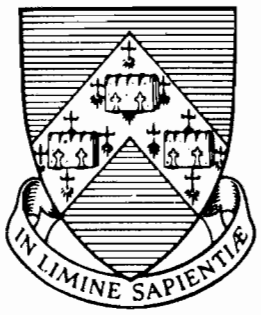

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Factors Influencing The Consumption of Alcohol and Tobacco - A Review of Demand Models

by

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DISCUSSION PAPER 17

FACTORS INFLUENCING THE CONSUMPTION OF ALCOHOL AND TOBACCO - A REVIEW OF DEMAND MODELS.

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ABSTRACT

There has been considerable debate about the need for Government action in relation to the consumption of alcohol and tobacco. The policies discussed include tax changes, advertising controls, health education and regulation of outlets. In order to develop effective policies, an understanding of the factors which influence consumption of these substances is necessary. There have been many attempts to estimate models of consumer demand for alcohol and tobacco. The purpose of this paper is to review several of these studies.

Previously estimated models have varied in a number of respects. The differences between previous studies are examined in three sections. Firstly, the underlying demand theory and some aspects of specification employed in the empirical studies are explored. Secondly, the aspects of the main variables and their policy relevance are discussed. Thirdly, some results of recent studies are compared and the statistical procedures that may help to choose between competing models are considered. Thus a framework for further analysis can be devised. Finally some concluding remarks are made on the advantages and disadvantages of using demand models for policy formulation.

INTRODUCTION

There has been considerable debate about the need for preventive policies in relation to the consumption of alcohol and tobacco. The role of smoking and alcohol misuse in health problems is recognised in the White Paper, 'Prevention and Health' (Parliamentary Expenditure Committee, 1977) and the Government's policy on smoking is to:

> "aim to discourage people from smoking or take up the habit"
>
> (Hansard, 1984)

Attitudes to alcohol consumption are not so clear. The Government has registered concern over the rising levels of alcohol misuse and stated in "Prevention and Health, Drinking Sensibly" that:

> "The recent sharp increase in misuse as measured by a variety of indicators seems clearly to be linked with the equally marked rise in overall consumption of alcohol that has occured in the U.K. in recent years".
>
> (DHSS, 1981)

As trends in the levels of consumption are linked with health problems, it therefore seems necessary to consider the factors that influence the consumption of alcohol and tobacco in order to inform the debate on prevention policies.

One method of investigating the consumption of alcohol and tobacco has been the specification and empirical testing of demand models. Such models are designed to provide estimates of the relationship between levels of consumption and the variables thought to influence these levels and have been used to measure directly the impact of preventive health measures, e.g. health warnings and cigarette consumption.

Several such papers will be reviewed below. The purpose of this review is not only to consider variations in the parameter estimates for such models but also to consider the methodology employed with a view to constructing new models on recent data in a way that is useful for the discussion of prevention policies.

Trends in alcohol and tobacco consumption in the U.K. have in general diverged over the last 20 years. Per capita tobacco consumption has fallen by 31 per cent since 1960, per capita pure alcohol consumption has risen 54 per cent in the same period. Obviously different factors may influence these trends in consumption and it is worthwhile comparing models of these substances. Both commodities are linked with health problems and both can be considered to be addictive, although of different degrees (see Office of Health Economics, 1981, for a discussion of the addictive nature of alcohol). There is also some association between consumption of alcohol and tobacco; heavy drinkers are also more likely than average to be heavy smokers (General Household Survey, 1982).

It may therefore be useful to bring together some of the elements of the parallel debates about the factors that influence consumption and the policies that are necessary to control this consumption. The model and variable specifications used to study both commodities will be considered together.

The primary concern of this paper is to examine the factors influencing consumption in the U.K. Emphasis is therefore given to studies using U.K. data. Models of consumption for other countries are however important especially when considering the methodology employed.

Previously estimated models have varied in a number of respects. In the first section of this paper the underlying demand theory and some aspects of specification employed in the empirical studies are explored.

The studies differ not only in the number of variables which are included, but also in the method and data used to construct the variables. The second section of the paper considers the main variables, including discussions of their policy relevance. The third section of the paper reviews results of recent studies, some of the statistical problems encountered in the demand models, and some of the statistical procedures that may help to choose between competing model specifications. Thus a framework for further analysis can be devised. Some concluding remarks are offered in the final section on the advantages and disadvantages of using demand models for policy formulation.

1. MODELS: THEORETICAL BASIS AND IMPLEMENTATION

The demand functions previously estimated can most generally be described as relating the quantity of the commodity consumed to the price of the commodity, price of all other goods, income and a set of other factors. The specifications of these and other factors, e.g. advertising, is obviously crucially important in obtaining unbiased and consistent estimates of the price and income coefficients as well as in correctly estimating the importance of these other factors. The primary concern of this sector is, however, the examination of the theoretical basis of the models underpinning the relationship between the demand for alcohol and tobacco and the variables considered to influence it, and their implementation in empirical analysis. The type and construction of the variables involved in the estimatable model are considered in the next section.

1.1 Theoretical Foundations

Deaton and Muellbauer (1980) in their study of economics and consumer behaviour stated that:

> "... the theory is used in a highly cavalier fashion. It is called upon when convenient, ignored when inconvenient and relatively little attention is paid to the problems of moving from theoretical abstration to empirical reality".

The usual demand theory starts from the premise that consumers maximise their utility or satisfaction from the goods they purchase subject to the limitations of their income. The individual's demand for any one good (like alcohol or tobacco) is related not only to its own price but to the prices of all other goods, income and possibly other factors. This can be written for, say, the first of n goods as:

$$Q_1 = f\ (P_1,\ P_2 \ldots P_n,\ Y,\ Z) \qquad (1)$$

Where Q_1 is the quantity consumed of the first good,

P_1 is the price of the good,

$P_2 \ldots P_n$ are the prices of all other goods,

Y is income

and Z is a number of other relevant factors.

Equation (1) cannot be estimated as it stands. It is necessary to choose a functional form. Another choice which must be made is whether to estimate the equation by itself or as part of the whole demand system.

Economic theory provides some results on the properties of sets of equations like (1). These are usually referred to as the adding up constraint, homogeneity, symmetry and negativity. The adding up constraint is simply that the sum of individual expenditures implied by the set of demand equations should equal the total budget (income). The other three properties are more technical in nature and are discussed by Deaton and Muellbauer (Chapter 2).

Once it had been decided whether to estimate only a single equation or the complete set of equations, and functional forms have been specified, the relationships between the properties of the model to be estimated and economic theory can be explored.

Although the detailed examination of data problems will be discussed at a later stage, the nature of the data can influence the type of theory that will be relevant. In particular, with some sets of time series observations it is useful to incorporate adjustment or habit forming processes in the theory of behaviour, usually by the inclusion of past values of variables.

We now consider the commonly used functional forms, the choice between single equations and complete systems and some dynamic models devised for time series applications. Separate consideration is then given to studies using disaggregated time series and cross sectional data.

1.2 Functional Forms

Equation (1) only represents the existence of a relationship and gives no guidance to its mathematical form. The functional form is therefore left to be decided by empirical testing and/or considerations of e.g. convenience of interpretation. It is worth considering the economic implications of some of the most common forms imposed while noting that these are often selected for ease of estimation and analysis and do not exhaust the possible forms of the equation.

The most common forms considered are the linear, semi-log and log linear forms. The log linear is derived from the model:

$$Q_1 = aP_1^{b_1} P_2^{b_2} \ldots P_n^{b_n} Y^c Z_1^{d_1} \ldots Z_m^{d_m} \qquad (2)$$

where Q, $P_1..P_n$Y, Z are defined as in (1). When logs are taken of both sides the models become linear in parameters and can be estimated by ordinary least squares (OLS) methods in the form:

$$\ln Q_1 = a + b_1 \ln P_1 + b_2 \ln P_2 \ldots b_n \ln P_n + c\ln Y + \sum_{j=1}^{m} d_j \ln Z_j \qquad (3)$$

This model is not only simple to estimate but the parameters of (3) directly measure elasticities e.g. b_1 gives the proportionate change Q_1 resulting from a 1 per cent change in P_1 ceteris paribus. The elasticities of all variables are constant over observations and are independent of the levels of the variable concerned and all other variables. It is, however, not clear that this is always a plausible assumption.

In the linear model:

$$Q_1 = a + b_1P_1 + b_2P_2\ldots + b_nP_n + cY + d_1Z_1\ldots + d_mZ_m \qquad (4)$$

elasticities vary, with, for example, the own price elasticity being $\frac{b_1P_1}{Q_1}$ which varies directly with own price and inversely with the level of demand.

The semi-log model defined as:

$$Q_1 = a + b_1 \ln P_1 + b_2 \ln P_2 \ldots b_n \ln P_n + c\ln Y + d_1 \ln Z_1 \ldots + d_m \ln Z_m \qquad (5)$$

also has varying elasticities. The own price elasticity would be evaluated in this model as $\frac{b_1}{Q_1}$.

These three models therefore have different behavioural implications. Considering the effect of own price, e.g. through tax increases, in both

the linear and semi log model, the own price elasticities depend on the price level P_1 ceteris paribus.[1] In normal conditions this implies that as price P_1 rise the good in question becomes more elastic. Rising income levels (again ceteris paribus) may be expected in the linear and semi-log form to lower the price elasticity of demand. This may be a very plausible model for wines and spirits consumption where the consumption of these goods rises substantially with income.

Although no theoretical guidance is given to functional form, the log-linear model has been criticised as a reasonable functional form for all goods. This is because it does not accommodate the 'adding-up' criteria i.e. the total quantitites of all goods add up to the total budget or income.[2] It has been argued that for the analysis of a single commodity (or group of commodities) the use of this functional form as a useful approximation can be justified (see Kennedy, Walsh and Ebrill, 1973 for a summary of some of the arguments for using this form). Deaton and Muellbauer (1980) go further to argue that even in the analysis of single commodities the log linear form can be criticised unless the variability of total expenditure is limited. There have been similarities in results when different functional forms have been applied to data. Although this might be regarded as to some extent comforting it may in part be due to lack of variability in the data and so reflect an inability to determine any effect precisely. Predictions of the effects of large policy changes outside the range of observed data variations may, however, differ between models, so that consideration of models' behaviour outside data limits is important. It is also clear that the criteria for choosing the 'best' functional form cannot be in terms of goodness of fit and, for example, attention has to be paid to parameter constancy and predictive failure.

Some authors (e.g. Leu, 1984 and Tsolakis, Riethmuller and Watts, 1983) have avoided the need to impose either the linear or log-linear functional forms on the data by using the more flexible Box-Cox (1964) regression model. The Box-Cox model links transformations of variables and includes linear and log-linear specifications as special cases. It, therefore, provides a basis for testing the acceptability of the surplus forms, see Leu, 1984. The parameters of the Box-Cox model are, however, difficult to interpret. Moreover, as discussed by Amemiya and Powell (1981), this model is inconsistent with the assumption of normally distributed errors thus invalidating standard results.

The general specification of equation (1) also raises problems which have implications for the form of the estimating equation. There are two related issues. The first issue is that in the unrestricted specification prices of all goods are entered separately. The number of variables and the collinearity between them clearly presents problems. The second issue is whether the equation is specified in real or current price terms. Theoretical restrictions can in part help to solve these problems. One of the general assumptions of demand models is that they are homogenous of degree zero, i.e. the unit of account is irrelevant to consumers, so that for example, if all prices double and income doubles, the real quantity demanded remains unchanged.

In order to illustrate how economic theory and a specified functional form can together provide restrictions on parameters, consider the homogeneity property in the context of log-linear models for two goods. The model for the first good is then

$$\ln Q_1 = b_1 \ln P_1 + b_2 \ln P_2 + c \ln Y + \text{other terms} \qquad (6)$$

and if Q_1 is unaltered by replacing P_1, P_2 and Y by kP_1, kP_2 and kY respectively then

$$(b_1 + b_2 + c) \ln k = 0$$

i.e. $$(b_1 + b_2 + c) = 0$$

so that the sum of the income and price elasticities is zero. On substitution of this restriction, the model can be reduced to

$$\ln Q_1 = b_1 \ln \frac{P_1}{P_2} + c \ln \frac{Y}{P_2} + \text{other term} \qquad (7)$$

by using $b_2 = -(b_1 + c)$. If Y in (6) is measured in real, rather than money terms then the homogeneity constraint becomes $b_1 + b_2 = 0$.

Estimates of log linear demand functions like (6) have been used to test the validity of the homogeneity restriction e.g. Duffy (1980, 1983) and Sumner (1971). Other studies have simply imposed such restrictions.

Even if it is valid, the homogeneity property only imposes a single restriction in the log linear model, namely that the income elasticity is minus the sum of the price elasticities. There will remain the set of price elasticities to be estimated and there may be too many such coefficients. Estimates of demand models based upon time series data have in general been unsuccessful in identifying the cross-substitution effects with accuracy, even for the case of close substitutes. This deficiency has been observed in alcohol and tobacco models. There are two distinct approaches aimed at overcoming this problem. The first is to impose upon the coefficients of a single equation restrictions based upon extra assumptions, e.g. the exclusion of a number of price terms. The second approach is to consider a complete system of demand equations and to use the many cross-equation restrictions provided by economic theory. These two approaches will now be considered.

1.3 The Single Equation Approach

This approach involves the estimating of an equation such as (3) with restrictions on price terms but without regard to demand relationships for any other good. One obvious procedure for reducing the price effects to be estimated is to set a large number of the cross price elasticities equal to zero. This approach can be unattractive because even if a good is regarded as unrelated, increases in its price may affect the consumption of the good in question indirectly by reducing real income, technically this is referred to as the income effect. Stone (1954) attempted to overcome this problem for a log linear model by using an approximation to a general index of prices and arrives at a relationship in which log of quantity demanded in a linear function of the log of real income and the logs of the ratios of a set of prices of "close" substitutes and complements to the general price index. Mathematically this can be expressed as

$$\ln Q_1 = a + \sum_j b_j \ln \frac{P_j}{P} + c \ln \frac{Y}{P} \qquad (8)$$

where the range of the summation for $\sum_j$ is for the set of close substitutes and complements, and P is the overall index. [See Deaton and Muellbauer, Chapter 3 for this derivation]. Close substitutes have been included as explanatory variables in some studies of alcohol and tobacco but they have generally found to be statistically insignificant, possibly because of multicollinearity.

An alternative approach is based upon the assumption that it is valid to aggregate all other goods. This leads to models of the form of (6) where the subscript 2 denotes "all other goods" as in Sumner (1971). Imposing the homogeneity restriction results in models of the form (7). The aggregation assumptions involved in this approach may, however, be implausible. As Duffy (1980) states in his study of the demand for alcoholic drinks, the disadvantage of this specification is that it

implicitly assumes that other drinks are no more or less close substitutes for the type of drink considered than all other non alcoholic goods. When considering policy implications therefore, these models may prove to be somewhat unsatisfactory, because it would be useful to identify substitution between different types of alcoholic and tobacco goods.

On the other hand the single equation approach has the useful property that it is simple to incorporate effects specific to the good in question, e.g. health effects and tobacco consumption, retail outlets and alcohol. Further it is not necessary to specify or estimate all other demand functions.

1.4 Demand Systems

The inadequacies of the single equation approach to throw light on the cross-substitution effects has led some researchers to study demand systems. One important development of demand theory has been the use of utility theory to assist the estimation of complete systems of demand equations. By considering consumers to be utility maximisers making rational choices between goods, the additional properties of 'symmetry', 'adding-up' and 'negativity' can be derived. The adding-up condition is simply, as previously stated, that the sum of the individual expenditures implied by the demand system should equal total outlay. The properties of symmetry and negativity are less easy to describe but Deaton and Muellbauer (1980) give the following example as the consequence of negativity:

> "an increase in price with utility held constant must cause the demand for the good to fall or at least remain unchanged"

and illustrate symmetry with the following:

> "a compensated penny per pound increase in the price of apples should increase the number of bars of soap bought

by a number equal to the number of more pounds of apples bought consequent on a compensated penny per bar increase in the price of soap".

Walsh (1982) uses the symmetry restrictions in his empirical work. Re-estimating the McGuinness (1980) model, (a linear model with real price and income), for beer, spirits and wine separately, he used the symmetry restrictions to equate, for example, the coefficient of the spirits price in the demand for beer equation with the coefficient of the beer price in the spirits equation.

In order to specify an estimatable model adding-up, homogeneity and symmetry are combined with a specified functional form either of the demand equation or a form of the direct or indirect utility function.[3] If the restrictions are enforced in the estimation of the model then the number of independent parameters that need to be determined by the data is reduced thereby increasing the degrees of freedom and the precision if the estimates of these parameters. Thus incorporating theory restrictions can facilitate a finer disaggregation of the commodities.

It is, of course, important to test the validity of the theoretical restrictions in order to avoid imposing incorrect constraints. The need to estimate an unrestricted model for testing the restrictions, however, limits the level of disaggregation amongst goods.

The problems in determining the level of aggregation and specification of a 'good' are important in analysing the demand for alcohol and tobacco. Both alcohol and tobacco products contain a number of different constituent parts. Cigarettes, cigars and pipe tobacco are all, for example, tobacco products. The variety of alcohol products is also very wide, even the groups of beer, spirits and wine contain many different products within each section of the market. Problems have therefore occured in interpreting models that have used a broad categories definition

whether they be for single equation or complete systems. In particular, McGuinness' (1980) study estimated a demand model for alcohol and was criticised by Walsh (1982) for aggregating alcohol products. Walsh detailed the theoretical conditions needed to justify the grouping of commodities as in McGuinness' work. He noted that one of the following must hold: (i) relative prices of the commodities in the group remain constant (ii) individual commodities are always consumed in constant proportions or (iii) the utility function is separate which would imply in this instance that, for example, the marginal rate of substitution between beer and wine is independent of the level of expenditure on all other items (e.g. foreign travel). These conditions are described in Walsh (page 440).

There are other advantages and disadvantages of these demand system models for the understanding of the consumption of alcohol and tobacco, and the effects of policy changes. The demand system approach is designed to consider the inter-relationships between goods. So, for example, it could be used to estimate what would be substituted in consumer budgets if policies were successful in reducing the demand for cigarettes. Similarly the inter-relationship between the demand for alcohol and tobacco products or between various types of alcohol could be examined.

There are, however, problems with this approach. The estimating procedure requires that all members of the system of equations be estimated together and it is therefore a far more complicated procedure than that required for the single equation approach. The empirical work has also neither been satisfactory as regards to the consistency of the theoretical restrictions with the data nor can one system of demand systems be said to be deemed the best model. (See Barten, 1975 and Deaton and Muellbauer, 1980 for an assessment of previous empirical estimates).

In general demand systems have been considered with fairly broad

commodity groups, and with only price and income terms included. For the control of consumption we are interested in other factors that influence demand, e.g. advertising, and where such detailed analysis is concerned the use of single equation models is usually recommended. The problem under investigation is, however, one of trying to understand at least some of the inter-relationships between this group of commodities. One development which may be fruitful combines features of both the single and systems approach by examining sub-systems of demand equations.

1.5 Sub-Systems of Demand Equations

Such sub-system models stem from considering the idea of two-stage budgeting. In this approach to budgeting consumers can be considered to first allocate their budget to broad groups say food, shelter, transport, etc. and then only as a second stage to allocate the groups expenditures to individual commodities within the group. This assumes a separate utility framework in which there is a 'utility tree' with the main branches being the broad groups and having various smaller branches representing each of the individual commodities. In the first stage, the factors influencing the allocation of the total budget to broad groups are total expenditure and the group price indices, while the allocation of the thus determined group expenditure is a function of the group expenditure and prices within the group only. This clearly involves restrictions on the substitution effects possible between goods.[4] In Bartens' (1975) words, the approaches'

> "usefulness depends on the ability to classify goods into groups for which the separability assumption may be considered empirically valid".

With alcohol and tobacco consumption it is not clear that the 'utility tree' branches could be clearly drawn. Simmons (1981) suggests that the

clearest case against the two stage budgeting process is the one in which particular goods within the specified group have quite different income elasticities as might be the case for beer and spirits.

Several empirical studies have used the sub-system approach to investigate the consumption of alcohol. Clements and Johnson (1983), Duffy (1985) and Salvananthan (1985) have considered models of total alcohol consumption. These studies have a number of features in common. In the sub-systems levels of consumption of beer, wines and spirits are related to prices of these goods and the total alcohol budget. The parameters of the sub-system were estimated using the Rotterdam parameterization.[5] The studies differ in coverage: Duffy and Salvananthan examined U.K. alcohol data whereas Clements and Johnson were concerned with the Australian alcohol market. Duffy additionally included advertising effects in his model.

Salvananthan's and Clements and Johnson's studies both indicated the importance of the intercept term. In the Rotterdam model this intercept has been regarded as capturing changes in taste. Salvananthan investigated the importance of this variable and calculated that other factors caused the consumption of beer to be 22 per cent higher and spirits 70 per cent lower at the end of the period of the study in 1975 than they were at the beginning of the period 1955. Clements and Johnson had to introduce dummy variables to allow for a changing intercepts after 9 observations and these dummy variables were introduced without a priori justification. As the authors state, this may indicate the need to incorporate other variables in models i.e. that their relationships are mis-specified.

The results of Salvananthan and Duffy did not indicate in general that cross-price elasticities were large. Duffy's analysis of UK annual data from 1963 to 1983 found all cross-price elasticities to be very small

and insignificant. Salvananthan found some evidence that wine was a complement for spirits using UK annual data from 1955 to 1975.

Duffy (1982b) also estimated two sub-systems, using a log linear specification to investigate the demand for different types of wines and spirits. In one sub-system the wine budget was treated as predetermined and the demand of four groups of wine (imported heavy wine, imported light, imported sparkling and British wines) were linked to the type's own price relative to the price of other wines, its own advertising outlay, total wine expenditure and a time trend. A similar sub-system model was constructed for the spirits market, the four groups distinguished being whisky, gin and vodka, rum and brandy. The results from the dissaggregate analysis of demand showed that the elasticities with respect to price, advertising and expenditure varied considerably between the different wine products. This was not the case with the spirits sector but perhaps this is in part due to an inappropriate definition of groups. One alternative would be to group by quality e.g. premium malt whisky might be coupled with five star brandy. Data on spirits by quality is, however, difficult to obtain.

Duffy's specification is clearly not without the theoretical problems of the log linear specification previously discussed and homogeneity is assumed and not tested. It is, however, perhaps more promising to consider budget separability between different types of wines and spirits than to treat wines, spirits and beer as a single group.

The problems of separating goods into the appropriate group or branches have led theorists to consider other methods of structuring the preferences and substitutability between goods. One approach considered is Lancaster's propositon that the utility function can be stated in terms of the 'characteristics' of the goods rather than the goods themselves. This

ideaof relating goods by characteristics they possess has attractions and it has been suggested that this may be a useful approach to consider for goods such as alcohol and tobacoo (Weedon, 1983). Consumers' tastes for these goods may well be affected by characteristics in this way. Unfortunately, the very nature in which these substances work on the body's chemistry, e.g. the stress relieving characteristics, makes it more difficult to specify an estimatable form of this approach than would be the case for, e.g., cars. This approach while at the present time difficult to translate into an estimable model should not be dismissed entirely. Developments in other disciplines which may help in the understanding of tobacco and alcohol consumption could provide a useful contribution to the development of more satisfactory demand models.

To conclude, the use of demand systems has led to insights into behavioural assumptions both in the specified systems and the single equation specifications. Empirical estimates of complete systems have not always been supportive of theoretical restrictions but this may reflect deficiencies in the models. The importance of time trends in models and other characteristics of estimated models indicate that there may well be a problem with omitted variables or dynamic specifications, both aspects which have been more thoroughly examined in the single equation approach.

1.6 Dynamic and habit forming specifications

In the simple static single equation system it is assumed that tastes (and therefore parameters) do not change during the sample period. The inadequacies of such models for some goods, and a growing interest in the importance of taste changes for understanding demand behaviour, has led to the specification of habit formation models in which current levels of consumption depend on past consumption decision. Much of this work stems from the pioneering analysis of Houthakker and Taylor (1970) and variants

of their model have been used for demand studies of types of alcohol and tobacco consumption. Some of the most common variants of the model are examined below along with other models designed to capture the 'addictive' nature of the goods.

(i) Time Trend Models

One of the ways in which changing taste has been incorporated in demand models has been the inclusion of a simple linear trend. The coefficient of this variable is interpreted as the autonomous shift in demand occurring each time period. There are, however, considerable problems with this approach. If tastes are changing there is no reason to believe they would change in the smooth way indicated by a time trend variable. If, as suggested, the significance of the variable in the model is attributable to factors e.g. change in the number of women smokers, then clearly it would seem better to enter measures of such factors in the equation itself.[6] Moreover, there is a problem in the use of such models for policy purposes if they are indicating some autonomous shift in demand without exploring the reason for the shift occurring or how it might be altered. Models including time trends therefore have to be interpreted with some care, especially when the time trend has been included with no a priori explanation.

(ii) Houthakker-Taylor models

Two equations form the basis of the Houthakker-Taylor (1970) model. These authors related demand not only to price and income but also to a variable measuring the existing stocks of the commodity. For items such as consumer durables, it may be expected that the coefficient of the stocks variable would be negative, high stocks from a previous period having a dampening effect on current demand and vice versa. For non-durables, Houthakker-Taylor considered that the stock measure could be viewed as a

'psychological' stock variable, measuring habit formation and inertia. In this case, the coefficient of the stock variable should be positive i.e. the more the consumer drank/smoked in the past, the more he will want to drink/smoke now. The basic Houthakker-Taylor model consists of the following equations which are specified in continuous time:

$$Q(t) = a + b\,S(t) + cY(t) + eP(t) \tag{9}$$

$$\dot{S}(t) = \frac{d\,S(t)}{dt} = Q(t) - f\,S(t), \tag{10}$$

where S(t) is the stock variable. The coefficient f measures the rate of depreciation of the stock. Data are, however, only observed at discrete intervals and in order to obtain an estimable relationship, Houthakker-Taylor employ discrete time approximations which lead to the following relationship:

$$Q_t = A_o + A_1 Q_{t-1} + A_2 \Delta Y_t + A_3 Y_{t-1} + A_4 \Delta P_t + A_5 P_{t-1} \tag{11}$$

Where $\Delta Y_t = Y_t - Y_{t-1}$ and $\Delta P_t = P_t - P_{t-1}$.

There are two aspects of this equation worth noting. The first point is that this model can only be derived for the linear functional form. The second point concerns the relationship between (22) and the structural coefficients of b and f. The combining of (9) and (10) implies restrictions on the coefficients of (11). To estimate this model without the restrictions being imposed would result in consistent but inefficient estimates of the structural parameters. Imposing the restrictions and estimating (11) by some non-linear OLS procedure will increase the efficiency of the estimates. Both restricted and unrestricted forms have been estimated in practice.

The estimated values of the structural coefficients provide some evidence on the appropriateness of the model. Duffy (1980) in his estimates of beer, spirits and wine demand equations found that all estimates of f fell outside the (0, 1) range of acceptability and that the estimates of b were, in general, negative. This would imply that for alcoholic drink this model was measuring a physical stock adjustment, a stock of drinking habits from a previous period depressing consumption in the present. Clearly for spirits and wine this may seem plausible but it seems an unlikely model for beer consumption. Kennedy et al. (1973) in their unrestricted estimation of a Houthakker-Taylor model for Irish beer, spirits and wine consumption came to more positive conclusion on the usefulness of dynamic specifications. In their results, b and f were estimated as positive. It was noted in this study that in the models' unrestricted form, f is over identified and a simple average of the alternative estimates of this parameter was taken. Tsolakis, Reithmuller and Watts (1983) also found the Houthakker-Taylor model compatible with Australian wine consumption data, but its application to beer consumption was less successful. The estimated parameters suggested that habit plays little or no part in determining beer consumption.

An alternative form of the Houthakker-Taylor model is available, namely the Bergstrom Flow model. In this model consumers are seen to attempt to adjust their consumption level to some desire level. Denoting the desired level of consumption by $\hat{Q}$, the two equations of this model, again in continuous time, can be represented by the following example,

$$\hat{Q}_1 = a + b\,Y + cP_1 \qquad (12)$$

$$\frac{dQ_1}{dt} = g(\hat{Q}_1 - Q_1), \qquad (13)$$

so (12) indicates that the desired consumption is dependent on income and price, and in (13) the rate at which actual consumption levels move towards desired level is specified as g. From this model it is possible to use approximations to reach an estimating equation of the form:

$$Q = A_o + A_1 Q_{1t-1} + A_2 (Y_t + Y_{t-1}) + A_3 (P_{1t} + P_{1t-1}) \qquad (14)$$

It should be noted that this model can unlike the Houthakker-Taylor model, be estimated in a log-linear specification as well as in a linear form. Kennedy et al also report estimates for this model on Irish data. The beer equation again provided reasonable estimates, the g estimate indicating a rapid response rate. The spirits equation, however, implied a value of g greater than 1, suggesting overcompensation of actual to desired levels of consumption.

(iii) Partial Adjustment Models

A model which has been used more frequently, particularly for cigarette consumption, is the partial adjustment model. The basis of this model is similar to the Bergstrom Flow model but is specified in discrete time. The desired level of consumption is a function of prices, income and other factors as before and a variety of other circumstances prevent customers fully adjusting to this desired level in the period. If h is the measure of the coefficient of adjustment and Q^*_t is the desired level of consumption then:

$$Q_t - Q_{t-1} = h(Q^*_t - Q^{t-1}) \qquad (15)$$

Which can be combined with for example a log linear model such as

$$\ln Q^*_t = A_o + A_1 \ln P_t + A_2 \ln Y_t \qquad (16)$$

to provide an estimatable equation

$$\ln Q_t = hA_o + hA_1 \ln P_t + hA_2 \ln Y_t + (1 - h) \ln Q_{t-1} \quad (17)$$

This form has been the basis of many of the demand studies e.g. McGuinness and Cowling (1975) and Metra (1979). An estimatable equation can also be defined for other functional forms and the linear form of the partial adjustment model can be viewed as a special case of the unrestricted form of the Houthakker-Taylor model in which the coefficients of the lagged variables other than the lagged dependent variable are set equal to zero. (See Green, Pope and Phipps, 1981).

The use of this model for modelling cigarette or tobacco consumption has been criticised by Johnston (1980) who suggested that the partial adjustment model is appropriate for situations where the cost of adjustment (e.g. financial, legal or institutional) is high but that there is no reason for this to be the case for cigarettes or tobacco consumption. Duffy (1980), suggested that this argument also holds for alcohol consumption. Another interpretation of the coefficient lagged consumption is that it is indirectly mesuring the habit effect (Brown, 1952), past consumption levels influencing present levels.

(iv) General dynamic models.

The three types of models described above do not exhaust the possible theoretical and dynamic structures. Davidson, Hendry, Srba and Yeo (1978) have considered alternative models of annual changes in total consumers expenditure. By using general lag processes, the alternative models can be nested in an encompassing framework. This analysis and methodology can be extended to single commodity demand equations and Metra considered one of a Davidson-Hendry type of equations for tobacco consumption. Quarterly data were used to relate annual changes in cigarette consumption to annual changes in price, income and advertising, these annual change variables lagged one quarter, and the lagged annual change in consumption.[7]

(v) Addiction Models

An alternative set of models has considered the possibility of 'addiction' demand. These models have been developed from the work of Scitovsky (1976, 1978) and Marshall (1927) who argued that consumers may respond asymmetrically to changes in market forces e.g. change in the quantity demanded may be different in absolute magnitude according to whether prices have risen or fallen. In particular, for a substance like tobacco and alcohol consumers may have a tendancy to acquire a habit more easily at times of low prices or high income and be reluctant to abandon them when prices rise and income falls. So, for example, considering price changes only, the response to a price rise would be smaller than to a price fall of the same amount. This gives rise to a consumption - price relationship which is sawtoothed in appearance, as in Figure 1. Young (1983) has estimated a model for U.S. tobacco consumption. He derived an

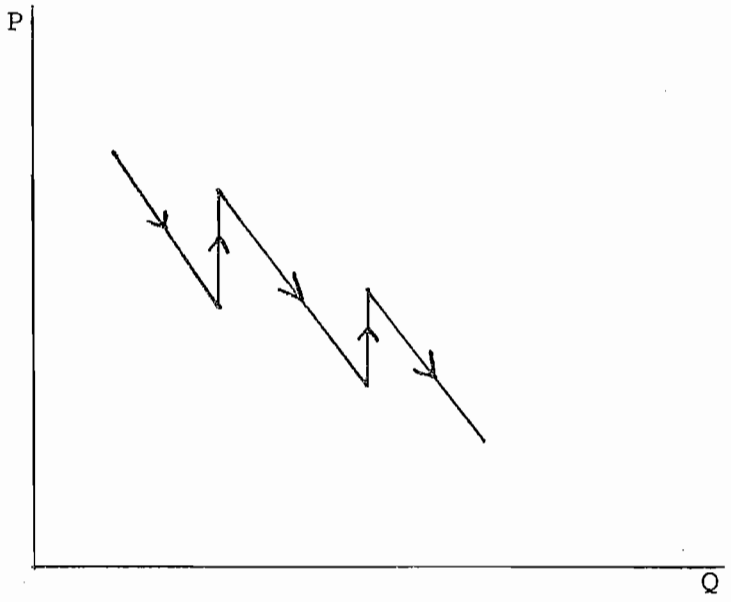


Figure 1

estimating equation by using a method of price composition suggested by Wolffram (1971). If the demand function is of the simple form

$$Q_t = A_o + A_1 P_t + A_2 Y_t \qquad (18)$$

and incorporates asymmetric responses for price and income then the equation becomes

$$Q_t = B_o + B_1 PR_t + B_2 PF_t + B_3 YR_t + B_4 YF_1 \qquad (19)$$

Where PR_t is the sum of all period to period rises in P_t defined as

$$PR_t = \sum_{i=1}^{t} g_i (P_i - P_{i-1}) \qquad \text{with}$$

$$g_i = 1 \quad \text{if} \quad P_i > P_{i-1}$$

$$= 0 \text{ otherwise}$$

and the YR_t is similarly defined for period to period income rises PF_t and YF_t are defined as the sum of all the period to period falls in P_t and Y_t respectively. This equation can be respecified (see Young, 1982) using:

$$P_t = P_o + PR_t + PF_t \qquad \text{and}$$

$$Y_t = Y_o + YR_t + YF_t$$

where the subscript o denotes the initial starting value, to

$$Q_t = C_o + C_1 P_t + C_2 PF_t + C_3 Y_t + C_4 YR_t \qquad (20)$$

The coefficients C_2 and C_4 in this form provide a direct assessment of the validity of the asymmetric model.

Young also considered an alternative model in which it is at record low prices that new 'addicts' are captured. As before, habits developed when the product has a low price will not be given up if prices subsequently rise. The price falling series is specified by adding only the proportion of the price decrease which brings the markets below the

previous minimum price paid i.e. this series can be defined as:

$$TPF_t = \sum_{i=1}^{t} (PMIN_i - PMIN_{i-1})$$

where $PMIN_i$ is the minimum price at time i. Young's (1983) re-estimates of the Fujii (1980) model of US cigarette demand using these two models indicated that:

> "there is substantial evidence of asymmetry of consumer response to price and income changes."

Whereas Fujii's analysis suggested that a price rise of 10 per cent would lower consumption by 4.5 per cent, Young's estimates indicate a price rise of 14 per cent would be required to obtain the same reduction in consumption. Clearly models allowing asymmetric responses have important implications and estimates based upon UK data would be of interest. Walsh (1982) has suggested that such specifications might fruitfully be applied to data for alcoholic consumption.

There are, however, disadvantages associated with this form of demand equation which may call for further developments. Young pointed to two problems. First, unlike models like that of Houthakker-Taylor, no account is taken of the erosion of distant price or income changes. The second problem is that ratchet models will generally change with the length of the period of observation: the pattern of price or income changes for a set of annual figures may be quite different from that for the corresponding quarterly data.

Young's specification is one for market demand and is not based on an individual utility equation approach. In a recent paper Jones (1986) has outlined a model exploring the effects on individual demand of two common elements of addiction, withdrawal effects and increased tolerance.

All these formulations of 'habit' or 'dynamic' models have considered

the influence of past levels of variables on current consumption levels. Empirical estimates on the importance of such dynamic effects have been mixed but this is clearly an aspect of modelling alcohol and tobacco consumption that would benefit from a more extensive empirical evaluation.

1.7 Disaggregated Time Series Models

There is a great deal of approximation and aggregation involved in deriving demand equations from individual utility functions. If parameters vary between individuals then this presents an obstacle to valid aggregation. It is sometimes necessary to add extra variables to the equation in an attempt to reduce the impact of such difficulties. For example, some measure to account for changes in income distribution might be added if income elasticities vary between high and low income individuals. An alternative, and more satisfactory approach is, however, to build disaggregated models. Two UK studies have used disaggregated time series of cigarette and tobacco consumption, using data provided by the Tobacco Research Council.

Atkinson and Skegg (1973) as part of a wider study estimated a log linear model of consumption of tobacco and cigarettes relating them to disposable income and relative price separately for men and women's consumption for the years 1951 to 1970. The estimated equations showed that both the price and education effects varied between men and women. The health education effect estimated from the aggregate equation was found to mask an insignificant effect for women, while the coefficient estimate for the equation for men was significant. There were also clear differences in the price elasticities calculated, which were significantly different from zero for men and significant (but small at 0.35) for women.

In a further disaggregation of the data, Townsend (nee Skegg, 1983)

considered separate consumption by sex and social class. Again a constant elasticity model was used relating consumption in gender/social class to relative real personal disposable income, a time trend and health education dummies. This study revealed the interesting result that men from a lower social class had a much higher price elasticity than those for a higher class group. Thus, if taxes were raised substantially and the price coefficients remained the same, the distributive effect of a tax increase would not be regressive as normally predicted but might even be generally progressive. Townsend calculates that men in Social Class 2 pay twice as much extra tax for a given increase as men in Social Class 4 or 5. Such a constant price elasticity model may however be inappropriate during a time of falling smoking rates. The price elasticity relationship with social class may also reflect the greater drop in smoking among the higher social classes, leaving more of those 'addicted' and therefore less responsive in their consumption to price changes. Since 1977, the last date of Townsend's data, participation rates have fallen still further and smoking is now a minority habit in all social groups. There are still large differences between social classes: the professional male participation rate being estimated at 20 per cent in 1982 and unskilled manual at 49 per cent, but between 1980 and 1982 there were large reductions in smoking in manual groups comparable to previous falls in smoking amongst non-manual groups (GHS, 1982). Clearly there is a need to obtain similar data so that a study of more recent years can be carried out.

The use of the national figure for personal disposable income in all equations may also lead to mis-specification. Certainly with more recent figures, this variable may not have reflected changes in the average levels of income in different social classes or for men and women separately. Results for estimated income coefficients for women were not significant. The increasing number of women working in the period of the study and an

increase in their resources may, however, be one of the factors influencing the upward trend in women smoking in the period of the study.

Whatever the findings of the disaggregated studies, their results certainly show that estimates based upon aggregate time series data must be interpreted with considerable care since they might correspond to some combination of quite distinct parameter values.

Disaggregated studies have also been carried out using cross-section data and such analyses will be considered in the next part of this section.

1.8 Cross Sectional Analysis

(i) Advantages and disadvantages of cross-sectional studies

Although many demand studies have utilised time series data, there are difficulties in obtaining reliable estimates of price and income elasticities and in examining certain other effects in consumption from time series data alone. Cross-sectional data does come from a wide range of sources, having their own advantages and disadvantages and deserve consideration as a supplement to time series.

Time series data have been criticised for the lack of variability in price data which inhibits precise estimation. In countries where state taxes on tobacco or alcohol are allowed, price varies regionally to a far greater degree than it would in the UK. Many studies using Canadian or US data have utilised this inter-state variability in consumption, price and income, and pooled data from different states and over time.

Other cross-section data, from sources such as budget surveys, in which individual (or household) information is collected can also be used to supplement time series analysis. Also considering demand over families with very different incomes can assist the estimation of elasticities (the

assumption here is that if low income households had an increase in income they would attain the same expenditure as the existing high income household and therefore the elasticities obtained are considered as long run). In any one budget survey, however, prices are normally assumed to be constant and so to be able to measure price elasticities several budget surveys would need to be pooled.

Another advantage of some cross-sectional data is that it allows the introduction of sociological and other variables thought to influence consumption habits. These variables do not necessarily show a great deal of variation over limited time spells or may not be available as time series. Measuring the effect of these variables, however, helps further understanding of consumption habits but care has to be taken to avoid misspecification due to the omission of important influences.

Cross-sectional studies have other important uses. By considering different price and income responses over different groups of individuals, such as rich and poor, male and female, heavy or light consumers, the differential effects of policy and the consequences of policy can be investigated. If, for example, heavy drinkers have a less elastic price response than other drinkers, then tax increases may be less effective in reducing their consumption than an overall estimate from a time series model would predict. If such drinkers have an inelastic demand then higher expenditure resulting from such a policy may cause additional problems to their families. A study of the response of smoking behaviour to health education messages across different social classes may also be very informative for future health campaigns.

Data collected by re-interviewing the same sample of people over a number of times are especially valuable for understanding why individuals change their behaviour e.g. they start or stop smoking or change from a

moderate to heavy drinker. Such surveys are clearly expensive and time has to elapse before they can be fully utilised. Such cohort data sets when they do exist, for example, for medical studies, sometimes suffer from the omission of important economic variables such as income.

Measures of alcohol and tobacco consumption obtained from budget and other surveys have been criticised on the grounds of reliability. In many countries grossing up estimates of expenditure from budget surveys seriously underestimates the total expenditure given in national accounts. Several reasons have been put forward to explain these discrepancies. One is that such budget surveys do not include tourism and therefore budget expenditure can be predicted to be below that of national accounts (see Warner (1978) for estimates of this effect on American data). Such under-reporting may not be considered important by a nation's government for considering health effects. A more serious problem arises for analysis if respondents under-report their consumption, particularly if such under-reporting varies with the degree of consumption. Heavy drinkers may, for example, feel ashamed of their consumption levels or teenagers may under-report smoking if their parents are present at the interviews. There is a general awareness of such problems and checks are usually built into questionnaires or extraneous checks are made, for example, by comparing income and expenditure to check if households are under-reporting expenditure. Another source of under-reporting, however, can be found in representativeness of sample surveys as regards heavy smokers and drinkers. Household surveys are limited to private households excluding the homeless and those in institutions who may typically have high smoking and drinking consumption. Similarly there may be a differential response rate with heavy drinkers and smokers being possibly harder to contact or more likely to refuse interview. Such general surveys may therefore under-represent those with high levels of consumption, particularly of heavy drinkers. Any

projections from such samples to the whole population have, therefore, to be considered with care.

The majority of cross-section studies have been undertaken in other countries. Although there are clear problems with comparing results across countries, both the methodology and the results obtained do give some indication of the relative advantages and disadvantages of such studies and throw light on some of the additional factors which may influence smoking and drinking habits. Following the discussion of the findings in other countries, data available and the studies undertaken in the UK are examined.

(ii) Non UK Studies

The federal structure of counries such as the USA and Canada, means not only that taxes on alcohol and tobacco vary between state but also that more data are available at a state level. Not surprisingly, there have been several studies using such state level data pooled over some years to generate a time series of cross-sections. Such pooling involves assumptions about the disturbance terms of models over time and across states in order to determine the appropriate estimation techniques. Johnson and Oksansen (1977) used several alternative methods for a pooled sample of 10 Canadian states and 15 years for a study of beer, spirits and wine consumption and found similar own-price coefficients estimates from these different methods.

Other explanatory variables have been added to price and income terms in the pooled time series cross-section studies of this kind. Johnson and Oksansen considered various ethnic, religious and educational factors. In their previous study (Johnson and Oksansen, 1974) individual variables were considered, but in the second study principal component analysis was used to 'reduce' each group of sociological variables to combat collinearity.

Results on these variables differ between the two studies. In the second study the ethnic effect was significant in all equations, whereas previously it was not significant in the spirits equation. Of the other variables, only education was significant in the beer equation whereas previously religion had been significant for spirits and wine consumption and education only significant in the spirits equation.

Another study of Canadian alcohol consumption, Bourgeois and Barnes (1979) involved the pooling of data from 10 provinces over 24 years and divided variables into three groups: controllable marketing variables such as advertising, price, number of outlets; semi-controllable non marketing varibles such as unemployment rates, number of immigrants, home ownership etc; and non controllable non marketing variables such as income, religion, population etc. Again principal component analysis was used to 'reduce' the number of variables. In their analysis the authors found:

> "more variance in per capita consumption is explained by the uncontrollable variables than is explained by the controllable marketing variables".

Ornstein and Hanssens' (1981) study of US alcohol data of 50 states over 4 years grouped variables according to whether they could be regarded as economic, socio-demographic or regulatory. The socio-demographic included variables to measure urbanisation, religion, age and temperature. The main emphasis of the study was on the effect of differences in state regulations relating to retail availability, price controls and advertising controls. All variables were, however, entered separately, and multicollinearity caused problems. The main findings were that control laws were unrelated to consumption or had very low elasticities, the main determinants of inter-state differences in consumption being price, income and inter-state travel and not differences in alcohol control laws.

The evidence on the effects of regulatory variables is, however, mixed. In a recent paper Hoadley, Fuchs and Holder (1984) concluded that regulatory variables, including price regulation, did have an effect on the consumption of spirits in the United States. Their data were for 48 states of the U.S. and for 5 year intervals between 1955 and 1980, i.e. six individual years in total. Their model was estimated for individual years and also for the pooled data set. Regulatory variables, income, tourism and religion were found to be significant in the pooled model with dummy variables for state and year. The authors calculated that there would be a decrease of about two drinks per person per month if a state were to shift its regulatory laws from being relatively loose (i.e. ranking 12th) to being relatively strict (ranking 36th). Even if the impact of price were excluded from this calculation there would still be predicted decrease of nearly one drink per person per month.

Another development has been the linking of model of consumption to health effects. Schweitzer, Intriligator and Salehi (1983) used cross-sectional US data for one year to estimate a simultaneous model of beer and spirits consumption, alcoholism and alcohol related mortality. Included with alcoholism in the demand equation are such variables as tourism, urbanisation, temperature, religion, advertising, minimum drinking age and unemployment. Maynard (1983) while welcoming this innovative study, describes some of the methodological difficulties of this and other cross-sectional studies. Many of the difficulties arise from the lack of theoretical basis for this work. It is not clear what variables are required in a satisfactory specification and therefore there may be omitted variable problems. There may also be problems of interpretation of results and the choice of estimator if it is not clear which variables can be treated as jointly determined and which can be taken as exogenous. Similar models have not been constructed for cigarette demand although Yucelt and

Kaynak (1984) introduced health variables such as the total number of lung cancer deaths into a time-series model of cigarette consumption and concluded that a high number of cancer deaths lowered cigarette consumption.

Some of the difficulties with cross-sectional data discussed above have led researchers to use 'quasi-experimental' techniques to determine price elasticities. This method was pioneered by Simon (1966) who used observed variations in consumption after a tax change for various states in the US to estimate price elsticities for alcohol and also cigarettes (Lyon and Simon, 1968). Cook (1981) disucsses the advantages of this approach in which control states are used to take account of non price influences and compares it to the normal econometric method of specifying the variables in a regression analysis. As Cook indicates this method, as others, still faces the difficulty of the 'border' effect when tax rates vary between states. Also illicit alcohol is a problem in some states and these were excluded in Simons' study. This study was replicated by Cook, in which he used the quasi-experimental technique to consider not only the relationship between spirits consumption and tax changes but also considered cirrhosis and auto accidents in relation to tax changes.

Cook and Tauchen (1982) also tried to avoid some of the problems of price and taste factors by considering a fixed effect model relating logged spirits consumption on a distributed lag of state taxes, per capita income and a set of state and year dummy variables for a 16 year period covering 30 states. By also considering a similar model relating the cirrhosis mortality rate, as a proxy for heavy drinking, to state taxes and per capita income, they came to the conclusion that heavy drinkers were responsive to spirits price changes.

The development of more general models than those of Cook and Tauchen involving consumption and indicators of harm is clearly of interest. The difficulties in building adequate models do, however, stem as Maynard (1983) suggests, from the lack of theoretical knowledge about the factors which influence consumption. Surveys of individual smoking and drinking behaviour can clearly aid in the development of such models.

Lewitt, Coate and Grossman (1981) have used such a sample of teenagers, undertaken between 1966 and 1970, to study the effect of government regulation on teenage smoking. In this study self reported consumption was used to derive two models, to explain first whether or not the teenager is a current smoker and second, the number of packs of cigarettes smoked per day. Consumption measures were related to price, the family and teenagers' characteristics, including income, parents' smoking habits, age, sex and race of the teenager; average smoking participation in the locality; and the health education variables. The interesting results from the study were the effectiveness of price as a means of controlling teenage smoking and the finding that teenagers were sensitive to anti-smoking messages.

Unfortunately, such data sets are rare, especially concerning groups of individuals who are of particular policy interst e.g. teenagers. This means the development of models using new and promising statistical techniques will be thwarted by the lack of suitable data.

(iii) UK Studies

In the UK there have been far fewer cross-section studies. This has been due partly to the lack of regional data of the type used in other countries. Some data is available in the UK and it is worth considering its quality and usefulness in research into smoking and drinking behaviour. Apart from 'one-off' surveys on drinking and smoking behaviour, two other

widely available surveys, namely the GHS and the Family Expenditure Survey (FES) contain information on drinking and smoking consumption.

The GHS is an annual government survey of households with varying questions each year. Smoking questions were first introduced into the GHS in 1972, and repeated annually until 1976 since when they have been included every two years. This survey has provided a rich source of information on the prevalence of smoking, disaggregated by sex and social class. By linking this information to the drinking and health questions, other aspects of smoking have been considered (see GHS, 1982). Questions on drinking have been included biannually in the GHS since 1978. The method used to determine alcohol consumption does, however, pose problems. The questions are based on a quantity frequency index which distinguishes, for example, between those who drink little but often and those who drink much larger quantities on a few occasions. This distinction could not be necessarily made by weekly consumption measures. Unfortunately the questions employed by the GHS relate to the type of drink consumed most regularly and not to all alcohol and answers may therefore lead to serious under-statements of consumption of those who regularly mix drinks. Atkinson, Gomulka and Stern (1984) point out another disadvantage to the use of the GHS in that there was some paucity of income data before 1976.

The FES is another household survey administered annually on some 7,000 households. Data are collected by means of questionnaires and diaries on details of income and expenditure. These data when grossed up to the whole population, like other surveys, give a far lower estimate of total expenditure on alcohol and tobacco than the corresponding figures from national accounts. The shortfall has been calculated at 22 to 26 per cent for tobacco and even larger at 40 to 45 per cent for alcohol (see Atkinson, Gomulka and Stern for a fuller discussion of these points).

These discrepancies have been investigated and Kemsely, Redpath and Holmes (1980) came to the conclusion that the problem arose from the sample design e.g. non inclusion of institutions and differing response rates for heavy smokers and drinkers, rather than being a sign of respondents under-estimating their consumption.

The discrepanices between national account figures and those obtained from the FES perhaps explain why these data have not often been used in the rigorous study of tobacco and alcohol consumption, despite the richness of this micro-data set. The recent work by Atkinson, Gomulka and Stern on tobacco and alcohol expenditure using a combined set of the FES from 1970 to 1980 is therfore welcome.

In the work on tobacco the problem of zero entries for households are examined. Atkinson et al. consider two possibile reasons for zero expenditure, firstly that the people are non smokers, secondly, that they could be potential smokers but at certain levels of price, income and other variables their consumption falls to zero, the 'double hurdle' problem. This is explicitly modelled by the authors and the share of tobacco expenditure in total expenditure related to real total expenditure, prices of tobacco relative to total prices and a vector of other variables. The model was estimated using the homogeneity and adding-up restrictions. The household characteristics included in the model are occupation of the head of the household, employment structure, household structure, owner occupation and age of the head of the household. A time trend was also included in an attempt to investigate the health education effect. The problems of measuring health education, and other specifications of this effects are considered in the next section of the paper.

The results of this analysis indicate that a number of variables have a significant influence on the level of household tobacco expenditure,

including occupation, household composition, work status and own occupation.[8] Esimated price elasticities varied between households but there was some problem with the relative price variable which the authors did not consider to be well determined. An example of their results is that for a household in which the head is unemployed and there is an additional working man, the implied price elasticity is -0.66, while for a household whose head is a professional or managerial workers and an owner occupier elasticity is -0.46.

In a subsequent analysis of household expenditure the double hurdle model was found to be less successful when applied to alcohol expenditure (Atkinson, Gomulka and Stern, 1984b). The authors therefore explored a more flexible form of the Tobit model. In their analysis of the alcohol data the model was specified for total alcohol and not its individual components. (As previously discussed in Seciton 1.4 there are problems involve in grouping the alcohol data).

The model was specified in logarithms and the share of alcohol expenditure was related to income, price and a number of household characteristics, including occupation, employment situation, the number of men in the household, owner occupation and regions. A time trend, age and squared age were also added to the model along with a squared income term. The equation was estimated using different estimation techniques of tobit, probit and Gamma-tobit, of which Gamma-tobit is the most general. (See Gomulka, 1984 for a fuller discussion of these models).

The authors found that the results were sensitive to the form of the model and concluded that great care should be taken in the specification of the model. In the Gamma-tobit form of the model, the important variables in explaining the share of alcohol expenditure appeared to be income and its square, the number of men in the household and regional differences.

It is interesting to note that the unemployment dummy, although not well determined indicated a lower expenditure for households with an unemployed head. Some of the variables included in the Atkinson et al analysis are difficult to interpret. The role of owner occupation in determining both alcohol and tobacco expenditure could, for example, be explained in a number of ways and such variables may be proxies for a number of other household characteristics. As with tobacco, the price coefficient in the alcohol model was not well determined but the average values weighted by the 1975 expenditure weights gives a figure of -0.74 for the price elasticity and 1.42 for the income elasticity, compared to the tobacco results whichcentered on -0.6 for the price elasticity and 0.6 for the income elasticity.

The work of Atkinson, Gomulka and Stern will be of interest to applied workers in many fields as an illustration of careful application of sophisticated techniques. Although the statistical content may be difficult for non-econometricians to follow the results indicate the usefulness of the FES as a data source to compliment existing time series data.

Another study of interest although out of the main stread of demand analysis is the work of Kendell, Roumanie and Ritson (1983). After the Budget alcohol tax increases of March 1981, the researchers followed up a sample of Scottish residents previously interviewed about alcohol consumption in 1978. The study found that consumption by the participants had fallen and that heavy drinkers and suspected dependent drinkers had reduced consumption as much as light and moderate drinkers. As there were no data on income or employment status of the individual there is clearly some difficulty in calculating the effects of price in isolation. This survey, however, indicates that it would be very interesting and informative to carry out more detailed surveys of individual behaviour.

(iv) Some concluding remarks about cross-sectional studies

To summarise, there are clear advantages of cross-sectional analysis. The building and development of econometric models, when used with care, can help in the understanding of the factors influencing smoking and drinking behaviour, aid the development of policies designed to reduce consumption and be used to investigate any possible consequences of such policies e.g. any change in the taxation burden between poor and rich families, the effect on heavy consumers' families etc. Problems with data quality, and more particularly in the UK, data availability are clearly an impediment to further analysis. While recognising some of the limitations of the available statistics further work is possible with existing data sets.

2. INDIVIDUAL VARIABLES : DATA, CONSTRUCTION AND POLICY RELEVANCE

In the previous section different theoretical forms of demand models were considered. The specification of a theoretical framework is, however, only one of the steps involved in obtaining an estimable model. Another step in the process is identifying the variables other than price and income that influences demand for alcohol and tobacco. One purpose of this section is to review the factors thought to influence demand and their relevance to prevention policy measures.

Previously estimated models vary not only in the variables they have included but also in the way the variables have been measured. Differences can occur because of alternative theoretical views about the way variables influence demand. Does only current advertising expenditure affect demand, for example, or are consumers influenced by some stock of advertising? Also differences can occur because alternative data series are chosen for

the same theoretical concept. The problems of the construction of individual variables are therefore discussed inthis section.

The third focus of this section is the examination of statistical problems. These problems include those arising from the inclusion and specification of certain variables as well as such issues as lag structures, simultaneity and multicollinearity.

In order to facilitate considerations of policy, all these issues are considered for each of the variables in turn.

2.1 Consumption

The variety in models estimated even extends to having different consumption measures. Consumption has been measured most generally either in constant expenditure terms or a physical quantity measure. Quantity variables can themselves take a number of forms e.g. units of alcohol or pints of beer; weight of tobacco or the number of cigarettes. If different measures of consumption are not perfectly correlated with each other over time then it is obvious that different results can be obtained by using different dependent variables.

The choice of dependent variables in these situations is, however, not always straightforward. Different researchers have chosen measures related to the primary aim of their research. A study focussing on estimating demand for business purposes may, for example, be mainly concerned with an expenditure series. For considering health issues a measure more related to the 'harmful' aspects may be of interst e.g. units of pure alcohol. Theoretical models are, however, based on consumers' behaviour and a characteristic of a 'good' such as units of alcohol, may be only one of several characteristics that determine consumption levels. A further complication arises from the quality changes that have occurred in

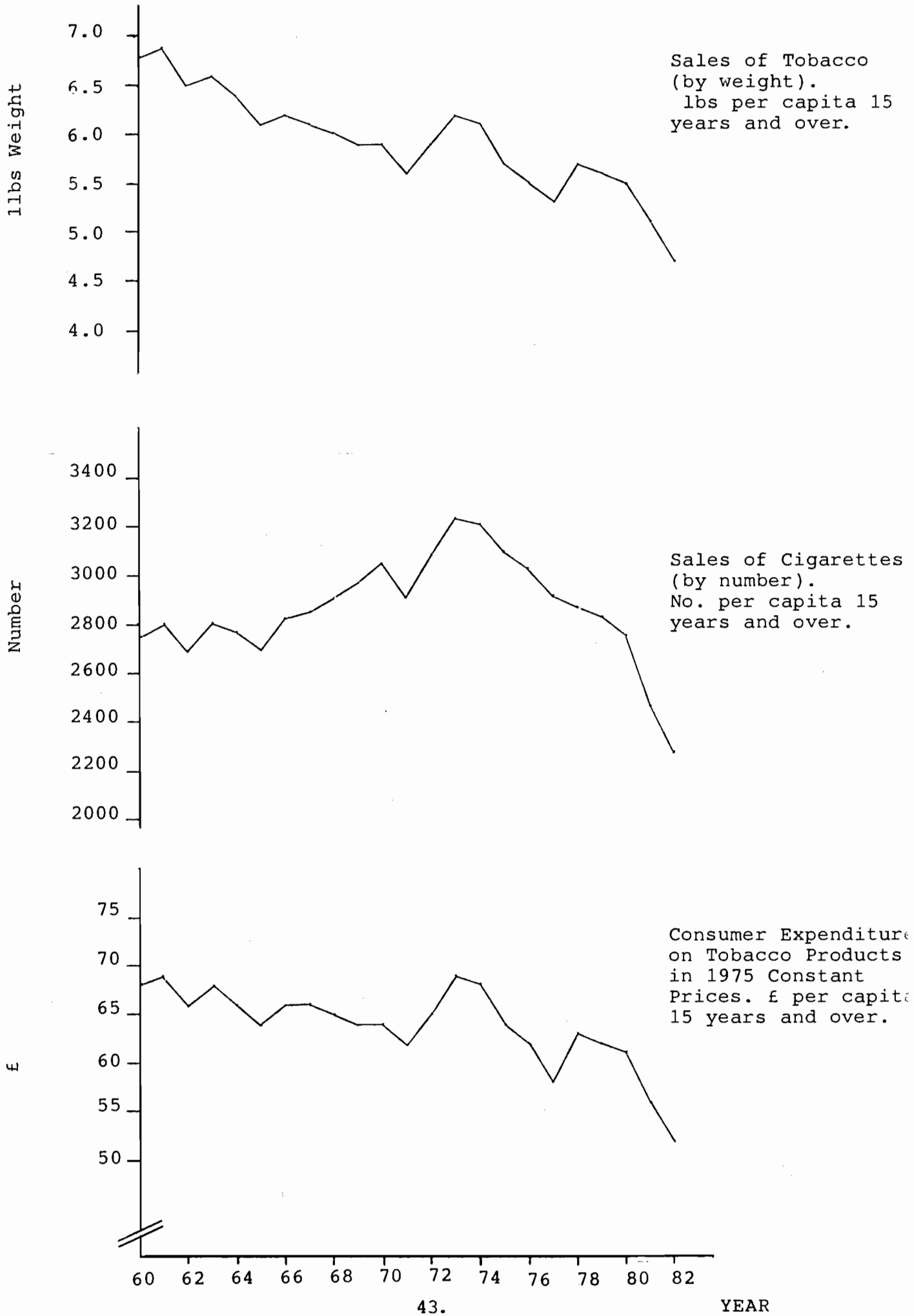
both alcohol and tobacco markets over recent years. It is clear that a 'typical' product in any of the subgroups has changed to some degree. Wine and cigarettes in particular have shown considerable changes in the range of quality over the last 20 years. Some of the implications of these issues are considered separately for alcohol and tobacco series below.

Three separate series have been used extensively in demand studies of tobacco. Consumption figures have been expressed in terms of expenditure, weight of tobacco and the number of cigarettes. It should, of course, be recognised that the latter series only covers part, if a large part, of the tobacco market. Atkinson and Skegg (1973) considered these three series for the period 1950 to 1970 and considered that the series diverged from one another from 1961. Figure 2 which shows annual data from 1960 to 1983 also indicates, in particular, how the series for the number, of cigarettes has moved away from the other two series.

The changes in the type of cigarette consumed during this period gives some indication as to the reasons for the behaviour of the series. In the first part of the period, there was a switch to filtered cigarettes; the proportion of tipped cigarettes was 20 per cent in 1962 and rose to 78 per cent in 1970. In the later part of the period there has also been a switch to cigarettes with a lower tar content, which in general lowers the quantity of tobacco per cigarette. However, it has been suggested that smokers compensate for the lower tar content in cigarettes by smoking more, hence the number of cigarettes smoked may rise. A further complication in the cigarette market has been the move towards tax harmonisation, from 1976 onwards, within the EEC. The first part of this process was to switch excise taxes which were previously levied on the raw material input to a system that levies tax on the end product i.e. per cigarette. This change lowered price differentials between small and larger cigarettes. Changing production techniques and the use of additives have allowed an increase in

Figure 2

TOBACCO CONSUMPTION SERIES, 1960-1982



cigarette size without necessarily the same proportionate rise in tobacco content.

These changes in the 'quality' of cigarettes can be related to demand and supply factors, health education, government policy as well as changes in taste. The trend towards filtered cigarettes had started before the first Royal College of Physicians Report (RCP, 1962) and may be related to relative price, filtered cigarettes being on average cheaper. There have also been government agreements with industry to limit tar content in cigarettes. Health education may have also played a part in the switch to filtered and low tar cigarettes.

The arguments for the choice of series for a tobacco demand study are equally complex. As Atkinson and Skegg (1973) indicated, the weight of tobacco measure may well be the most appropriate index for health concerns but a demand model explaining only this series may not be the most appropriate for a study of how health education has affected demand. Schneider, Klein and Murphy (1981) considered the problem of estimating the effects of health education and argued that previous studies, by only considering number of cigarettes, had greatly underestimated the health education effect. They introduced new variables measuring the percentage of filter tipped cigarettes, the percentage of low tar cigarettes in their equation for the demand for tobacco by weight.(9) McGuinness and Cowling (1975) argued that the expenditure series did take account of quality changes across time, and a constant value expenditure series provided a reasonable measure of aggregate quality. They argued that cigarettes, in a Lancaster sense, can be regarded as a group of goods where different brands represent different combinations of basic quality variables or characteristics. Such characteristics could be price or brand image, health aspect etc. McGuinness and Cowling assume that relative prices

between brands reflect these different combinations of characteristics. Total expenditure when corrected for inflation then becomes a measure of the aggregate level of characteristics. The method of obtaining current price series by the CSO, as discussed in Atkinson and Skegg, are not revealed in detail and therefore it is difficult to discern how far such a series has been derived from a constant quality price series.

Other researchers have argued that different circumstances result in cigarettes being smoked in different ways so that none of these consumption measures may accurately reflect the amount of cigarettes smoked or the volume of harmful material being delivered to the smoker. Simon (1968), for example, argued that a rise in the price of cigarettes may encourage smokers to smoke more of the cigarette, which may increase health problems. There is also considerable debate about the reduced risk to health from low tar compared to high tar cigarettes. It seems therefore none of the series available can necessarily be regarded as the 'right' series. Modelling different series and interpreting the results needs to be qualified by the difficulties associated with each of the series as discussed above.

There has been less discussion about the relative merits of different expenditure and quality measures of alcohol consumption. The main debate has been the disaggregation of the alcohol series for separate analysis of beer, spirits and wine.(10) Even within these subgroups the 'units of alcohol' consumed is again only one of the characteristics of the good. A particular feature of alcohol consumption is that for alcool consumed outside the home, price reflects the amenity value of the drinking place. A volume series will not reflect any changes in the proportion of drink consumed in, compared to that consumed outside the home. In other words, such a volume series would not reflect changes in consumption of these other characteristics. Also, as with tobacco, changes in the quality of goods have occurred over the period e.g. a switch to lager; lower strength

and quality of spirits; white spirits from dark spirits; the expansion of the variety of wines being available and consumed. Some of these changes may be reflected in changes in series measuring bulk quantity rather than units of alcohol. Although the alcohol market changes have been a result more of changes in exogenous taste and supply factors, when it comes to choosing a series for studying demand it is clear that it is necessary at least to consider how such factors may have influenced the overall consumption levels. Again there may be a need to add additional variables to the model.

To summarise, changes in the tobacco, beer, spirits and wine markets suggest that different series of consumption may differ in their trends and fluctuations over time. To understand the factors that influence the changing consumption patterns and its influence on health it may be necessary to consider more than one of the available series.

2.2 Population Standardisation

Aggregate consumption figures, as discussed above, are influenced by the size of the population. So, for example, a rise in the aggregate consumption levels of tobacco or alcohol may not be indicative of individuals drinking or smoking more but merely reflects an increase in those of drinking and smoking ages. It has therefore been usual in demand studies to use per capita consumption figures, with the number over 15 years of age being used to deflate the consumption figures.

Atkinson and Skegg (1973) however, argued that this crude deflation could be unsatisfactory, for both alcohol and tobacco consumption varies systematically with age (see GHS, 1982). The period of Atkinson and Skegg's study of tobacco consumption included 1962 when there was a jump in thepopulation figures as a result of the 'baby boom' reaching the age of

15. As 1962 was additionally the year of the RCP Report, the population standardisation used could crucially affect the results. In their study they therefore weighted each age group according to their cigarette consumption in the base year. Metra's (1979) later analysis also followed this practice, weighting by sex as well as age group. This approach has not been widely used in alcohol studies. Clearly reliable data on the age/sex differences in consumption are required for satisfactory weighting and the data has been less readily available for alcohol consumption that for tobacco.

Kennedy, Walsh and Ebrill (1973) used a different method in their study of Irish data. They deflated by total population and then included additional population variables in their beer and spirits equations. One of these variables, which performed well in their estimates, was a dependency ratio measured by the ratio of employed to the unemployed population. They believed that this measure also reflected changes in the income distribution and therefore preferred the equations with this variable included to those in which they deflated consumption by the population aged 15 to 64.

Hamilton (1972) in his study of US data, argued that while consumption should be deflated by the population of 14 years or older, the income should be deflated by the entire population on the grounds that persons under 14 years of age also had expenditure claims on income.

2.3 Price

One of the government's main policy instruments is tax rates which enters the demand equation through the price term. The effectiveness of this instrument depends on the size of the price elasticity. Changes in tax rates have not, of course, generally been motivated by a concern for health. One of the government's concerns is the yield from tobacco and

alcohol duties which form a significant part of government revenues. Estimates from demand models can be used to consider the revenue implications of tax changes (see Duffy, 1980, for consideration of these issues). Another factor which hs been influential in the consideration of tax rates has been EEC tax harmonisation policy. This has not only changed the method of taxation on tobacco as previously discussed, but also brought into question the relative tax incidence between different types of drink. In the 1984 budget the government responded to these pressures by lowering the taxation on wine by 18p per bottle. To measure the effects of the resulting changes in relative prices between alcoholic drinks highlights the importance of estimating cross price as well as own price effects.

As already discussed there are several problems with the theoretical modelling of price effects especially as regards identifying price substitutes between different goods. The choice of functional form and theoretical specification of the demand models determines the interpretation of the price coefficient in the equation. In log-linear models for example the coefficient directly measures the price elasticity. The specification of the income variable can also determine whether the price elasticities can be interpreted as compensated (Slutsky), where real income is used or uncompensted where money income is used. (A compensated elasticity measures the effect of price where real income and other variables are held constant, while an uncompensated elasticity is an amalgam of substitution and income effects). A third type of elasticity is obtained from a subsystem demand approach such as that used by Duffy (1982b) to investigate the consumption of various types of wines and spirits. Here the elasticities are partial elasticities measuring the sensitivity of a type of wine and spirit to changes in that goods price, all other things including the total wine or spirits budget remaining constant (see Duffy for a further discussion of this issue).

In specifying the model studies have varied not only according to whether they included the prices of substitutes, but in how they have dealt with incorporating the effects of other prices. Some models have used relative own price i.e. own price deflated by some index of other prices, but others have own price and other prices entered separately. If the variables are entered separately, then there may be some problems with multicollinearity. This problem occurs when series move in line with one another and makes it difficult to estimate precisely the separate effect of each variable. In the semi-log and log-linear specification this has been countered by imposing the homogeneity restriction and therefore the ratio of the two variables has been used.

Different definitions of the 'other price' variables have also been employed in empirical work.(11) The difference such adjustements will make to the results depends on how important the price of the good is in determining the overall price index and how closely own price follows all other prices.

Therehas been less variation in the data used to construct price indices. In general, studies have used implicit price deflators calculated from consumer expenditure series valued at current and constant prices. Alternative indices are, however, available and have been used. Measuring price changes raises the problem of taking account of quality changes. Two alternative forms of price index exist, one which takes account of different mixes of the good being consumed over time and the other is based on a fixed basket of 'brands' or types of goods.

The implicit price index in an example of the former measure. Unfortunately, not many details are available as to the construction of the constant expenditure series. Some assumption concerning quality changes

have to be made. For example, the price index for cigarettes and tobacco isobtained by comparing the current price to the base year price weighted by the current consumption, although the means of weighting the prices has not been outlined in detail. Similar methods are apparently used for spirits and wine, but for beer prices a different system is adopted. A compromise is reached between a method that makes no allowance for quality changes and one which takes quality into account. The two methods are to use the average price per bulk barrel in the base year which makes no allowance for changes in quality as measured by the strength or average gravity of the beer. The second method is to use the standard barrel price which assumes the sole criteria for consumers' choice is the alcoholic strength. The price index used is based on an average of these two indices.

An alternative index that takes account of quality changes is the Retail Price Index. This has not in general been used because it is published in less detail than consumers' expenditure figures. For example, separate indices are not published for spirits and wine. It is not clear how the indices obtained would differ from the implicit price deflators but some of the methodology is common to both series (see Maurice, 1968) and the all items index of the RPI covers fewer items than the implicit deflator on all consumers' expenditure.

Some studies have considered price indices based on a fixed basket or standard commodity approach. Russell (1973) used the price of 20 standard plain non-tipped cigarettes for his study of cigarette consumption from 1946-1971. Atkinson and Skegg (1973) criticised the use of this measure, as did Russell, as it fails to take account of the shift towards filter and small-sized cigarettes. Peto (1974) however, compared the two measures from 1953 to 1970 and considered that the Russell measure corresponded to consumption changes more closely than to the implicit price deflator and

therefore employed this in his analysis. Two price variables were also considered in the Metra study of cigarette consumption. One measure was of a fixed basket kind, measuring the changes in price of not one brand but four, each with a substantial market. The second measure was based on the average price paid for cigarettes taking account of changing brands. Both measures used data provided by the tobacco industry.

Metra (1979) argued that the sales weighted index was the appropriate measure of price and in fact, found it lead to a slightly higher R^2. Moreover, the lack of price data available of the 'fixed basket' type may limit other researchers to the more conventional implicit deflator index.

2.4 Income

Income, unlike own price, is not a specific policy variable that can be directly controlled to adjust the levels of alcohol and tobacco consumption. Income elasticities are, however, important in determining the possible effectiveness of tax changes. If alcoholic drinks or tobacco are income elastic then the effect an increase in tax has on reducing consumption will be offset if incomes are rising. If tax changes are used to influence consumption, then to reach a targetted level, the effect of income changes (as well as other factors) needs to be taken into account when setting the tax change.

Two alternative concepts of income have been used in demand studies and the choice has largely followed the theoretical basis of the model. Researchers investigating demand systems have generally used total expenditure as their 'income' variable. This ensures that the 'adding-up' constraint is automatically met. There are, however, additional reasons for choosing this varible. It has been argued that total expenditure is a better measure of 'permanent income' than current income. Consumers'

decisions are usually viewed as being made taking past and future factors into account, rather than being solely constrained by current valued variables. The increase in credit may also widen the choices consumers can make. Total expenditure is however, only a 'proxy' and Kennedy, Walsh and Ebrill (1973) suggest the way national accounts treat items such as durables, including expenditure rather than the flow of services from them, may lower its usefulness. Duffy (1980) used the predicted values of income from a regression of current income on a time trend as an alternative measure of permanent income but the results obtained were unsatisfactory.

Most single equation demand studies have used figures for personal disposable income. One advantage of this measure is that it can be taken as exogenous to the model, whereas total expenditure is in part determined by the level of consumption of the good in question (a point explicitly recognised by the adding-up criteria in demand systems). Such a measure does not, of course, take account of any changes in savings or dissavings.

Another problem with the personal disposable income measure is its failure to take account of the distribution of income which may be important as a result of aggregation effects. This deficiency may become severe when the income distribution exhibits marked fluctuations. Duffy (1981), for example, in forecasting alcohol consumption for 1980, failed to predict the fall in the demand for drink. Duffy attributes his over-predictions both to income expectations and to distribution effects.

Notwithstanding differences in their measurement, consumption, income and price are the common elements in all but a few of the demand studies. There has, however, been considerably more variation in the number and type of additional variables that have been considered. It is worth at this point considering the statistical problem of including or excluding such variables. If an important variable has been omitted, coefficient

estimates will be biased and inconsistent, as are the variance estimates on which the standard errors are based, thus invalidating the usual significance tests. Some authors have justified the inclusion of a time trend on the grounds that it reflects the influence of omitted variables. Itis difficult to accept this argument because it is unlikely that the omitted variables follow a smooth linear trend.

More generally, variables should not be added without some discussion of their role. Maynard (1983) has indicated some of the difficulties of the 'ad hoc' nature of additional variables employed without consideration of the causal basis for their inclusion. Statistical problems of the loss of degrees of freedom and multicollinearity may also occur making estimates of parameters of interest less precise. This is not to argue that variables should be dropped if insignificant, but that systematic tests for their inclusion should be carried out. In the next part of this section, the variables used to augment price and income measures are discussed.

2.5 Advertising

The effect of advertising on consumption has been widely disputed. Legal and voluntary controls have been introduced on both alcohol and tobacco advertising. The Royal College of Physicians has argued for a complete ban on all but point-of-sale advertising for cigarettes (RCP, 1983).

(i) Measuring the effects of advertising

Advertising is undertaken by firms to increase demand for their product and economic controversy has surrounded the question as to whether advertising only alters brand shares of a market for a commodity or is capable of increasing the total demand for that commodity. In order to measure the effectiveness of advertising it is necessary to specify the way

in which advertising enters demand models. These measures have varied between studies. Some, for example Witt and Pass (1981), used the size of current advertising expenditure as a measure. Others have followed Telsers' (1962) work by proposing that advertising should be measured in terms of the number of messages received. A 'volume' rather expenditure measure of advertising is implied, with the measure taking account of the physical volume of advertising e.g. column inches and the audience size.

There are two difficulties in comparing the two forms of measure, volume and expenditure. The first problem is that it is much more difficult to measure changes in 'quality' that may occur with advertising over time. The second problem is defining these variables appropriately. One measure of real expenditure is to deflate advertising by a general price deflator, the procedure followed by Witt and Pass in their study. Metra, (1979) however, used a similar measure as an indicator of advertising messages per unit audience. They observed that different media rates, press, TV, etc.) are, in part, determined by changes in audience size so that if a circulation of a magazine increase then so does the cost of advertising in that magazine. The other main influence on media rates was inflation. They argued therefore if advertising expenditure was deflated by the RPI then the resulting series reflected the level of advertising messages received taking account of audience size. An assumption of this measure is, however, that the RPI adequately reflects the changes in the costs of supplying advertising space which are passed on in media rates.

Other authors e.g. Duffy (1983) and McGuinness (1980) have used an index of media rates to deflate advertising expenditure. The index used by these authors is compiled by the Advertising Association and is designed to take account of changing audience size and therefore can be viewed as an index of advertising cost per message. McGuinness and Duffy did however

differ in the application of the index. Duffy applies an overall index to all advertising expenditure whereas McGuinness applies a separate index to expenditure for each media and then aggregates the resulting figures. As regulations and voluntary agreements have not been applied over all the media, the most appropriate course may be to disaggreate expenditure by media type. Again data problems may prevent this disaggregation for some periods as MEAL did not publish disaggregated figures for the whole period.

Metra (1979) constructed a third alternative measure by considering the volume of advertising in terms of the numberof 'units' purchased without reference to any changes in audience size for these units. With access to trade data, they constructed their own rate card cost index based on the advertising channels used by tobacco companies. Thus this measure provided an index of the changing cost of media time or space and when used to deflate advertising expenditure yielded a variable measuring the volume of advertising. As Metra claim that prices for the media are set with reference to changing audience size, there is a relationship between the two alternative Metra measures.

(ii) Coverage of Advertising

It is difficult to assess the usefulness of aggregate measures of advertising and the impact of changes in the media mix of advertising because there is little information about the effectiveness of advertising in different media. There are additional complicating factors. One is determining what actually constitutes advertising, should it, for example, include expenditure on other marketing activities such as salesmen. The second factor is the constraint of data availability.

Press and TV advertising clearly account for the bulk of firms' advertising budgets, although a lack of data prevents an estimate of their

importance. It is, however, more difficult to decide whether sponsorship should be included as advertising expenditure. Firms do not necessarily admit to a direct link from sponsorship to consumption although those promoting and seeking sponsors clearly stress such links. Sponsorship may well be cheaper per message than other media forms. The CCPR (1983) report highlights the low cost of advertising exposure per minute for a snooker sponsor compared to the average rate. However it is not clear how the effects of sponsorship can be compared to those of direct advertising.

From the point of view of policy makers the issues described above are important. TV advertising for cigarettes and spirits has been banned but other media have not been subjected to the same restrictions, although content of the advertisements have been subject to voluntary agreements. Tobacco sports sponsorship is also subject to another voluntary agreement limiting total expenditure. The media mix of companies may, in the light of such pressure change over the period and it would be necessary that measures of advertising accurately reflected the associated changes in advertising quantity and quality.

Data availability makes such measurements difficult. No government statistics on advertising are available. A survey of press and TV advertising has been undertaken by private firms. These data, although covering the major part of advertising expenditure, clearly omits all other forms of advertising. If advertising was unregulated, this might not be a serious omission. Advertising, especially in recent years, has tended to take the form of campaigns where all forms of media are used. If this were a general practice in might be reasonable to conjecture that the omitted expenditure was a constant proportion of the observed expenditure so its omisison would be of no real consequences. If, however, as a result of agreement and regulation, the proportion being spent on other forms of advertising has varied than this constitutes a serious problem. The only

study that had access to a wider data base was that carried out by Metra who were able to include poster advertising in their study of cigarette consumption. It would of course be extremely useful for other researchers also to have access to these data.

(iii) Galbraith's hypothesis

Before the dynamics of advertising are discussed, one other approach to modelling the advertising effect should be mentioned. This approach is used by Duffy (1980) who not only has a variable measuring advertising on the product in question but has also included a variable measuring advertising on all other commodities. This additional variable was introduced to test the Galbraith's hypothesis that, in Duffy's (1980) words:

> "advertising influences not only firms' market shares but may also affect the relative shares of products in the total volume of demand".

This variable is predicted to have a negative effect on demand. Thus, for example, if advertising on all other goods other than beer increases and all other relevant variables are held constant, then the demand for beer will fall. The problems of measurement of this variable for all other goods clearly poses the same sort of problems as previously discussed for the advertising variables of tobacco and alcohol.

(iv) Dynamic advertising effects

The consideration of the dynamics of the advertising effect introduces several statistical problems. The hypothesis is that the impact of demand of an advertising campaign is not confined to the current period. Lasting effects may arise from habit; consumers stay loyal to one brand, there may be a threshold effect; and/or advertisements may appear in a

durable medium. It would be expected, however, that such effects would all diminish over time.

To allow for such effects a set of lagged advertising terms could be added to the demand equation. This approach, however, poses a number of problems for estimation. There is no theory to guide the maximum length of lag i.e. the maximum time period for which past advertising has any effect on sales. Even if the lag length is determined experimentally there remains the problem that in general estimating equations of this type suffer from a high degree of collinearity between successive lagged values. In order to avoid such problems, econometricians have devised specifications which place restrictions on the lag scheme. One such scheme is a Koyck transformation which assumes that the lag coefficients decline geometrically over time. By applying a lag transformation all lagged values of advertising are eliminated although lagged values of the dependent and other explanatory variables are introduced and serial correlation is introduced in the error them. Researchers into alcohol and tobacco demand have not used this technique, and Duffy (1980) and McGuinness and Cowling (1975) have all argued against using this approach. Duffy stressed that the assumed structure was very restrictive and that since the lag transformation resulted in serial correlation, some more complicated estimates than OLS would be required. The alternative specification employed by both Duffy and McGuinness and Cowling is, however, simply a truncated Koyck model which is estimated without eliminating the lagged values of advertising. A stock variable is employed in a model e.g.

$$Q_t = f\ (P_t,\ Y_t\ K_t) \qquad (21)$$

with the stock variable defined by:

$$K_t = A_t + bA_{t-1} + b^2A_{t-2} \cdots\cdots b^nA_{t-n} = \sum_{i=1}^{n} (1-b)^i A_{t-i} \qquad (22)$$

Hence, if b is estimated as not significantly different than 1 it implies current advertising only affects current demand.

Duffy and McGuinness and Cowling use different approaches estimating this stock effect of advertising. One of the problems is that some finite value of n must be used. McGuinness and Cowling chose a 9 quarter period. Metra criticised the arbitrariness of this decision but in turn set their own arbitrary limit at 30 quarters. Duffy used different values from 4 to 12 quarters inclusively.

The second problem involves substituting equation (22) into the demand equation, which results in an equation which is non linear in parameters and therefore OLS cannot be used directly. Duffy uses an iterative non linear technique to estimate the equation. McGuinness and Cowling used a number of values of b between 0 and 1 and then applied OLS with K_t constructed using the specified value of b. The value of b = 0.05 was found to maximise the explanatory power of the equation. This 'grid search' is an approximation to Duffy's non linear least squares technique.

Duffy pointed out that this fine grid search still has disadvantages compared to the non linear least squares method, because when using the fine grid method the usual t-tests will not be valid. The need to estimate b when constructing K_t invalidates conventional OLS standard errors and therefore tests of significance reported by McGuinness and Cowling. These remarks apply to the work of Metra (1979) and Radfar (1983) who also used the grid search approach. Additionally, Duffy argues that a search restricted to the range $0 < b < 1$ does not allow the data to indicate model misspecification through implausible estimates.

Finally, all these researchers assume the lagged effect of advertising is geometric in nature and it may be useful to consider alternative less restrictive lag schemes.

(v) Simultaneity

The final problem to consider whether there is any simultaneity in the relationship between advertising and consumption. This may occur if, for example, firms adjust advertising budgets in response to changes in sales and other factors. Advertising expenditure would then not be exogenous to the equation and an estimating technique such as OLS would be biased and inconsistent.

Some authors e.g. Duffy have used techniques such as two stage least squares to check on the consistency of the results. Others have considered that measuring advertising in the form of messages breaks down any possible simultaneity. It would seem, however, appropriate to use a statistical test such as a 'Hausman-Wu' test to consider the exogeneity or endogenity of the advertising variable (Hausman, 1978 and Wu, 1973). This type of test is based upon the difference between the OLS and two stage least squares (2 SLS) estimates.

(vi) Relationship to policy initiatives

Some problems involved in identifying effects of restrictions on advertising have already been considered. Data restrictions and ambiguities about the construction of advertising variables have made it difficult to measure whether the restrictions lowered the overall volume of advertising or resulted in a switch to alternative forms of non regulated advertising. Also estimated models are based on existing data variations and the estimates may break down in the event of a major policy change. A cigarette advertising ban as recommended by the RCP may, for example, have

different effects than that predicted on the basis of previous changes in the level of advertising. Such a policy may act to change social acceptability of a product with a ban, for example, reinforcing health education messages. It is the problems of measuring the effect of health education policies that are now considered.

2.6 Health Education

The consequences of changes in taxes, advertising and trade restrictions are not necessarily restricted to their effects on tobacco and alcohol consumption. Some of these other effects such as the burden of extra tax on families, the effect of restrictive trade regulation on competition between firms may need to be evaluated along with the policies' effectiveness in reducing consumption of the targetted good. Health education may therefore seem an attractive policy if it can be proved to be effective. Demand models may be seen as playing a part in the process of assessing the effectiveness of this type of policy. As with advertising, there are, however, considerable difficulties in determining the purpose, definition of health education and the mechanism of which it affects consumption. Some of these issues are worth considering before reviewing the attempts previously made to incorporated health education variables in demand models.

Health education can be viewed as a means of providing information to aid consumers to make rational choices. In this context, Littlechild and Wiseman (1984) have argued that the content of such information

> "should not go beyond the bounds of what is scientifically established".

Fujii (1980) uses an information approach along with demand models to develop a framework for assessing welfare gains from health education

expenditure. By considering information about the safety of a product as one of the characteristics of the good, the consumer surplus approach can be used to evaluate the gain in welfare from an increase in health education. Whether overall gains in welfare are achieved can be assessed by comparing welfare gains with the cost of collecting and disseminating the information.(12)

The basis of the consumer surplus approach has, however, been questioned and alternative models may indicate a different trade off between health education expenditure and welfare gains. The first problem with the Fujii approach is although consumers may be aware of health risks in general terms, they may not be informed as to the true seriousness of the risk. So, for example, they may think they are too young, not consuming enough or that detrimental health consquences will not affect them personally. A second problem with the approach is that if tobacco and alcohol are addictive substances then consumers may not act 'rationally'. Different opinions about the purpose of health education not only alter the model of trade offs between expenditure and welfare gains but also what is viewed as health education. Some see health education as having wider aims than providing information extending to changing behaviour and the social acceptability of these products by, for example, pressure group activity. Education may also be thought to include expenditure on such measures as 'stop smoking' campaigns. Such a widening of health education aims clearly implies additional problems of measurement.

Health education is not confined to government financed campaigns. The effects which have been considered to be most influential in tobacco consumption have been the reports prepared by the Royal College of Physicians and the attendant 'free' publicity. Other moves such as cigarette health warnings have also some information value. It is

difficult to construct adequate proxy variables of these effects.

Measuring the impact of more recent campaigns aimed, for example, at the young poses particular problems. Such campaigns might influence the number of young starting to smoke but his would not have a noticeable effect on aggregate consumption in the short run. More generally the evaluation of campaigns directed at a particular subset of the population requires appropriate disaggregated data.

Clearly, it is also difficult to assess the 'quality' of campaigns. Any constructed variable in a demand model, as Atkinson and Skegg (1973) conclude, only attempts to measure the effect of existing policies which may not be reliable predictors for future campaigns. Others have compared the expenditure of health education campaigns to that of industrial advertising and felt that there may be a threshold effect. Health education campaigns would need considerably more expenditure before they were effective. Whether health education is considered as informative or as having a wider purpose, any measure of its effect may need to be cumulative in nature i.e. we may as with promotional advertising, want to consider a measure of health education 'stock' rather than consider current expenditure only.

Given these considerable measurement problems it is perhaps not surprising that models have incorporated these effects in a somewhat 'ad hoc' manner. Many studies of tobacco consumption have included a health education effect in the form of dummy variables. The simplest specification has been to include a dummy variable for each noteworthy event. (See Sumner, 1971 for example). The 1962 RCP Report represented by a simple dummy would, for example, be assumed to have had an effect of shifting demand in a once and for all manner. (The dummy variable defined as 0 in the years preceeding the report and one for the year of and years

after the report, so that its estimated coefficient measures the size of this effect).

Alternatively, Sumner (1971) also considered a zero trend dummy variable which took the value 0 in the years before 1962, 1 in 1962, 2 in 1963 etc. This specification assumes the publicity effect increased steadily (and for evermore) during the period after the report. Sumner's estimate was some 2 per cent per year. Atkinson and Skegg (1973) commented that this estimate would predict that demand would be 12 per cent lower by 1967 than otherwise expected and if extrapolated to the year 2000, consumption would be half that at the time the model was estimated without any additional health publicity. If the effect of the RCP Report had been to stop a proportion of the population smoking and thereafter a large proportion of young did not take up smoking, a trend effect on consumption may result.

By using data on the number of cigarettes rather than tobacco expenditure, Atkinson and Skegg found some evidence of drops in consumption around significant points such as the RCP Report and the 1965 television advertising ban followed by a gradual return to previous levels of consumption. In order to model this effect, they introduced zero/one

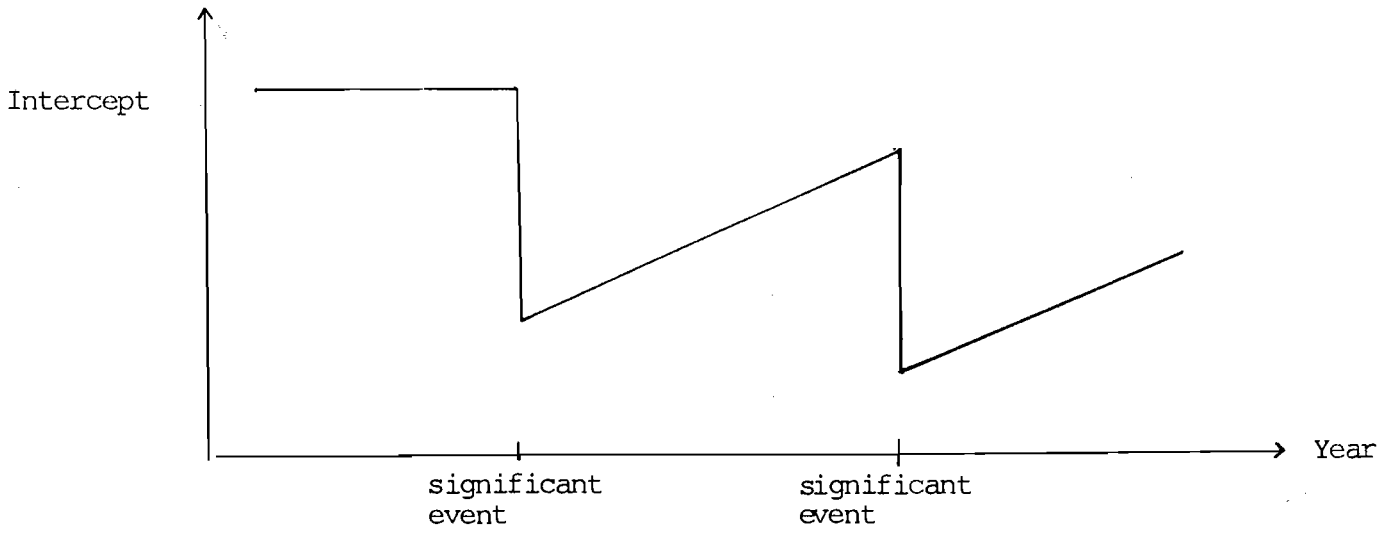


Figure 3

dummies into the demand equation with a returning trend dummy of the form t=1, 2...n for the years after the significant event, to mimic a consumption series of a type illustrated by Figure 3. (The same returning trend was assumed for both events as in the figure).

A similar hypothesis that health education shocks have a limited effect on consumption was proposed by Witt and Pass (1981). Their hypothesis was that demand would fall in the year of the health scare and a specified number of years after the scare, but demand would then recover in the subsequent years. They tried three alternative values for the duraction of health effects, namely one, two and three years. In a subsequent paper (Witt and Pass, 1983) they compared results from using their specification with variants of the zero/trend and zero/one dummies with recovery trend previously discussed. They found no support for zero/trend model but the zero/one and recovery trend and the two year limited duration dummy variable model both provided significant estimates of the health variables and reasonable coefficients of the other determining variables. The latter was preferred by the authors because the R^2 was higher and the Durbin Watson statistic was closer to 2. Such comparative estimates are clearly of considerable interest even though further testing of the individual models may be necessary before a preferred model is accepted.

An alternative form of health scare effect was proposed by McGuinness and Cowling (1975). They assume that health publicity had an anti-advertising effect. Thus, in their framework, health publicity can be regarded as a certain volume of anti-advertising messages and this may reduce the promotional effect of advertising on cigarette sales. They therefore, included a slope dummy variable which allowed the coefficient on advertising to change in 1962. Their equation was therefore specified as:

$$\ln Q_t = A_o + A_1 \ln P_t + A_2 \ln Y_t + A_3 \ln K_t + A_4 H.\ln K_t + A_5 \ln Q_{t-1} \qquad (23)$$

where K_t is advertising stock as previously discussed and H=0 for 1957 to 1962 first quarter and H=1 for 1962, second quarter onwards. Radfar (1983) extended this approach when re-estimating the McGuinness and Cowling model, specifying slope dummies for the second and third RCP reports, 1971 and 1977 respectively.

These specifications do not constitute an exhaustive list of models of health publicity effects. There is no reason to restrict these effects to consist of discrete changes to the intercepts or coefficients of only the advertising variable. It could be hypothesised that if health education succeeded in stopping the less addicted smoker, then it might lead to lower price elasticities. Similarly a differential effect of health publicity across social classes may be reflected by changing income elasticities. These possibilities suggest that a more comprehensive set of slope dummies might be required. (Leu, 1984, in a cigarette demand study of Swiss data suggests that health education has had wider implications affecting responses to other policy changes such as tobacco tax increases).

Whatever the nature of the appropriate model of health effects it is clear that their reliable estimation requires the use of appropriate data. Atkinson and Skegg (1973) and Schneider et al. (1981) suggest that data problems may lead to the understatement of health effects. This is because studies have used numbers of cigarettes or cigarette expenditure. As previously noted, it is difficult with these series to measure the switch to filter and low tar cigarettes which would be attributable to health shocks. Atkinson and Skegg considered these problems by using different consumption series combined with various health effects. The zero/one returning trend model was used with the series of the number of cigarettes

consumed. When consumption of tobacco was examined, however, the dummy variables were replaced by either a measure of the proportion of filter cigarettes consumed or a modified time trend introduced to take account of the decline in the average weight of tobacco per cigarette. In their work on cigarette demand equations, Schneider et al introduced variables measuring the market shares of filter cigarettes, the share of low tar cigarettes and a variable measuring the average annual amount of tobacco in each cigarette consumed, a dummy variable for the period of the Fairness Doctrine[13] in the US and a split measure of the advertising stock variable consisting of components before and after the advertising ban. The tobacco equation omitted the variable measuring the amount of tobacco per cigarette. Schneider et al. concluded that other studies had underestimated the health education effect both by misspecification and by not considering the impact of health education on the type of cigarette consumed. Atkinson and Skegg took a more cautious position questioning how far publicity, rather than supply or advertising changes, is responsible for the changing pattern of demand.[14].

It has been an important part of government policy to encourage the switch to lower tar cigarettes but the most recent RCP Report (RCP, 1983) has questioned how far low tar cigarettes reduce mortality and morbidity. The value of previous health education is likely to remain hard to determine. In recent years, however, although some switching in tastes has occurred, the series of tobacco quantity, expenditure and the number of cigarettes have been moving more in line with one another, which may facilitate future studies.

All the studies so far discussed have concentrated on measuring the effect of health education shocks. It is not clear that these measures are adequate in providing an estimate of the usefulness of health education. Authors have claimed that such dummy variables are capturing not only the

effect of a particular event such as the publication of a report but also the free publicity that surrounds it. It may be felt that such shocks are reinforced by government sponsored health education campaigns. The only study that has attempted to directly measure the effect of government expenditure on health education has been the Metra (1979) study. They defined a health education stock variable in the same manner as the advertising stock model. Government and government-financed media expenditure was deflated by their advertising rate card index. In these models this variable was the only measure of health education included and so no allowance for any shock effect was made.

To conclude, the types of measures of health education used in tobacco models do not lend themselves to forecasting the effects of any policy initiative, unless a proposed policy can be regarded as being very similar to some previous one.

In the alcohol field health education effects have not been incorporated in models. It has sometimes been suggested that since promotional advertising seems to have little effect it is unlikely that increasing expenditure on health education would be effective. It is worth noting that estimates of some tobacco models have indicated both non significant advertising effects and very large health education responses.

Measuring the health education of tobacco demand has been clearly made difficult by the changes in the type of cigarettes consumed. Future campaigns and health information of the effect of alcohol may also affect the type and quality of the beverages consumed. The possibility that industry will respond to health campaigns by introducing new brands of both tobacco and alcohol goods also requires further study, and any analysis of health education must consider these quality changes.

Although more complex specifications of health effects may be of interst, estimating the health education impact will still involve considerable measurement problems and such models are unlikely to be capable of providing a complete evaluation of the impact of any one education campaign. The effectiveness of media campaigns relative to other forms of health education campaigns is in general outside the scope of such models.

2.7 Licensing and other regulations

The retailing of alcohol has historically been subject to considerable regulation. Liberalisation of the licensing laws has been criticised by many of those worried about increasing alcohol abuse. It is therefore perhaps surprising that demand models for alcohol have not always considered a variable measuring the influence of alcohol availability. The link between the number of licenses and overall consumption is however, not straightforward.

If licensing laws restrict the number of available outlets then this obviously affects suppliers but may not necessarily directly affect demand. Indirect effects may occur if the licensing laws restrict competition and prices are higher (or public houses offer less services) than if licensing laws were laxer. Two arguments have been proposed for a direct effect on demand. A restricted number of outlets may increase transaction costs e.g. travel to outlets etc., and thereby reduce demand. Also the outlets (and posters, logos near them) may act as advertising stimulating demand.

The interpretation of the licensing laws is, however, complex and varies between petty sessional divisions and at appeal (see Tether, 1984 for a discussion of these issues). The effect of the law may therefore be that the number of licenses granted increase in line with an upturn in the demand for alcohol products. This would suggest that the causal links

between consumption and licenses may not be clear.

As with advertising expenditure, it would therefore be useful to investigate this simultaneity problem by means of appropriate statistical techniques. Existing studies have, however, either included or excluded this variable without the application of such tests. McGuinness included a variable measuring the total annual number of licenses, both off and on licenses. Duffy excluded this variable because he took the view that the causality was in the form that an increase in demand led to an increase in the number of licenses. Differences in their results indicates that this is a problem that needs to be thoroughly investigated.

An examination of the changes in licenses granted does, however, reveal that the overall figure hides changes in the composition of licenses. Increases have occurred in the number of off licenses, clubs and restaurants whereas the number of full on licenses has fallen.

Changes in licensing law increasing the hours of trading and abolishing Retail Price Maintenance have altered the nature of the off license trade. The appearance of alcoholic drink on open supermarket shelves and the consequent 'normalisation' of alcohol associated with the increasae in availability have been linked with increases in drinking by women and youths. Prys Williams (1975) investigated this problem comparing convictions for drunkeness for women and youths with increases in the number of supermarkets licensed to sell alcohol, and he found a strong association between the series. To incorporate such effects into a demand model in order to try and measure precisely these effects would require consumption data by outlet as well as by age and sex of the consumer. The effects of changes in retail availability on consumption may be obscured in a more aggregate model.

More recent discussion on licensing laws has, however, been concerned more with changes in the conditions of licenses than changes in the absolute numbers. Recent changes in Scotland have introduced more flexible licensing laws and a variable that measures only the number of licenses is an inadequate proxy for such changes. Measures of consumption may also fail to reflect changes that occur in the social costs associated with alcohol abuse. Advocates of liberalisation would argue that flexible licensing laws would lessen excessive drinking and disturbances centred around closing times. Similar per capita consumption figures before and after such changes in licensing laws might be associated with different levels of this type of abuse. The evaluation of the Scottish changes, will depend on an assessment of the changes in all the indicators of alcoholic abuse, and not just, for example, the social cost of disturbances.

Tobacco retailing is not subject to the same degree of regulation as alcohol, retailing licensing law being abolished in 1962. As with alcohol, retailing of tobacco has undergone considerable changes. The promotion of loss leaders, including the discounting of large quantities of cigarettes, is likely to directly affect demand through changes in price and the number of outlets is probably not needed as a separate variable in the demand equation. Although no UK study has attempted to measure the effect of the number of outlets on cigarette demand Yucelt and Kaynak (1984) did include such a variable in their analysis of US data. Their results, indicated that this variable was not significant in any of their model specifications.

One factor that has been recently the subject of public concern is the retailing of cigarettes to school children, following the survey of school childrens' smoking habits (Dobbs and Marsh, 1983). Time series information as to whether this has been a growing problem is not available and possibly differences in smoking by children would not play a

significant part in short run changes in consumption. Any change in legislation or public awareness of the problem although an important policy issue, may not be appropriate to consider within the general demand models discussed in this paper.

Regulation of the retailing of alcohol and tobacco clearly has some effects on the marketing of these products. How these regulations affect the demand for the products rather than their supply is difficult to measure. The effect on consumers' welfare can also be questioned. Orstein and Hanssens (1981) discuss the variety of regulation of the US alcohol market and the possible trade offs between social cost savings from reduced consumption and monopoly welfare losses sustained by restricting competition.

2.8 Other variables

Many additional social and cultural factors have been linked with drinking and smoking behaviour. As previously discussed in relation to cross-sectional models such factors do not usually show sufficient variation over different years to enable them to be incorporated in time series models. Some suthors have included variables such as unemployment rates in their models and some of the difficulties of introducing such factors are discussed in this section.

Kitchen (1983) has recently attempted to measure the effects of such socio-economic variables. In a model of pure alcohol consumption based on McGuinness' original model he included three additional variables; unemployment rate, the rate of inflation, and the number of deaths in the population. These variables were introduced as measures of stress. There are two questsions to be asked of such measures. Firstly, are they adequate stress measures? Secondly, are such variables acting as

indicators of stress or do they have other interpretations? Maynard (1983) questioned the use of unemployment indicators in demand models as in fact, higher unemployment rates may well be reflected in income measures, although a measure of the distribution of income might be required. An unemployment variable in an equation cannot therefore be considered as measuring stress alone. Similarly the meaning of an inflation rate variable is not clear cut. Kitchen gives alternative specifications and interprets the inflation variable as a type of 'money illusion' effect.(15) Previous criticism of the McGuinness model (for example, see Walsh 1982) and these difficulties in interpreting 'stress' variables, indicate the care needed in introducing extra variables to any model.

3. COMPARISON AND EVALUATION OF ALTERNATIVE MODELS

The previoussections have indicated that there are many different approaches to modelling alcohol and tobacco consumption. For policy analysis the interest centres both on the estimated coefficients of policy orientated variables and those variables of relative importance in determining consumption. It may be felt that if the policy conclusions have not varied between competing models then for policy purposes the differences in model specifications may not be of importance. In the first part of this section, therefore, some results from recent studies are examined, especially those related to the consequences of policy changes. In subsequent parts of this section, reasons for variations in the results are considered, a review of the statistical problems involved in constructing these models is presented and finally, some proposals for systematically testing competing models are examined.

3.1 Comparison of recent results

Many previous works have surveyed results and it is not the purpose of this section to review all previous empirical findings. A more

comprehensive survey of alcohol and tobacco studies can be found in Maynard and Kennan (1981). A survey of price and income elasticities for beer, wine and distilled spirits is provided by Orstein (1980) and Metra (1979) and Simon (1968) review previous results of tobacco demand equations. These reviews are extended in this section and some recent results are compared.

Four recent studies of tobacco demand are considered namely those of McGuinness and Cowling (1975), Metra (1979), Radfar (1983) and Witt and Pass (1981). Details of these studies can be found in other parts of the paper but the salient features of their models are described here toguide comparisons of results. Differences found in results, cannot however be readily attributed to differences in specification.

The McGuinness and Cowling model was a log-linear partial adjustment model of cigarette expenditure incorporating an advertising stock effect and a health education variable that worked through reducing advertising stock. Radfar, whose study used the most recent data, replicated as far as possible the original McGuinness and Cowling specification. Metra carried out many analyses but emphasis is given here to their augmented partial adjustment model with a given rather than estimated depreciation rate of advertising stock. The Metra study also used different data and variable definitions than were used in other studies. Witt and Pass used a simple log linear model with no dynamic elements. The distinguishing feature of their work was the specification of limited duration effects for health education. The Witt and Pass model used annual observations in contrast to the other three studies which used quarterly data.

The three recent alcoholic drink demand studies considered are McGuinness (1983), Walsh (1982) and Duffy (1980, 1983). All presented separate demand equations for beer, spirits and wine.

McGuinness reformulated his model in disaggregated terms and used a linear functional form incorporating a time trend. A volume measure of expenditure was related to own and cross-price terms for the remaining two alcoholic categories, own and cross advertising effects, the total number of licensed premises and real income. Walsh re-estimated the original McGuinness model in disaggregated terms and imposed the symmetry restrictions on the price but not the advertising terms. Duffy conducted a very comprehensive analysis using various functional forms and dynamic as well as static models. The general model related alcoholic expenditure of beer, spirits or wine to own price and all other prices, own advertising and all advertising, and income. A range of estimates was therefore obtained from this study.

The results of these studies are now presented for each of the main variables in turn, and compared to the Tresury estimates (H.M. Treasury, 1980). The Treasury estimates would appear to be derived from a log-linear model for beer, spirits, wine and tobacco, (H.M. Treasury, 1982).

(i) Price

For a comparison of results from different studies, it has been useful to consider elasticities. Obviously they have the advantage of being unit free measures, but the evaluation of elasticities does vary between models. The log-linear model produces constant elasticities but for other models the elasticity will vary and access to the raw data is needed to evaluate the elasticity at varying data points. Comparisons of elasticities therefore are restricted to those quoted by the authors. Another complication arises when dynamic models are considered, since both a long-run and a short-run elasticity figure may be estimated.

Previous surveys have indicated a low price elasticity for tobacco and the more recent work also indicated a low but significant price effect. InTable 1 the elasticities, all of which are based on constant elasticity models, are considered.

The three studies had similar figures which, on average, are smaller in absolute magnitude than the figure of -0.5 used by the Treasury (H.M. Treasury, 1980) to calculate tax revenues. Such a figure would imply that a 10 per cent rise in prices would ceteris paribus, reduce consumption by 5 per cent.

For the results of the alcohol study it is necessary to consider not only own-price results for beer, spirits and wine, but also any cross price effects estimated. Unlike tobacco, the results are not all derived from constant elasticity models. Walsh estimates elasticities at the last date of his study, 1975, and similarly McGuinness estimates related to the 1980 levels of his variables.

Table 1 Price Elasticities of Tobacco Studies

Study	Time Period	Elasticity
McGuinness/Cowling	1957-1968 (quarterly)	SR. -0.99 LR. -1.05
Witt and Pass	1955-1975 (annual)	-0.32
Metra	1958-1978 (quarterly)	SR. -0.34 to -0.54 LR. -0.42 to -0.54
Radfar	1965-1980 (quarterly)	SR. -0.23 LR. -0.39

Table 2 indicates there is more variation about price effects in the alcohol models, apart from beer where in all models the elasticity is small. For the other two commodities' price elasticities Duffy's results are consistently higher than the other two sets, while still being inelastic. The Treasury estimates of price elasticity are also low for beer at -0.2; wine is taken at -1.1 which is similar to some of Duffy's estimates and spirits, which is now taken as -1.3 (private communication) again close to Duffy's estimate.

Table 2 Own Price Alcohol Elasticities

Study	Time Period	Elasticity		
		Beer	Spirits	Wine
Walsh	1955-1975 (annual)	Vol. -0.13 Exp. -0.26	-0.47* -0.45*	-0.28* -0.38*
McGuinness	1956-1979 (annual)	-0.30*	-0.38*	-0.17
Duffy	1963-1978 (quarterly)	not available	-0.8 to -1.0	-0.7 to -1.0

* Denotes based on significant coefficient except for Duffy where estimates cover a number of estimated coefficients.

Until recently the only evidence on cross-price effects came from overseas studies. Johnson and Oksansen's pooled cross section/time series study had mixed results with some of the price effects having the 'wrong' i.e. negative sign. (A negative sign would suggest that goods are complements rather than substitutes). Low and insignificant cross-price elasticities have also been found in studies employing the sub-systems approach to UK data. Duffy's (1985) estimates of the unconditional cross-price effects were all insignificant. Salvananthan (1985) estimates were somewhat larger and some evidence of wine being a complement for spirits was found with an unconditional elasticity of -0.78 evaluated at the sample

mean.

The three studies under consideration also had mixed results. Duffy reports unsuccessful attempts to obtain useful results after including more price terms in his model and suggests that this may be due to multicollinearity problems. Walsh imposed symmetry restrictions on the price coefficients and in both the expenditure and value forms only the the cross-price effects between wines and spirits were significant and negative. Possible multicollinearity between variables may suggest that the lack of significance does not justify failure to consider their influences. It is therefore perhaps interesting to note that despite the lack of precision cross-price effects between wine and beer was also negative but the estimated cross-price coefficient between spirits and beer was positive. McGuinness results also in general indicate insignificant cross-price elasticities. In his unrestricted estimates only the coefficient of the spirits price in the beer equation is both significant and positive with an elasticity evaluated at 0.12.

(ii) Income

The estimated influence of income on consumption has varied between alcohol and tobacco studies; in general income has been found to have a smaller impact on tobacco than alcohol expenditure. There are variations in the results within these commodities as shown in Table 3.

The tobacco estimates are all quite small and are lower than the Treasury estimate of 0.6. For the alcohol studies variations between the studies are much wider, Duffy's estimates being closer to the Treasury's at 0.7 for beer, 2.5 for wine and 1.8 for spirits respectively.

Table 3 Income Elasticities of Alcohol and Tobacco Studies

Study	Elasticity		
(a) Tobacco			
McGuinness/Cowling	SR. 0.31 LR. 0.33		
Witt and Pass	0.13		
Metra	Not available		
Radfar	SR. 0.12 LR. 0.19		
(b) Alcohol	Beer	Spirits	Wine
Walsh	Exp. 0.13 Vol. 0.12	1.20 0.99	0.51 0.49
McGuinness	0.13	1.54	1.11
Duffy	0.8 to 1.1	1.6	2.2 to 2.5

(iii) Advertising

The differences in results for the advertising coefficient have been one of the most controversial areas of tobacco demand research. All the studies considered in this section included an advertising term. McGuinness and Cowling, Radfar and Witt and Pass all found significant advertising effects, although the estimated coefficient were small, between 0.09 (short-run) and 0.15 (long-run) for Radfar; 0.07 for Witt and Pass; and Johnston's corrected long-run elasticities for the McGuinness/Cowling model being 0.09. All these estimates suggest that a 10 per cent rise in advertising levels yield a rise of less than 1 to 1.5 per cent in sales. In the Metra Report no significant advertising effect was found.

Results in alcohol demand have also been the subject of controversy. Duffy found a significant but low advertising effect in the beer equation, the elasticity being 0.07. In the wine equation there was no evidence that advertising affected demand and there were mixed results for spirits, the

elasticities too being small but significant in his two stage least squares results.

Walsh entered advertising disaggregated by alcohol type. Beer consumption seems to be significnatly influenced by beer advertising with again a low elasticity of 0.1; spirits advertising appear to stimulate both wine and spirits consumption. McGuinness' results are also a mixture of significant and insignificant coefficients and, in his own words "do not suggest that small changes in the levels of real advertising of alcohol will have much of an effect on consumption levels."

(iv) Health Education

As previously discussed health education variables have only been introduced into tobacco demand equations. Witt and Pass specified limited durationdummies for the following events: the 1962 RCP Report, the 1964 report by the US Surgeon-General's Advisory Committee; and the 1971 RCP Report. They concluded that health education reduces cigarette consumption by a small but significant amount for the first and subsequent year after the campaign by some 3 to 7 per cent. McGuinness and Cowling and Radfar calculated health education effects by the amount it reduced the advertising coefficient. Both studies found significant effects of the health dummies although the calculated fall in advertising elasticities attributable to health shocks was small.

(v) Licensing

A licensing variable was used in only two of the alcohol studies, namely those of McGuinness and Walsh and in both the number of licenses was found to have significant coefficients in the beer equation; the estimated coefficient was also large in McGuinness' results. Moreover, in Walsh's estimates the licenses variable was also significant in the spirits

and wine equations. The differences between Walsh, McGuinness and Duffy may well be explained by the inclusion of this variable which makes further investigation of its influence important.

To conclude, although coefficients of price and income did not vary strikingly between studies, very different conclusions were reached on the important issues of advertising and health education. The alcohol studies considered have shown considerable variations, in parameter estimates.

3.2 Statistical Testing of Models

The previous section indicates that there is variation in the conclusions reached. Even when there is some measure of agreement between the studies there is still a need for caution. One problem is that the models (and combinations of these models) have not been systematically tested. There is no evidence that existing specificationsinclude an adequate approximation and, for example, an addiction alcohol model may result in completely different conclusions. Another problem may arise with the variability or rather lack of variability of data during the period in which models are estimated. Different data and/or such different specifications may yield very different results. Clearly researchers need some criteria for choosing between models and consideration of some of the statistical tests available is the concern of this section.

In general, existing studies have not made use of many such statistical tests to judge the validity of their estimated models. The R^2 statistic which gives a measure of the goodness of fit, tests of significance of coefficient estimates used to consider the importance of the variable in determining consumption are considered but the only test for misspecification generally used is the Durbin Watson statistic. This is a test for first order autocorrelation in the residuals which, if reflecting autocorrelated errors, would lead to biased estimates of the

standard errors, invalid tests and inefficiency of OLS. Other than this check,models in general have been considered for the plausibility of the results and in comparison to other studies.

Different statistical problems have different implications for the conclusions being drawn from empirical results. If the problem causes bias then the estimated coefficient may overestimate or underestimate the 'true' effect. If the statistical problem affects the estimates of standard errors(SE) then tests of significance on the coefficients calculated from SE may lead to wrong conclusions as to the importance of that variable in influencing demand. Clearly the thrust of the Metra (1979) report was that the advertising variable was not a significant variable in their esimates. It is therefore important before any conclusions are drawn from a model that some confidence can be placed in the model's results. (See Godfrey, 1986 for a fuller discussion of these points in relation to cigarette consumption and advertising). In the field of alcohol and tobacco there are also many competing models and therefore it is necessary to devise means of comparing models. In the first part therefore, statistical problems and tests within a given model are considered and in the second part, tests between competing but individually validated models are considered.

(i) Problems within a model

Some of the statistical problems associated with particular theoretical approaches, e.g. restrictions imposed, functional forms and individual variables e.g. simultaneity have already been discussed. To judge the validity of a model,two different types of statistical test are available. Firstly, those with a specific alternative in mind e.g. some specific omitted variable, and others that have more general alternatives. An example of the latter type of test is the RESET test which is designed

to act as a general check for omitted variables and incorrect functional form. This test involves comparing the estimates of the original model with those of an augmented model obtained by adding powers of OLS predicted values for the former specification.

It is worth considering some of the statistical problems that may occur. The DW test for autocorrelation in the residuals has already been mentioned. The presence of correlation in the error term would render least square estimation procedures and significance tests inappropriate. The presence of first order autocorrelation in the residuals as indicated by this test has also been considered as a signal that the equation is misspecified in some specific way e.g. omitted variables and incorrect functional form. The DW statistics may, however, be inadequate in some situations. Many models have been estimated using quarterly data and this would suggest that tests for higher autocorrelation should be carried out in addition to the DW (see Wallis, 1972). It should also be noted that in certain circumstances e.g. the presence of a lagged dependent variable, the DW statistic is invalid.

Simultaneity between advertising and consumption, and outlets and consumption has already been discussed as has testing for this phenomena by means of a Hausman-Wu test. In a recent paper Bishop and Yoo (1985) have questioned the endogenity of the price vaiable and considered a simultaneous demand and supply model of the US cigarette industry. If simultaneity does exist then the correct procedure is to use an estimating technique that takes it into account e.g. 2SLS. In other areas of economic study such re-estimates have revised the policy conclusions from the wrongly estimated model.

As indicated in previous sections the theoretical specification of some models leaves aspects of the model to be tested empirically. So there

may be, for example, a choice of functional form. As indicated the RESET test is one test than can be employed, while the procedures advocated by Davidson and MacKinnan (1985) may be of interest if a Box-Cox model has been fitted, see Section 1.2. There is also considerable scope for empirically testing whether some variables should or should not be included in the model. However, relying on significance tests calculated from untested models could clearly have misleading results. An alternative strategy would be to apply a set of tests to the model in question including the variable in question and if it passed the test then to assess the significance of the doubtful variable.

Some of the models discussed had imposed untested restrictions e.g. symmetry restriction in the study of Walsh (1982). Whenever possible it is clearly important to test these restrictions against the data rather than just applying them.

Another feature of a model not previously considered is structural stability i.e. is the model stable over different periods of time? This can, however, be viewed in two ways. Some may predict that, for example, in tobacco demand there has in fact been structural changes in the nature of the demand relationship. Walsh (1980) considered this by dividing the period of his data 1953 to 1976 into a number of sub-periods and used Chow test to compare results from applying a simple tobacco demand equation for the whole period to that of sub-periods, and from his results concluded the demand relationship was not stable over the period.[16] Duffy (1981, 1982a) also considered stability by considering the one period ahead forecast error of the equation using a method devised by Brown, Durbin and Evans (1975) which indicated instability in the beer demand equation in 1971, about half way through the sample period he used. However, such structural stability may be viewed as an indication of model specification

and tests of structural stability and forecasting performance of a model may be seen as an additional test of the model.[17]

Even if a model is comprehensively tested, problems can remain. The problem most discussed in the alcohol and tobacco studies is that of multicollinearity. This problem arises when series move in line with one another and therfore makes if difficult to estimate precisely the effect of any one of the variables. Some of the so-called 'cures' for this problem may, however, cause statistical problems of their own e.g. dropping some of the terms of the equation would lead to omitted variable bias on the resulting coefficients if the dropped variables had an influence on demand. Clearly the results from a model modified in this form may not hold if the model was re-estimated over a different data period when multicollinearity was not such a problem.

Another way some authors have tried to overcome this problem is by using extraneous estimates of effects e.g. from cross section studies and substituting these results in the estimation of the demand relationship (see Hamilton, 1972 for example). Brown and Deaton (1972) discuss some of the difficulties in interpretation of the results and clearly there are some statistical problems associated with this method.

The second problem is that of generally omitted variables. There may be important influences on tobacco and alcohol consumption that have not yet been considered for inclusion in a demand model. To some extent this problem cannot be overcome. One way to guard against possible omitted variables is to apply appropriate tests to judge whether these variables should be included in the demand model.

A third problem arises with measurement error e.g. the omission of poster advertising in the advertising measure. Only under strict conditions can the bias caused by such errors be calculated. (If one could

predict the bias and its effect on the coefficients or significance of other variables there would be less cause for concern). Problems with data will, however, remain and the importance of the area suggests that as much data as possible should be made available to independent researchers.

The problems of omitted variables and measurement error can be considered more important for the validity of the model than multicollinearity. The presence of multicollinearity may limit the usefulness of the estimates but will not necessarily interfere with the testing of the model. Assuming models are subjected to a number of tests, the next consideration is comparison between models.

(ii) Testing between models

Many different models have been discussed in the paper and there clearly is some need to be able to distinguish between them. One way is to apply the tests described above and look at the competing models' performance. Another way is to consider the forecasting ability of the models. More systematic statistical tests do exist. The type of test applied depends on the relationship of various models to one another. Some models are special cases of other models e.g. it was described in section 1 that the linear estimating forms of the partial adjustment model can be viewed as a special case of the Houthakker Taylor model. In this form therefore these models can be reviewed and tested and the results from each model can be compared using standard tests for linear restrictions. In other cases models are completely distinct from one another and this requires an alternative form of testing, non-nested tests (see Godfrey, (1984) for a discussion of these approaches).

(iii) Procedures necessary for building satisfactory models

In this section arguments have been put forward for more extensive tests of models. To build an adequate model therefore the many possible alternatives, already estimated or new theories, need to be re-estimated using a current data set. Statistical procedures and detective work as for example used by Davidson, Hendry, Sobra and Yeo (1978), can be employed to try and obtain a satisfactory model.

It is of course also true that obtaining results of comparative studies enables researchers to examine in more detail the different policy outcomes predicted by such problems. Such work can never, however, be regarded as totally conclusive. Models used to be regularly tested against new data and developments in general theory and knowledge of factors influencing smoking and drinking behaviour must be included in future work.

CONCLUSIONS

This review has indicated a number of variations in data, the choice of explanatory variables and the general approach to modelling demand for alcohol and tobacco. These differences have led to varying conclusions about the size and significance of various effects, and some comparisons have been reported in section 3. One interesting and useful exercise would be to estimate a number of models using a common data set, using the statistical tests discussed above to evaluate their adequacy and the reliability of the various sets of results. It is worth noting that recent changes in relative prices in the alcohol market and the drop in cigarette consumption may have introduced more variability in the data and so enhance the sensitivity of the test procedures. Also some interesting models have yet to be estimated and tested using UK data, e.g. Young's (1983) addiction model.

If, satisfactory models could be constructed using recent data, how useful could they be in policy analysis? Should governments depend on such research to determine policy? Recent statements by Ministers on the proposals to ban advertising stating, for example, that evidence must be "clear and unequivocal" (Hansard, 1984) that such a ban would decrease smoking by children, demand a level of authority for their results that many researchers would be unwilling to claim.

The models, however well constructed, cannot throw light onto all aspects of policy. As discussed in Section 2, evaluating particularly health and education campaigns, may be outside the scope of these models. Demand models can only assess broad policy moves and may be something of a blunt instrument. New and radical policies e.g. a truly co-ordinated preventive health campaign, may in themselves have effects previously not experienced and not measured by models based on previous data variations.

Nor can models of this sort predict other consequences of policy changes. The predictions of these economic models are based upon 'ceteris paribus' assumptions. Many policies e.g. advertising restrictions, will draw forth reactions from industry which need further consideration.

Well constructed and tested demand models represent, however, one method of increasing knowledge of drinking and smoking behaviour. Although conclusions from these models are limited by problems of interpretation and model comparison discussed in this paper, provided these difficulties are recognised, they can at least be one of the tools in the policy making process.

FOOTNOTES

1. See Duffy (1980) for a discussion of the implications of these different models for estimating the effect of a tax change on thetax revenue obtained.

2. See Deaton and Muellbauer (page 77) for the mathematical proof.

3. The restrictions, of course, rule out the log linear demand function, see Deaton and Muellbauer.

4. See Duffy for an explanation of the interpretation of coefficients and elasticities derived from these types of models.

5. See Deaton and Muellbauer for a discussion of the characteristics of this model.

6. The justification for claiming that a time trend in some way picks up the effect of 'omitted' variables also seems open to question.

7. Metra also considered other statistical techniques to examine the time series relationship between cigarette consumption and other factors, see Godfrey (86) for a discussion of their approach.

8. Clearly this type of analysis shares some of the problems of other studies in the exact interpretation and specification of variables to be included.

9. They also considered a cigarette consumption equation with an additional variable measuring the average amount of tobacco in each cigarette consumed.

10. Duffy (1980) did compare annual expenditure and volume series for the period 1963 to 1978 and found high correlation between the series for beer, spirits and wine which may indicate why alcohol studies have been less concerned about the choice of dependant variables.

11. Sometimes the price of the good being studied has been included, in the overall price index, but in other cases it has been omitted.

12. Surveys such as the GHS may indicate that health education has been successful in that there is widespread knowledge about the detrimental health effects of both smoking and drinking (see GHS, 1982).

13. The Fairness Doctrine period in the US was a time of a substantial number of health education broadcasts.

14. Supply changes have of course in part occurred in response to health campaign and agreements with the Government.

15. See Deaton (1977) for an explanation of using inflation rates in demand models.

16. Per capital tobacco consumption was linearly related to per capita real consumer expenditure and real tobacco price only.

17. Some authors, e.g. McGuinness, have used first differencing techniques to overcome detected autocorrelated residuals rather than considering that the autocorrelated error were a sign of misspecification.

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