The Elasticity of Demand for Petrol in Ireland: A Comment[1]

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IN an article in this journal (April 1972) W. K. O'Riordan estimated the price elasticity of petrol to be between minus 1·2 and minus 1·7.[2] These values are surprisingly high. Petrol is expensive but the other major expenses in running a car, insurance, depreciation, road taxes, and maintenance, account for the greater part of the car owner's annual bill, perhaps as much as 75 per cent. With such a heavy annual investment in the privilege of driving, the motorist can hardly be expected to cut down his mileage significantly because of a petrol price increase. Petrol, we would suspect, is unlikely to be very price-elastic.

Dr. O'Riordan's study is important for a country which raises a considerable part of its indirect tax revenue from petrol sales taxes: if the elasticity is around the quoted $-1{\cdot}5$, then any revenue gains from a petrol tax increase would be eradicated by the resulting decline in petrol consumption. On the other hand, if elasticity were low, as one would expect, petrol would continue to be a good source of extra revenue. The article deserves some scrutiny.

The author selects, with some care, as factors likely to influence petrol consumption (Q), income (Y), petrol price (P), (both in absolute and relative versions), stock of cars (C), a "dieselisation factor" (D) to account for commercial vehicles' switch-over from petrol to diesel fuel, and the price of public transport (P_t). Data on these variables, in time series of 17 years, are highly multicollinear, most of the

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2. O'Riordan, W. K., "The Elasticity of Demand for Petrol in Ireland", Dublin: *The Economic and Social Review*, Vol. 3, No. 3, (April 1972).

variables being highly correlated with income Y. (See Table 1.) Multicollinearity of this order can aggravate specification problems if any are present.

Most of the problems that arise in this study can be traced to the treatment of dieselisation and we shall look at this in more detail. According to the article the switch to diesel fuel in the period caused a decline in commercial vehicle petrol consumption. Data on the change-over being scant, Dr. O'Riordan constructs a model of dieselisation where the declining commercial demand for petrol is given by $R'D$, R' being a constant and D (called the dieselisation factor), declining over the period. In this sub-model D is a function of petrol demand Q, and of diesel demand Q_d, both of which are measurable. Hence D is known; R', the constant, is unknown.

In the regression, one of the independent variables is to be the stock of *private* cars so that properly speaking the dependent variable should be the amount of petrol consumed *privately* $Q-R'D$. In multiplicative form, a reasonable model could be then specified as $Q-R'D = b_0 Y^{b_1} P^{b_2} C^{b_3} P_t^{b_4} U$ (where U is the error term). But the constant R' is unknown and Dr. O'Riordan is forced to use *total* petrol consumption Q, private plus commercial, as the dependent variable. Dieselisation has still to be accounted for and the author, with some misgivings, includes D as an explanatory, multiplicative variable on the right hand side. Thus, the actual model used in the study becomes $Q-k = b_0 Y^{b_1} P^{b_2} C^{b_3} D^{b_4} P_t^{b_5} U$ (The constant k is brought in to avoid constraining the regression to pass through the origin).

The model is estimated in log form: $\log (Q-k) = \log b_0 + b_1 \log Y + \ldots$. Here further trouble arises. In the data, D declines steadily and is given as zero from 1963 onward. This means that during the regression, $\log D$ becomes minus infinity and the model degenerates rather nonsensically to $Q-k = 0$ or $Q=k$. Obviously the degenerate model with $D=0$ and $Q=K$ could not have given the close fits quoted with $R=\cdot 99$. The author's regression programme must have escaped the collapse of the model in some way, probably by dropping D from the specification, that is, taking $D=1$ from 1963 onward. All of Dr. O'Riordan's high-elasticity estimates come from this multiplicative form of the model.

The linear form of the model, $Q=b_0+b_1Y+\ldots$, fares better. D (or $R'D$) is now an additive term. This model shows an extremely good fit ($R=\cdot 998$) and we note that petrol price is not significant in explaining consumption.

An alternative specification, proposed here, which would avoid using D entirely, would regress total petrol sales on the total stock of petrol-driven vehicles, cars plus goods vehicles, other dependent variables being income Y, petrol price P, and the price of public transport P_t. A quick incursion into Irish fuel statistics in search of data on petrol-driven goods vehicles reveals a surprising fact. Although diesel consumption grew rapidly, the stock of petrol-driven commercial vehicles was virtually the same in 1963 as in 1953. (See Table 2.) Thus, it is safe to say that commercial petrol consumption did not taper off to zero as the $R'D$ model would imply. The change to diesel occurred mostly for heavier vehicles (see Table 3), but the main stock of lighter petrol-driven goods vehicles stayed fairly constant. To obtain the total stock of petrol-driven vehicles we can view each light-goods vehicle as one and a half "equivalent cars" (goods vehicles use 1·5 times as much petrol per mile as a car. However, relative mileages per year are unknown.) For want of more data, we shall assume that the stock of petrol-driven goods vehicles stayed roughly constant over the period at the 1953 and 1963 level, at about 30,000 (making 45,000 "equivalent cars"). We can now regress total petrol consumption Q on income Y, petrol price P, total stock of actual plus equivalent cars C', and the price of public transport P_t.

The results of this model are given in tables 4 to 7. In both linear and multiplicative versions of this model using both relative and absolute prices, price-elasticity lay in the range 0 to minus 0·75. Adding a constant k to the model (which is questionable in any case) showed price-elasticities in the same range and did not improve the regressions markedly.

The findings presented here suggest that petrol has a low price-elasticity. The possible implications for fiscal policy should be clear.

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TABLE 1: *Correlation Coefficients of the Variables*

	Q	*Y*	*PA*	*PR*	*C*	*D*	*PT*
Q	1·00	·99	·87	·36	·97	—·77	·39
Y	·99	1·00	·92	·48	·99	—·85	·29
PA	·87	·91	1·00	·77	·94	—·95	—·77
PR	·36	·48	·77	1·00	·53	—·79	—·65
C	·97	·98	·94	·52	1·00	—·87	·22
D	—·77	—·85	—·95	—·79	—·87	1·00	·17
PT	·40	·29	—·77	—·65	·22	·17	1·00

TABLE 2: *Petrol-engined Goods Vehicles; 1953 and 1963*

Type of Vehicle	*Number, in thousands*		*Fuel Consumption*	
	1953 (est.)	*1963*	*m.p.g.*	*Gals., mile*
Petrol-driven goods vehicles, unladen weight				
Up to 16 cwt.	10·0	12·4	30	·033
16 cwt. to 2 tons	15·0	16·6	20	·050
2 tons to 3 tons	5·1	1·1	12	·080
3 tons and over	1·0	0·5	9	·110
	31·1	30·6		
Miscellaneous vehicles	0·3	0·0	15	·066
Total "goods transport, petrol"	31·4	30·6		
Weighted average fuel consumption				·052 (1953)
				·045 (1963)

Source: J. L. Booth: *Fuel and Power in Ireland: Part IV.* Dublin: The Economic and Social Research Institute. Paper No. 37, February, 1967.

TABLE 3: *Diesel-engined Goods Vehicles; 1953 and 1963*

Type of Vehicle	*Number, in thousands*		*Fuel Consumption*	
	1953 (est.)	*1963*	*m.p.g.*	*Gals./mile*
Diesel-driven goods vehicles, unladen weight				
Up to 16 cwt.	0·0	0·0	—	—
16 cwt. to 2 tons	0·0	1·9	22	·045
2 tons to 3 tons	1·5	3·2	14	·070
3 tons and over	0·7	9·1	10	·100
Miscellaneous vehicles	0·3	1·2	13	·075
Total "goods transport, diesel"	2·5	15·4		
Weighted average fuel consumption				·079 (1953) ·085 (1963)

Source: J. L. Booth: *Fuel and Power in Ireland: Part IV.* Dublin: The Economic and Social Research Institute, Paper No. 37, February, 1967.

Tables 4 and 5 present the coefficients in regressions of the form:

$$Q = b_0 + b_1 Y + b_2 + b_3 C' + b_4 P_t$$

TABLE 4: (*Price*=*PA*)

Const	*Y*	P_A	*C′*	P_t	R^2
−78·1 (−3·38)	0·15 (2·79)	−0·054 (−0·35)	0·16 (2·24)	0·44 (1·89)	·991

TABLE 5: (*Price*=P_R)

Const	*Y*	P_R	*C′*	P_t	R^2
−4·6 (−0·13)	0·18 (4·23)	−0·49 (−2·33)	0·14 (2·44)	−0·043 (−0·17)	·993

Tables 6 and 7 present the coefficients in regressions of the form:

$$\log Q = \log b_0 + b_1 \log Y + b_2 \log P + b_3 \log C' + b_4 \log P_t$$

TABLE 6: (*Price*=P_A)

Const	*Y*	P_A	C'	P_t	R^2
−5·4	1·14	−0·17	0·39	0·28	·992
(−5·2)	(3·76)	(−1·06)	(2·48)	(1·53)	
−5·03	1·41	−0·39	0·42	—	·990
(−4·75)	(5·46)	(−4·3)	(2·61)	—	

TABLE 7: (*Price*=P_R)

Const	*Y*	P_R	C'	P_t	R^2
−1·52	1·38	−0·74	0·31	−0.25	·996
(−1·15)	(6·26)	(−3·8)	(3·22)	(−1·28)	
−2·83	1·22	−0·50	0·33	—	·995
(−3·25)	(6·60)	(−7·31)	(3·44)	—	

Notes: All logs are to base *e* (this affects only values of the constants in Tables 6 and 7). C', the stock of actual plus equivalent cars, is $C+45$. Data for the regressions are given in O'Riordan's article.