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Indirect Tax Reform in Ireland

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I INTRODUCTION

The Irish tax system is characterised by a narrow base with high rates. This is true of both the direct and indirect system. This paper examines the possibilities for indirect tax reform in Ireland. A model of the economy and its initial equilibrium is specified. This is embodied in a social welfare function, together with value judgements and the question is then posed as to whether it is possible to reform taxes so as to increase social welfare. If we are at an optimum with respect to the social welfare function, then no improvement is possible. Alternatively we could ask whether there is a set of value judgements for which, given the model of the economy, the initial state of affairs would be deemed as optimum. This is the inverse optimum problem. Finally, we can seek to discover Pareto improvements in order to avoid using a possibly controversial social welfare function.

This paper closely follows similar work by Ahmad and Stern (1984). In the next section the theory is developed. We show how, given a social welfare


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function, directions of improving reform can be found. We define for each good the marginal cost in terms of social welfare of raising an extra unit of revenue from increasing the tax on that good. If these marginal costs differ across goods then we can increase welfare at constant revenue by reducing taxes on goods with higher marginal costs and increasing them on goods with lower marginal costs.

At an optimum all these marginal costs must be equal, thus giving for each tax a first-order condition for optimality. In the inverse optimum problem these first-order conditions are solved to give social welfare weights on increments in income to each household assuming existing taxes are optimum.

In Section III the data requirements for implementing this approach are discussed with particular reference to the Irish data for 1980. Section IV presents results for the Irish case.

If some of the welfare weights derived in Section IV are negative then this implies that Pareto improvements are possible. Section V shows how Pareto improvements may be investigated using linear programming techniques while Section VI indicates directions for tax reform.

Section VII discusses the possibility of extending the analysis to include direct taxation and labour supply, while Section VIII offers concluding remarks.

Before outlining the model it is useful to review the existing work in the area for Ireland. Taxation and tax reform have been the subject of much debate in Ireland in the 1980s but little, if any, of the work has explicitly included a model examining the directions of possible tax reform. Honohan and Irvine (1987) examine the deadweight losses associated with different forms of taxation in Ireland. While their paper provides a range of figures for deadweight loss depending upon values for different parameters it does not give specific recommendations for directions of tax reform. Other discussions of tax reform (e.g., de Buitlair (1983/84) and the Commission on Taxation (1984)) examine and cost various proposals but do not derive their results from a specific social welfare function.

II THE MODEL

This paper concentrates on consumer welfare and the government revenue constraint. Thus a simple model of the production side of the economy is adopted. We assume that producer prices are fixed and there are constant returns to scale, so that tax increases are reflected as consumer price increases and there are no pure profits. If factor incomes are fixed then we may write household utility as functions of consumer prices, q. There are n goods indexed by i and t in a vector of specific taxes. Thus we have:
\[ q = p + t \]  \hspace{1cm} (1)

where \( p \) is the fixed producer price vector. We can speak interchangeably of changes in, and derivatives with respect to, \( q \) and \( t \). There are \( H \) households indexed by \( h = 1, 2 \ldots H \).

Given prices \( q \), the demand of household \( h \), \( x^h(q) \), maximises utility, \( u^h(x^h) \) subject to the household budget constraint. Then \( v^h(q) \), the indirect utility function, gives the maximum utility possible at prices \( q \):

\[ v^h(q) = u^h(x^h(q)) \]  \hspace{1cm} (2)

We assume that the social welfare function is of the Bergson-Samuelson variety which may be written

\[ W(u^1, u^2, \ldots, u^H) \]  \hspace{1cm} (3)

and we can also write social welfare as a function of prices, \( V(q) \), where

\[ V(q) = W(v^1(q), v^2(q), \ldots, v^H(q)) \]  \hspace{1cm} (4)

The aggregate demand vector is given by

\[ X(q) = \sum_h x^h(q) \]  \hspace{1cm} (5)

and government tax revenue \( R \) is

\[ R = t.X = \sum_i t_i X_i. \]  \hspace{1cm} (6)

The tax problem is then to find a vector of tax changes \( dt \) such that \( dV > 0 \) and \( dR > 0 \) with one of the inequalities holding strictly. Thus we wish to find a tax change which will increase welfare but not decrease revenue. We can find such improvements if the marginal cost, \( \lambda_i \), in terms of social welfare of an extra pound raised via the \( i^{th} \) good exceeds that for the \( j^{th} \) good. Then welfare can be increased at constant revenue by increasing taxes on the \( j^{th} \) good by an amount sufficient to raise £1 and decreasing taxes on the \( i^{th} \) good by an amount sufficient to lose £1. To raise an extra £1 on the \( i^{th} \) good we increase the \( i^{th} \) tax by \( 1/\partial R/\partial t_i \).

Thus we have

\[ \lambda_i = - \frac{\partial V}{\partial t_i} / \frac{\partial R}{\partial t_i} \]  \hspace{1cm} (7)
since \( \frac{\partial V}{\partial t_i} \) is the response of social welfare to a tax change and we have a minus sign to denote marginal cost. Obviously away from the optimum the \( \lambda_i \) will differ. Thus a sufficient condition for a welfare improvement to be possible is that there exists \( i \) and \( j \) such that \( \lambda_i \neq \lambda_j \).

In general there will be many welfare improving directions given by the intersection of the two half-spaces defined by

\[
dV = v_i dt \geq 0
\]
and

\[
dR = r_i dt \geq 0
\]

where \( v_i = \frac{\partial V}{\partial t_i} \) and \( r_i = \frac{\partial R}{\partial t_i} \).

To compute \( \lambda_i \) we must examine \( \frac{\partial V}{\partial t_i} \) and \( \frac{\partial R}{\partial t_i} \) so we go back to our definition of the indirect social welfare function (4) and our revenue equation (6).

From Roy's identity we have

\[
\frac{\partial V^h}{\partial q_i} = -\alpha^h x_i^h
\]

where \( \alpha^h \) is the private marginal utility of income.

Then using (10), (4) and the constancy of producer prices

\[
\frac{\partial V^h}{\partial t_i} = -\sum_{h} \beta^h x_i^h
\]

where

\[
\beta^h = \frac{\partial W}{\partial u^h} \alpha^h
\]

is the social marginal utility of income of household \( h \), i.e., the welfare weight.

From (6) we have

\[
\frac{\partial R}{\partial t_i} = X_i + \sum_{k} t_k \frac{\partial X_k}{\partial t_i}.
\]

Thus we now have an expression for \( \lambda_i \) from (7), (11) and (13)

\[
\lambda_i = \frac{\sum_{h} \beta^h x_i^h}{X_i + \sum_{k} t_k \left( \frac{\partial X_k}{\partial t_i} \right)}.
\]
\( \lambda_i \) can be more conveniently analysed by examining its inverse:

\[
\frac{1}{\lambda_i} = \frac{X_i}{\Sigma_h \beta^h x_i^h} + \frac{\Sigma_k \frac{\partial X_k}{\partial t_i}}{\Sigma_h \beta^h x_i^h}.
\]  

(15)

\( \frac{1}{\lambda_i} \) is the revenue cost at the margin of generating an extra unit of welfare via a reduction in the \( i^{th} \) tax. It can be decomposed into two components, the first of which involves only household demands and welfare weights, and the second, in addition, taxes and aggregate demand responses. The first term on the right hand side of (15) is the reciprocal of the “distributional characteristic” of the good (see Atkinson and Stiglitz (1980)). With a strong aversion to inequality this term will play an important role in the ranking of \( \frac{1}{\lambda_i} \) across goods, since the dominant contribution to it would be the reciprocal of the share in total consumption of good \( i \) by the poorest groups. With equal welfare weights (say unity) this term will be one for all goods and so will not contribute to the ranking of \( \lambda_i \). The second term in (15) involves the effect of demand responses on revenue.

By multiplying the nominator and denominator of (14) by \( q_i \) we obtain

\[
\lambda_i = \frac{\Sigma_h \beta^h q_i x_i^h}{q_i X_i + \Sigma_j \frac{X_j}{q_j} q_j X_j e_{ij}}.
\]  

(16)

where \( e_{ij} \) is the cross price elasticity of good \( j \) with respect to good \( i \).

(16) gives an expression for \( \lambda_i \) which is readily calculable from available data. Below we discuss the actual data used but first we will examine the inverse optimum problem.

A necessary condition for an optimum is that all the lambda\( _i \) be equal. If we use the common value lambda, then the condition can be expressed as

\[
\frac{\partial V}{\partial t_i} + \lambda \frac{\partial R}{\partial t_i} = 0.
\]  

(17)

This is the first order condition we would obtain if we considered the problem

maximise \( v(t) \) subject to \( R(t) \geq \bar{R} \),

where we have a Lagrange multiplier for the constraint and form the Lagrangean

\[
L = v + \lambda (R - \bar{R}).
\]  

(18)
Using (11), and writing \( r_i = \frac{\partial R}{\partial t_i} \) and dividing by \( \lambda \) we have

\[
\sum_h \frac{\beta^h}{\lambda} x^h_i = r_i
\]

(19)

or in matrix notation

\[
\beta' C = r'
\]

(20)

where the \( h^{th} \) component of \( \beta \) is \( \beta^h \) and \( C \) is the \( H \times n \) consumption matrix with \( h^{th} \) component \( x^h_i \). We can set \( \lambda = 1 \) for convenience. Then the inverse optimum problem is to find \( \beta \) satisfying (20).

We can interpret the inverse optimum problem as follows: if the Government imposes these taxes in this environment then it is behaving as if its objective were described by this set of welfare weights. In other words, this set of taxes would only be optimum for a rational decision-maker in this environment if he had these values.

Obviously in solving the inverse optimum problem the number of tax instruments (goods) relative to the number of households will be of considerable importance. Here we have grouped goods and households so that \( H = n = 11 \). Thus providing \( C \) is invertible we have

\[
\beta' = r'C^{-1}
\]

(21)

The reader is referred to Ahmad and Stern (op. cit.) for the case where \( H \neq n \).

III DATA

There are four necessary items of information: the household demands, \( x^h_i \), the taxes \( t_k \), the aggregate demand derivatives \( \frac{\partial X_k}{\partial t_i} \) and the welfare weights \( \beta^h \). The household demands are available from the expenditure data in the Household Budget Survey. The taxes we use are taxes on final consumption goods. Strictly speaking “effective” taxes, which take into account taxes on intermediate goods, should be used. However, the extent of taxation on intermediate goods in Ireland is not as great as for many other countries so taxes on final goods should provide a reasonable measure of effective taxes. Demand derivatives can be obtained from estimates of aggregate demand systems. This paper uses Thom’s estimates using an Almost Ideal Demand System (1988) with both restricted and unrestricted elasticity estimates. The welfare weights are explicit value judgements introduced exogenously. Experimentation with different types of weights is carried out.
One of the problems with the data is the correspondence between commodity classification in the Household Budget Survey (which is used for $x_i^h$) and that for $\frac{\partial X_k}{\partial t_i}$ which is based on National Accounts data. For some commodities the correspondence is extremely close, if not exact. However for Rent (which is not included in the Household Budget Survey) and for Services and Other Goods this is not the case. The details of the commodity classification breakdown is given in the appendix.

One point which should be made is that the analysis carried out is marginal. We do not need estimates of demand and utility functions for individual household groups. For a marginal reform all the household information that is necessary is the consumptions since these tell us what the utility consequences of marginal changes would be.

### IV CALCULATION OF $\lambda_1$ AND $\beta_i$

As stated above, in the calculation of the $\lambda_i$, $\beta_i$, the values for the social marginal utility of income for each group, are introduced exogenously. We will now explain in more detail how this is done.

Atkinson (1970) showed how welfare weights could be generated, using the following function:

$$U^h(I) = \frac{kI^{1-e}}{1-e}, \quad e \neq 1, \quad e > 0$$

$$= k \log(I), \quad e = 1$$

where $I^h$ is the total expenditure of the $h^{th}$ household and $e > 0$ for concavity. We have $\beta^h = U'(I^h)$ and we choose a normalisation for $\beta^h$ by choice of $k$, so that the welfare weight for the poorest household is unity. Then we have

$$\beta^h = \left( \frac{I^1}{I^h} \right)^e.$$ 

Thus, we can view $\beta^h$ as representing the marginal social value of a unit of expenditure to group $h$ relative to a unit to group 1, according to the perception of the Government. With $e > 0$, $\beta^h < 1$ so that increments of expenditure to the poor are seen as more valuable than those to the rich. The ratio $\beta^h / \beta^{h'}$ increases with $e$ for $I^h < I^{h'}$ and thus $e$ may be thought of as an inequality aversion parameter. We have used six values of $e$ in this paper: 0, 0.1, 0.5, 1, 2 and 5. A value for $e$ of 0 implies that the policy-maker values £1 of expenditure for the poorest individual as being equivalent to £1 for the richest. A value of $e = 1$ implies that a marginal unit of expenditure to group $h$ is worth half as much as a marginal unit to group 1 if the expenditure of group $h$ is
twice that of group 1. A value of e in excess of 2 gives a very large weight to poorer groups while a value of 5 approaches the Rawlsian case of considering only the welfare of the poorest.

Tables 1 and 2 give the values and rankings of \( \lambda_i \) for different values of e and for the case of unrestricted elasticities and restricted elasticities (i.e., additivity, homogeneity and symmetry imposed). It is worth remembering that a high value of \( \lambda_i \) implies a high marginal social cost of taxation and thus a reduction in the tax on this good, while a low \( \lambda_i \) would imply an increase in the tax.

Before looking at the actual values of \( \lambda_i \) calculated, it is useful to refer again to the expression for \( \lambda_i \):

\[
\lambda_i = \frac{\sum h q_i^h x_i^h}{q_i x_i + \sum j t_{ij} q_j x_j e_{ji}}
\]

Suppose for the moment that we are not concerned with distributional issues. In that case the elements of \( g^h \) are unity and the nominator becomes \( q_i x_i \). Thus, if we call the second term in the denominator \( E_i \) for convenience we have

\[
\lambda_i = \frac{q_i x_i}{q_i x_i + E_i}
\]

\( E_i \) will be composed of eleven terms and depending on whether goods are substitutes or complements, each term will be positive or negative. Obviously as \( E_i \) becomes more negative, \( \lambda_i \) will rise, i.e., the more a good is complementary to other goods, the higher the marginal social cost of raising an extra unit of revenue by taxing that good. Intuitively, if an increase in the tax on good i reduces demand for good i and for its complements, the increase in revenue from the increase in \( t_i \) will be partially offset by the reduction in revenue due to the fall in demand for its complements. Thus, the rise in \( t_i \) (and consequent distortion) to raise revenue by one unit increases (decreases) as other goods are greater complements (substitutes).

If \( E_i \) is large enough in absolute terms it is possible for it to exceed \( q_i x_i \) thus making \( \lambda_i \) negative. In this case, the loss in revenue due to the fall in demand for complements exceeds the increase in revenue due to the increase in \( t_i \). The implication is that \( t_i \) was above its revenue maximising level, i.e., \( \frac{\partial R}{\partial t_i} < 0 \). To make some intuitive sense of this, we go back to our definition of \( \lambda_i \) as being equal to \(-\frac{\partial V}{\partial t_i} \frac{\partial R}{\partial t_i}\). This was because to raise an extra £1 via a tax
on the $i^{th}$ good, it was necessary to raise the tax on the $i^{th}$ good by $1/\frac{\partial R}{\partial t_i}$. However, if $\frac{\partial R}{\partial t_i} < 0$, then to raise £1 it is necessary to lower the tax by $1/\frac{\partial R}{\partial t_i}$.

Thus, the interpretation of $\lambda_i$ is the same in terms of absolute value except that the marginal social cost is associated with a tax cut rather than tax rise.

We will now examine the $\lambda_i$ calculated for Irish data for 1980 for the case of unrestricted and restricted elasticities. The elasticities come from an Almost Ideal Demand System model estimated by Thom. The restrictions imposed are additivity, homogeneity and symmetry.

Table 1 reproduces the $\lambda_i$ for the case of unrestricted elasticities for various values of $e$. The most notable feature is that one of the $\lambda_i$, that for durables, is negative. As was outlined above, this comes from strong complementarity between durables and certain key goods, in particular services and transport and equipment. An examination of $E_i$ for durables term by term (the figures are available on request) reveals that the high proportion of expenditure devoted to services and the high tax on transport and equipment gives them a high weight and given that they are complementary with durables, this is sufficient to make $\lambda_i$ negative. The negative $\lambda_i$ for durables, however, does seem counter-intuitive. The tax as a proportion of the market price in 1980 was 26 per cent which, although quite high, is by no means the highest. As well as that, expenditure on durables would have received an implicit subsidy since interest on money borrowed to purchase a durable received tax relief. Due to the nature of the data available, it is not possible to incorporate this in the model, but it is still surprising that the tax should be found to be above the revenue maximising level.

The $\lambda_i$ are ranked in order of absolute magnitude. The highest value is for rent, which once again is surprising since the nominal tax for our model is zero (the data do not permit the inclusion of the subsidies, both implicit and explicit, on housing). Examining $E_i$ for rent term by term, the main contribution to its negativity comes, once again, from services and transport and equipment. Given the role that terms involving these two goods have played in determining the values of $\lambda_i$ for durables and rent it would be useful to have standard errors for the estimates of the elasticities. Unfortunately, such standard errors are not available. In any event, the values for the elasticities (ranging from −.7 to −.86) do not seem implausible.

At the other end of the scale, the lowest $\lambda_i$ are for clothing and footwear and petrol. The low $\lambda_i$ for petrol (suggesting that its tax be raised) is caused mainly by its very high substitutability with services. The cross elasticity is 2.48, a figure which does seem implausibly high. Also contributing would be the fact that services are acting as a kind of residual term thus including the errors in aggregating the other goods. More disaggregated data, if it were
### Table 1: $\lambda_i$ Using Unrestricted Elasticities

<table>
<thead>
<tr>
<th>Good</th>
<th>$e = 0$</th>
<th></th>
<th></th>
<th>$e = 0.1$</th>
<th></th>
<th></th>
<th>$e = 0.5$</th>
<th></th>
<th></th>
<th>$e = 1$</th>
<th></th>
<th></th>
<th>$e = 2$</th>
<th></th>
<th></th>
<th>$e = 5$</th>
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<tbody>
<tr>
<td></td>
<td>$\lambda$</td>
<td>Rank</td>
<td></td>
<td>$\lambda$</td>
<td>Rank</td>
<td></td>
<td>$\lambda$</td>
<td>Rank</td>
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<td>$\lambda$</td>
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<td></td>
<td>$\lambda$</td>
<td>Rank</td>
<td></td>
<td>$\lambda$</td>
<td>Rank</td>
<td></td>
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<tr>
<td>Food</td>
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<td>9</td>
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<td>0.302</td>
<td>8</td>
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<td>6</td>
<td>0.054</td>
<td>5</td>
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<tr>
<td>Alcohol</td>
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<td>2</td>
<td>1.614</td>
<td>2</td>
<td>0.938</td>
<td>2</td>
<td>0.506</td>
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<td>Tobacco</td>
<td>1.279</td>
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<td>1.127</td>
<td>6</td>
<td>0.696</td>
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<td>Clothing and Footwear</td>
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<td>0.664</td>
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<td>Petrol</td>
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<td>11</td>
<td>0.116</td>
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<td>6.890</td>
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<td>2.691</td>
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<td>Durables</td>
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<td>4</td>
<td>-0.713</td>
<td>4</td>
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<tr>
<td>Transport and Equipment</td>
<td>1.317</td>
<td>5</td>
<td>1.138</td>
<td>5</td>
<td>0.644</td>
<td>6</td>
<td>0.333</td>
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<td>0.110</td>
<td>8</td>
<td>0.024</td>
<td>8</td>
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<tr>
<td>Services</td>
<td>1.035</td>
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<td>0.891</td>
<td>8</td>
<td>0.501</td>
<td>9</td>
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<td>9</td>
<td>0.020</td>
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<tr>
<td>Other Goods</td>
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<td>7</td>
<td>0.984</td>
<td>7</td>
<td>0.573</td>
<td>7</td>
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<td>0.116</td>
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<td>0.034</td>
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available, would presumably alleviate this problem somewhat.

The sensitivity of the ranking of $\lambda_i$ with respect to values of $e$ is not very
great, the only exception really being food, which goes from ninth to fifth as $e$
increases from zero to two. This is as would be expected, i.e., as we become
more inequality averse the marginal social cost of raising revenue by increasing
the tax on food rises. Correspondingly that for services and transport and
equipment falls.

Table 2 provides the calculations of $\lambda_i$ for the case of restricted elasticities.
Once again we have a negative $\lambda_i$, this time for tobacco. Once again, the cause
of the negative $\lambda_i$ was complementarity with services, transport and equipment
and also alcohol. Given the very high tax on tobacco, a negative $\lambda_i$ seems
more plausible than it did for durables. Another possible reason for a negative
$\lambda_i$ would be if part of the tax on tobacco was seen as a corrective or Pigovian
tax since the marginal social cost of consuming tobacco exceeds the marginal
private cost.

The good with the highest absolute $\lambda_i$ is tobacco, followed by durables and
transport and equipment. Once again, the ranking of durables is slightly
counter-intuitive.

Probably the most surprising result from the restricted elasticities case is
that rent, which was ranked one in the unrestricted case, is ranked eleven here,
i.e., the recommendation is that its tax be increased. The main reason for
this turnaround is that services which were previously a complement with
rent are now a substitute. The cross-elasticity with respect to transport and
equipment also falls significantly from -.722 to -.045. Once again, without
standard errors, it is difficult to comment on the relative reliability of the
coefficients.

The effect of the distributional parameter, $e$, once again is more or less as
expected. The ranking of food and fuel and power increased while that of
services and petrol fall.

The final question to be addressed is whether to use the restricted or unre-
stricted elasticities. The estimation of the restricted elasticities obviously had
greater degrees of freedom; however, it involved the imposition of restrictions
which virtually all studies of the theory of demand reject. On the other hand,
the restricted model did give more "plausible" results. On a more fundamental
level, there are problems involved in using parameters based on aggregate time-
series data for what is essentially a cross-sectional study. Unfortunately, the
type of data which might overcome this problem are not available here.

Now we turn to examine the $\beta_i$ consistent with the existing tax vector,
revenue responses and equal $\lambda_i$ implying the policy-maker is equalising mar-
ginal social costs of taxation for each good. These $\beta_i$ are the solution for
Equation (21). Table 3 shows these $\beta$'s for the restricted and unrestricted
<table>
<thead>
<tr>
<th>Good</th>
<th>( \lambda )</th>
<th>Rank</th>
<th>( \lambda )</th>
<th>Rank</th>
<th>( \lambda )</th>
<th>Rank</th>
<th>( \lambda )</th>
<th>Rank</th>
<th>( \lambda )</th>
<th>Rank</th>
<th>( \lambda )</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food</td>
<td>1.017</td>
<td>7</td>
<td>0.895</td>
<td>6</td>
<td>0.552</td>
<td>6</td>
<td>0.325</td>
<td>6</td>
<td>0.146</td>
<td>6</td>
<td>0.057</td>
<td>4</td>
</tr>
<tr>
<td>Alcohol</td>
<td>0.994</td>
<td>8</td>
<td>0.863</td>
<td>8</td>
<td>0.502</td>
<td>7</td>
<td>0.270</td>
<td>7</td>
<td>0.100</td>
<td>7</td>
<td>0.029</td>
<td>7</td>
</tr>
<tr>
<td>Tobacco</td>
<td>-4.410</td>
<td>1</td>
<td>-3.880</td>
<td>1</td>
<td>-2.400</td>
<td>1</td>
<td>-1.410</td>
<td>1</td>
<td>-0.620</td>
<td>1</td>
<td>-0.224</td>
<td>1</td>
</tr>
<tr>
<td>Clothing and Footwear</td>
<td>0.978</td>
<td>9</td>
<td>0.849</td>
<td>9</td>
<td>0.493</td>
<td>9</td>
<td>0.266</td>
<td>8</td>
<td>0.098</td>
<td>8</td>
<td>0.029</td>
<td>8</td>
</tr>
<tr>
<td>Fuel and Power</td>
<td>1.255</td>
<td>5</td>
<td>1.109</td>
<td>5</td>
<td>0.696</td>
<td>5</td>
<td>0.420</td>
<td>5</td>
<td>0.200</td>
<td>4</td>
<td>0.089</td>
<td>3</td>
</tr>
<tr>
<td>Petrol</td>
<td>1.652</td>
<td>4</td>
<td>1.435</td>
<td>4</td>
<td>0.833</td>
<td>4</td>
<td>0.446</td>
<td>4</td>
<td>0.159</td>
<td>5</td>
<td>0.042</td>
<td>6</td>
</tr>
<tr>
<td>Rent</td>
<td>0.763</td>
<td>11</td>
<td>0.664</td>
<td>11</td>
<td>0.390</td>
<td>11</td>
<td>0.215</td>
<td>11</td>
<td>0.084</td>
<td>10</td>
<td>0.028</td>
<td>10</td>
</tr>
<tr>
<td>Durables</td>
<td>3.270</td>
<td>2</td>
<td>2.825</td>
<td>2</td>
<td>1.606</td>
<td>2</td>
<td>0.844</td>
<td>2</td>
<td>0.306</td>
<td>2</td>
<td>0.100</td>
<td>2</td>
</tr>
<tr>
<td>Transport and Equipment</td>
<td>2.550</td>
<td>3</td>
<td>2.206</td>
<td>3</td>
<td>1.249</td>
<td>3</td>
<td>0.645</td>
<td>3</td>
<td>0.213</td>
<td>3</td>
<td>0.047</td>
<td>5</td>
</tr>
<tr>
<td>Services</td>
<td>1.030</td>
<td>6</td>
<td>0.885</td>
<td>7</td>
<td>0.497</td>
<td>8</td>
<td>0.255</td>
<td>10</td>
<td>0.083</td>
<td>11</td>
<td>0.020</td>
<td>11</td>
</tr>
<tr>
<td>Other Goods</td>
<td>0.940</td>
<td>10</td>
<td>0.817</td>
<td>10</td>
<td>0.476</td>
<td>10</td>
<td>0.257</td>
<td>9</td>
<td>0.096</td>
<td>9</td>
<td>0.028</td>
<td>9</td>
</tr>
</tbody>
</table>

Table 2: \( \lambda \) Using Restricted Elasticities
case. The figures are normalised so that the absolute value of the weight attached to the poorest household is one.

Table 3: *The Inverse Optimum* β’s

<table>
<thead>
<tr>
<th>Household Income per Week (£)</th>
<th>Unrestricted Elasticities</th>
<th>Restricted Elasticities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under 30</td>
<td>1.00</td>
<td>~1.00</td>
</tr>
<tr>
<td>30 - 40</td>
<td>~9.57</td>
<td>8.40</td>
</tr>
<tr>
<td>40 - 60</td>
<td>5.77</td>
<td>~5.02</td>
</tr>
<tr>
<td>60 - 80</td>
<td>2.50</td>
<td>~2.29</td>
</tr>
<tr>
<td>80 - 100</td>
<td>0.447</td>
<td>~0.405</td>
</tr>
<tr>
<td>100 - 120</td>
<td>~3.41</td>
<td>2.90</td>
</tr>
<tr>
<td>120 - 140</td>
<td>~0.705</td>
<td>0.55</td>
</tr>
<tr>
<td>140 - 170</td>
<td>4.876</td>
<td>~3.92</td>
</tr>
<tr>
<td>170 - 200</td>
<td>~2.34</td>
<td>2.04</td>
</tr>
<tr>
<td>200 - 250</td>
<td>0.17</td>
<td>~0.133</td>
</tr>
<tr>
<td>Above 250</td>
<td>~0.19</td>
<td>0.07</td>
</tr>
</tbody>
</table>

The existence of negative welfare weights implies that Pareto improvements are possible. It should be noted that, with a substantial degree of inequality, some governments may not have Paretian social welfare functions, i.e., negative social welfare weights on increments to the very rich may genuinely reflect preferences. However, given that there are negative welfare weights on one or other of the two poorest groups, it is unlikely that the above β’s could be considered as optimum. One remarkable feature of Table 3 is that every group which has a positive weight in the unrestricted case has a negative weight in the restricted case and vice versa. The different revenue responses for the restricted and unrestricted cases are the source of the differences in weights, but the alternative sign pattern seems to be no more than a coincidence.

We will now examine the possibility of Pareto improvements.

V PARETO IMPROVEMENTS AND THE INVERSE OPTIMUM

The change in utility of the \( h \)th household in response to tax changes \( dt \) is

\[
du^h = -\alpha^h \sum_i x_i^h \ dt_i
\]  

(22)

where \( \alpha^h \) is the private marginal utility of income.

The condition for the tax change not to decrease revenue is

\[
dR = r \ dt \geq 0.
\]
Thus we have a Pareto improving change if we can find \( dt \) such that the \( H+1 \) inequalities

\[
C dt \leq 0 \text{ and } r dt \geq 0
\]  

(23)

are satisfied with at least one of them holding with strict inequality.

Specifically we can address the problem of finding a Pareto improvement as seeking a tax change which increases revenue without making anyone worse off. Then we could make everyone better off by reducing the tax on a good which everyone consumes by an amount which is sufficiently small to keep the revenue increase positive. Thus we are looking for \( dt \) such that

\[
C dt \leq 0 \text{ and } r dt > 0
\]  

(24)

It can be shown by the Minkowski-Farkas lemma that either there exists a \( dt \) satisfying (24) or \( r \) is a non-negative linear combination of the rows of \( C \), i.e., there is a \( H \) - vector \( y \), with \( y^h \geq 0 \) such that

\[
r' = y'C
\]  

(25)

is exactly of the form of (20). Thus the Minkowski-Farkas lemma tells us that either a feasible Pareto improvement exists, or a solution to the inverse optimum problem with non-negative welfare weights exists.

Intuitively we can view the problem as follows: there is one row of \( C \) for each household and thus as we increase the number of households (e.g., by taking finer disaggregations), we increase the likelihood of being able to express \( r \) as a linear combination of the rows of \( C \), i.e., as we increase the number of households it will become more and more difficult to find a Pareto improvement.

Thus we are looking for \( dt \) which satisfies (24). Another way of expressing this is to maximise the increase in revenue subject to no person being made worse off. Thus we can see whether the following linear programme has solutions

\[
\text{maximise } r dt \text{ subject to } C dt \leq 0
\]  

(26)

The programme is linear homogeneous in \( dt \) thus we must impose some bounds on \( dt \) since if we found that a Pareto improvement, \( dt_o \), did exist we could multiply \( dt_o \) by any positive number and obtain as large an improvement as we wished. Thus we will impose bounds on \( dt \) which will restrict the maximum increase or decrease in any tax. Accordingly we will consider increases in taxes sufficient to raise £1. Thus we change the variable in (26)
from \( dt \) to \( \delta \) with \( \delta_i \) being the extra revenue raised from increasing taxes on the \( i^{th} \) good.

\[
\delta_i = r_i \cdot dt_i
\]  
(27)

Then we write (26) as

\[
\begin{align*}
\text{maximise } & \ i.\delta \\
\text{subject to } & \ L\delta \leqslant 0 \\
& \ -1 \leqslant \delta_i \leqslant +1
\end{align*}
\]  
(28)

where the elements of \( i \) are unity. \( L \) is the matrix with \( h^{th} \) element \( \lambda_i^h \) where

\[
\lambda_i^h = x_i^h \frac{\partial R}{\partial t_i}
\]  
(29)

and we have bounded tax changes with the requirement that we cannot increase or reduce any tax by an amount which changes revenue by more than £1. Thus \( \lambda_i^h \) is the marginal cost in money terms to the \( h^{th} \) household of increasing the tax on good \( i \) by an amount sufficient to raise £1. The constraints in (28) are that the sum of the marginal costs from the tax changes to each household be negative. The results from solving (28) for Irish data are presented in the next section.

\( \lambda_i^h \) corresponds to the \( \lambda_i \) from Section II with \( \beta^h \) being the unit vector with 1 in the \( h^{th} \) place and zeros elsewhere. Thus

\[
\lambda_i = \Sigma_h \beta^h \lambda_i^h
\]  
(30)

or

\[
\lambda' = \beta'L
\]

where the \( \beta' \)'s are specified exogenously.

In general if we have one direction of Pareto improvement we will have many. We could alternatively have maximised the utility increase for one household, e.g., the poorest, while neither reducing revenue nor the utility of any other household. Formally the programme would be

\[
\begin{align*}
\text{maximise } & \ -\delta \lambda^h \\
\text{subject to } & \ i.\delta \geqslant 0
\end{align*}
\]  
(31)
and

\[ L_{-h} \delta \leq 0, -1 \leq \delta_i \leq +1 \]

where \( \lambda^h \) is the \( h \)th row of \( L \) and \( L_{-h} \) is the \((H-1) \times n\) matrix corresponding to \( L \) with the \( h \)th row deleted.

### VI DIRECTIONS OF TAX REFORM

Table 4a shows the solution of the linear programme in (28) using the unrestricted elasticities.

**Table 4a: Solutions to Equation (28) with Unrestricted Elasticities**

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Tax Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food</td>
<td>+1</td>
</tr>
<tr>
<td>Alcohol</td>
<td>+1</td>
</tr>
<tr>
<td>Tobacco</td>
<td>+1</td>
</tr>
<tr>
<td>Clothing and Footwear</td>
<td>+1</td>
</tr>
<tr>
<td>Fuel</td>
<td>+1</td>
</tr>
<tr>
<td>Petrol</td>
<td>+1</td>
</tr>
<tr>
<td>Rent</td>
<td>-0.47</td>
</tr>
<tr>
<td>Durables</td>
<td>+1*</td>
</tr>
<tr>
<td>Transport and Equipment</td>
<td>+1</td>
</tr>
<tr>
<td>Services</td>
<td>+1</td>
</tr>
<tr>
<td>Other Goods</td>
<td>+1</td>
</tr>
<tr>
<td>Revenue Gain</td>
<td>7.53</td>
</tr>
</tbody>
</table>

*Since \( \frac{\partial R}{\partial t_i} \) for durables is negative, an increase in the tax will cause a fall in revenue.

The increase in the tax on durables will actually cause a fall in revenue. Thus the increase in revenue is just about 7½ units. As would be expected, a reduction in the tax on rent is recommended. In fact, this is the only good for which a reduction in tax is recommended. This is not as surprising as it may seem at first since the marginal social cost associated with rent is so high that the tax on it could be reduced and this decrease in social cost could more than offset the increase in social cost associated with the rise in other taxes.

Table 4b shows the change in household welfare after solving (28). The constraint on (28) is that no household group can suffer a loss in welfare. As the table shows, not only does no group suffer a loss, all groups, with the exception of group 9, gain. The gains to households roughly increase with expenditure levels, except for groups 8 and 9. The explanation for this seems
to lie in their slightly lower consumption of durables. The linear programme in (28) assumed all $\beta_i$'s equal to one. If we were to change the $\beta_i$'s so as to introduce the inequality aversion parameter then the changes in social welfare would differ from those in private welfare.

Table 4b: Changes in Household Welfare (£s)

<table>
<thead>
<tr>
<th>Household Group</th>
<th>Weekly Expenditure</th>
<th>Change in Welfare</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0 - 30</td>
<td>.06</td>
</tr>
<tr>
<td>2</td>
<td>30 - 40</td>
<td>.07</td>
</tr>
<tr>
<td>3</td>
<td>40 - 60</td>
<td>.07</td>
</tr>
<tr>
<td>4</td>
<td>60 - 80</td>
<td>.15</td>
</tr>
<tr>
<td>5</td>
<td>80 - 100</td>
<td>.16</td>
</tr>
<tr>
<td>6</td>
<td>100 - 120</td>
<td>.19</td>
</tr>
<tr>
<td>7</td>
<td>120 - 140</td>
<td>.28</td>
</tr>
<tr>
<td>8</td>
<td>140 - 170</td>
<td>.03</td>
</tr>
<tr>
<td>9</td>
<td>170 - 200</td>
<td>0</td>
</tr>
<tr>
<td>10</td>
<td>200 - 230</td>
<td>.64</td>
</tr>
<tr>
<td>11</td>
<td>Above 230</td>
<td>.59</td>
</tr>
</tbody>
</table>

Table 5a shows the solution of (28) for the case of restricted elasticities. The results show a decrease in tax on durables and transport and equipment (which were ranked 2 and 3 in terms of $\lambda_j$). Also recommended is an increase in tax on tobacco. The explanation for this is the same as the case for durables

Table 5a: Solutions to Equation (28) using Restricted Elasticities

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Tax Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food</td>
<td>+1</td>
</tr>
<tr>
<td>Alcohol</td>
<td>+1</td>
</tr>
<tr>
<td>Tobacco</td>
<td>+1*</td>
</tr>
<tr>
<td>Clothing and Footwear</td>
<td>+1</td>
</tr>
<tr>
<td>Fuel</td>
<td>+1</td>
</tr>
<tr>
<td>Petrol</td>
<td>+1</td>
</tr>
<tr>
<td>Rent</td>
<td>+1</td>
</tr>
<tr>
<td>Durables</td>
<td>-1</td>
</tr>
<tr>
<td>Transport and Equipment</td>
<td>-0.7</td>
</tr>
<tr>
<td>Services</td>
<td>+1</td>
</tr>
<tr>
<td>Other Goods</td>
<td>+1</td>
</tr>
<tr>
<td>Revenue Gain</td>
<td>+5.3</td>
</tr>
</tbody>
</table>

*Because $\frac{\partial R}{\partial t_i}$ for tobacco is negative the rise in tax will cause a fall in revenue.
above. Since an increase in the tax on tobacco would increase revenue and have a negative marginal social cost associated with it, obviously it would be recommended. The overall revenue effects of this change is to increase revenue by over 5 units. It must be stressed that these are changes at the margin and merely show directions of tax reform. For example, one would not expect a negative marginal social cost of taxation for tobacco over all ranges of taxes. The cross-elasticities and $\lambda_i$ would change, thus giving different solutions to the linear programme.

Table 5b shows the change in household welfare after solving (28) with restricted elasticities. The most obvious differences between this case and the one for unrestricted elasticities is that here there is no longer such a clear-cut positive relationship between the change in welfare and weekly expenditure levels. Group 10 shows a very large gain. This can be explained by the fact that it shows unusually high consumption of durables and so benefits from the reduction in tax on that good. Group 8 shows no gain. This may be explained by its relatively low consumption of durables and transport and equipment, both of which have their tax reduced.

Table 5b: Changes in Household Welfare (£s)

<table>
<thead>
<tr>
<th>Household Group</th>
<th>Weekly Expenditure</th>
<th>Change in Welfare</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0 - 30</td>
<td>+.02</td>
</tr>
<tr>
<td>2</td>
<td>30 - 40</td>
<td>+.06</td>
</tr>
<tr>
<td>3</td>
<td>40 - 60</td>
<td>+.05</td>
</tr>
<tr>
<td>4</td>
<td>60 - 80</td>
<td>+.12</td>
</tr>
<tr>
<td>5</td>
<td>80 - 100</td>
<td>+.03</td>
</tr>
<tr>
<td>6</td>
<td>100 - 120</td>
<td>+.01</td>
</tr>
<tr>
<td>7</td>
<td>120 - 140</td>
<td>+.04</td>
</tr>
<tr>
<td>8</td>
<td>140 - 170</td>
<td>0</td>
</tr>
<tr>
<td>9</td>
<td>170 - 200</td>
<td>+.03</td>
</tr>
<tr>
<td>10</td>
<td>200 - 230</td>
<td>+.44</td>
</tr>
<tr>
<td>11</td>
<td>Above 230</td>
<td>+.03</td>
</tr>
</tbody>
</table>

Table 6 shows the solution to (31) for the cases of restricted and unrestricted elasticities. In both cases the revenue changes are zero. Two things are noticeable. First of all, the welfare changes are higher for the unrestricted than for the restricted case for all households. This is because the $\lambda_i$ for the unrestricted are generally higher in absolute value than for the restricted case. Obviously, with higher marginal social costs to begin with, the scope for increases in welfare due to improvements is greater. The second noticeable feature is that while (31) involves maximising the welfare of the poorest group, all the other
groups actually fare better in absolute terms after the welfare reform. The explanation for this goes as follows: for any given tax change at the margin, the change in utility is given from Roy’s identity as $-\alpha^h x_j^h$. For these tax changes we have been assuming $\alpha^h$ to be the same (effectively the case where $e = 0$). Thus the change in utility depends on $x_j^h$. Since $x_j^h$ tends to increase as households’ expenditure increases, the consequent welfare improvements increase also.

Table 6: Changes in Household Welfare (£s)

<table>
<thead>
<tr>
<th>Household Group</th>
<th>Weekly Expenditure</th>
<th>Unrestricted Elasticities</th>
<th>Restricted Elasticities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0 - 30</td>
<td>0.803</td>
<td>0.323</td>
</tr>
<tr>
<td>2</td>
<td>30 - 40</td>
<td>1.08</td>
<td>0.45</td>
</tr>
<tr>
<td>3</td>
<td>40 - 60</td>
<td>1.47</td>
<td>0.57</td>
</tr>
<tr>
<td>4</td>
<td>60 - 80</td>
<td>1.88</td>
<td>0.79</td>
</tr>
<tr>
<td>5</td>
<td>80 - 100</td>
<td>2.08</td>
<td>0.79</td>
</tr>
<tr>
<td>6</td>
<td>100 - 120</td>
<td>2.43</td>
<td>0.89</td>
</tr>
<tr>
<td>7</td>
<td>120 - 140</td>
<td>2.83</td>
<td>1.04</td>
</tr>
<tr>
<td>8</td>
<td>140 - 170</td>
<td>2.66</td>
<td>1.00</td>
</tr>
<tr>
<td>9</td>
<td>170 - 200</td>
<td>3.17</td>
<td>1.19</td>
</tr>
<tr>
<td>10</td>
<td>200 - 230</td>
<td>4.14</td>
<td>1.67</td>
</tr>
<tr>
<td>11</td>
<td>Above 230</td>
<td>4.73</td>
<td>1.49</td>
</tr>
</tbody>
</table>

VII POSSIBLE EXTENSIONS OF THE MODEL

Implicit in the model we have been using so far is some form of separability between goods and leisure (i.e., labour supply). If separability between goods and leisure does not hold, then parameter estimates derived from a model which either imposes it or which excludes leisure from the preference ordering will be inconsistent. This is obviously important for taxation theory and for the work presented here. The inclusion of labour supply could affect the magnitude (and possibly the direction) of cross elasticities as well as introducing another source of tax revenue (income tax) in the model.

Murphy and Thom (1987) estimate a model based on the joint determination of commodity demands and labour supply. They reject the hypotheses of separability between goods and leisure. However, comparison between their model and the model used here is difficult. While Murphy and Thom assume that individuals face common commodity prices, they do not make the same assumption with regard to wage rates. Thus they work with functional
forms which permit linear aggregation in money-wages and non-labour incomes. This implies the use of functions which involve quasi-homothetic preferences, i.e., Engel curves that are linear in full income. It also rules out the use of the Almost Ideal Demand System which was used to estimate the elasticities referred to in this paper. Thus, the introduction of labour supply implies the use of demand responses which are based on more restrictive functional forms.

Allowing for this difficulty, the procedure would be exactly as before, except that there would now be one extra "good". Extension to further sources of revenue such as corporation or capital taxes would be much more difficult as it would involve specifying a model with not just individuals but also firms as agents. It would also require a much more detailed modelling of the production side of the economy.

VIII SUMMARY

This paper has examined the possibility of marginal reforms to the Irish indirect tax system. Due to the fact that the analysis is marginal it is only possible to examine directions of tax reform. In particular, the marginal social cost of taxation from various goods has been calculated. Even taking account of problems with regard to data and aggregation there seem to be significant differences in the marginal social costs of taxation for different goods. This implies the possibility of welfare enhancing reforms while keeping revenue constant.

The calculation of the $\lambda_i$ involved using specific distributional value judgements. By setting the $\lambda_i$ equal we can infer the social welfare weights implicit in the existing tax system. The existence of negative weights implies that a Pareto improvement exists. Linear programmes are carried out showing the direction of the possible reforms.

The use of the restricted and unrestricted elasticities demonstrates how the analysis can be quite sensitive to the demand responses. However, as Ahmad and Stern point out, tax reform is less sensitive to demand responses than tax design. For tax reform we only need aggregate demand derivatives for the point at which we find ourselves whereas for optimal tax design we would need demand responses for different household groups and for an extended range. However, on the other hand, the nature of the data available (not to mention the very wide disparity in tax rates between different goods) means that rankings of $\lambda_i$ were quite sensitive to certain cross elasticities.

Of course, the data presented in this paper refer to 1980. The publication of the next Household Budget Survey will provide an opportunity to see whether the tax measures adopted in the 1980s have actually improved the situation.
REFERENCES


Appendix I: Classifications and Aggregation of Goods from Household Budget Survey

<table>
<thead>
<tr>
<th>Good</th>
<th>Classification from HBS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food (excl. restaurants and cafes)</td>
<td>Items 70-192</td>
</tr>
<tr>
<td>Alcohol</td>
<td>Items 195-198</td>
</tr>
<tr>
<td>Tobacco</td>
<td>Items 199-201</td>
</tr>
<tr>
<td>Clothing &amp; Footwear</td>
<td>Items 202-269</td>
</tr>
<tr>
<td>Fuel &amp; Power</td>
<td>Items 270-279</td>
</tr>
<tr>
<td>Petrol</td>
<td>Item 350</td>
</tr>
<tr>
<td>Rent</td>
<td>Grossed from NIE*</td>
</tr>
<tr>
<td>Durables</td>
<td>Items 303-324 excl. 308</td>
</tr>
<tr>
<td>Transport &amp; Equipment</td>
<td>Items 341-349, 351-356, 362</td>
</tr>
<tr>
<td>Services</td>
<td>Residual</td>
</tr>
<tr>
<td>Other Goods</td>
<td>Items 290-302, 325-328, 390, 391, 330-338, 340</td>
</tr>
</tbody>
</table>

*The figure for rent was obtained as follows: from the National Accounts for 1980 we can see that expenditure on rent was 72.5 per cent of that on clothing and footwear (a category for which we can be reasonably sure of a close correspondence between the HBS and NIE). Then we let expenditure on rent equal .723 times expenditure on clothing and footwear in the HBS. We keep this as a constant ratio for different levels of expenditure, implying a unitary expenditure elasticity of rent. While this is not an ideal assumption to make, it seems preferable to the alternatives.