take account the sales that will be diverted from its own other models.

TABLE IV

Values of the increase in average cost it would be worth incurring in order to generate extra sales.

Change in quality proposed	Increase in cost as a percentage of price to manufacturer that would lead to break even.
1. Improve delivery date by one week.	½%
2. Increase guarantee period by one month.	½%
3. Reduce average age of model by one year.	- ¼%
4. Increase number of variations on basic models by one	¾%
5. Get car into next insurance group down	3⅝%
6. Improve fuel economy by 1 MPG	1%
7. Provide the typical extras as an option rather than "built in"	1⅝%
8. Increase reliability so as to reduce the average number of days off the road by one	3⅝%

Notes Based on coefficients of equation (2) of Table I (except for (8) which is based on equation (1)) Assumes a price-cost margin of 12½% which is not substantially altered by the proposed quality change. It is also assumed that firms do not collude to restrict quality improvements.

selling price per extra, which can be reaped. Offering extras at inflated prices with large mark ups over costs has traditionally been a method of price discrimination in the U.K. This is only profitable where the firms involved collude* and act in an essentially monopolistic manner

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* or have an implicit understanding

if the change considered is not infinitesimal the formula used becomes inexact. We see from the table that it is worth improving delivery dates by one week provided that this does not increase costs by more than ½% of selling price. Since increasing guarantee period by one month is equally advantageous in terms of sales generated this will also be profitable provided that the cost increase involved is less than ½%. It appears that the sales advantages from having new models are so slight or even negative that it is not worth incurring more than ¼% of the selling price to reduce the average age of the firm's stock of model designs by one year.* Indeed, according to equation 2 it is only worthwhile if costs can be reduced by ¼% through the introduction of new models. Since the average age of a firm's stock of designs is, in a steady state, one half of the lifetime of its designs, it follows that in order to reduce average age of designs by one year the firm would have to reduce the length of the replacement cycle for its designs by two years. This would increase not only design costs, but also the average level of costs for fixed plant over the model's shorter production run. It thus appears that rapid model changes in the British car market are not particularly profitable, and this is perhaps one difference from the U.S. market. The exception to this is that new models are useful where they allow the introduction of modern production techniques.

Improving the range of models offered can be profitable, but probably only if the car has been designed from scratch to allow for this possibility; otherwise costs might well be increased by more than ¾ % per model necessary to break even. It does not appear that providing built in extras without the option of a stripped down version is particularly profitable unless there are substantial economies, amounting to 1⅝% of

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* The exception is the Which sample, where it is worth incurring ¾% of selling price.

for this is undoubtedly the past increase in service charges made by garages and worries about further increases in the future.

Drawing conclusions from table I about policy with respect to the number of dealers and advertising is a little more difficult. There is some worry here about the possibility of simultaneous equation bias*, since advertising and dealer networks may expand proportionally to sales, although most probably with some time lag.

Table II helps us to avoid this difficulty. The advertising coefficient gives the answer to the question, "Given the characteristics of the product, and given the previous year's sales, what is the relationship of current sales to current advertising?" We obtain a short-run elasticity of demand with respect to advertising of 0.23 for the full sample. The figure obtained by two-stage least squares by Cowling and Cubbin was 0.3 and their long-run elasticity was 0.91. Again assuming a price-cost margin of 12½% and no collusion between firms over advertising this suggests an optimal level of 0.91 x 12½% = 11.4%.**

However, the figures of 0.91 should really be corrected to allow for the fact that advertising for one model may well attract customers away from the same firm's other models. It is impossible to say where customers will be attracted from, but it seems a reasonable neutral assumption to make that they will be attracted from all firms in

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* Strictly speaking, of course, this bias will affect all the coefficients in the equation.

** Using the first-order condition for the profit-maximising advertising intensity under monopolistic competition $\frac{A}{R} = \eta_A \left(\frac{P - MC}{P}\right)$. See Cowling (ed.) η_A = advertising intensity of demand.

over such extras. In a more competititve environment where import penetration is significant and the importers do not take part in such collusion having high mark ups on extras will be unprofitable due to loss of sales to the foreign manufacturers; so where a radio or a heated rear windscreen is offered as an optional extra (and it should probably be optional rather than built in) the percentage profit margin should probably be not much greater than that on the whole car.

Is it possible to improve fuel economy by 1MPG at an expenditure of less than 1% of selling price? If so, it is worth doing. The success of the Escort Popular suggests, amongst other things such as the demand for stripped down models, that people are willing to accept small reductions in horsepower to improve fuel economy.

However, the two areas where there is a bigger margin for increases in costs in order to ensure a profitable increase in quality are in insurance grouping and reliability. There is not a great deal that can usually be done about insurance group for a given type of car but improving safety and reliability and keeping down spares costs should help. Alternatively a firm could sell its own cheap insurance for buyers of its cars.

There is probably more scope for improving reliability than there is for having much impact on insurance grouping. Reliability is affected by simplicity of design and use of well-proved components. New models are often unreliable, and this is another reason for not being too hasty about introducing them. Good industrial relations and rigorous testing procedures will also tend to improve the reliability of cars. According to the results of Table 2, this variable, together with fuel economy, is becoming more important to consumers. A major reason for

no economic rationale for this disparity unless it is believed that elasticity of demand with respect to advertising declines considerably with sales or there is excess demand for British cars or else British manufacturers have an implicit or explicit understanding, not only with each other but also with importers, not to engage in advertising competition.* Another possibility is that their estimate of the effect of advertising is much lower than the one assumed here, possibly because they ignore the long-run effect of advertising. Unless either collusion or fear of retaliation is assumed the figure of 0.92% of sales for the advertising intensity implies, for a price-cost margin of 12½% an assumed advertising elasticity of demand of 0.0736.** This is much lower than the values typically observed in our equations (even those in Table II which are not subject to the criticism of possible simultaneous equation bias.)

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* Or else feel that increased advertising intensity would bring forth retaliation in kind.

** Perhaps British Leyland have realised this, as they now seem to be advertising more intensively, especially on T.V.

proportion to their share of the market.* Thus if a firm's other cars constitute 20% of the market the relevant elasticity of demand is one which represents the sales gained from competitors, which will be only 80 % of total sales gained. When this adjustment is made the optimal level of advertising drops to 9½% of sales revenue. Notice that the figure is only as low as this for the larger firms in the industry.

If we now consider a strategy of maximising the profits generated by British-assembled cars we must allow for self-cancelling effects between British manufacturers. Assuming an import penetration of 35% this produces an optimal advertising intensity for British assemblers working in collusion of 4% of sales. (If the object were not maximisation of profits but of British sales the required advertising would be larger than this figure, of course).

It may be interesting to compare these with the actual advertising/sales ratios observed. (In calculating this figure, a proportion of the firm or "range" advertising was added to the advertising of individual models.) Revenue was estimated by multiplying sales by price which was adjusted to take account of dealers' discount. Finally, an adjustment was made to take into account the fact that the sales figures only referred to a 9-month period, but the advertising figures covered a whole year. Thus, advertising on the Mini worked out at £291,300, revenue for 12 months was calculated at £53.1m, giving an advertising/sales ratio of 0.55%. The simple average ratio for British cars was 0.92% compared with 1.36% for foreign models. One can explain this difference partly in terms of the lower level of sales per model of imports, but there is

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* Strictly, their share of the market excluding the model under consideration. In this calculation we are also ignoring extra sales generated by expanding the total market.

6. Summary and Conclusions

For a sample of seventeen British and fifty-one foreign cars we have collected data on various characteristics, prices, advertising and sales in order to examine various hypotheses concerning the determination of import penetration in the United Kingdom car market. For all the British cars and a subsample of twenty three foreign cars (the Which? sample) we also obtained data on reliability.

First we examined how the British sample and the two foreign samples differed from each other. In general it was found that the Which? subsample of foreign cars was superior to the full sample of foriegn cars. The major differences favouring British cars were found in the number of dealers, the number of variants in the model range, length of guarantee period offered and delivery dates. The major differences favouring foreign cars were reliability, and newness of model design.

We then estimate the effect of these differences on sales and found that they varied somewhat in statistical significance according to the sample used. Only amongst the full sample of imports and excluding British models, for example, was the age of the model design a significant variable. In all cases where the sample size was larger than twenty, however, the reliability variable was statistically significant (with the expected sign) in explaining sales.

Using the estimated coefficients were then able to calculate the conditions under which it would be profitable to change the current level of quality characteristic, such as the number of variants in a model range, the inclusions of built in extras, and fuel economy. The type of change most likely to be profitable appeared to be the improvement

of reliability. This conclusion is strengthened when consideration is given to the fact that the Which? sample of foreign cars appeared to be more reliable than the British cars in the sample.* This implies that some scope exists for the improvement in reliability.

Another way in which profitability might be raised is through increased advertising. This conclusion is more tentative, however, and depends on an assumption of little or no retaliation to increased advertising intensity. (Currently British firms advertise on average more per model but less per unit of sales revenue than importers).

Finally, we note that the variables which have been most important in recent changes in market share have been fuel economy, price, advertising and reliability. The increase in petrol prices is probably responsible for a shift to more economical models, and greater emphasis on reliability may well owe something to the availability of the fairly objective information contained in Motoring Which? and other publications.

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* We assume that the Which? sample tended to contain the most popular foreign cars. Comparison of the average characteristics of the Which?and the full sample of foreign cars tends to confirm this. Hence we cannot say that British cars are less reliable than all foreign cars, only the (presumably) biased Which? sample.

Appendix (1)

The variables used are defined as follows

1. Sales (Q_{75}). The number of new registrations in the first nine months of 1975. Source SMMT.

2. Lagged sales (Q_{74}). The number of new registrations in the first nine months of 1974. Source SMMT.

3. Delivery. The average delivery time in weeks based on a cross section of the retail trade and manufacturers' figures. Source What Car?

4. Guarantee. period of the guarantee in months. Source What Car?

5. Range. The number of variants of the same model, for example, there are 19 varieties of Cortina. Source What Car?

6. Insurance Group. Source What Car?

7. M.P.G. Average miles per gallon. No allowance has been made for differences in fuel grade. Source What Car?

8. Price. Price including VAT and car tax. This was computed as the average of the figures for February, April, June, August and September 1975, and then adjusted for additional equipment included in the purchase price of some models, as follows: Seat belts £17; Reversing light, £11; Heated rear window, £26; Radio, £60; Exterior mirror, £5. Source What Car?

9. No. of dealers. Number of offical dealers appointed by manufacturer. Source What Car?

10. Advertising. Total advertising expenditure during the first nine months of 1975. Range advertising was averaged over the models in the range and added to the figure for model advertising. Source MEAL.

11. No. of extras. The number of extra items of equipment included in the purchase price. These are
(1) seat belts, (2) reclinding seats, (3) reversing light, (4) heated rear window, (5) radio, (6) exterior mirros, (7) overdrive, (8) 5-speed gearbox. Source What Car?

12. Yrs.intro. Number of years since the introduction of the model. Source Motorists Guide

13. Av.Off Rd. Average number of days spent off the road in a garage for repairs or servicing. Source Motoring Which?

Appendix (2)

Price-quality relations

	Log Price	Insurance Group	MPG
Constant	4.71 (7.55)	-0.27 (-0.06)	53.6 (4.51)
Guarantee		-0.15 (-2.55)	0.19 (1.11)
Max speed	0.02 (3.65)	0.06 (1.70)	-0.12 (-1.25)
0 - 60	0.007 (1.22)	-0.02 (-0.56)	0.24 (2.61)
Tank cap.	0.03 (1.98)	0.04 (0.37)	-0.51 (-1.86)
Length	0.0004 (0.29)	-0.002 (-0.17)	0.03 (1.05)
Width	0.002 (0.28)	0.03 (0.69)	-0.09 (-0.85)
Boot cap.	0.003 (0.84)	0.003 (0.14)	-0.03 (-0.49)
Shoulder width	0.004 (0.46)	-0.04 (-0.68)	-0.07 (-0.44)
No. of seats		-0.12 (-0.38)	0.36 (0.41)
Rear Suspension	0.07 (1.75)	-0.24 (-0.87)	1.71 (2.25)
Engine BHP	-0.002 (-1.08)	0.01 (0.74)	0.07 (1.65)
Engine Size	0.0002 (1.82)	0.0007 (0.96)	-0.007 (-3.78)
Seat Belts		0.15 (0.52)	-0.77 (-0.97)
Reclining Seats		-0.06 (-0.21)	-0.73 (-0.84)
Reversing light		0.57 (1.68)	-0.57 (-0.61)
HRW		-0.08 (-0.29)	0.13 (0.17)
Radio		-0.06 (-0.16)	1.45 (1.36)
Exterior mirror		-0.75 (-1.10)	-1.46 (-0.77)
5-speed gearbox		0.43 (0.79)	-2.08 (-1.38)
Doors		-0.15 (-1.11)	0.25 (0.66)
F	20.2	8.74	19.8
R^2	0.78	0.79	0.89

Appendix (3)

List of models used in the analysis.

British models

British Leyland

- Mini
- Allegro
- Marina
- Maxi
- 18/22
- Triumph 2000/2500
- Toledo/1500
- Dolomite Sprint

Chrysler U.K.

- Imp
- Avenger
- Hunter

Ford

- Capri
- Cortina
- Escort
- Granada/Consul

Vauxhall

- Viva/Magnum
- Victor range

Imports

Skoda*

Daf*

Chrysler France

- Simca 1000
- Simca 1100*
- Simca 1301/1501*
- 180/2 litre

Citroen

- Ami/2CV
- Dyane
- GS*

Peugeot

- 104
- 204
- 304*
- 504*

Renault

- R4*
- R5*
- R6*
- R12*
- R15/17 Coupes*
- R16*

Wartburg

BMW 1602/2000

Opel

- Kadett
- Ascona
- Manta
- Rekord
- Commodore

Volkswagen-Audi/NSU

- Audi 80
- Audi 100*
- VW Beetle*
- VW Passat*

Alfa Sud

Fiat

- 126
- 127*
- 128*
- 131
- 132

Datsun

- Cherry*
- Sunny
- Violet
- Bluebird*
- Laurel
- 240 K.G.T.

Honda Civic

Mazda

Toyota

- Corolla*
- Carina/Corona
- Celica

Moskvitch

Lada

Saab

- 95/96*
- 99*

* Denotes a model included in the "Which?" sample of imports.

References

(1) Central Policy Review Staff, The Future of the British Car Industry, London, H.M.S.O., 1975.

(2) Consumers Association, Motoring Which?, July 1974 and October 1975.

(3) Cowling, K.G. (ed.) Market Structure & Corporate Behaviour, London: Gray-Mills 1972.

(4) Cowling and Cubbin, "Price, quality and advertising competition: an econometric investigation of the U.K. car market", Economica, 38, (1971), 378-394.

(5) Cowling and Rayner, "Price, quality and Market Share", Journal of Political Economy, 78 (1970), 1292-1309.

(6) Cubbin, J.S., "Quality change and Pricing Behaviour in the United Kingdom Car Industry 1956-1968", Economica, 42, (1975), pp.43-58.

(7) Fisher, F.M. "Tests of Equality between sets of coefficients in Two Linear Regressions: An expository Note", Econometrica, 38, (1970), pp.361-366.

(8) Goldfield S.M. and R.E.Quandt, Nonlinear Methods in Econometrics, Amsterdam, North-Holland, 1972.

(9) MEAL (Media Expenditure Analysis Ltd), Quarterly Digest of Advertising Expenditure, 3rd Quarter 1975.

(10) Motorists Guide to New and Used Car Prices, October 1975.

(11) Nerlove, Mac, Estimation and Identification of Cobb-Douglas Production Functions, Amsterdam, North-Holland, 1965.

(12) Rao, P. and R.L.Miller, Applied Econometrics, Belmont, California, Wadsworth, 1971.

(13) Schmalensee, R., The Economics of Advertising, Amsterdam, North-Holland, 1972.

(14) Society of Motor Manufacturers and Traders, Monthly Statistical Review, October 1975 and October 1974.

(15) What Car? Haymarket Publishing Ltd., various issues.