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CAN WE INFERENCE EXTERNAL EFFECTS FROM A STUDY OF THE IRISH INDIRECT TAX SYSTEM?

by

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Can We Infer External Effects from a Study of the Irish Indirect Tax System?

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Can We Infer External Effects from a Study of the Irish Indirect Tax System

Introduction

The justification for the existence of corrective or Pigovian taxes or subsidies to take account of diseconomies or economies of consumption is well known. Owing to the divergence between private and social utility of consuming various goods, it may be optimal for taxes or subsidies to be imposed. Various attempts have been made to estimate what these external effects are and how they may influence the rate of taxation on different goods. (We will concentrate on the case of corrective taxes although of course our arguments could also be applied to corrective subsidies.) Examples of such work in the Irish context are the papers by Walsh (1987) and O'Hagan (1983) and there are numerous examples from the international literature.

This paper looks at the question of corrective taxation in Ireland from the approach of the inverse optimum and marginal tax reform literature of Christiansen and Jansen (1978) and Ahmad and Stern (1984). Thus, consistent with the tradition in this literature, rather than attempting to estimate what the optimal tax rates should be, we attempt to estimate what are the external effects implicit in the existing Irish indirect tax system. In
doing so we also attempt to infer the degree of inequality aversion in the Irish indirect tax system.

The paper also looks more generally at the issue of corrective taxation. It has been shown that where it may be infeasible (or undesirable) to apply a direct corrective tax to a good (i.e. a tax on the good itself), it may be possible to apply an indirect corrective tax, by taxing a complementary good or subsidising a substitute good. Previous work on the Irish indirect tax system by the author (Madden (1989, 1992a)), suggests that the tax on tobacco may exceed its revenue-maximising level. Thus it is argued that it may be preferable for at least some of the corrective tax on tobacco to be applied indirectly. Based on aggregate demand responses derived in previous work on indirect tax reform in Ireland, some possible indirect corrective taxes are suggested.

1. Incorporating social costs into marginal tax reform models.

Recent work carried out by the author examines the Irish indirect tax system from the point of view of the marginal social cost (MSC) of taxation associated with raising the tax rates on different goods. A feature of the results was the relatively wide dispersion of values of the MSC for the different goods, suggesting that there was room for marginal reforms that would raise welfare while leaving revenue unchanged. A further feature
of the results was the consistently high MSC of increasing the
tax on tobacco. As the model used in that work did not take
account of the possibility of externalities associated with the
consumption of various goods, it was speculated that the very
high tax on tobacco might reflect a corrective or Pigovian tax,
arising from the divergence between the private and public
marginal evaluation attached to the consumption of tobacco.

This section of the paper attempts to incorporate such exter-
enity effects into the model used in previous work on tax
reform. It does so using a technique known as the "inverse
optimum" which infers the external effects implicit in the
indirect tax system. The relatively high "distributional
characteristic" of some of these goods suggests that the degree
of inequality aversion of the government may also influence its
tax and so the sensitivity of the external effect to the degree
of inequality aversion of the government is examined.

The model used is essentially that of Madden (1992a) except
that we incorporate external effects. We have a Bergson-
Samuelson social welfare function:

\[ V(q) = W(v^1(q), v^2(q), \ldots, v^h(q)). \] (1)

where \( v^h \) is the indirect utility function of household \( h \), giving
the maximum utility attainable at prices \( q \). We assume incomes
are fixed.
The aggregate demand vector is given by

\[ X(q) = \sum_{k} x^k(q) \]

\[ \lambda_i = \sum_{h} \lambda^h_i \]

(2)

and government revenue is given by

\[ R = t.X = \sum_{i} t_i X_i \]

(3)

where \( t \) is a vector of specific taxes.

The tax reform model used in Madden (1992a) involved the calculation of the MSC of increasing the tax on different goods. Formally the expression for MSC, more commonly referred to as \( \lambda_i \), is:

\[ \lambda_i = - \frac{\delta V/\delta t_i}{\delta R/\delta t_i} \]

(4)

Intuitively it is obvious that at a welfare optimum these \( \lambda_i \) should be equal, since otherwise it would be possible, by lowering the tax on a good with a high \( \lambda_i \) and raising the tax on a good with a low \( \lambda_i \), to increase welfare for constant revenue.

\( \lambda_i \) can be re-expressed in a way that is readily calculable (see Ahmad and Stern (1984) or Madden (1992a) for the derivation).

\[ \lambda_i = \frac{\sum_{k} \beta^h q_k x^h_i}{\gamma_i X_i + \sum_{k} \epsilon_{x_k} \tau_k q_k X_k} \]

(5)
where $\beta^h$ is the welfare weight of household $h$ (introduced to take account of distributonal considerations), $q_i x_i^h$ is the value of expenditure on good $i$ by household $h$, $q_i X_i$ is the total expenditure on good $i$, $\epsilon_{ki}$ is the uncompensated cross-elasticity of demand for good $k$ with respect to a change in the price of good $i$ and $t_k$ is the ad valorem tax on good $k$, expressed as a fraction of the consumer price.

Formally it is quite straightforward to incorporate external diseconomies, or social costs into this model. In the expression above the social welfare function (equation 1) is of the form $V=W(v^1,\ldots,v^h,\ldots,v^n)$. This function can be modified to take account of the social costs associated with the consumption of certain goods by including total expenditure of the goods in question as separate arguments in the social welfare function. Thus our social welfare function becomes $W(v^1,\ldots,v^h,\ldots,v^n, X_i,\ldots,X_n)$ where the external effect is introduced via the inclusion of the aggregate consumption of the good into the social welfare function. The sign of $\delta V/\delta X_i$ depends upon whether the good in question is a social "good" or "bad". This inclusion of this term alters the expression of the numerator of $\lambda_i$ as follows:

$$\frac{\delta V}{\delta c_i} = \sum \beta^h x_i^h + \sum \mu^*_k (\frac{\delta X_k}{\delta q_i})$$

(6)

where $\mu^*_i = \delta W/\delta X_k$. Thus the expression for $\lambda_i$ becomes:
\[ \lambda_i = \frac{\sum_{b} \beta^b q_i x_i^b - \sum_k \mu_k \varepsilon_k q_k x_k}{q_i X_i + \sum_k \varepsilon_k \tau_k q_k X_k} \]  

where \( \mu_k = \mu_k^* / q_k \).

Alternatively we can express it as follows

\[ \lambda_i = \lambda_i - \frac{\sum_k \mu_k \varepsilon_k q_k x_k}{q_i X_i + \sum_k \varepsilon_k \tau_k q_k X_k} \]

Thus a non-zero value for \( \mu_k \) affects the MSC of an indirect tax on good \( k \) itself, and in general also affects that on every good, through the workings of cross-price effects.

It is worthwhile working through a couple of examples to see how the \( \mu_k \) term affects the MSC. Since it does not enter the expression for the denominator, we need only concentrate on the expression for the numerator. To further simplify matters we will neglect distributional issues, and assume \( \beta^b = 1 \) for all households (i.e. all households have equal welfare weights).

Suppose we take the example of a good such as tobacco, where we assume that \( \mu_k < 0 \). The numerator of the expression for \( \lambda_i \) then becomes: \( q_i X_i - \mu_{\text{tob}} \varepsilon_{\text{tob},i} q_{\text{tob}} X_{\text{tob}} \). If the two goods are substitutes \( \varepsilon_{\text{tob},i} > 0 \), and thus the second term in the expression above is also positive, thus tending to increase the marginal social cost of the tax on good \( i \). The intuition behind this is that if the goods are substitutes, then increasing the tax on good \( i \) will cause a substitution towards consumption of tobacco, which will
have negative external effects. An analogous explanation can be presented for the case where the goods are complements.

The two crucial questions to be addressed are: How do we obtain estimates of the $\mu_k$ and for which goods do we attempt to find these estimates? In principle we could attempt to find estimates of the $\mu_k$ for all goods. However, as will be explained below, this is not desirable using the approach adopted in this paper. There is, to some extent, a trade-off between the number of goods for which we will attempt to find estimates of $\mu_k$ and the reliability of those estimates. Thus, we arbitrarily choose which goods we feel may reasonably be expected to have $\mu_k$ different from zero. The relatively broad aggregates of goods we are using constrained us to choosing three goods which we feel, a priori, might have $\mu_k < 0$. They were tobacco, alcohol and petrol. Given the relatively broad aggregate of goods used in this study, we did not feel there was any good for which $\mu_k > 0$.

The other question to be answered is where to obtain estimates of the $\mu_k$? We could simply impose exogenous values, as is usually done with the $\beta^h$, perhaps deriving them from health studies, in the case of alcohol and tobacco, or from environmental studies in the case of petrol. (For a recent example of such an approach in the case of alcohol, see the paper by Holm and Suoniemi (1992)). An alternative route is to attempt to derive them from what has become known as the "inverse optimum" approach. This approach was first adopted by Christiansen and Jansen (1978) for the case of Norway, who also,
in the same paper, calculated MSCs for the Norwegian indirect tax system. (Other examples of this approach are Decoster and Schokkaert (1989) and Craggs(1990) for the Belgian and Canadian tax systems respectively.) Christiansen and Jansen’s paper attempted to find the social preferences implicit in the Norwegian indirect tax system viz. the implicit value of e (the inequality aversion parameter, which enters the expression for \( \lambda_i \) via the \( \beta^h \) term), the implicit equivalence scales and the implicit social costs associated with certain goods. In this paper we will apply this methodology to the Irish indirect tax system, although we will not address the issue of the implicit equivalence scales.

Adapting their solution procedure to our model, we maximize a social welfare function with respect to specific taxes, \( t_1, \ldots, t_n \) subject to the fiscal requirement \( \Sigma t_j X_j = R \). We form the Lagrangian:

\[
L = W ( v^1, \ldots, v^n, X_1, \ldots, X_n ) - \lambda ( \Sigma t_j X_j - R ).
\]  

(9)

\( \lambda \) is the Lagrange multiplier associated with the fiscal constraint. We derive the first order conditions for the social optimisation problem as:

\[
\frac{\partial}{\partial \lambda} \left( -\Sigma \beta^h x^h_i + \Sigma \mu^*_k \delta x_k / \delta q_i \right) = \lambda \left( x_i + \Sigma t_k \delta x_k / \delta q_i \right)
\]  

(10)

where the notation is as before. Note the similarity between this condition and the expression for \( \lambda^*_i \) in (7), with the only
differences being that we have not expressed it in terms of 
elasticities and ad valorem taxes and we are assuming a common 
value of $\lambda_i$ for all goods. What we are essentially saying here 
is that assuming the existing indirect tax system is optimal, in 
the sense that all the $\lambda_i$ are equal, what are the implied values 
of the $\beta^h$, the $\mu^*_k$ and $\lambda$? We can thus solve for these parameters 
on the assumption that the existing tax system is optimal.

Before going any further, it is necessary to provide a more 
explicit functional form for the $\beta^h$. We use the utility of 
generated welfare weights from the following function:

$$U^h(I) = \frac{k I^{1-e}}{1-e}, \quad e \neq 1, \ e > 0$$  \hspace{1cm} \text{(11)}

$$\beta^h = \begin{cases} 
1 & \Rightarrow \text{poorest} \\
\left[\frac{\infty}{\infty}\right]^{1/2} = 0.3 \lambda < \Delta \\
\left[\frac{1000}{500}\right]^{1/2} = 0.26 < \Delta 
\end{cases}$$

where $I^h$ is total expenditure per equivalent adult of the hth 
household. $\beta^h = U'(I^h)$ and we can normalise $\beta^h$ through choice of 
k so that $\beta^h$ for the poorest household is unity. Then we have 
$\beta^h = (I^1/I^h)^e$. Thus $e$ can be viewed as an inequality aversion 
parameter, since $e=0$ implies equal weights for all households, 
while $e>0$ implies $\beta^h<1$ for $h>1$, so that increments of expenditure 
to the poor are seen to have a higher marginal social value than 
those to the rich. \hspace{1cm} $\beta^h < 1$

Using this definition of $\beta^h$, and following the usual
manipulation to express the above first-order condition in elasticity terms, we have the following expression:

\[-\Sigma_k (I^n / \Gamma^n)^o q_i x_i^o + \Sigma_k \mu_k \epsilon_{k_i} q_k x_k = \lambda (q_i x_i + \Sigma_k \epsilon_{k_i} \tau_k q_k x_k) \quad (12)\]

where \( \mu_k = \mu^*_k / q_k \).

The unknowns in the above expression are \( e, \lambda \), and the \( \mu_k \). We can estimate them using a non-linear estimation procedure as we have ten observations (one for each good) on this equation. However, before involving ourselves with non-linear estimation, we can adopt a simpler route, by simply imposing a value of \( e \), which effectively linearises the above expression. The \( \epsilon_{k_i} \) are obtained from an Almost Ideal Demand System estimated in levels. For further details of the elasticities, see Madden (1992a, 1992b).

We will initially examine the case where \( e = 0 \). Thus we are looking at the case where we are assuming that the governments preferences are of the extreme utilitarian variety i.e. it is not concerned with distributional considerations. The above expression can then be estimated by OLS. (A further reason for carrying out linear estimation first is that it gives a reasonable set of starting values for the non-linear estimation).

An alternative equation which we could attempt to estimate is equation (8), since we have estimates of the \( \lambda_i \) from Madden (1992a). Thus our estimate of \( \lambda' \) would simply be the estimate of
the constant from this regression. Note however, that although
the $\mu_x$ in both expressions are the same, we would not expect the
estimates to be the same since equation (12) is OLS without an
intercept while equation (8) is WLS with an intercept. In fact,
the estimates of $\mu_x$ turn out to be quite similar in magnitude.
We will concentrate on the estimates from equation (12) since the
non-linear version that we estimate is in this form also.

We now explain why there is a trade-off between the number
of $\mu_x$ we try to estimate and the reliability of these estimates.
Firstly, the more $\mu_x$ are included on the RHS of (11), the fewer
degrees of freedom we have and the more highly determined the
equation becomes until eventually we would be solving a system
of equations rather than estimating a relationship. The
inclusion of a $\mu_x$ for all goods would mean that we are
essentially saying that the tax system is as it is because the
government has decreed that there are special effects attaching
to all goods, and therefore the current system must be optimal.
In only choosing three goods, what we are saying is that the
current system of indirect taxation is optimal (barring
estimation errors) when external effects for these goods are
included.

Table 1 in the appendix gives the results of this
estimation. The coefficients are negative, as expected, with a
common value of $\lambda$ of 1.06. The standard errors for the $\mu_x$ are
comparatively large but in line with those obtained for the
Norwegian and Canadian cases. Thus, these are the external
effects implicit in the Irish indirect tax system of 1987, given zero inequality aversion. We normalise these values by dividing by $\lambda$. There are two reasons for doing this. Firstly, we will be estimating $\mu_k$ for the case where $e>0$, which will essentially involve a normalisation of the welfare function and so to facilitate comparison of the $\mu_k$ across the cases of different levels of inequality aversion we need to normalise. Secondly, the choice of $\lambda$ as normalising variable seems reasonable as it gives the externality effects in terms of the gross welfare loss to taxpayers of raising one extra unit of revenue. Thus at the margin, the consumption of one unit extra of tobacco gives the same social welfare loss as would the raising of 0.83 units of revenue.

Further understanding of these figures can be obtained by seeing how they affect $\delta V/\delta t_i$ as shown in Table 2 in the appendix. This expression is: $\Sigma_h \beta^h q_i x_i^h - \Sigma_k \mu_k e_{ki} q_k x_k$, with $\beta^h=1$ in this case. Thus taking the case of food, $q_i X_i = 49.977$, while $\Sigma_k \mu_k e_{ki} q_k x_k = 12.04$. The numerator thus becomes 37.94, indicating that the MSC of food is reduced, owing to its cross-price effects with the goods which have external effects i.e. on balance food is complementary with goods with negative social effects. Of course, the effect could work the other way. If $\Sigma_k \mu_k e_{ki} q_k x_k<0$, then the MSC of a good will be increased by the inclusion of external effects. This happens for alcohol, fuel and power, services and is marginally the case for clothing and footwear and transport and equipment.
\[
\lambda_i^* = \frac{\sum_{k} \beta_k^h q_k x_i^h - \sum_{k} \mu_k^i \sigma_k q_k x_k}{q_i x_i + \sum_{k} \sigma_k q_k x_k}
\]

Having obtained estimates for the \( \mu_k^i \), we can now recalculate the MSC of each good including the \( \mu_k^i \) in the expression for \( \delta V/\delta t_i \) (what we termed \( \lambda_i^* \) above; these are presented in table 2). However, a word of caution should be entered here. There is a certain sleight of hand in calculating these \( \lambda_i^* \). We estimated the \( \mu_k^i \) on the basis that \( \lambda_i = \lambda \) for all \( i \), and then used these \( \mu_k^i \) in the calculation of the \( \lambda_i^* \). In many ways the different \( \lambda_i^* \) may merely reflect the poor fit in the calculation of the \( \mu_k^i \) in the inverse optimum problem. Thus in some ways it is inconsistent to "solve" an inverse optimum problem and then calculate welfare improving directions of tax reform. In defence of this procedure it must be pointed out that estimates of the \( \mu_k^i \) must be obtained from somewhere and their calculation from the inverse optimum problem is a potentially interesting option.

Before presenting these \( \lambda_i^* \) we must point out a further possible paradox. As we have seen, if \( \sum \mu_k \varepsilon_{k} q_{k} x_{k} > 0 \), then the MSC of a good is reduced. It is entirely possible that \( \sum \mu_k \varepsilon_{k} q_{k} x_{k} \) be so large as to make the numerator negative i.e. \( \sum_{k} \beta_k^h q_k x_i^h - \sum_{k} \mu_k^i q_k x_k < 0 \). Thus welfare would be increased by raising the tax on this good owing to the reduced consumption of social "bads" it would induce. This actually occurs for two goods in the Irish case, tobacco and durables. Coincidentally, these are the two goods for which \( \delta R/\delta t_i \) was found to be less than zero in Madden (1992a) i.e. those goods whose tax was so high it was beyond its revenue maximising level. Thus when we recalculate \( \lambda_i \) including external effects, calling them \( \lambda_i^* \), we find that the MSC returns to being positive, but for the "wrong" reason. Instead of
\[-\delta V/\delta t_i > 0 \text{ and } \delta R/\delta t_i > 0, \text{ we have } -\delta V/\delta t_i < 0 \text{ and } \delta R/\delta t_i < 0!\]

The inclusion of the \( \mu_k \) also alters the ranking of goods by MSC as well as narrowing their spread. While the fact that the rankings are very sensitive to the inclusion of social costs may seem somewhat alarming, it is worth noting that the same phenomenon occurs in the Norwegian and Belgian cases. The inclusion of social costs has differing effects on the MSCs of the three externality-creating goods. As indicated above, the case of tobacco is difficult to interpret. However it seems reasonable to suggest that if the tax on tobacco were at a rate such that \( \delta R/\delta t_i > 0 \), then the inclusion of social costs would lower the MSC of raising its tax. The same is true of petrol, but as was mentioned above, the inclusion of external effects actually increases the MSC of raising the tax on alcohol. This may appear strange, given that we have identified a negative external effect for alcohol, but it is explained by the pattern of substitutability and complementarity with the other goods with external effects. In particular, our elasticity estimates suggest that alcohol is highly complementary with petrol and it is this which contributes most to the paradoxical result.

Of course, ideally we would like to estimate the value of \( e \) rather than impose it. It is possible that what we estimate as an external effect may, in fact, reflect distributional considerations on behalf of the government. For example, an estimated negative externality for a good such as alcohol may reflect the fact that it is disproportionately consumed by higher
income households and so the social cost in fact reflects
distributional concerns. Before attempting to estimate \( \epsilon \), our
inequality aversion parameter, it is worth looking at what
Feldstein terms the "distributional characteristic" of each good
for different levels of \( \epsilon \). This essentially shows what the
relative MSCs of goods are, when we are solely taking account of
distributional considerations i.e. the values of \( \lambda \) when \( \epsilon_{ij}=0, \)
\( \forall i,j \). Table 3 shows these characteristics. When \( \epsilon=0 \) they are
all equal to unity. However, as \( \epsilon \) increases, goods that are
necessities get a relatively higher and luxuries a relatively
lower value for the distributional characteristic. As might be
expected, food has a relatively high characteristic and so too
has tobacco. Petrol and alcohol have relatively low
characteristics. Thus we might expect that the introduction of
distributional considerations might reduce the estimated
externality attached to tobacco, while leaving those for petrol
and alcohol relatively unchanged.

Recall expression (12) for the first-order condition when
including the full expression for \( \beta^\prime \). As we can see, this is a
non-linear expression with unknowns, \( \epsilon, \lambda, \mu_{\text{tob}}, \mu_{\text{pet}} \) and \( \mu_{\text{alc}} \). To
facilitate non-linear estimation we re-write the expression as
follows:

\[
q_i X_i = \left[ (\Sigma q_i X_i) - \Sigma \mu_k \epsilon_k q_i X_k \right] / \lambda + \Sigma \epsilon_k \tau_k q_k X_k \tag{13}
\]

We have ten observations of this equation and five
parameters to estimate. The non-linear programme in SHAZAM was
used for estimation. This is a quasi-Newton method and the reader is referred to the SHAZAM manual (White et al. (1990)) for further details. One of the crucial elements in non-linear estimation is a suitable choice of starting values for the parameters being estimated. A number of different starting values for the parameters were experimented with, commencing with the values obtained in the linear regressions and also including a few "rogue" values. In all cases the estimates converged to the values given in table 1 suggesting that this is a global rather than merely a local optimum. The typical number of iterations was 15-20.

First of all, note that the estimate for $e$ is not significantly different from zero, suggesting that the Irish indirect tax system is not progressive. Even if the coefficient were significant, it would still indicate that the government's preferences, as indicated by the indirect tax system were virtually utilitarian. Furthermore, when eqn (13) was re-estimated with the $\mu_r=0$, a negative estimate of $e$ was obtained, suggesting that the government's preferences, in the absence of external effects, are regressive. (More formally, a value of $e<0$ implies that the social welfare function violates "s-concavity". Sen (1973) provides a discussion of s-concavity). The lack of inequality aversion is most probably caused by the high tax on tobacco, the good with the highest distributional characteristic. This finding is consistent with the results of Madden (1992a) where it was shown that the ranking of goods by MSC was
relatively insensitive to changes in $e$, suggesting that the Irish indirect tax system is relatively inefficient at addressing distributional issues. Sah (1983) provides a theoretical explanation of why, in general, one might expect this to be the case.

The estimates for the $\mu_k$ are very similar to those in the linear case, which is not surprising, given that the estimate of $e$ is so close to the value of zero which was imposed in the linearised case. Thus we do not present the values of $\lambda'_1$ for these $\mu_k$ since they are virtually identical to those presented in table 2.

To summarise the results of this section of the paper, we have applied the inverse optimum technique to estimate possible external effects and also the degree of inequality aversion implicit in the Irish indirect tax system. Our results suggest that there is virtually no inequality aversion in the indirect tax system and also underline the importance of patterns of substitutability and complementarity in analysing external effects. This latter aspect was also highlighted in Madden (1992a) and it reinforces more than ever the importance of reliable elasticity estimates. In this respect the elasticity estimates used are not ideal (as is outlined in Madden (1992a) less than half the parameters in the estimation of the elasticities were significant and even some of the significant elasticities had implausible values). The sensitivity of Irish consumer demand elasticities to such factors as stochastic
specification is examined in Madden (1992b) where a wide range of elasticities is presented. Not for the first time in applied work on the Irish economy, the importance of having reliable estimates of crucial parameters is stressed.

Section 2: Should We Apply Corrective Taxes Directly or Indirectly?

So far we have selected three goods which we feel have a corrective tax element. In two of these cases (petrol and tobacco) they are goods with relatively high MSCs (when the MSCs are calculated both with and in the absence of external effects and allowing for the paradoxically low positive value of the MSC for tobacco) and in the case of tobacco, a good whose tax exceeds its revenue-maximising level. In such cases it may be worthwhile to ask whether it might not be possible to impose corrective taxes on such goods indirectly rather than directly. The possibility of indirect corrective taxes has been recognised in the economics literature for quite some time (see, for example, Sandmo (1976), Wenzel and Wiegard (1981) and Wijkander (1985)). Their analysis looks at situations where administrative considerations may render it infeasible to directly impose corrective taxes. The question of which taxes should be used indirectly requires knowledge of aggregate patterns of demand, information which is available from marginal tax reform analysis. Thus, there appears to be potential for investigating the possibility of indirect corrective taxation using the marginal
In the estimation carried out in section 1 we identified two goods whose taxes appear to have both external effects and high MSCs (tobacco and petrol). It is also arguable that, given the very high tax rates on these goods, these are two of the principal revenue-raising taxes (as an illustration, tobacco and petrol excise receipts made up 22.4% and 36.5% respectively of total excise receipts on home-produced and imported goods in 1987). As has been seen in previous work by the author, so high is the tax on tobacco, in particular, that it appears to be beyond its revenue maximising level. Given that part of this tax appears to be a corrective tax, it suggests that a switch from a direct corrective tax on tobacco towards an indirect corrective tax could lead to an increase in revenue, while keeping external effects constant. Moreover, if the good upon which the indirect corrective tax is levied had a low MSC, there could also be an increase in welfare. (Note that this would also most likely be redistributive since tobacco has a higher "distributional characteristic" than other goods, except for fuel and power at very high levels of inequality aversion). The same would apply to a switch from a direct to an indirect corrective tax on

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1Note that there is also a related literature on the possibility of counter-intuitive corrective taxation, where owing to the possibility of imposing differential corrective taxes on different consumers it may be optimal to subsidise either an external diseconomy, or a complement to an external diseconomy. See, for example, the papers by Diamond (1973), Green and Sheshinski (1976), and Balcer (1983). Ng (1980) also provides a case where owing to the excess burden of raising taxes, counter-intuitive possibilities arise. However, he does not examine the possibility of indirectly taxing diseconomies.
petrol/alcohol, providing the good upon which the indirect corrective tax was levied had a greater $\delta R/\delta t_i$ than petrol/alcohol and also ranked lower in MSC. (Note that the relatively greater is $\delta R/\delta t_i$ for any good, the more likely is it to have a low MSC, suggesting that the location of suitable candidates for indirect corrective taxes might not be too difficult). A further point to note is that in our analysis in Section 1 we identified only corrective taxes and did not refer to corrective subsidies. If we identified a good we wished to subsidise owing to it having a positive externality, then we would have to address the issue of raising the revenue to finance the subsidy and whether the welfare loss would be warranted.

Thus to identify possible goods for indirect corrective taxation, we need goods which (a) have higher $\delta R/\delta t_i$ than tobacco/alcohol/petrol, (b) goods with which tobacco/alcohol/petrol are complementary, (c) have a lower MSC than tobacco/alcohol/petrol and finally (d) hopefully have a low distributional characteristic.

Criterion (a) is not too difficult to fulfill. With the exception of durables, tobacco and petrol have the lowest values of $\delta R/\delta t_i$ of all the goods (for tobacco, of course, $\delta R/\delta t_i < 0$). Only food and services have a higher $\delta R/\delta t_i$ than alcohol. Care has to be taken with regard to criterion (b). It is important to identify goods with which tobacco/alcohol/petrol are complements rather than vice versa, although one would hope that it would be the same goods in both cases. Thus we are looking
for goods such that $x_{j}<0$, where $j$ represents tobacco/alcohol/petrol and $i$ represents the good we are looking for. In this case for tobacco we identified four goods which fulfill this criterion: food, petrol, transport and equipment, durables and other goods. Of these, only food and durables are significant. We identified five such goods for petrol: Food, tobacco, clothing and footwear, transport and equipment and durables, with the coefficients on food and tobacco being significant. We identified five such goods for alcohol: food, tobacco, clothing and footwear, durables and services, with only the coefficient on durables being significant. Thus, so far, food and durables appear to be the leading candidates. Food fulfills criterion (c) of having a relatively low MSC (both with and without the inclusion of external effects), while durables, given that its $\delta R/\delta t_{i}<0$, is ruled out. While food has a higher MSC than tobacco when external effects are taken into account, the paradoxical reasons as to why tobacco has a low and positive MSC in this case have already been explained, so it still appears reasonable to suggest that food "passes" criterion (c).

Finally, if we wish to take account of distributional considerations, we would like the chosen good to have a low distributional characteristic. This is not the case for food. Nevertheless, the choice of food as a candidate for an indirect corrective tax can still be defended on two grounds. Firstly, if the tax on food were to be raised, while that on tobacco were lowered, we would still be lowering the tax on the good with the higher distributional characteristic (tobacco). Secondly, we
have already seen that the Irish indirect tax system takes little account of distributional considerations.

To conclude, we have investigated the possibility of indirectly imposing corrective taxes and have suggested that a switch at the margin from tobacco to food might bring about a welfare gain and a revenue gain while still imposing the same degree of corrective taxation. The policy recommendations from this paper are very similar to the type of recommendations emanating from the author's previous work on indirect tax reform indicating that marginal tax reforms are robust to the incorporation of external effects. This work also raises questions about the distributional impact of government policy to reduce smoking. The policy over the last twenty years or so has been a mixture of high taxation coupled with health education warnings about the harmful effects of smoking. Atkinson (1974) notes that in the UK over the period 1958-71 the proportion smoking among social class I (professional etc.) fell from 54% to 37% while the proportion among social class V (unskilled) fell only from 61% to 59%. If smoking patterns in Ireland were to have changed in the same manner in recent years (and casual reading of the Household Budget Survey is not inconsistent with this) then Irish anti-smoking policy may have unwittingly been regressive.
References


