tion is not at base responsible for the observed negative relationship. However, since the pollution measures employed vary among these investigations, precise comparisons are not possible. Nevertheless, estimates of marginal property value losses calculated in the manner of Ridker and Henning vary between roughly 250 and 1000 dollars per residential unit for ten to fifteen per cent increments in the mean values of the various pollution measures used.

To summarize, we believe that Freeman has incorrectly assessed the merits of property value studies. This is because he has, understandably, in view of the Ridker-Henning explanation of their calculations, misinterpreted these studies as purporting to measure rent gradients. Freeman is correct when he asserts that rent gradients have not been measured. But it does not follow that such studies are useless. We have argued that there is a procedure by which the results of property value studies can, in principle, be used to approximate equilibrium rent changes due to environmental quality changes, and that, even if there were no such procedure, these studies produce the only reasonably hard answers yet obtained on individual willingness to pay to abate pollution.

We nevertheless hasten to add that Freeman's comment and our reply have focused in the main on theoretical issues. It must be stressed that there are many practical problems of specification, data, estimation, and computation which render difficult applications of the approach discussed above.

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SOME ESTIMATES OF PRICE AND EXPENDITURE ELASTICITIES OF DEMAND FOR MARIJUANA AMONG U.C.L.A. STUDENTS

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It is the purpose of this note to add some economic considerations to the growing literature on drug use by offering some estimates of the price and expenditure elasticities of demand for marijuana.

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* This note has benefited from comments by Barry Chiswick, Robert Michael and Robert Meyer, Jr. The authors are responsible for any remaining errors.

The Sample and the Data

The data were gathered through the use of an anonymous mail questionnaire. Out of the 926 respondents, 52.8 per cent claimed to have never

tried marijuana and were classified as "non-smokers," while 47.2 per cent said they have tried marijuana and were classified as "smokers." Out of the 437 "smokers," 184 were "purchasers" and 253 were "non-purchasers," obtaining marijuana only from friends.

The intent of the questionnaires was to obtain data with respect to how much marijuana [1] in "lids" (ounces) a consumer, at a given income, is purchasing and would be willing to purchase when facing a number of alternative prices.[2]

Each individual purchaser was thus asked to trace out his particular demand function. The objections to the derivation of this type of hypothetical demand function are well known: people have not thought out in advance what they will do when confronted with such a hypothetical situation, snap judgments cannot inspire great confidence, expectation of a particular action may diverge from actual action when confronted with the concrete situation (Baumol, 1968). Additional data on actual prices and the corresponding quantities demanded were also collected.[3]

Total monthly expenditures were used as proxies for income in the estimation of elasticities. This is frequently done in most budget studies because measured income is known to be, in most cases, an unreliable estimate of permanent income.

The Model and Results

Two alternative functional forms were used in the estimation of an average individual's demand curve for marijuana: the double log and the linear. It follows that,

$$\log\ (Qm) = b_0 + b_1\ \log\ (Pm) + b_2 \log\ (E) + b_3\ log\ (S) + e \qquad (1)$$

where Qm = quantity of marijuana in lids/month, Pm = price of marijuana in \$/lid, E = mean monthly total expenditures in dollars,[4] S = expenditure dispersion measure, the b's are parameters to be estimated and e is the error term.

[1] Note that the unit of consumption is a "lid" (or ounce of dried marijuana).

[2] Students were asked to indicate how much their *use* of marijuana changes with variations in prices per unit of time so the increased quantity demanded at lower prices would not represent stocking up or hoarding.

[3] Stigler (1963, pp. 45–56) suggests that when quizzed, individuals tend to see fewer substitution possibilities than when confronted with a higher price. Consequently demand curves based on market surveys tend to be less elastic than empirically estimated demand curves using marking data.

[4] The sample was partitioned into six expenditure groups, giving a mean monthly total expenditure (E) for each group as well as a dispersion measure (S).

The advantages of using a double log function are obvious. The price elasticity of demand is simply b_1 and the expenditure elasticity is b_2. It has been used repeatedly with success. The basic drawback for our purposes is the assumption of constant elasticities.

To overcome this difficulty and to obtain an idea of the possible variations in elasticities, the linear form was also used,

$$Qm = c_0 + c_1\ Pm + c_2E + c_3S + d \qquad (2)$$

where the explanatory variables are the same as in (1), the c's are the parameters to be estimated and d is the error term. In this case the price and expenditure elasticities of demand are simply:

$e_p = \partial Qm/\partial Pm \cdot Pm/Qm$ and
$e_E = \partial Qm/\partial E \cdot E/Qm$.

The regression results for both functional forms are shown in table 1. The determination coefficients (R^2) are rather low because the information consisted of raw budget data. The coefficients estimates appear with the standard errors in parentheses.

For both functional forms on the basis of a two-tail t-test, only price is statistically significant at a 5 per cent level of significance. As expected the average individual's demand curve for marijuana derived from purchase data as opposed to market survey data exhibits a greater degree of elasticity (i.e., -1.013 vs. -0.365 for the double-log; -1.51 vs. $-.51$ for the linear at the going market price of 10 dollars). Also, by the R^2's, which have been made comparable, the linear function seems to provide a little better fit to the data.

In both cases the simultaneous equation bias introduced in the estimation of the expenditure elasticities (Summers (1959)) is positive leading to an overstatement of these elasticities. It is quite likely, therefore, that the price elasticities of demand are downwardly biased.[5]

The estimated expenditure elasticities, for both market survey and actual purchase data, by contrast are not significantly different from zero (at a 5 per cent level). This suggests at first glance that an individual's consumption of marijuana depends on factors other than total expenditures.

Alternatively, it is quite possible that this result may be a function of other factors; most notably (1) total expenditures have been mismeasured or (2) all prices are not held constant. More specifically the "cost of illegality or of incarceration" is probably not constant over the range of expenditure

[5] This statement follows from the zero homogeneity property of the demand function, i.e., the sum of the own price elasticity, the cross elasticities and the income elasticity must be zero.

TABLE 1. — ESTIMATED REGRESSION COEFFICIENTS

Items	Double-Log		Linear	
	Market Survey Data	Actual Purchase Data	Market Survey Data	Actual Purchase Data
Constant	1.815 (0.409)	2.609 (1.017)	2.117 (0.145)	3.236 (0.509)
Price Elasticity	−0.365 (0.058)	−1.013 (0.300)	−0.070 (0.006)	−0.225 (0.046)
Expenditure Elasticity	−0.252 (0.225)	−0.311 (0.267)	−0.0005 (0.0006)	−0.002 (0.00015)
Dispersion Elasticity	0.061 (0.167)	0.404 (0.357)	−0.0004 (0.0108)	0.036 (0.025)
R^2	0.0591	0.0764	0.1414	0.1366

groups in our sample. It is quite likely that the higher an individual's permanent income prospect the higher the cost of incarceration and consequently the less likely will be the willingness to risk the act of purchase (or consumption). To the extent that permanent income prospects at present and total expenditures are positively correlated, then we might expect the tendency to increase the consumption of marijuana with total expenditures to be compensated by the higher cost of incarceration and the consequent lower willingness to pay this price in the face of such high opportunity costs.

Conclusions

(1) The individual college student's demand curve for marijuana exhibits the standard characteristics prescribed by conventional economic theory.

(2) Estimates of price elasticities around the going market price ranged from −0.40 to −1.51 depending on the type of data used and on the functional form. Given that these figures are downwardly biased, it is quite likely that a price elasticity slightly greater than one would give a reasonable estimate.

(3) The price elasticity data suggest that policies designed to restrict supply, such as "operation intercept," may be effective in reducing the quantity consumed of marijuana. However, rising prices of marijuana may also encourage substitutes to other more harmful drugs.

(4) The expenditure elasticity is seen to be very close to zero.

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ESTIMATING THE DURABILITY OF CONSUMERS' DURABLE GOODS

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In 1957 Stone and Rowe (1957) presented a model of demand for consumers' durables. About three years later, they introduced some modifications in their model, following a suggestion by Nerlove (1960), to allow for the estimation of the rate of depreciation consistently with the other parameters of the model (1960). The purpose of this note is to improve the estimating procedure. This procedure is markedly changed due to the fact that we use our a priori knowledge of the covariance structure of the error term of the reduced equation. The maximum-likelihood estimating procedure used allows for the nonsphericalness of the disturbance, leading to consistent estimates.

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* This note was written when the author was at the Université Catholique de Louvain. He is now an Economist at the International Bank for Reconstruction and Development. The author benefited from invaluable discussions with Professors L. Phlips and P. Balestra.