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Conditional Demands and Marginal Tax Reform

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Abstract: This paper examines Irish demand patterns using conditional demand functions. This overcomes the problems faced by traditional demand analysis in its neglect of the influence of labour supply and consequent imposition of weak separability. The conditional approach allows for more exact tests of weak separability using more flexible functional forms than is possible when estimating an unconditional commodity demand-labour supply model. The impact of the conditioned demand responses and the relaxation of weak separability on measures of marginal tax reform is examined.

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Conditional Demands and Marginal Tax Reform.[1]

1. Introduction.

Traditional demand analysis usually assumes weak separability between goods and leisure, despite casual observation to the contrary.[2] The assumption of weak separability can be relaxed in two ways. Firstly, we could regard goods and leisure (labour) as being jointly determined i.e. both goods and leisure are endogenous.[3] A second approach, which we concentrate on here, involves the use of conditional demand functions.[4] In this approach leisure is regarded as fixed, and goods are demanded conditional on the quantity of leisure being consumed. This conditional approach possesses a number of advantages over the jointly determined approach. Firstly, the results obtained from estimation are not dependent upon having the correct specification for leisure demand, or equivalently, the correct model of labour force participation or hours worked. Secondly, more flexible forms for preferences for non-leisure goods may be used.

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[1] I would like to thank Peter Neary for helpful comments. I also gratefully acknowledge financial support from the Foundation for Fiscal Studies and the HCM Network on the Microeconometrics of Public Policy funded by grant 930225.

[2] For a recent example see the volume by Pollak and Wales (1992) and the references therein. For examples in the Irish case, see Madden (1993a).

[3] For examples of this approach see Abbott and Ashenfelter (1976), Barnett (1979) and Blundell and Walker (1982). For examples in the Irish case, see Murphy and Thom (1987a) and Madden (1993c).

[4] The earliest references here are Pollak (1969, 1971). For a recent application, see Browning and Meghir (1991).

This second advantage is particularly relevant when we wish to test for weak separability. This is because it avoids the trade-off present in jointly determined models between exact tests for separability using quite restrictive functional forms and approximate tests using less restrictive forms.[5] The conditional approach allows us to test for weak separability exactly while at the same time using such a flexible representation of preferences as Deaton and Muellbauer's Almost Ideal Demand System (AIDS, Deaton and Muellbauer (1980)). Thus the possible misspecification involved in assuming leisure demand to be fixed is balanced by our using more flexible functional forms than those typically employed in jointly determined models.[6]

Conditional demand functions may also be of use in analysing issues in both optimal taxation and tax reform. Under certain conditions weak separability between goods and leisure implies that uniform indirect taxation is optimal.[7] Empirically, Ray (1986) has shown how optimally estimated indirect tax rates are

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[5] For examples of the former where separability is tested for exactly, but with preferences which are quasi-homothetic in full income, see Blundell and Walker (1982), Murphy and Thom (1987a) and Madden (1993c). For an example of approximate testing for separability see Barnett (1979).

[6] An alternative, and, in principle, attractive, approach would be to estimate matched pairs of rationed and unrationed demands, generated from the same preferences. However, closed form representations of preferences for such an approach with aggregate time-series data involve the use of restrictive assumptions about either preferences and/or the form of rationing; see Deaton and Muellbauer (1981) and Murphy and Thom (1987b). For an example with more flexible functional forms, but using numerical methods, see Kooreman and Kapteyn (1986).

[7] For a recent survey, see Stern (1990). However the <u>form</u> of separability in question (in particular whether weak or quasi separability is assumed) can influence these results. See Deaton (1981) and Besley and Jewitt (1988).

very sensitive to the functional forms assumed for consumer preferences, while Ebrahimi and Heady (1988) have shown their sensitivity to weak separability. Marginal tax reform recommendations do not appear to show the same sensitivity to functional form given the assumption of weak separability (see Decoster and Schokkaert (1990) and Madden (1993b)). Madden (1993c) also shows that they do not appear to show great sensitivity to the assumption of weak separability itself. However, his model uses aggregate time series data for the estimation of a jointly determined unconditional commodity demand-labour supply model thus implying relatively restrictive functional forms (in effect generalisations of the Linear Expenditure System (LES)). Such analysis using conditional demand functions permits allows us to examine the sensitivity of marginal tax reform recommendations to weak separability in the context of more general preferences.[8]

In section 2 we briefly discuss the theoretical results underlying the use of conditional demand functions and possible functional forms. Section 3 compares demand responses from conditional and unconditional systems and examines tests for weak separability and homogeneity. In section 4 we investigate the impact of conditional estimates on marginal tax reform recommendations, while section 5 offers some concluding remarks.

[8] Since we do not specify any labour supply function, we can only analyses the sensitivity of <u>commodity</u> tax reform recommendations to weak separability.

2. Conditional Demand Functions.

In this section we discuss some of the fundamental results in conditional demand analysis.[9] We divide all goods into two exclusive classes. Firstly, there are those goods of direct interest to us, whose price and quantity vectors we denote by $[q_1, .., q_n]$ and $[x_1, .., x_n]$ respectively. Secondly, there are "conditioning goods" which may affect preferences over the goods of direct interest, but which are not of direct interest to us. We denote their price and quantity vectors by $[r_1, .., r_n]$ and $[h_1, .., h_n]$ respectively.[10] As examples of possible conditioning goods we could have housing, public goods or labour supply (leisure). In our application of the conditional approach our goods of direct interest will consist of non-durable and durable goods (excluding housing) and our conditioning good will be labour supply.

Suppose preferences over all goods are represented by the utility function U(x, h). Then we can define the *conditional cost function*

$$c(q, h, u) = \min_x (qx \mid U(x, h) = u) \tag{1}$$

Under conventional assumptions the conditional cost function has the following properties: (1) it is concave, linear homogeneous and non-decreasing in q for fixed (h, u); (2) it is convex in h for fixed (q, u); (3) it is monotone in h, increasing in the case

[9] This section draws on the discussion in Browning and Meghir (1991).

[10] We note that for the estimation of conditional demand functions, we do not require observations on r.

of goods which lower utility and decreasing in the case of goods which increase utility.[11]

Following application of Shepherd's lemma to the conditional cost function we obtain compensated conditional demands. If we invert the relationship c(q, h, u)=m, where m is expenditure on the goods of direct interest we obtain u in terms of (q, h, m). This can then be substituted into the compensated demands to give the uncompensated demands

$$x_i = f_i(q, h, m) \qquad i=1,\ldots, n \tag{2}$$

We now discuss the relationship between the structure of conditional cost functions and that of the direct utility function. As Browning and Meghir (1991) point out, in general the structure of the direct utility function does not have any clearcut implications for the structure of the dual functions. They show, however, that this is not the case for the conditional cost function, a result which they use for testing weak separability. Suppose the goods of direct interest are weakly separable from the conditioning good so that the direct utility function takes the form F(U(x), h). Browning and Meghir (1987) show that this implies that the conditional cost function takes the form c(q, g(h, u)). This implies that under weak separability, conditioning goods will only have income effects.

[11] See Browning (1983) for a full account of the properties of the conditional cost function and its relation to the unconditional cost function which is defined over (q, r, u).

Thus under weak separability the conditional demand system for goods of direct interest has the form

$$x_i = f_i(q, m) \quad i=1, \ldots, n. \tag{3}$$

Thus a simple test for weak separability consists of testing whether demands x_i depend on quantities of goods h_i, given that we have conditioned on the prices of the goods of interest, q_i, and total expenditure on these goods, m.

We should note that the demand system in (2) is unchanged if we start off with a cost function of the type c(q, h, ϕ(h, u)) rather than c(q, h, u) where ϕ is any arbitrary function increasing in u. This means that we cannot in general infer anything about preferences over h from observing demands on x alone.[12] We can test for weak separability, but can do little else.[13] This is the principal disadvantage of the unconditional approach and for tax reform purposes it implies that we will only be able to analyse the sensitivity of indirect tax reform proposals to weak separability.

We now discuss the issue of choice of functional form for the conditional cost function. As mentioned earlier, the advantage of the conditional approach is that weak separability can be tested for exactly using more general functional forms than is the case with the jointly determined approach. One of

[12] Bradford and Hildebrabdt (1977) show the conditions under which it is possible to use aggregate demand functions from individual utility maximisation to obtain consumers' preferences for certain classes of public goods.

[13] The derivation of elasticities from (2) in the usual way is dependent upon the quantities h being pre-determined.

the most popular functional forms for the analysis of consumer demand is the Almost Ideal Demand System (AIDS) of Deaton and Muellbauer (1980). Following Deaton (1981b) we can specify an analogous model which conditions over labour supply and whose conditional cost function has the form

$$\ln c(q,\ h,\ u) = a(q,\ h) + ub(q,\ h) \tag{4}$$

where

$$a(q,\ h)=\alpha_0+\sum_k (\alpha_k+\eta_k h)\ln q_k+\frac{1}{2}\sum_k\sum_k \gamma^*_{kj}\ln q_k \ln q_j \tag{5}$$

$$ub(q,\ h)=\beta_0\prod q_k^{\beta_k}(u+\theta_0 h+\frac{1}{2}\theta_1 h^2+\frac{1}{2}\theta_2 uh) \tag{6}$$

Application of Shepherd's lemma to the log of the cost function gives us the following equation for the budget share of good i

$$w_i=\alpha_i+\eta_i h+\sum_j \gamma_{ij}\ln q_j+\beta_i \ln\frac{m}{P} \tag{7}$$

where

$$\ln P=\alpha_0+\sum_k (\alpha_k+\eta_k h)\ln q_k+\frac{1}{2}\sum\sum \gamma_{kj}\ln q_k \ln q_j \tag{8}$$

and $\gamma_{ij}=0.5(\gamma_{ij}^*+\gamma_{ji}^*)$.

This conditional model which we label the CAIDS follows the usual parameter restrictions of the AIDS model; for adding-up and homogeneity

$$\sum_i \alpha_i = 1,\ \sum_i \eta_i = 0,\ \sum_i \gamma_{ij} = 0,\ \sum_i \beta_i = 0 \tag{9}$$

$$\sum_j \gamma_{ij} = 0 \tag{10}$$

and for symmetry,

$$\gamma_{ij} = \gamma_{ji} \tag{11}$$

Equation (7) is linear in parameters if we adopt the Stone approximation $\ln P = \sum_k w_k \ln q_k$.[14] Given this parameterisation, the test for whether our goods of direct interest are weakly separable from h consists of testing whether the relevant η_i are zero for all i.

It remains to choose our appropriate measure for h. We will be using aggregate time series data for w_i, q_i and m. As our measure of labour supply we propose two possibilities. One of these is aggregate employment. If we believe that the major change in total hours worked arises due to changes at the intensive rather than extensive margin (i.e. via changes in the numbers employed, rather than in average hours worked per worker) then aggregate employment (EMPTOT) would be an appropriate

[14] For a discussion of the use of the Stone approximation, see Pashardes (1993). He demonstrates a bias in its use when estimating with cross-sectional data but concludes that the bias is not so severe when using time series data, as we do here.

measure. One possible objection to this measure would be that owing to the rising population in Ireland for much of the period under review, it is possible to observe years where both total employment and unemployment grew. To check for the sensitivity of this we propose an alternative measure which is the employment rate, (EMP=total employment divided by the total labour force). We present results for both these cases. We also present results for what we label "traditional" demands (i.e. where demand for goods is a function of prices and total expenditure only, and weak separability between goods and leisure is assumed).

Our data consists of aggregate time series data from the Irish National accounts[15], covering the period 1959-88 and broken down into ten categories of goods: food, alcohol, tobacco, clothing and footwear, fuel and power, petrol, transport and equipment, durable goods, other goods and services. For estimation purposes services were treated as a residual.

3. Results.

In the tables in the appendix we present results for own-price elasticities for all goods for six different demand systems. We have tarditional AIDS with no restrictions placed on preferences, and traditional AIDS with homogeneity imposed. We also have AIDS conditioned on total employment and conditioned on the employment rate, each estimated both unrestricted and with

[15] I am grateful to John Fitzgerald and Feargal O'Brollchain for providing the data.

homogeneity imposed. We also present results for tests of separability on a *system wide* and on an equation by equation basis. Finally we present results for tests of homogeneity on a system wide and individual basis, for both conditioned and traditional demands.

We first examine results for own-price elasticities for the different systems.[16] Looking at unrestricted estimates first, we can see that for all goods with the exception of alcohol and petrol, the inclusion of the conditioning good appears to have little impact on the value of own-price elasticities. In the traditional case the own-price elasticity for alcohol is -0.36. When conditioned on EMPTOT this changes to -0.09, but when conditioned on EMP it becomes -0.63. The t-ratios for the traditional estimate and that for the estimate conditioned on EMPTOT are both significant at 95%; that for the estimate conditioned on EMP is not significant[17]. It should be mentioned that reliable estimates for elasticities involving alcohol can be difficult to obtain (see Madden (1993a)) owing to problems associated with cross-border trade.

The estimated elasticities for petrol also show volatility across models. For the traditional model and for the model conditioned on EMP the own-price elasticity is *positive* and

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[16] In this discussion we will concentrate on the impact of the introduction of conditioning goods on estimates. For detailed discussion of unconditioned estimates of own-price and expenditure elasticities for a variety of demand systems, see Madden (1993a).

[17] In this context "significant" means that the estimated coefficient upon which the calculation of the elasticity was based is significant.

significant. For the estimate conditioned on EMPTOT it is -0.09 and is significant. Cross-border trade may also be a factor behind this volatility.

Turning now to the models estimated with homogeneity imposed, the pattern is quite similar. Once again estimated elasticities for alcohol and petrol show volatility and the pattern of volatility across models is similar to the unrestricted models e.g. a strongly negative (but insignificant) own-price elasticity for alcohol when it is conditioned on EMP, and a positive (and significant) own-price elasticity for petrol when it is conditioned on EMP.

We now examine the tests for weak separability. In all cases the system-wide test for weak separability was rejected at the 95% level. However, in the unrestricted model, when conditioned on EMPTOT the Wald statistic was 19.2, compared to a critical value for 95% of 16.92. At the 99% significance level, weak separability would not have been rejected. A further feature of the results is that weak separability appears to be more strongly rejected when homogeneity is imposed than when not imposed e.g. Wald statistics in the unrestricted cases of 19.2 and 31.4, compared to 45.4 and 51.6 when homogeneity is imposed. These results are broadly consistent with those of Browning and Meghir (1991) for the UK economy.

Turning now to separability tests on an good-by-good basis, it is difficult to find any pattern in the results. Consistent with the system-wide tests, there are more significant coefficients on EMP than on EMPTOT. Once again, in the case of alcohol and petrol, there is a difference between the unrestricted and restricted models. Neither EMPTOT nor EMP are significant in the unrestricted model, while both are significant in the restricted model.

Finally, we can examine how tests for homogeneity are affected by the inclusion of conditioning goods. Deaton (1981b) found that the inclusion of a conditioning good (in his case housing) reduced the values of the F statistics in his good-by-good tests for homogeneity, compared with his tests for homogeneity in the original AIDS paper (Deaton and Muellbauer (1980)). He had earlier speculated that the rejection of homogeneity in Deaton and Muellbauer (1980) might have been due to dynamic mis-specification. In a different context, Stoker (1986) found a statistical equivalence between dynamic mis-specification and omitted variables in a static model. This suggests that dynamic specification and omitted variables are important for tests of homogeneity, a conjecture confirmed in the case of the former by Madden (1993a) for Ireland.[18] It seems worthwhile to check if Irish demand estimates are also sensitive to the inclusion of (previously omitted) conditioning goods.

The evidence from these estimates is consistent with the findings of Deaton. On a system-wide basis the Wald statistic for traditional AIDS estimated in levels is 270.8. When the AIDS

[18] This issue is examined in more detail in Madden (1993e).

model is estimated in first differences, this statistic falls to 110.1. When the AIDS model is estimated conditioned on EMPTOT and EMP the Wald statistics fall to 84.2 and 101.9 respectively. While both these Wald statistics still indicate rejection of homogeneity, the degree of rejection is much reduced.[19]

On a good-by-good basis, we can examine the F-statistics for the homogeneity test. In the unconditioned model three goods, alcohol, petrol and durable goods all reject homogeneity at the 95% significance level (alcohol and durable goods also reject it at 99%). When conditioned on EMPTOT there are four goods which reject homogeneity at 95%, tobacco, clothing and footwear, petrol and durable goods. However, none of the goods reject homogeneity at 99%. When conditioned on EMP only durable goods reject homogeneity at 95% (it also rejects it at 99%).

4. Conditional Demands and Marginal Tax Reform.

We now investigate how the use of conditional demands affects marginal tax reform. The marginal tax reform model we use is that of Ahmad and Stern (1984). Practically all applications of the Ahmad-Stern (henceforth AS) model examine indirect taxation only and assume that incomes are fixed.[20] In most cases also, weak separability is assumed and unconditional

[19] As is pointed out by Laitinen (1978) tests for homogeneity using Wald statistics can be biased towards rejection for small samples. They suggest use of Hotelling's T^2 statistic to correct for this. Even using this statistic homogeneity is still rejected for both conditional models, but once again the degree of rejection is much reduced.

[20] For an exception, see Madden (1993c).

demand responses are used.[21] To the extent that weak separability does not hold, then demand responses from a model which imposes it will be biased. In the light of the evidence presented above, that weak separability is rejected for Irish data, the question we wish to address is how sensitive are marginal tax reform proposals to the relaxation of weak separability and the inclusion of employment as a conditioning variable.[22]

The AS model examines tax reform using a measure known as the marginal revenue cost (MRC) of raising the tax on a good. This measure shows us the revenue foregone when that tax is lowered sufficiently to increase welfare by one unit.[23] Thus we can express the MRC for good i, which we label ρ_i, as

$$\rho_i = -\frac{\partial R/\partial t_i}{\partial W/\partial t_i} \tag{12}$$

Calculation of ρ_i enables us to identify welfare-improving directions of reform. Intuitively, at the optimum all ρ_i will be equal, since otherwise it would be possible to raise the tax on a good with a high ρ_i and lower the tax on a good with a low ρ_j,

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[21] For an exception, see Van de Gare, Schokkaert and de Bruyne (1991). They examine the sensitivity of marginal tax reform to a number of assumptions, mainly on the production side of the model. Their demand functions are conditional on employment, but they do not address the issue of sensitivity of marginal tax reforms to conditioning, *per se*.

[22] Note that we are not examining the sensitivity of indirect tax reform proposals to the deterministic specification of functional form. This is done in Madden (1993b). Here we are examining the sensitivity to the inclusion of a conditioning variable, for a given functional form.

[23] The original AS reference presented what they called the marginal social cost of raising tax on a good which is the reciprocal of MRC. For reasons outlined in Madden (1993d) we prefer the MRC measure.

thus raising welfare while keeping revenue constant. Thus if all the ρ_i are not equal, our tax reform rule is to lower the tax on goods with low ρ_i and raise the tax on a good with a high ρ_j. Following the analysis of AS (1984) it can be shown that

$$\rho_i = \frac{X_i + \sum_k t_k \frac{\partial X_k}{\partial t_i}}{\sum_h \beta^h x_i^h} \tag{13}$$

where X_i is total consumption of good i, x_i^h is the consumption by household h of good i, t_k is the *specific* tax on good k and β^h is the welfare weight for household h. Multiplying the numerator and denominator by q_i, we obtain (13) in terms of magnitudes that are readily measurable

$$\rho_i = \frac{q_i X_i}{\sum_h \beta^h q_i x_i^h} + \frac{\sum_k \tau_k q_k X_k \varepsilon_{ki}}{\beta^h q_i x_i^h} \tag{14}$$

where τ_k is the tax on good k as a fraction of the tax inclusive price and ε_{ki} is the uncompensated cross-price elasticity of demand between goods k and i.

Data on the constituent parts of equation (14) are readily available. Household consumption of different goods can be obtained from the Household Budget Survey, tax rates are available from Reports of the Revenue Commissioners, while estimates of ε_{ki} can be obtained from demand systems. We will also confine ourselves to the case where welfare weights are the same for each household i.e. $\beta^h=1 \ \forall \ h$.[24] In this part of the

[24] For an examination of the sensitivity of ρ_i to different welfare weights, see Madden (1993d).

paper, we examine the sensitivity of the ranking of goods by ρ_i to the different demand systems of section 3.

In our analysis we present values of ρ_i for Ireland for the year 1987.[25] Since our tax reform rule examines the ranking of goods by ρ_i, we examine sensitivity of ρ_i to the presence of conditioning variables by analysis of rank correlation coefficients between different systems. Rank correlation coefficients are a non-parametric measure and so to take account of the actual values of the ρ_i we also present simple correlation coefficients.

In total we have six demand systems from which we have calculated values of ρ_i. They are AIDS estimated unrestricted and with homogeneity imposed but not conditioned on employment. These systems we label AIDS1 and AIDS2 respectively. We also have unrestricted and homogeneity imposed estimates with EMPTOT used as the conditioning variable (these systems we label CAIDS11 and CAIDS21). Finally, we have unrestricted and homogeneity imposed estimates with EMP as the conditioning variable, which we label CAIDS12 and CAIDS22.

First we will examine the effect of introducing the conditioning variable on the ranking of goods. To control for the effect of imposing homogeneity we thus compare correlations between systems with the same restrictions on preferences. Thus

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[25] We choose the year 1987 as it is the most recent year for which household consumption data is available.

we examine AIDS1/CAIDS11, AIDS1/CAIDS12, AIDS2/CAIDS21 and AIDS2/CAIDS22 in tables A5 and A6. Looking at rank correlations we see very high correlations (in excess of 0.879) for all these cases except that of AIDS2/CAIDS22. Thus the introduction of conditioning variables has little effect on the ranking of goods by MRC except for the case where homogeneity is imposed and the conditioning variable is the employment rate. This particular case arises from the change in ranking for clothing and footwear (ranked 2 in AIDS2 and ranked 8 in CAIDS22) and other goods (ranked 7 in AIDS2 and 1 in CAIDS22). In the case of both goods the coefficient on EMP in the estimating equation is significant, indicating that for this model, weak separability with the employment rate would have been rejected for these goods. These findings are confirmed by the simple correlation coefficients; the AIDS2/CAIDS22 correlation at only 0.25. In terms of which conditioning variable has the least impact on rankings of goods, the evidence is that EMPTOT affects rankings less than does EMP.

We turn now to rank correlations between unrestricted and restricted models. The rank correlation coefficient between AIDS1 and AIDS2 is 0.77. When conditioning variables are included, this rank correlation drops to 0.515 in the case of EMPTOT and 0.503 in the case of EMP. This contrasts with the results of Decoster and Schokkaert (1990) and Madden (1993b) who find that in a variety of unconditioned demand systems the imposition of homogeneity has little, if any, effect on rankings of goods by MRC. This result is counter-intuitive, given the other results outlined above. We have seen that the inclusion of conditioning variables has made our demand systems "more homogeneous" in the sense that homogeneity is much less emphatically rejected. Given this finding, we might expect that the *imposition* of homogeneity in a system which includes conditioning variables would have less impact on demand patterns, and hence rankings of goods by MRC, than in the case where conditioning variables are excluded. The rank correlation coefficients (and the simple correlation coefficients) reported here reveal that this is not the case, for this data set at least.

Thus we can summarise the results of this section by noting that the inclusion of conditioning variables (thus relaxing the assumption of weak separability between goods and leisure) has relatively little impact on tax reform proposals, except in the case where homogeneity is imposed and our conditioning variable is EMP, the employment rate.[26] The inclusion of conditioning variables also tends to increase the sensitivity of rankings to the imposition of homogeneity, in contrast to demand systems where conditioning variables are not included.

[26] We have noted above how weak separability can crucially affect optimal tax results (e.g. when accompanied by a linear direct tax and linear Engel curves it leads to optimality of uniform indirect taxation (see Stern (1990)). The results presented here suggest that marginal tax reform recommendations are not as sensitive to assumptions regarding weak separability. However, in addressing this question, we would ideally wish to model direct taxation also, and present tax reform results from a jointly determined commodity demand-labour supply system as in Madden (1993c). His results are also consistent with weak separability having little impact on tax reform recommendations. However, owing to the constraints of using aggregate time-series data, the system estimated in that paper is quite restrictive (assuming quasi-homotheticity in full income).

6. Conclusions

This paper has estimated demand systems for Ireland in the presence of conditioning variables, namely, the level of employment and the unemployment rate, thus abandoning the assumption of weak separability between goods and labour implicit in demand systems that do not condition on these variables. It notes the ease of testing exactly for weak separability when using conditional demands and discovers that weak separability is rejected for Irish data, although in one case only barely so.

The paper also examines how the inclusion of conditioning variables influences tests for homogeneity, and finds that the degree of rejection is reduced by their inclusion. It notes that this is consistent with previous empirical findings by Deaton (1981b) and the more general result of Stoker (1986).

Finally the paper examines the sensitivity of marginal tax reform proposals to the inclusion of conditioning variables (and hence the abandonement of weak separability) and finds little such sensitivity. However, we also find, contrary to our intuition, that for the case where demands are conditioned on the employment rate, marginal tax reform proposals do exhibit sensitivity to the imposition of homogeneity.

Table A1: Own-Price Elasticities (at average budget shares).

Unrestricted Elasticities (t-statistics in brackets)

Good	Unconditioned	Conditioned on EMPTOT	Conditioned on EMP
Food	-0.91 (1.20)	-0.87 (1.32)	-0.81 (2.05)
Alcohol	-0.36 (1.74)	-0.09 (1.87)	-0.63 (0.75)
Tobacco	-0.60 (4.00)	-0.44 (3.85)	-0.50 (3.10)
C & F	-0.87 (0.55)	-1.20 (0.68)	-1.01 (0.04)
F & P	-0.06 (11.03)	-0.05 (11.17)	-0.12 (10.07)
Petrol	0.05 (3.35)	-0.09 (3.54)	0.41 (4.64)
T & E	-1.23 (0.55)	-1.21 (0.43)	-1.36 (0.81)
Durables	-1.43 (1.62)	-1.41 (1.56)	-1.53 (2.05)
Other Goods	-0.44 (2.67)	-0.62 (1.82)	-0.67 (1.69)
Services	-1.28	-1.09	-1.08
LLF	1349.12	1356.50	1359.87

Critical t-statistics: 1.701 (95%), 2.462 (99%).

Table A1 (contd.)

Elasticities with Homogeneity Imposed (t-statistics in brackets)

Good	Unconditioned	Conditioned on EMPTOT	Conditioned on EMP
Food	-0.92 (1.00)	-0.86 (1.45)	-0.90 (1.20)
Alcohol	0.21 (3.01)	0.70 (4.28)	-0.87 (0.25)
Tobacco	-0.65 (3.28)	-0.68 (2.36)	-0.41 (3.92)
C & F	-0.68 (1.30)	-0.68 (1.21)	-1.02 (0.07)
F & P	-0.02 (12.71)	-0.04 (12.46)	-0.03 (12.81)
Petrol	-0.49 (1.62)	-0.40 (1.87)	0.38 (4.49)
T & E	-1.01 (0.03)	-0.98 (0.05)	-1.35 (0.79)
Durables	-0.71 (0.90)	-1.01 (0.04)	-0.80 (0.63)
Other Goods	-0.39 (2.91)	-0.43 (2.73)	-0.65 (1.76)
Services	-1.24	-1.21	-0.81
LLF	1322.65	1336.48	1337.65

Critical t-statistics: 1.699 (95%), 2.462 (99%).

Table A2: Separability Tests

Coefficients on conditioning variable (t-statistics in brackets).

Dependent Variable	AIDS1 cond. on EMPTOT	AIDS1 cond.on EMP	AIDS2 cond. on EMPTOT	AIDS2 cond. on EMP
Food	0.000044 (0.59)	0.205 (1.79)	0.000062 (1.07)	0.063 (0.68)
Alcohol	-0.000067 (0.84)	0.103 (0.81)	-0.000190 (2.80)	0.297 (2.83)
Tobacco	0.00043 (1.46)	0.037 (0.76)	-0.000010 (0.43)	0.081 (2.11)
C & F	0.000076 (1.83)	0.087 (1.27)	-0.000001 (0.02)	0.126 (2.37)
F & P	0.000015 (0.80)	0.052 (1.85)	0.000018 (1.23)	0.016 (0.72)
Petrol	0.000066 (1.25)	0.222 (2.90)	-0.000049 (1.01)	0.272 (4.60)
T & E	0.000060 (0.06)	-0.119 (0.74)	0.000047 (0.60)	-0.140 (1.13)
Durables	-0.000034 (1.25)	-0.782 (1.84)	-0.000090 (3.8)	0.072 (1.57)
Other G	-0.000078 (2.4)	-0.154 (3.13)	-0.000028 (1.00)	-0.121 (3.15)
Services	-0.000071	0.349	0.000240	-0.666
System Test	19.18	31.43	45.40	51.57

Critical t-statistics: 1.699 (95%), 2.462 (99%)

Critical Wald statistic for System test: 16.92 (95%), 21.67 (99%).

Table A3: Homogeneity Tests - F statistics.

Good	Unconditioned	Conditioned on EMPTOT	Conditioned on EMP
Food	0.557	0.080	2.116
Alcohol	8.591	3.331	3.253
Tobacco	3.630	4.749	1.121
C & F	2.819	4.859	0.441
F & P	0.551	0.032	2.194
Petrol	6.675	6.691	0.581
T & E	0.463	0.233	0.022
Durables	17.137	6.735	17.106
Other Goods	0.727	3.435	0.623
System Test	270.84	84.20	101.92

Critical F values: 4.41 (95%), 8.29 (99%).

Critical Wald value for System test: 16.92 (95%), 21.67 (99%).

Table A4: Marginal Revenue Costs - 1987

AIDS1

e=0	e=2	e=5
1. Alcohol 1.836	1. Alcohol 3.983	1. Alcohol 8.017
2. F & P 1.187	2. Services 2.331	2. Services 5.229
3. Services 0.991	3. F & P 2.096	3. C & F 3.447
4. Other G 0.834	4. Other G 1.687	4. F & P 3.376
5. Food 0.751	5. C & F 1.629	5. T & E 3.358
6. C & F 0.727	6. T & E 1.540	6. Other G 3.168
7. Petrol 0.684	7. Petrol 1.496	7. Petrol 3.153
8. T & E 0.680	8. Food 1.402	8. Food 2.410
9. Durables -0.420	9. Durables -0.920	9. Tobacco -1.617
10. Tobacco -0.568	10. Tobacco -0.995	10. Durables-1.875

AIDS2

e=0	e=2	e=5
1. Alcohol 2.560	1. Alcohol 5.552	1. Alcohol 11.175
2. C & F 0.942	2. C & F 2.417	2. Services 5.204
3. Services 0.987	3. Services 2.320	3. C & F 5.116
4. F & P 0.942	4. F & P 1.664	4. F & P 2.681
5. Food 0.783	5. Food 1.461	5. Food 2.511
6. T & E 0.460	6. T & E 1.041	6. T & E 2.270
7. Other G 0.450	7. Other G 0.910	7. Durables 1.772
8. Durables 0.397	8. Durables 0.870	8. Other G 1.708
9. Petrol 0.317	9. Petrol 0.693	9. Petrol 1.461
10. Tobacco -0.829	10. Tobacco -1.450	10. Tobacco -2.358

Table A4 (contd.)

CAIDS11

e=0	e=2	e=5
1. Alcohol 1.312	1. Alcohol 2.845	1. Alcohol 5.726
2. F & P 1.209	2. Services 2.305	2. Services 5.169
3. Other G 1.007	3. F & P 2.135	3. T & E 3.838
4. Services 0.980	4. Other G 2.037	4. Other G 3.824
5. Food 0.807	5. T & E 1.760	5. F & P 3.438
6. T & E 0.777	6. Petrol 1.600	6. Petrol 3.373
7. Petrol 0.732	7. Food 1.505	7. Food 2.587
8. C & F 0.440	8. C & F 0.985	8. C & F 2.085
9. Tobacco -0.218	9. Tobacco -0.381	9. Tobacco -0.619
10. Durables-0.432	10. Durables-0.947	10. Durables-1.929

CAIDS12

e=0	e=2	e=5
1. Alcohol 1.152	1. Alcohol 2.498	1. Services 5.106
2. Other G 1.068	2. Services 2.277	2. Alcohol 5.029
3. Services 0.968	3. Other G 2.160	3. Other G 4.055
4. F & P 0.922	4. Petrol 1.879	4. Petrol 3.962
5. Petrol 0.860	5. T & E 1.748	5. T & E 3.811
6. Food 0.819	6. F & P 1.628	6. Food 2.625
7. T & E 0.772	7. Food 1.528	7. F & P 2.623
8. C & F 0.499	8. C & F 1.118	8. C & F 2.366
9. Tobacco -0.048	9. Tobacco -0.084	9. Tobacco -0.136
10. Durables-0.214	10. Durables-0.469	10. Durables-0.955

Table A4 (contd.)

CAIDS21

e=0		e=2		e=5	
1. Alcohol	2.770	1. Alcohol	6.007	1. Alcohol	12.090
2. C & F	1.249	2. C & F	2.798	2. C & F	5.921
3. Services	0.979	3. Services	2.302	3. Services	5.164
4. F & P	0.964	4. F & P	1.703	4. F & P	2.743
5. Food	0.745	5. Food	1.391	5. Food	2.390
6. Other G	0.444	6. Other G	0.899	6. T & E	1.900
7. Durables	0.402	7. Durables	0.881	7. Durables	1.795
8. T & E	0.385	8. T & E	0.871	8. Petrol	1.748
9. Petrol	0.379	9. Petrol	0.829	9. Other G	1.687
10. Tobacco	-0.104	10. Tobacco	-0.181	10. Tobacco	-0.295

CAIDS22

e=0		e=2		e=5	
1. Other G	1.131	1. Other G	2.288	1. Services	4.967
2. Alcohol	0.943	2. Services	2.215	2. Other G	4.297
3. Services	0.942	3. Alcohol	2.045	3. Alcohol	4.117
4. F & P	0.912	4. Petrol	1.786	4. Petrol	3.767
5. Food	0.877	5. T & E	1.666	5. T & E	3.632
6. Petrol	0.817	6. Food	1.637	6. Food	2.813
7. T & E	0.736	7. F & P	1.611	7. F & P	2.595
8. C & F	0.479	8. C & F	1.074	8. C & F	2.274
9. Tobacco	0.245	9. Durables	0.522	9. Durables	1.063
10. Durables	0.238	10. Tobacco	0.429	10. Tobacco	0.697

Table A5: Rank Correlation Coefficients

AIDS1	1.000					
AIDS2	0.770	1.000				
CAIDS11	0.927	0.600	1.000			
CAIDS12	0.879	0.491	0.927	1.000		
CAIDS21	0.806	0.964	0.588	0.515	1.000	
CAIDS22	0.867	0.467	0.927	0.976	0.503	1.000
	AIDS1	AIDS2	CAIDS11	CAIDS12	CAIDS21	CAIDS22

TABLE A6: Correlation Coefficients

AIDS1	1.000					
AIDS2	0.728	1.000				
CAIDS11	0.900	0.433	1.000			
CAIDS12	0.859	0.453	0.919	1.000		
CAIDS21	0.620	0.924	0.329	0.287	1.000	
CAIDS22	0.678	0.250	0.869	0.897	0.140	1.000
	AIDS1	AIDS2	CAIDS11	CAIDS12	CAIDS21	CAIDS22

AIDS1: Unrestricted AIDS.

AIDS2: AIDS with homogeneity imposed

CAIDS11: Unrestricted AIDS conditioned on EMPTOT

CAIDS12: Unrestricted AIDS conditioned on EMP

CAIDS21: AIDS with homogeneity imposed conditioned on EMPTOT

CAIDS22: AIDS with homogeneity imposed conditioned on EMP.

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