MEASURING THE MARGINAL EFFICIENCY COST OF REDISTRIBUTION IN THE UK

Stuart Adam

THE INSTITUTE FOR FISCAL STUDIES
WP05/14

Measuring the Marginal Efficiency Cost of Redistribution in the UK

Stuart Adam*

Institute for Fiscal Studies

July 2005

Abstract

This paper estimates the marginal efficiency cost of redistribution (MECR) associated with a demogrant and an in-work benefit for the UK since 1979, taking account of extensive as well as intensive labour supply responses. The principal methodological advance in the paper is its greater allowance for heterogeneity in the population than previous work. The rate of tax on consumption expenditure is allowed to vary across households and overall tax rates are allowed to vary across all individuals in all years, using a microsimulation methodology for the calculations. This disaggregation makes a substantial difference to the results.

The central finding of the paper is that the MECR is much lower for the in-work benefit policy than the demogrant. The efficiency loss associated with a marginal in-work benefit has consistently been low (and occasionally negative): even at its current 25-year high, the policy would cost losers only £1.30 per pound that the gainers gained. By contrast, losers from a demogrant would currently lose £4.30 per pound that gainers received, higher than at other times over the last 15 years but still well short of the peak of £8.02 seen in 1981. Although precise estimates are highly sensitive to the overall levels of tax rates and elasticities, and also to the composition of the overall labour supply elasticity, the principal finding of a stark contrast between the two policies is robust.

The paper also examines the effect of redistribution within family types. The in-work benefit policy looks even more favourable if paid to (and financed by) only singles; it looks less favourable if implemented only for childless couples. Increasing in-work benefits and/or cutting tax rates for lone parents have provided opportunities for Pareto-improving reforms to the tax and benefit system for most of the period since 1979.

Keywords: Redistribution, efficiency, optimal taxation, labour supply, extensive margin, tax rates.
JEL Classification: H21, H23, D61, D63, H31.

---

* Address for correspondence: Institute for Fiscal Studies, 7 Ridgmount Street, London, WC1E 7AE, UK. Email: stuart.adam@ifs.org.uk. Financial support from the ESRC Centre for the Microeconomic Analysis of Public Policy (CPP) at the IFS is gratefully acknowledged. The author would like to thank Richard Blundell and Mike Brewer for helpful advice and comments. All remaining errors and omissions are the responsibility of the author.

Contents

1. Introduction

Optimal income tax theory provides the classic framework economists use to think about how best to manage the trade-off between income inequality and economic efficiency. The marginal efficiency cost of redistribution (MECR) provides a measure of this trade-off for particular policies that does not require prior assumptions on social preferences, and which policy-makers can therefore compare against their own priorities when evaluating policy reforms.

Mirrlees' (1971) seminal paper on optimal income taxation allowed only for labour supply responses that took the form of smooth changes in hours. Since then, the empirical labour economics literature has increasingly emphasised the importance of discrete labour supply responses. Reflecting this, Saez (2002) extended optimal income tax theory to include both intensive and extensive margins of labour supply. Immervol et al (2004) showed how measurement of the MECR could take both margins into account and estimated the MECRs associated with a demogrant and an in-work benefit for 14 European countries for 1998.

In this paper, I take Immervol et al's (2004) analysis further for the UK, showing how allowing for a greater degree of heterogeneity in the tax rates facing the population can affect the results, and estimating how the MECRs associated with a demogrant and an in-work benefit have changed since 1979. I also show how the relative efficiency cost of the two policies differs between family types.

The layout of the paper is as follows. Section 2.1 briefly reviews the relevant existing literature. Section 2.2 and Section 2.3 set out and discuss the behavioural model I use and the calculation of the MECR for the two policies under consideration. Section 2.4 discusses the implications of heterogeneity in earnings, tax rates and elasticities, and lays out a strategy to deal with it. Section 3 describes the data used for estimation; Sections 4 and 5 respectively deal with the calculation of tax rates and the choice of assumed elasticities. Results are presented in Section 6, and their implications are discussed in Section 7 along with possible directions for future research. Section 8 concludes.

2. The model

2.1 Background

Economists have long recognised that redistributing income from rich to poor entails a trade-off between equality of income and economic efficiency. If redistribution is based directly on income, the withdrawal of benefits and imposition of taxes must at some point in the income distribution reduce the incentive to increase that income. For the last 30 years, the dominant framework among economists for thinking about the management of this trade-off has been optimal income tax theory, initiated in its modern form by Mirrlees (1971).

Mirrlees' seminal paper set out the relevant parameters, and the relationship between them, for designing a tax (and benefit) schedule that optimized the trade-off between equality and redistribution given a set of social preferences and certain other assumptions. Numerous papers followed, calibrating the optimal tax schedule for particular sets of parameters or altering the assumptions under which it operated (see Tuomala, 1990, for examples of both and a review of previous work).

All of these papers, however, required assuming a set of social preferences (typically utilitarian or Rawlsian). Browning and Johnson (1984) adopted a different approach: rather than calculating a tax schedule that optimized the equality-efficiency trade-off for a particular social welfare function, they formulated a measure of the trade-off associated with marginal reforms to the tax schedule (the marginal efficiency cost of redistribution [MECR]), against which policy-makers could measure their social preferences. Others (Ballard, 1988; Triest, 1994; Browning, 1995) followed.

However, these papers followed Mirrlees in allowing for labour supply to adjust only along the intensive margin (hours of work). Over the 1980s and 1990s, an increasing body of empirical work emphasised the importance of discontinuous participation responses (eg Cogan, 1981; MaCurdy et al, 1990). This became particularly important for the optimal taxation literature because over this period both the UK and the US greatly expanded their programmes of in-work support: these involved negative marginal tax rates, which were sub-optimal in the

Mirrlees model but not in Diamond's (1980) model of optimal income tax model with only extensive (participation) responses.

Saez's (2002) important paper integrated the Mirrlees (1971) and Diamond (1980) models, deriving an optimal taxation model with both intensive and extensive labour supply responses. In Saez's model, the merits of negative marginal tax rates depend on the importance of the extensive margin.[1] [2] Immervol et al (2004) did for this what Browning and Johnson (1984) did for the Mirrlees model: remove the need for an assumed social welfare function by estimating the MECR instead. Immervol et al (2004) estimated the MECR associated with a demogrant policy and an in-work benefit policy in 1998 for 14 European countries. Prior to this, Liebman (2002) had already incorporated an extensive margin in his analysis of the US Earned Income Tax Credit (accordingly generating a much more favourable view of it than Browning, 1995), but in a much less transparent way; Liebman also considered only large hypothetical reforms to the EITC, with rather narrower implications than a comparison of marginal reforms.

The framework within which I operate is that of Immervol et al (2004) (henceforth IKKS). It is ideally suited to the purpose of examining the equality-efficiency trade-off for marginal reforms which explicitly contrasts the intensive and extensive margins.[3]

2.2 The model

A key focus of this paper is the explicit modelling of an extensive margin of labour supply. Empirically, the distribution of working hours is not continuous: very few people work only 1 or 2 hours per week as we would expect if only the intensive margin were relevant. Accordingly, much of the policy debate is framed in terms of participation and unemployment rather than hours of work.

[1] Choné and Laroque (2001) present a model with only extensive responses, but allowing for a greater degree of heterogeneity than either Diamond (1980) or Saez (2002).
[2] The possible optimality of negative marginal rates remains controversial, however: see Homburg (2002).
[3] I deliberately set out the model in a similar way to IKKS, adopting the notation and much of the terminology of that paper for transparency and ease of comparison.

There are several ways in which an extensive margin could arise: for example, it could reflect a fixed cost employers face in employing someone, or non-workers' being off their labour supply curves. This paper follows most of the literature since Cogan (1981) in introducing the extensive margin via a fixed cost of working that the individual faces, denoted q. q may represent, amongst other things, the time and money needed to travel to work; the cost of buying an appropriate uniform/outfit; childcare costs;[4] pure (dis)taste for participation; or stigma associated with being out of work. It can perfectly well be negative in this model (people for whom stigma is especially important, for example), but it is probably not for most people as we would then expect to observe substantial bunching at one hour per week, which we do not.

The IKKS model assumes that the population can be divided into J distinct groups with N_j individuals in group j. Within each group, individuals differ only in their fixed cost of work q: they are assumed to have identical variable costs of work and productivities (which are exogenous); a competitive labour market is assumed so that identical productivities equate to identical wage rates w_j. Variable costs of work and productivities are allowed to vary across groups.

Individuals' utility takes the form

$$u_j(c,l,q) = c - v_j(l) - q \cdot 1(l > 0) \tag{1}$$

where c is family consumption, $1(\cdot)$ is the indicator function and $v_j(l)$ is the variable cost of working l hours, normalized so that $v_j(0) = 0$. Analogous to the fixed cost of working, $v_j(l)$ incorporates any cost that varies with hours worked, including the variable element of childcare costs, for example, as well as the pure disutility of working extra hours and having less leisure.

[4] Childcare costs frequently consume a very large share of earnings for families with all adults working, so it is worth taking some care as to how they are incorporated. They are likely to take neither a simple fixed cost nor a simple hourly rate form. Childcare might be available at an hourly rate, and even if not the cost could vary with hours or quality if childcare is available from different providers. On the other hand, such choices may be limited, or there may be associated fixed costs such as transporting the child(ren) to and from the provider. The prevalence of informal provision adds a further layer of complication since the cost, monetary or in terms of an implicit promise to reciprocate the favour, may or may not vary with the number of hours used. In any case, q incorporates only the fixed element; variable elements are incorporated in the variable costs of work, discussed below.

The quasilinear form of utility implies that there are no income effects. This is a strong assumption; however, since I consider only revenue-neutral reforms, the assumption is a problem only to the extent that true income effects are heterogeneous across groups affected differently by the reforms.

A word is in order on what equation (1) means for the treatment of couples. Individual utility is given as a function of family consumption, so income is fully pooled, a public good within the family; but only individual hours enter the variable cost of work: the value of an individual's leisure is assumed to be independent of the leisure of any partner. A feature of this model is that an individual's response to a reform takes no account of any response his/her partner may have. This can be embodied in an explicit assumption that each takes the other's labour supply behaviour as given; alternatively, a weaker assumption that q, like $v_j(l)$, is independent of the partner's labour supply behaviour is sufficient (along with the assumption of no income effects) to generate this feature. In any case, however, the assumptions that family income is completely pooled and that labour supply decisions are taken without reference to other family members seem individually rather implausible and certainly sit uneasily together. Bringing the burgeoning economic literature on modelling family decision-making to bear on this and similar models would be a fruitful avenue for future research.

Finally, note that utility is entirely independent of the incomes and labour supply behaviour of members of other households: there is no envy or guilt, no benchmarking one's own expectations against acquaintances' circumstances or societal norms.

Individuals face a non-linear tax and benefit schedule $T(w_j l, z)$, where z is an abstract shift parameter we use for analyzing tax reforms; thus $T(0, z)$ will usually be negative and defines the welfare benefit for non-workers. This characterization of the tax and benefit system is far from innocuous: it implies

that taxes and benefits depend only on individual earnings, independent of family structure, the earnings of any partner, non-labour income etc. [5]

The assumption of identical productivities and variable costs of work within groups ensures that all individuals in a group will work the same hours l_j conditional on participation, namely that which equates the net-of-tax wage rate to the marginal cost of work. They will therefore have the same net earnings, $w_j l_j - T(w_j l_j, z)$, if in work. This is a static model, so there is no saving and consumption equals net income. The difference between in-work consumption c_j and out-of-work consumption c_0, ie the net financial gain to work, is given by net earnings less out-of-work benefits, ie

$$c_j - c_0 = w_j l_j - T(w_j l_j, z) + T(0, z). \tag{2}$$

Since all individuals in a group have the same earnings if working, all face the same effective marginal tax rate if working, defined as

$$\tau_j \equiv \frac{\partial T(w_j l_j, z)}{\partial w_j l_j}, \tag{3}$$

and the same participation tax rate, defined as

$$a_j \equiv \frac{T(w_j l_j, z) - T(0, z)}{w_j l_j} \equiv 1 - \frac{c_j - c_0}{w_j l_j}. \tag{4}$$

The participation tax rate for group *j* is thus the proportion of earnings that is lost in tax and forgone benefits when an individual in that group starts work at l_j hours. While I use the terminology 'marginal tax rate' and 'participation tax rate' for brevity, it is important to remember throughout that these describe the work incentives induced by the whole tax and benefit system: particularly at the lower end of the income distribution, benefit withdrawal is frequently the largest component of these tax rates.

Individuals will choose to work if the utility from working exceeds that from not working, ie if their gain to work exceeds the fixed plus variable costs of working.

[5] An alternative assumption that all other characteristics upon which the tax and benefit schedule depends are constant within groups is sufficient to yield the key result of a constant in-work marginal rate and participation tax rate within each group.

Since all individuals in a group have the same gain to work and the same variable cost of working, we can define for each group a threshold value of the fixed cost,

$$q_j \equiv c_j - c_0 - v_j(l_j). \tag{5}$$

All individuals with a fixed cost below the threshold value for their group will work l_j hours, all with fixed costs above q_j will choose not to work. Denoting by $F_j(q)$ and $f_j(q)$ respectively the distribution and density functions of q, we can see that $F_j(q_j) = \int_0^{q_j} f_j(q)dq$ gives the employment rate for group j.

The extensive (participation) elasticity of labour supply for group j is defined as the percentage change in the number of workers in group j following a 1 percent change in the gain to work $c_j - c_0$:

$$\eta_j \equiv \frac{c_j - c_0}{F_j(q_j)} \frac{\partial F_j(q_j)}{\partial (c_j - c_0)} \equiv (c_j - c_0) \frac{f_j(q_j)}{F_j(q_j)} \tag{6}$$

The intensive (hours) elasticity of labour supply for each group is defined as

$$\varepsilon_j \equiv \frac{(1-\tau_j)w_j}{l_j} \frac{\partial l_j}{\partial (1-\tau_j)w_j}. \tag{7}$$

The absence of income effects means there is no distinction between compensated and uncompensated elasticities.

2.3 The marginal efficiency cost of redistribution

The general case

This paper explores the trade-off between economic efficiency and income redistribution in the model set out above. The focus of the paper is on the key parameters affecting this trade-off rather than on the realism of the reforms considered. To that end, I keep the analysis simple by considering only revenue-neutral marginal reforms. In this section I consider the general case of an arbitrary revenue-neutral marginal reform. The following two subsections look at the specific examples to be considered: lump-sum redistribution of the proceeds of a uniform increase in marginal tax rates, either to the whole population or just to those in work. These two reforms are simple, but capture the key features of a

central policy debate: the choice between providing additional support to all those with low incomes or just to low-income workers. Examining this choice by explicitly distinguishing between intensive and extensive labour supply responses is the key contribution of Saez (2002) and IKKS, and this paper attempts to refine and then build on their analyses.

The trade-off measure used is that of Browning and Johnson (1984). I divide the population into individuals who gain from the reform and those who lose; the trade-off measure Ψ is simply the ratio of the aggregate loss of the losers to the aggregate gain of the gainers. The identity of these gainers and losers is, of course, endogenous to the reform. I refer to this measure as the marginal efficiency cost of redistribution (MECR), although Ballard's (1988) original use of the term is in fact equal to $\Psi - 1$.[6]

One simplification that arises from analysing marginal reforms is that the (second-order) welfare effects of behavioural responses can be ignored, by application of the envelope theorem. There is thus no need to distinguish between monetary gains and losses and welfare gains and losses. Defining $T_j \equiv T(w_j l_j, z)$ and $T_0 \equiv T(0, z)$ to simplify notation, IKKS show that the effect of a marginal reform *dz* on an individual's utility is simply the mechanical change in the transfer payment resulting from the reform,

$$\frac{du}{dz} = \begin{cases} -\partial T_j / \partial z & q \le q_j \\ -\partial T_0 / \partial z & q > q_j \end{cases}, \tag{8}$$

except for those who start or stop working in response to the reform, whose change in utility is the difference in utilities between the two states. IKKS state that, because the marginal worker is indifferent towards working and the group of movers is infinitesimally small, this group can be ignored in calculating the

[6] As Browning and Johnson (1984) point out, the MECR is closely related to Okun's (1975) concept of 'leakage'. Okun likened income redistribution to transferring money using a leaky bucket. The proportion of cost to rich that leaks out during transfer process is one minus the reciprocal of Ψ. Of course, how much leakage one would accept depends on the identity of the gainers and losers as well as social preferences, and Okun gave examples in which he specified the leakage he would be willing to accept for redistribution between particular sets of gainers and losers.

MECR. The key insight is that the first-order effects of labour supply responses, whether intensive or extensive, are on revenue and not directly on welfare.

Using equation (8), IKKS state that the MECR for a general revenue-neutral reform is given by

$$\Psi = -\frac{\sum_{j \notin G} \frac{\partial T_j}{\partial z} E_j}{\sum_{j \in G} \frac{\partial T_j}{\partial z} E_j + \frac{\partial T_0}{\partial z}(N - E)} \tag{9}$$

where G is the set of groups for which employed individuals gain from the reform. The numerator gives the aggregate losses of those groups that lose from the reform, and the denominator gives the aggregate gains of the groups that gain, which can include the welfare gains of non-workers since we examine no reforms in which non-workers lose.

Demogrant

The first policy I consider is an infinitesimal increase τ in all marginal tax rates used to finance a universal lump-sum benefit *TR*: in other words, a revenue-neutral Negative Income Tax of infinitesimal size bolted on to the existing tax and benefit system. Following the literature, I refer to this as a demogrant policy. The policy is formally defined by

$$\frac{\partial \tau_j}{\partial z} = \tau, \quad \frac{\partial T_j}{\partial z} = \tau w_j l_j - TR, \quad \frac{\partial T_0}{\partial z} = -TR. \tag{10}$$

IKKS show that the deadweight cost of the reform (as a proportion of τ) – the deadweight cost of a marginal increase in tax rates, since in this model with no income effects a flat-rate distribution of the proceeds will have no behavioural effect – is given by

$$D_d = \sum_{j=1}^{J} \left(\frac{\tau_j}{1-\tau_j} \varepsilon_j + \frac{a_j}{1-a_j} \eta_j \right) s_j, \tag{11}$$

where $s_j \equiv w_j l_j E_j / \left(\sum_{j=1}^{J} w_j l_j E_j \right)$ is group j's share of aggregate labour income.

As well as being critical in determining the MECR, the deadweight loss rate D is interesting in itself. Many economists will be more familiar with the concept of deadweight loss than with the MECR, and it has the advantage that it does not depend on identifying endogenous winners and losers. However, D is purely a measure of the efficiency cost of the reform: it says nothing about its redistributive impact, so it does not suffice for present purposes. As IKKS imply, τD is the *difference* between the aggregate loss of the losers and the gain of gainers, while Ψ is the *ratio* between them. Thus for a progressive reform, a given level of deadweight loss will be associated with a lower MECR if the reform achieves a greater degree of redistribution. In Section 6 I report values of both D and Ψ for my baseline case.

D_d could in principle be negative, if tax rates were below zero or above 100% for groups with sufficiently high income shares and elasticities, but this possibility is rather far-fetched and I exclude it from further consideration. More interestingly, D_d could be greater than unity. This is quite feasible and would mean that existing tax rates exceeded the revenue-maximising level (Laffer bound), so that the government would actually lose money by raising them further. I ignore this possibility for now (in particular, equation (14) will be ill-defined for this case since there are no gainers from the reform and the denominator on the right-hand side is zero) but Section 6 and Appendix A present cases which fall into this category, and the implications of this are discussed in Section 7.

The revenue to be distributed is the fraction of 'mechanical' revenue (the increment in marginal rates times aggregate labour income) not lost due to behavioural response, ie

$$TR \cdot N = (1 - D_d) \cdot \tau \sum_{j=1}^{J} w_j l_j E_j \tag{12}$$

Substituting into equation (8) and simplifying, we see that the gainers from the policy are those not working and those groups for whom

$$w_j l_j < (1 - D_d) \frac{\sum_{j=1}^{J} w_j l_j}{N}. \tag{13}$$

Using equations (10), (11) and (12), IKKS rewrite (9) for this policy as

$$\Psi_d = 1 + \frac{D_d}{p_g(1-D_d) - s_g} \tag{14}$$

where $p_g \equiv \left(\sum_{j \in G} E_j + N - E\right)/N$ is the population share, and $s_g \equiv \sum_{j \in G} s_j$ the wage share, of those gaining from the reform.

In-work benefit

The second policy under consideration is again an increase in all marginal tax rates, but this time with the proceeds distributed (lump-sum) only to workers, leaving out-of-work income unchanged. This is referred to as the in-work benefit policy.

The policy is formally defined by

$$\frac{\partial \tau_j}{\partial z} = \tau, \quad \frac{\partial T_j}{\partial z} = \tau w_j l_j - TR, \quad \frac{\partial T_0}{\partial z} = 0. \tag{15}$$

The deadweight cost of raising the revenue is D_d as for the demogrant policy, but the in-work benefit will also induce a positive participation response, giving rise to an offsetting deadweight gain. IKKS derive the overall deadweight loss from the policy, D_w, as

$$1 - D_w = \frac{1 - D_d}{1 - \sum_{j=1}^{J} \frac{a_j}{1-a_j} \eta_j e_j} \tag{16}$$

where $e_j \equiv E_j / E$ is the proportion of workers who are in group j. The denominator here reflects the positive participation response to the reform, and D_w may be positive or negative according to whether the deadweight gain from this participation response outweighs the deadweight loss from raising the revenue. There are now two circumstances in which D_w can be greater than one and hence the MECR can be undefined in equation (19) below. The first is if $D_d > 1$: this is the case discussed above of tax rates above the Laffer bound, in which case there is no revenue raised with which to pay for the in-work benefit

and so no gainers and no trade-off. The second case is if $\sum_{j=1}^{J} \frac{a_j}{1-a_j} \eta_j e_j > 1$ so that the denominator of (16) is negative: this is the case in which a lump-sum payment to those in work actually *raises* money for the government because it induces so many people to enter work that the additional tax revenues and saved out-of-work benefits for entrants outweighs the cost of paying the in-work benefit to existing workers. In that case the reform cannot be made revenue-neutral, the size of the benefit is indeterminate and we cannot define a trade-off between gains and losses.[7] In principle, the numerator and denominator in (16) could both be negative at the same time, generating a value of D_w less than one and a well-behaved MECR. This is the highly perverse case of a revenue-raising in-work benefit being used to pay for a revenue-reducing rise in tax rates.

The revenue to be distributed is

$$TR \cdot E = (1 - D_w) \cdot \tau \sum_{j=1}^{J} w_j l_j E_j. \tag{17}$$

Gainers are those groups in work for whom

$$w_j l_j < (1 - D_w) \frac{\sum_{j=1}^{J} w_j l_j}{E}. \tag{18}$$

and IKKS show that the MECR is given by

$$\Psi_w = 1 + \frac{D_w}{e_g (1 - D_w) - s_g} \tag{19}$$

where $e_g \equiv \sum_{j \in G} e_j$ is the share of employed people gaining from the reform.[8]

[7] The fact that this is a *marginal* reform analysis is relevant here. A large enough in-work benefit will always cost money since, as the benefit raises employment rates towards 100%, the extensive elasticity of labour supply will tend towards zero, and further payments will generate no additional participation response and so no deadweight gain.

[8] S_g, the earnings share of those gaining from the reform, will of course take a different value here from in equation (14) since the set of gainers from the two reforms is different.

Redistribution within demographic groups

The analysis above need not apply to the whole population. It is equally applicable to a lump-sum payment to all individuals (or all working individuals) in any subsection of the population, financed by a tax increase for the same subsection. The majority of the results I present are for the whole population (subject to some exclusions detailed in the next two Sections), but I also analyse the two reforms introduced within each of four broad family types: singles and couples, with and without children.

One reason for looking at reforms within particular groups is that it allows sceptical readers to focus on an analysis for which the rather implausible model of couples' behaviour presented above does not need to be assumed. More fundamentally, it can give pointers as to whether the relative merits of a demogrant and an in-work benefit vary between family types, and whether more redistribution might reasonably be achieved within family types without redistributing between family types and thereby having to enter the choppy waters of utility comparisons between different family structures. Given a particular level of redistribution between family types, the optimal tax schedule might have very different shapes for different demographic groups.[9] For example, it might well be optimal to have higher in-work benefits for groups with higher extensive elasticities (notably those with higher fixed costs, such as parents). Similarly, tilting the existing budget constraint might be more efficient (or less inefficient) for some groups than others. In-work support in the UK has always been provided exclusively or primarily for couples and those with children, possibly for the very reason just mentioned. This exercise can be informative as to the merits of increasing or reducing this differential treatment – whether one groups would be better served by an increase in in-work benefits and another by a demogrant – while financing the reform within the group so as not to change the governments' chosen degree of redistribution between family types.

[9] An implication of Kremer (1997) is that, if group membership is exogenous, the optimal tax problem should be solved independently for each group, once an allocation between groups is decided on the basis of the groups' abilities/incomes (and needs or anything else that affects groups' social welfare weights).

2.4 Choice of groups and the role of disaggregation

This model assumes that all individuals in a group are identical except for their fixed cost of work, with the same earnings in work, labour supply elasticities and marginal and participation tax rates. The plausibility of any empirical results potentially rests on the plausibility of this assumption, and it is therefore important to ensure that results are not severely distorted by aggregating the population into excessively large groups. IKKS divide the population into 100 groups defined by pairs of (a) decile groups of gross individual earnings and (b) ten demographic types: singles, lone parents, childless men with working partners, childless men with non-working partners, fathers with working partners, fathers with non-working partners, childless women with working partners, childless women with non-working partners, mothers with working partners, and mothers with non-working partners. Disaggregating earnings, elasticities and tax rates into 100 groups allows for more variation across the population than most previous work, and IKKS argue that it adequately captures observed heterogeneity and that further disaggregation is therefore unnecessary.

However, even this level of aggregation may be excessive. Inspection of equation (11), reproduced here for easy viewing, reveals the effect on estimated deadweight loss of aggregating small (homogeneous) groups into larger (heterogeneous) groups and using average values of their earnings, tax rates and elasticities for the whole group.

$$D_d = \sum_{j=1}^{J} \left(\frac{\tau_j}{1-\tau_j} \varepsilon_j + \frac{a_j}{1-a_j} \eta_j \right) s_j ,$$

Using averaged elasticities or earnings will be benign if and only if they are uncorrelated with each other and with tax rates; otherwise D_d will be underestimated if the correlation is positive, overestimated if the correlation is negative. (Only correlations within the heterogeneous group are relevant, of course.) Using averaged tax rates, however, will lead to a systematic downward bias in estimates of D_d even if the tax rates are uncorrelated with other

characteristics, since D_d is nonlinear in τ_j and a_j.[10] This is a simple application of Jensen's inequality, but seems to have gone largely unnoticed in the literature to date despite its potentially far-reaching consequences.[11]

Clearly, then, it is worth taking pains to disaggregate the data as far as possible, and in particular to disaggregate tax rates as far as possible since ignoring any degree of heterogeneity in tax rates will result in systematically underestimating the marginal efficiency cost of taxation. In this paper I therefore use individual-level disaggregation of earnings and elasticities, with each group *j* containing a single worker. I do assume that elasticities are constant within each of IKKS's 100 groups – the use of individual-level elasticities would require estimating a full labour supply model, an exercise left for future research – but wage rates, hours of work and tax rates are allowed to vary and be correlated freely between individuals. Allowing for heterogeneity in this way is one of the major innovations introduced in this paper; how much difference it makes to the final results is an empirical question I address in Section 6.

[10] Similar problems accompany the estimation of D_w, but the direction of bias is ambiguous. Estimation of the trade-off measures Ψ_d and Ψ_w will be further bedevilled by averaging earnings within groups, which (along with the averaging of tax rates) will lead to errors in dividing the population into gainers and losers, although it is more difficult to ascertain the direction of the resulting biases in this case.

[11] See Fullerton and Gan (2003), however, for a similar point.

3. Data

The data used is drawn from the Family Expenditure Survey (FES) 1979-2000, and its successor the Expenditure and Food Survey (EFS) 2001. These are annual cross-sectional surveys of around 7,000 broadly representative UK households, which provide detailed micro-data on many individual and household characteristics, including individual income and household expenditure data. Grossing factors supplied with the data are used to make the sample representative of the UK population as a whole. Details of the FES and the EFS can be found in ONS (2001b) and ONS (2002) respectively.[12]

In order to produce estimates that are as up-to-date as possible, I uprate the 2001 EFS data to simulate data for the last three years, 2002-04. This is done by uprating monetary income and expenditure variables in line with changes in appropriate indices: earnings in line with the average earnings index, rents in line with the rent sub-index of the retail prices index (RPI) and so on. This procedure is fairly crude, neglecting any changes in income inequality as well as any changes in the demographic makeup of the population, but should be a reasonable approximation.

The sample used in this paper excludes a number of groups because their labour supply behaviour is likely to be very different from that of the rest of the population (or because their tax and benefit position is difficult to model). The excluded groups are: those aged under 19, those aged over 55, students, those with a self-employed individual in the family, those receiving a disability benefit, and those who report positive hours worked but no earnings. This is not merely a technical convenience: it means that the policy reforms analysed must be thought of as applying only to individuals who do not fall into these categories, and conclusions might be affected by this. The estimated trade-off between equality and efficiency applies to a reform covering the whole population only insofar as those excluded have characteristics and behaviour similar to that of the used

[12] The FES operated on a calendar-year basis before 1994 and a financial-year basis thereafter. All results given by year therefore refer to calendar years up to and including 1993 and financial years thereafter.

sample. The exclusion of older workers is of particular significance here, since they are a large group with special issues pertaining to their labour supply, and making policy without reference to the effect on this group is not a sensible or practical option.

The nature of the model is that only the number of non-workers, not their demographic characteristics or incomes, is used directly in the model. All their characteristics (including, importantly, their counterfactual wage distribution) are instead implicit in the extensive elasticities used. The employed sample consists of 128,626 observations in total, 112,099 excluding the simulated 2002-04 data. Employment rates by demographic type and sample sizes for each of IKKS's 100 groups are shown in Table 1.[13]

[13] This and all other Tables are contained in Appendix C.

4. Calculating tax rates

A vital part of the analysis in this paper is the calculation of marginal and participation tax rates for each working individual in the sample. This is done using the Institute for Fiscal Studies' tax and benefit microsimulation model, TAXBEN.[14] Microsimulation allows us to capture all the rich variation in individual circumstances we observe and all the complex interactions that occur between different parts of the tax and benefit system. Most of the literature to date has used highly simplified and stylized approximations to the relevant tax and benefit systems. IKKS's use of the EUROMOD model was a substantial improvement on this. But EUROMOD is necessarily less detailed than TAXBEN, since it is designed for comparative research across many countries. In addition to this, the treatment of consumption taxes (see below) and the disaggregation to individual level means that the estimation technique employed here represents a further increase in sophistication. As mentioned in Section 2.4, accurate calculation at this level of disaggregation may be essential for accurate analysis.[15]

This is not the place to describe the structure of the UK tax and benefit system for the past 25 years.[16] The methodology for calculating marginal and participation tax rates and some limitations of the tax and benefit modelling are detailed in Appendix B. Here, I focus on the main innovation in my methodology.

Consumption tax rates

Taxes on consumption expenditure make up more than a third of the overall tax wedge on labour supply, yet their treatment in the literature on tax reform evaluation has been remarkably cursory. Spending on different goods and

[14] TAXBEN is described in Giles and McCrae (1995).
[15] Indeed, in a sense even a separate calculation for each individual in the sample is an inadequate level of disaggregation, in that the use of grossing factors to 'replicate' each person in the sample understates the true degree of heterogeneity in the population. But in the absence of a rich survey of the whole UK population, little can be done to remedy this.
[16] For descriptions of the UK tax and benefit systems and brief overviews of their evolution, see Adam (2004) and Crawford and Shaw (2004) for taxes and benefits respectively. The main rates and thresholds in the tax and benefit system since 1979 can be found at www.ifs.org.uk/fiscalfacts.php.

services are taxed at different rates. Ideally, we would like to measure the tax rate that applies to spending out of marginal income (for the marginal tax rate) or out of the additional income from working (for the participation tax rate). Unfortunately, the requisite information on marginal spending patterns is not observable. IKKS therefore using a single rate calculated from national accounts aggregates, following the methodology of Mendoza et al (1994). Browning (1995) performs a similar but even simpler exercise, taking the consumption tax rate as the ratio of total sales and excise tax revenues to net national product.

My analysis uses a different methodology. Each household in the FES and EFS keeps a two-week diary containing detailed information on household spending. This allows us to calculate the average tax rate that applies to each household's actual spending, and I then use these as family-specific consumption tax rates (assuming this rate is shared by all families in multi-family households).

This methodology has two major advantages over the use of national accounts aggregates. First and foremost, it captures the observed heterogeneity in household spending patterns. As discussed in Section 2.4, the nonlinearity of deadweight cost with respect to tax rates means that even 'benign' variation in tax rates (orthogonal to other characteristics) can have an effect on the MECR; variation that is correlated with income and labour supply elasticities will have an even bigger effect, and is likely in practice since spending patterns vary with income and family type. Second, it restricts attention to the household sector. IKKS, for example, include spending by non-profit institutions and government non-wage outlays, while Browning (1995) looks at the whole economy; looking directly at household consumption spending allows us to focus more precisely on the wedge between family income and purchasing power.

The measure is far from perfect. What is in fact calculated is each household's average consumption tax rate, not their marginal consumption tax rate or consumption tax rate on participation. Treating all these as equal is akin to making the assumption that preferences are homothetic over the relevant margin[17]. The assumption is in fact slightly weaker than homotheticity, since it

[17] Homotheticity also ensures that the elasticities used in this paper, which are calculated with respect to income net of consumption taxes, are the same as those in the literature calculated with respect to income gross of consumption taxes.

need not be the case that the household buys the same goods in the same proportions when its income changes, only that the additional goods are taxed at the same rate, on average, as existing spending. The assumption nevertheless looks rather dubious; but the same implicit assumption is made on a national level if a national-accounts-aggregates methodology is used, and little alternative is available.

Average estimated consumption tax rates in each year are shown in Figure 1. They have increased over time as the UK has shifted gradually from direct to indirect taxation. As the Figure shows, my methodology yields a slightly higher estimate of the average consumption tax rate than IKKS's. Table 2 shows the mean and standard deviation of consumption tax rates, averaged over all years, for each of IKKS's 100 groups. Table 3 and Table 4, similarly, show the variation between groups in overall marginal and participation tax rates respectively. The standard deviations shown, which are substantial, reflect a combination of variation over time and heterogeneity within groups in each year; to the extent that they reflect the latter, they demonstrate the importance of the individual-level disaggregation I pursue.

Figure 1. Mean consumption tax rates

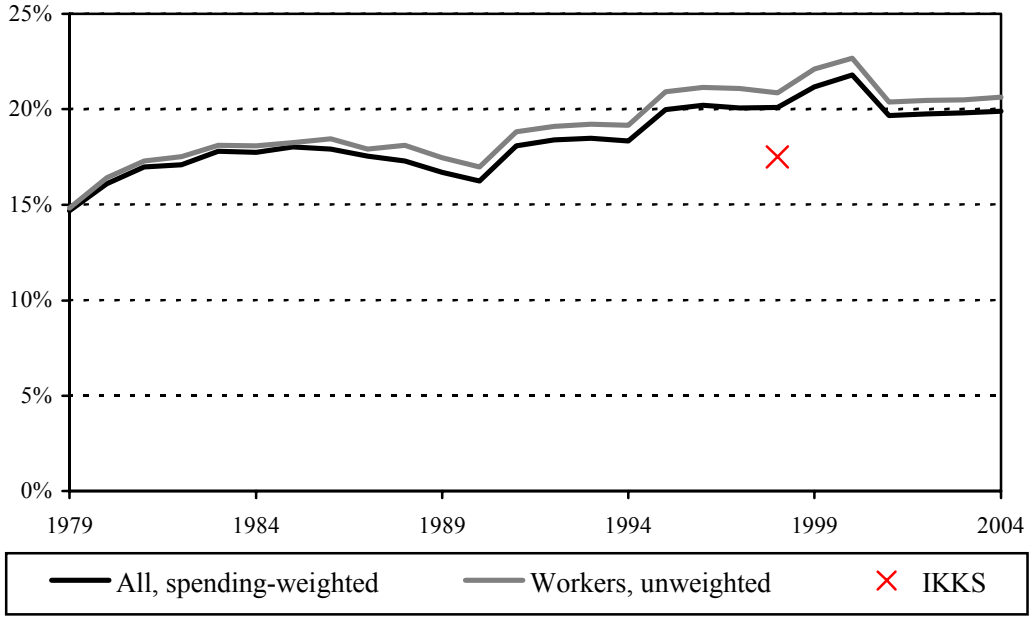
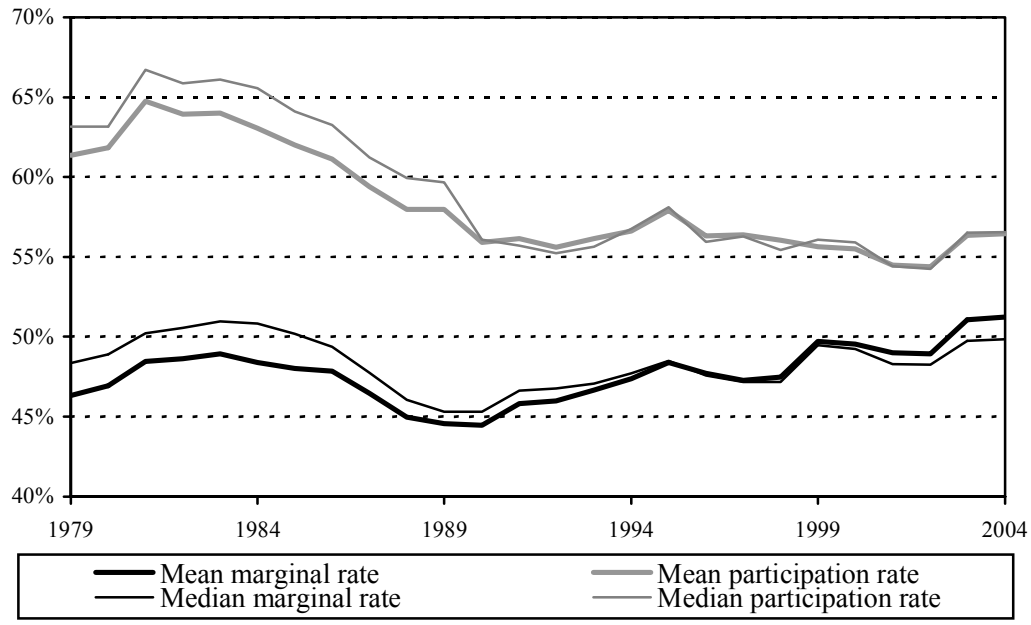


Figure 2 shows how average marginal and participation tax rates have changed since 1979. The Figure shows that the average participation tax rate is higher

than the average marginal tax rate, but that, although the two rates have moved in the same direction in almost every year, the gap between them has gradually narrowed over the period. The sharp rise in the average participation tax rate (and, to a lesser extent, in the average marginal tax rate) in 1981, which proves important to the final results, can largely be explained by a nominal freeze in income tax allowances at a time of double-digit inflation. However, in general one must be cautious about trying to track policy changes in these lines, since changes in average tax rates reflect changes in the demographic composition and gross income distribution of the population as well as changes in tax and benefit policy.[18] Ongoing work (Adam et al, forthcoming) examines changes in these and other work incentive measures in detail and attempts to separate out the various components of change.

Figure 2. Average effective marginal tax rates and participation tax rates among workers, 1979-2004

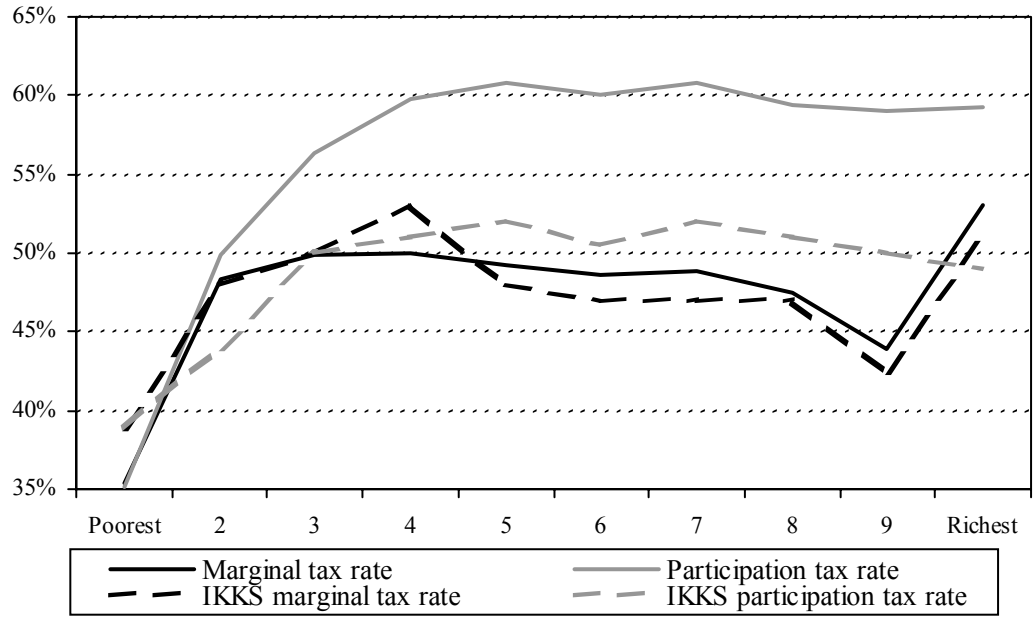


The similarity of mean and median tax rates in Figure 2, particularly since 1990, suggests that the distribution is not heavily skewed. Figure 3 shows how mean tax rates varied across the individual earnings distribution in a single year (1998,

[18] A related point is that tracking policy 'changes' requires a choice of counterfactual 'no change' scenario. The potential importance of this in explaining changes is highlighted by Clark and Leicester (2004), who find that tax and benefit reforms account for approximately half of the increase in UK income inequality since 1979 if the counterfactual is price indexation of the tax and benefit system, but virtually none of the increase if the counterfactual is earnings indexation.

the year examined by IKKS). The mean participation tax rate is flat across most of the income distribution but successively lower for the poorest three decile groups; the mean marginal rate is also lower for the poorest decile group, but is then flat for decile groups 2 to 8, lower for the 9th decile group and substantially higher for the richest tenth. It is of some concern that my estimates of mean participation tax rates are substantially higher than IKKS's for all but the poorest tenth; I have no reason to believe that my estimates are seriously flawed, but in the light of this difference I look at the impact of scaling down my estimated participation tax rates in Section 6.

Figure 3. Mean marginal and participation rates for workers across the earnings distribution, 1998



5. Elasticities

A multitude of studies has attempted to estimate labour supply elasticities, and, although less divided than during the 1980s, the economics profession remains far away from a consensus on their magnitude. This paper does not add to that literature. It would be futile to attempt to reach a definitive conclusion, and in any case the theoretical model used here does not justify too meticulous a view of elasticities:

- we assume no income effects, which raises the question of whether to prefer estimates of compensated or uncompensated elasticities.
- it is a static model, and, as Blundell and MaCurdy (1999) argue, static elasticities lack a viable interpretation in most circumstances
- the modelling of couples' labour supply decisions is unrealistic
- behavioural responses are restricted to labour supply. The incorporation of an extensive margin as well as an intensive one is an improvement on much of the previous literature, but Feldstein (1995) and subsequent studies have shown that other dimensions of response (effort, labour mobility, tax avoidance and evasion) are important so that the overall elasticity of taxable income, which is what matters for tax policy analysis (Feldstein 1999), is rather higher than that due to labour supply response alone. To some extent, the present model can crudely incorporate such considerations if, for example, the intensive elasticity is thought of rather loosely as measuring the responsiveness of hours worked in the UK and revealed to the Inland Revenue, rather than total hours worked. Such thought experiments are left to the reader's discretion.

To allow for some leeway in the treatment of these issues as well as catering for the sheer disagreement in the literature, I adopt an approach of choosing a broadly plausible baseline set of elasticities but testing a wide range of alternative specifications. As discussed in Section 2.4, elasticities are allowed to vary across 100 income-demographic type groups. Results are tested for robustness to the overall level of elasticities, the relative responsiveness of participation and hours, and the extent of variation across family types and

income groups (especially the responsiveness of the highest income decile group).

It is important to remember that the extensive elasticity in particular is not an intrinsic preference parameter. Simple inspection of the definition of the extensive elasticity in equation (6), reproduced below for easy viewing, shows that a group's extensive elasticity is determined by three components: the net financial gain to work for the group, $(c_j - c_0)$; the density of the distribution of fixed costs at the participation margin $f_j(q_j)$; and the group's employment rate, $F_j(q_j)$ (itself a function of the gain to work and of the fixed and variable costs of work).

$$\eta_j \equiv (c_j - c_0)\frac{f_j(q_j)}{F_j(q_j)}$$

The extensive elasticity is thus endogenous to the state of the economy in general and to the tax and benefit system in particular, via their effects on the gain to work, the costs of work, and the employment rate. It is purely for the sake of simplicity that I assume elasticities are constant over time.

In choosing the baseline case, I have drawn on four of the more robust findings of the recent empirical literature:

- labour supply responses tend to be concentrated on the extensive margin (Cogan, 1981; Robins, 1985; Blundell et al, 1987; MaCurdy et al, 1990; Triest, 1990; Zabel, 1993; Blundell, 1995; Eissa and Liebman, 1996)
- extensive elasticities are high towards the bottom of the income distribution and very low towards the top (Blundell, 1995; Krueger and Meyer, 2002; Hotz et al, 2003)
- intensive elasticities are higher at the very top of the income distribution (Goolsbee, 2000; Gruber and Saez, 2002; Saez, 2004)[19]

[19] This requires considerable qualification. The finding is in terms of the elasticity of taxable income, not necessarily the intensive elasticity of labour supply (although the results can loosely incorporate this, as mentioned above), and Saez (2004) argues that this effect may be restricted to the top 1% of taxpayers. Some of this responsiveness might only be short-term due to the exercise of stock options etc (Goolsbee, 2000), some might come from the self-employed, who are likely to have more scope to avoid or evade taxes (Blow and Preston, 2002) but who are

- women with working partners, and to a lesser extent mothers, are more responsive than others on the extensive margin (Robins, 1985; Eissa and Liebman, 1996) but similar on the intensive margin (Mroz, 1987; Blomquist and Hansson-Brusewitz, 1990).

The baseline elasticities are shown in Table 5. The numbers look perhaps surprisingly precise; they are best explained as follows:

- Extensive elasticities are five times as high for the poorest fifth of individuals as for the richest fifth, with even graduations in between
- Extensive elasticities are twice as high for women with working partners, and 1½ times as high for other mothers, as for others
- Intensive elasticities are twice as high for the richest tenth as for other groups, but otherwise do not vary
- With these relativities kept intact, all elasticities are then scaled so that the average extensive elasticity is 0.25 and the average intensive elasticity is 0.1.

The extensive elasticities thus range from a maximum of 0.598 for a married mother in the lowest earning fifth of workers, for example, to a minimum of 0.06 for, say, a single man in the top fifth of earners. Intensive elasticities are 0.182 for individuals in the top decile group and 0.091 for all others. For comparison purposes, IKKS's chosen elasticities are shown in Table 6.

---

excluded here, and some of the very richest individuals make private tax arrangements with the Inland Revenue rather than being subject to a rigid tax regime. Gruber and Saez's (2002) conclusion that "the patterns can only be taken as suggestive. But the findings do confirm the standard intuition that the highest income taxpayers are the ones that are most responsive to taxation" seems reasonable. It is important to take account of this group's responsiveness, since their high income share makes them vital for revenue effects – the richest 1% of UK income tax payers currently account for 22% of receipts, for example – but because of these complications, the results of varying just the elasticities of the richest decile group are provided in Appendix A.

6. Results

6.1. Baseline results

Figure 4 and Figure 5 show my central estimates of the deadweight cost and MECR associated with the two policies. The first point that leaps out is how

Figure 4. Deadweight loss rate D for the two policies

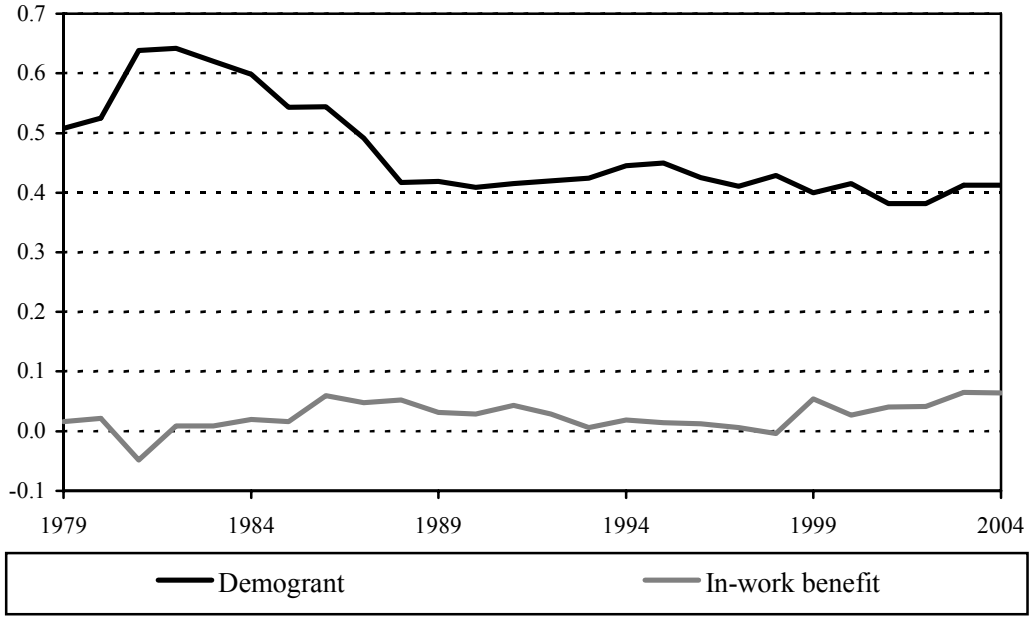
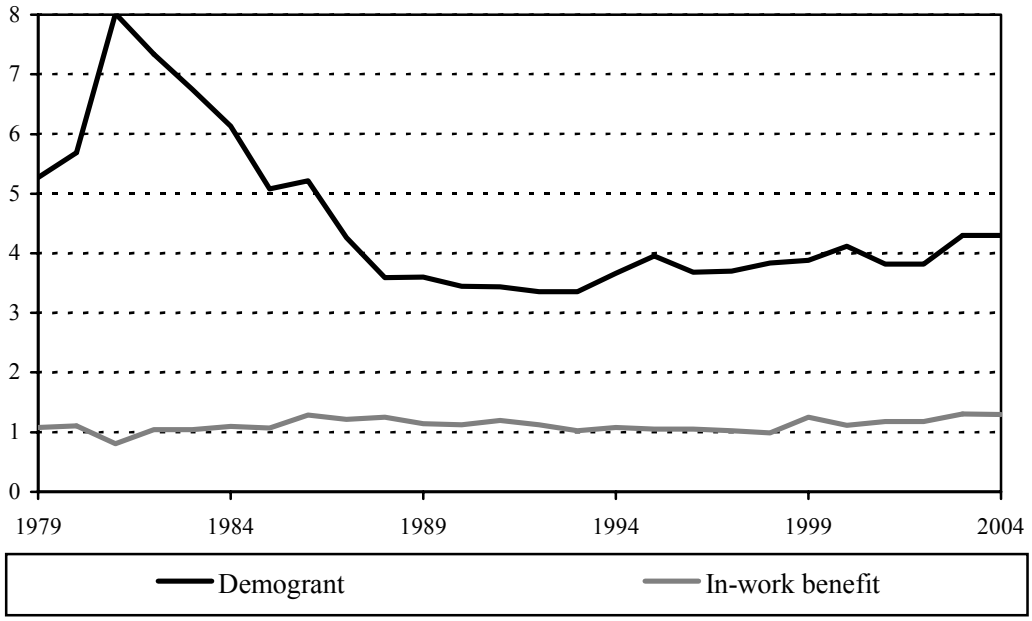


Figure 5. MECR ψ for the two policies



similar the two Figures look, which is unsurprising given how closely related the two measures are. The rare occasions in which they move in different directions reflect changes in the income distribution – the third determinant, alongside tax rates and elasticities, of the MECR, and one which has been little mentioned so far in this paper since it poses few difficulties in estimation. For example, Ψ_d has risen while D_d has fallen since the early-mid 1990s; inspection of equation (14) shows that this implies a fall in the proportion of people gaining from a demogrant policy or a rise in their earnings share. Given the similarity of the two measures and that the MECR is the object of interest, the remainder of the results are shown only for the MECR.

Ψ_d has averaged 4.52 over the last 25 years and is now estimated at 4.30. Its movements have tracked movements in the average marginal and participation tax rates shown in Figure 2 almost perfectly, but have been more pronounced, most notably with the huge rise in 1981. This happens because an increase in tax rates is much more distortionary when increased from a high base and when elasticities are high. The big increase in 1981 was in participation tax rates, which already averaged 65%, and for this calculation labour supply responses are concentrated at the extensive margin.

In contrast, Ψ_w, now estimated at 1.30 (its highest level over the period), has shown very little deviation from its average level of 1.12 over the years. With the extensive margin dominant (higher elasticities and higher tax rates than on the intensive margin), the positive participation response from an in-work benefit has tended to offset the negative response to the revenue-raising tax increase almost entirely.

The MECR looks very favourable to the in-work benefit relative to the demogrant: in 2004, losers from the demogrant policy would have pay £4.30 for each pound that gainers from the policy receive, but losers from the in-work benefit policy would have to pay only £1.30 per pound that gainers receive. As discussed in Section 7, this does not necessarily mean the in-work benefit is to be preferred, since the gains and losses accrue to different people in the two cases. But the contrast between the two is stark.

I do not wish to emphasise comparisons with the results of previous studies. One lesson from the extent of variation over time shown in Figure 5 is that we should not necessarily expect estimates for different years, let alone different countries, to be similar.[20] The only study which gives directly comparable results is IKKS, which contains estimates for the UK in 1998. They estimate that the MECR for the demogrant was 1.88 and that for the in-work benefit 1.06 for their baseline case; my baseline estimates for that year are 3.84 and 0.99 respectively, much more favourable to the in-work benefit. Some reasons for these differences are given in the sections that follow.

6.2. The choice of elasticities

The elasticities on which the results in Section 6.1 are based represent my own judgement of reasonable values based on the existing literature. However, the magnitudes of these elasticities remains a matter of fierce dispute in the economics profession, so it is essential to conduct a thorough sensitivity analysis.

While this exercise is a vital one, to be informative it must inevitably be long and somewhat repetitive, so a full exposition is left to an Appendix. The results can be summarised as follows:

- The value of Ψ_d is highly sensitive to the average extensive elasticity in the population and fairly sensitive to the average intensive elasticity; in each case, higher elasticities are associated with a higher MECR.
- Ψ_w increases rapidly in the average intensive elasticity. The effect of the extensive elasticity on Ψ_w is variable, however, tending to reduce it if low values of the intensive elasticity are assumed but not if high values are assumed.

[20] For readers who would nevertheless like a comparison, the principal estimates are those of Browning and Johnson (1984) and Ballard (1988), which estimate the MECR associated with a demogrant for the US in 1976 and 1979 respectively. Browning and Johnson's central estimate is 3.49 and Ballard's is 1.81. However, both distinguish between these utility-based MECRs and money-based MECRs (presumably because their analyses are not truly marginal so the envelope theorem result of page 10 does not apply), and their central estimates of money-based MECRs are substantially higher, at 9.51 and 3.25 respectively.

- As might be expected, weighting elasticities towards the intensive margin tends to make the demogrant look favourable relative to the in-work benefit, and vice versa. Responses wholly restricted to the intensive margin (as in the Mirrlees model) is the only case examined for which Ψ_w exceeds Ψ_d.

- In some cases with high extensive elasticities, the MECRs are undefined for some years because tax rates were so high that marginal rate rises were revenue-reducing and/or payments to workers were revenue-raising so that revenue-neutral marginal reforms were impossible. These possibilities were mentioned in Section 2.3 and are discussed further in Section 7.

- Results are fairly sensitive to the elasticities assumed for the top decile alone, suggesting that careful thought must be given as to the appropriate treatment of these high earners (cf footnote 19).

- Increasing the degree of variation in elasticities between groups results in higher estimates of both MECRs for the cases examined, although it is not clear how far this can be generalised.

- Overall, it is clear that estimates of MECRs are highly sensitive to assumed elasticities, a finding shared with virtually all the previous literature; but my findings also support Eissa et al's (2004) conclusion that "the *composition* of the total labour supply elasticity is as important as its size" [their italics].

6.3. The level and aggregation of tax rates

The discussion of Section 2.4 made clear the potential importance of disaggregating tax rates in the presence of heterogeneity. In Figure 6 and Figure 7, the gap between the thick grey and black lines shows, for baseline elasticities, the effect on the MECR of using within-year average marginal and participation tax rates for each of the 100 demographic type-income groups along the lines of

Figure 6. The effect on ψ_d of aggregating tax rates

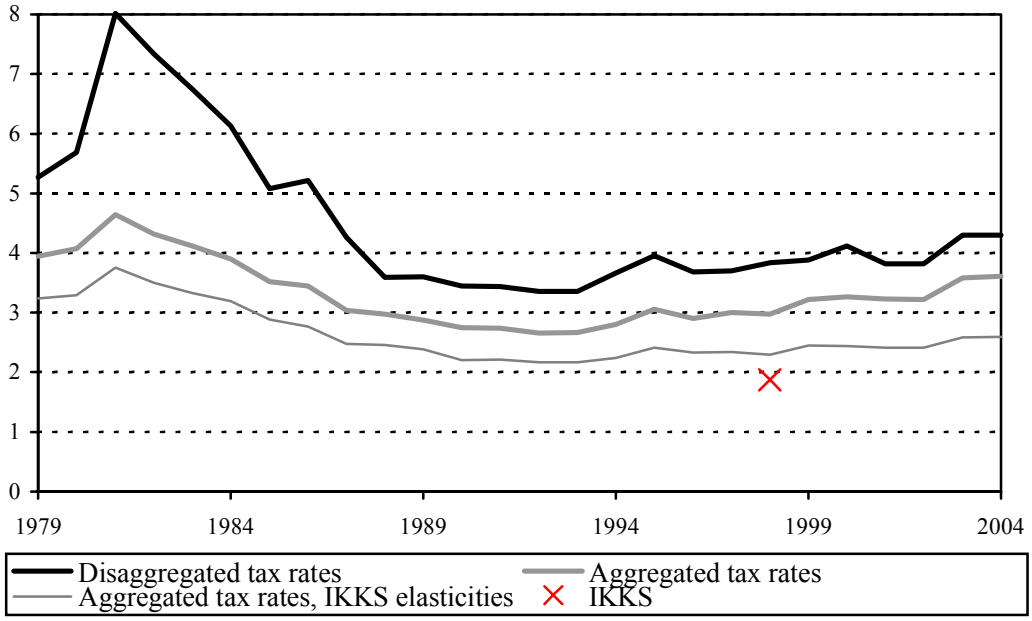
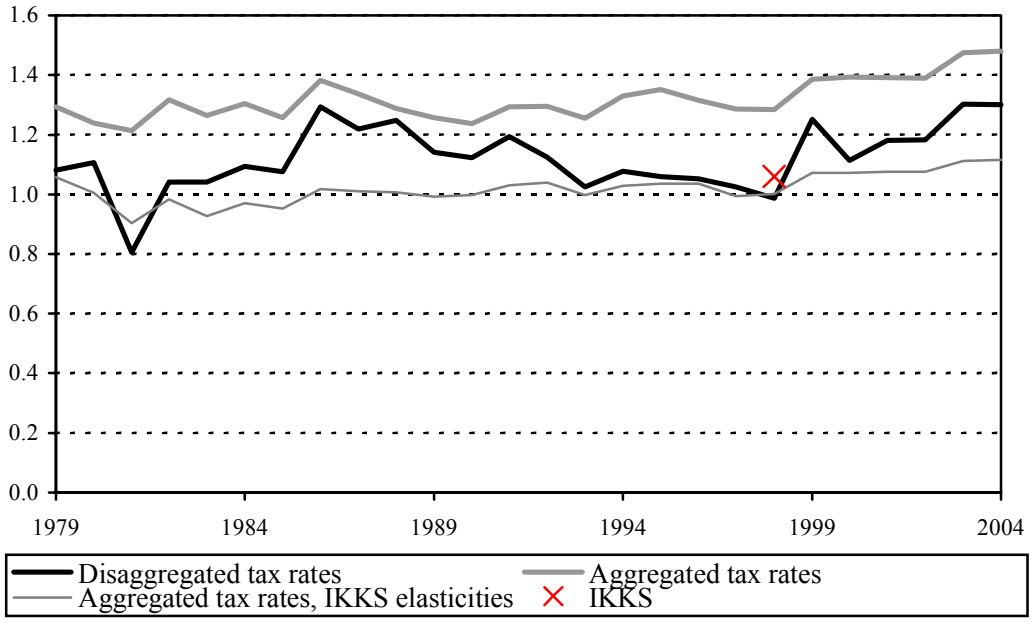


Figure 7. The effect on ψ_w of aggregating tax rates



IKKS, rather than allowing them to take different values for each individual in the sample.[21]

[21] Earnings are also averaged within groups for completeness, though this makes a negligible difference to the results.

As predicted, Ψ_d is lower when tax rates are aggregated, and it turns out that this difference is substantial: the average value of Ψ_d over the period is 4.52 using disaggregated tax rates, but only 3.31 if the tax rates are aggregated. Figure 6 also shows the effect of aggregating tax rates in combination with adopting IKKS's baseline specification of elasticities, and appears to show that these two differences can account for the bulk of the disparity between our estimates for 1998.[22]

The effect of disaggregation on Ψ_w is theoretically ambiguous. Figure 7 shows that, with my baseline elasticities, aggregating tax rates increases the estimated MECR for an in-work benefit. The similarity between my estimate and IKKS's estimate of Ψ_w in 1998 arises because this difference is offset by our different elasticity specifications. There is an added complication, however. As shown in Figure 3, my estimates of participation tax rates for 1998 substantially exceed IKKS's on average. The gap between the thick grey and black lines in Figure 8 and Figure 9 shows the effect of recalculating the MECRs with each individual's participation tax rate scaled down so that the average matches IKKS's estimate (the tax rates remain fully disaggregated and my baseline elasticities are used). As might be expected, this makes a large difference to the results. Interestingly, though, going on to use averages of these scaled-down tax rates within the usual 100 groups (the thin grey lines) makes very little difference. While not wholly surprising – since Ψ increases more than proportionately with tax rates, greater dispersion of tax rates should have a bigger effect if tax rates are high to start with – this illustrates the point that it is more important to disaggregate tax rates when they are high than when they are low.

[22] Remaining differences are primarily caused by different estimated levels of taxes (see below), although slight differences in samples might also matter.

Figure 8. MECR for demogrant with scaled-down tax rates

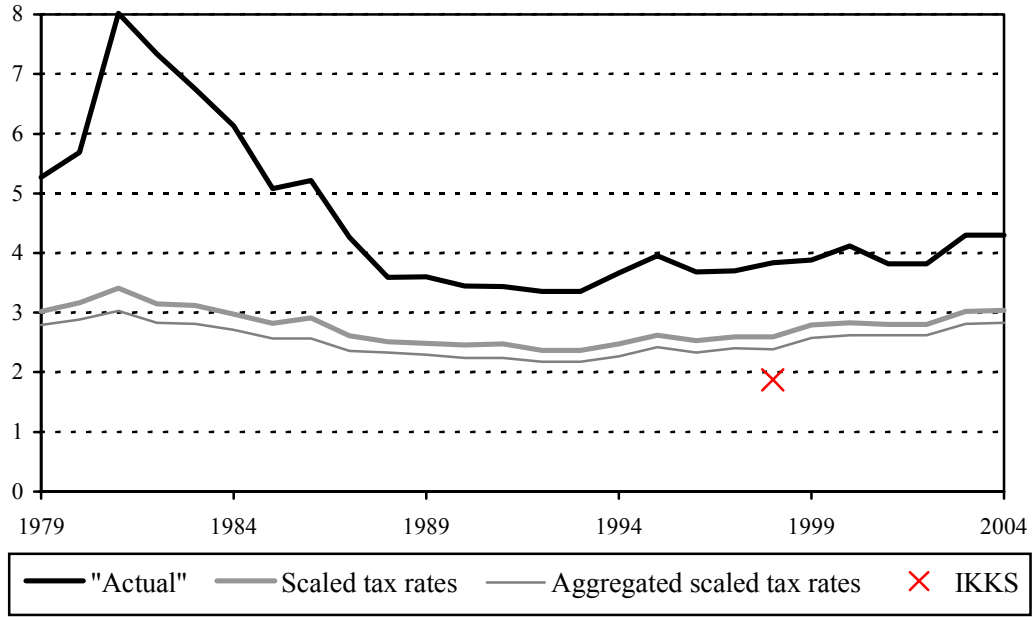
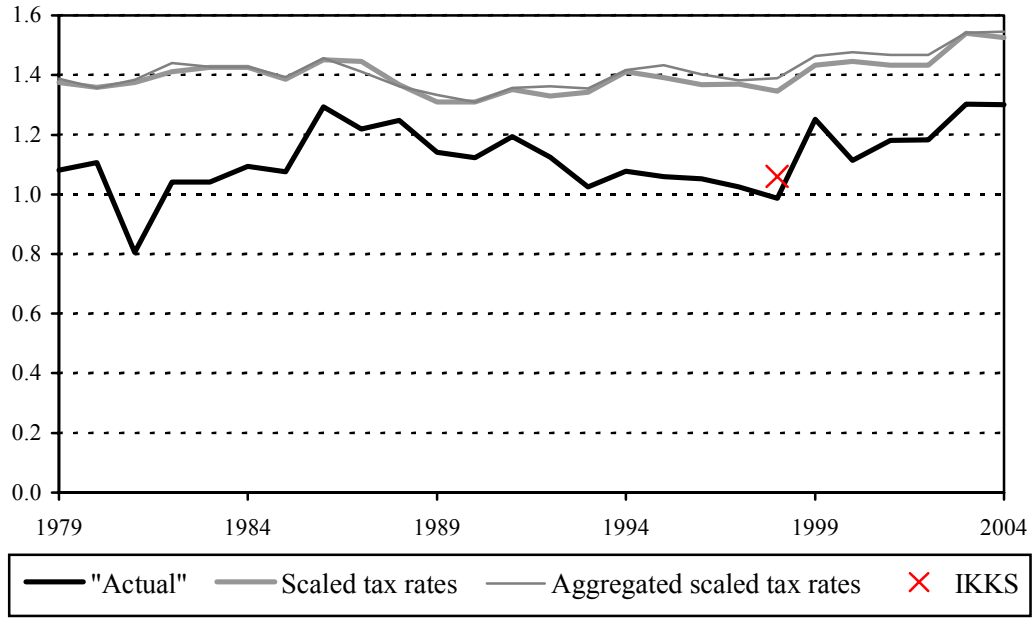


Figure 9. MECR for in-work benefit with scaled-down tax rates



6.4. Redistribution within demographic groups

Figure 10 and Figure 11 show the MECRs associated with redistributing income within four broad family types. As discussed in Section 2.4, this allows us to see whether the relative merits of a demogrant and an in-work benefit are different

Figure 10. ψ for a demogrant introduced within demographic groups

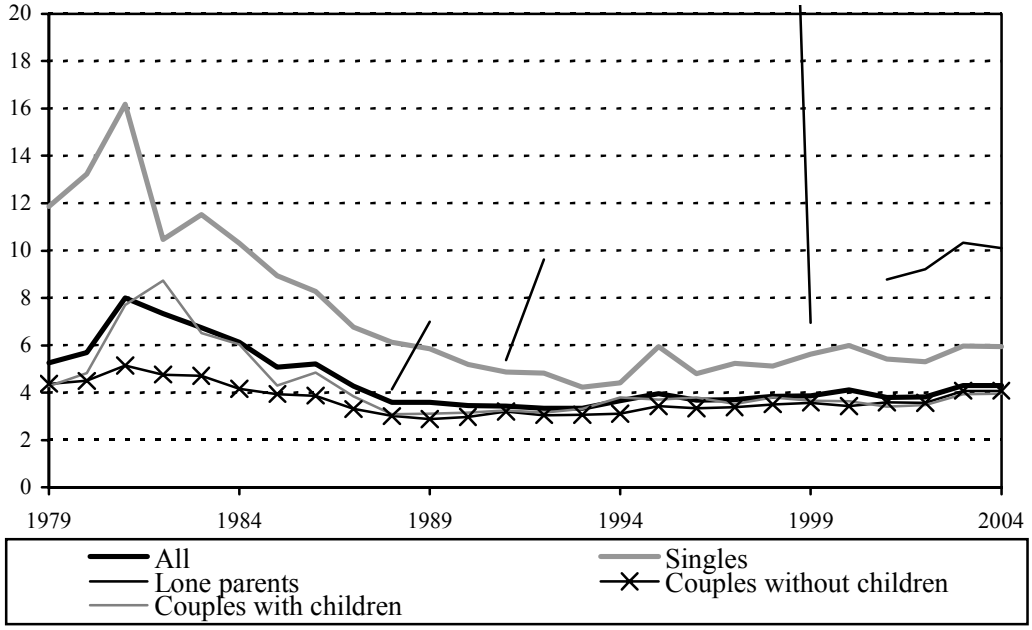
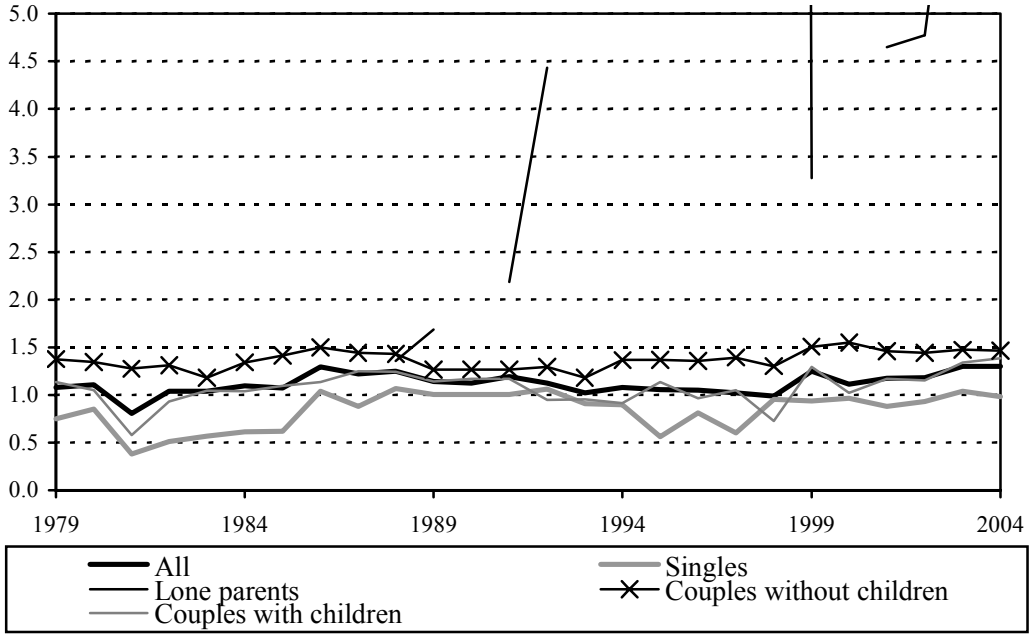


Figure 11. ψ for an in-work benefit introduced within demographic groups



for the different groups while taking as given the government's preferences for redistribution between family types.

The levels of, and trends in, the MECRs for couples with children are broadly similar to those for redistribution over the population as a whole. For singles, the

in-work benefit policy looks more favourable relative to the demogrant, and vice versa for childless couples.[23] The difference between these groups in the MECR for a demogrant has shrunk over time, but trends in the MECR for an in-work benefit have been similar for all of them.

The MECRs are undefined for lone parents over the majority of the period because (given the baseline elasticities) tax rates for lone parents have been above the Laffer bound. Before 1988 (and in 1990 and 2000), it was also the case that an (infinitesimal) lump-sum payment to working lone parents would have been revenue-raising. These are the possibilities mentioned in Section 2.3 in which additional taxes are revenue-reducing or lump-sum payments to workers are revenue-raising so a revenue-neutral marginal reform of this kind is impossible. The implications of this are considered in the next Section.

[23] Analysis of policies restricted to smaller groups (not shown) reveals a high degree of heterogeneity within couples: MECRs for women with non-working partners look like those for lone parents, those for childless men with non-working partners look like those for singles, and so on.

7. Interpretation, policy implications and directions for future research

The approach taken in this paper of estimating MECRs for particular policies rather than an optimal tax schedule reflects a desire to generate results without having to impose assumed social preferences. It is important to recognise that the corollary of this is that estimates of MECRs cannot in general answer the question of which of the policies under consideration is the 'better' policy in the sense of maximising a social welfare function, since they just aggregate all gains of gainers and all losses of losers. Aside from the difficulties of making interpersonal utility comparisons, the identity of the gainers and losers varies: specifically, gains from the in-work benefit extend further up the income distribution than those from a demogrant but are denied to non-workers; also, a given policy will have different gainers in different years as the income distribution changes. The relative merits of the two policies depend on the social welfare weights attached to the two groups as well as on the MECRs.

But there is some difficulty even with IKKS's claim that the MECR "can be interpreted as a critical value for the relative social welfare weight between the two groups" (the same basic idea as Okun's concept of acceptable leakage – see footnote 6): in general the MECR is uninformative as to the distribution of gains and losses *within* the two groups. Constructing (implicitly or explicitly) a single social welfare weight for each group is therefore complicated by the need to weight individuals in the group by the size of their gain or loss, which defeats the object of having a summary statistic. This problem might be thought less severe for the particular reforms considered here since both reforms involve net transfers that are linear in income (the only difference being whether non-workers are excluded), but this makes little difference since neither social welfare weights nor the underlying income distribution need follow this pattern.

One special case in which MECRs do yield policy recommendations is that of a utilitarian social welfare function. In that case, all individual gains and losses can simply be added together. This yields the general rule that the policy with the lower MECR is superior, and the action rule that a policy should be pursued if and only if there is a deadweight gain so that D is negative and Ψ is less than

one (ie rarely for the in-work benefit, never for the demogrant). But this simple outcome, with its strong aversion to redistribution, arises because the assumption of no income effects is crucial with a utilitarian social welfare function: for a utilitarian, the primary rationale for redistribution is declining marginal utility of income, which is assumed away in this model.

There is one result that yields more general policy recommendations. Section 6 and Appendix A present a number of scenarios in which the MECRs are undefined because D_d is greater than one (implying that a marginal reduction in tax rates would raise money) or because the denominator of equation (16) is negative (implying that an infinitesimal lump-sum payment to workers would raise money). Scenarios giving rise to this generally involve assuming high extensive elasticities of labour supply or redistributing only within the group of lone parents.

In a model where other families' incomes have no effect on individuals' utilities, tax cuts or benefit increases that increase government revenue are Pareto-improving. That leads to the striking conclusion that for these cases (subject to assumed elasticities and all the other assumptions of the model), the tax and benefit system in question is sub-optimal for *any* Paretian social welfare weights the government might have.

Almost any tax and benefit system can, of course, be justified by a non-Paretian social welfare function. For example, a 'super-Rawlsian' social welfare function, in which the reduction of inequality is so paramount a goal that the government would be willing to make everyone (including the poorest) worse off in order to achieve it, could justify taxation above the revenue-maximising level or a lack of in-work benefits. [24]

Indeed, the government might have objectives that do not correspond to a 'welfarist' social welfare function (ie one in which social welfare is a function only of individual/family utilities) of the type traditionally used in optimal taxation analysis: even if reducing lone parents' tax rates, say, was Pareto-improving, the government might decide that it is simply 'unfair' to give one family type preferential treatment in this way (this could be viewed as a

[24] Another non-Paretian objective function with similarly interesting characteristics is the equal sacrifice principle: see Young (1990) for a discussion.

horizontal equity argument). Such social preferences cannot easily be incorporated in a welfarist social welfare function, and the traditional approach of the optimal taxation literature to this kind of objective is to place direct restrictions on the set of available policy instruments instead.[25]

It is precisely in avoiding having to place any restrictions on the objective function of the government that the present approach of quantifying the MECR has advantages over the optimal taxation approach. However, a reader willing to accept the assumptions of the model and willing to assume a Paretian social welfare function might have a bone to pick with governments of the last 25 years.

The caveat that these results are subject to the assumptions made in this paper is an important one, however. Most obviously for these cases of apparently Pareto-inefficient levels of taxation, labour supply elasticities might be much lower than is assumed for these cases. But other assumptions are also relevant: for example, the model assumes that family structure is exogenous (reducing tax rates for lone parents creates incentives for parents to separate and for singles to have children, which might be thought undesirable in itself and have fiscal consequences) and neglects issues of administrative cost and transparency (reducing tax rates for lone parents could complicate the tax system, increasing its administrative burden and making it harder for the public to understand).

In fact, there is a whole raft of dubious assumptions underlying the conclusions in this paper and others in the field. Some assumptions are necessary to reach any kind of conclusion – something that is notoriously difficult in the field of optimal taxation – and others have been imposed perhaps unnecessarily in this paper for the sake of simplicity and transparency. But successive researchers have succeeded in building ever more plausible models, and if research in this field is ever to be (or deserve to be) taken seriously by policy-makers, future research should continue in this vein. Possible avenues for future investigation in terms of relaxing assumptions made in this paper include:

[25] Besley and Coate (1992, 1994) and Kanbur et al (1994) look at another non-welfarist objective, that of alleviating poverty in monetary terms (regardless of utility), and reach interesting conclusions.

- Further disaggregating elasticities. This analysis has allowed for separate elasticities for each of 100 groups. As noted in Section 2.4, this is insufficient if elasticities are correlated with income shares and tax rates within groups, a proposition that seems eminently plausible: if we accept that elasticities vary across income deciles, it seems likely that they also vary within deciles. Estimating a labour supply model on the same data would allow for fully disaggregated elasticities.
- Income effects. Recent papers using similar models such as Eissa et al (2004), Saez (2002) and Liebman (2004) do this.
- Treatment of couples. Dubious treatment of family decision-making is a feature this model shares with almost all of the optimal taxation and related literature.
- Incorporate concern for relative incomes etc in the utility function. Benchmarking of consumption expectations etc is a long-running but still active field in economics (see Galbraith, 1958, for a wide-ranging polemic and Layard, 2005, for an interesting recent discussion), and some progress has been made in integrating this into optimal taxation theory (see Boskin and Sheshinski, 1978, and, for a macroeconomic perspective, Abel, 2003). But more could be done, including looking at how this affects estimates of the MECR.
- Incorporate public services in tax rates. As noted in Appendix B, public services provided differentially by income can affect work incentives.
- Older workers. This paper deliberately excluded over-55s because their labour supply behaviour involves idiosyncratic issues. Incorporating this group without assuming away such issues would be a useful development.
- Time periods. This paper has been unspecific about the time period over which income and labour supply are considered (the empirical work has of necessity been done using whatever pay period individuals report in the FES and EFS). But as Saez (2002) points out, the intensive margin becomes relatively more important the longer the time frame considered (as the extreme case, almost everyone works at least one hour in their

lifetime). More fundamentally, redistribution of income in a particular year will look much less progressive over the distribution of lifetime income than over the distribution of income in that year (a similar point is made by Browning, 1995, endnote 14). If policy-makers care about redistributing towards those with low *permanent* incomes, therefore, estimates of the MECR understate the true efficiency cost of redistribution for these policies.

- Incorporate behavioural responses other than labour supply. A formal treatment allowing for taxable income to respond to tax reform via effort, avoidance and evasion responses as well as labour supply would be useful in light of the evidence on the importance of these responses (Feldstein 1995, 1999). More ambitiously, making family composition and human capital formation endogenous to the model would be an extremely interesting (albeit difficult) path to pursue.
- Dynamics. The previous three points all touch on the more general challenge of moving away from the static framework which has dominated this literature. Saving decisions, effects of non-work on human capital and labour market attachment, family planning, decisions to study/train and to retire, and expectations as to the permanency of reforms, are only a few of the myriad features of the 'real world' which are absent in this static model.

Relaxing such assumptions represents one huge and promising theme for future research. The other obvious theme would be to examine different reforms.

Moving beyond a framework of marginal reforms introduces the complication that the welfare effects of behavioural responses must be taken into account, so the welfare trade-off diverges from the money trade-off. A number of studies find this divergence to be quite large (see footnote 20 and Browning, 1995, amongst others), so the results here may not be generalizable to larger reforms. That the size of reforms affects the MECR is one of the attractions of a marginal analysis: infinitesimal perturbations provide a much cleaner analysis of the present situation. But for 'real world' reform proposals, a non-marginal analysis (along the lines of Liebman, 2001) might be a more promising approach than a

marginal analysis ignoring the direct welfare effect of behavioural responses (such as Eissa et al, 2004).

More interestingly, future research might focus on reforms that affect different demographic groups differently. This paper has looked at the MECR within groups, to see whether the relative merits of expanding a demogrant versus an in-work benefit differ between groups, but deliberately steered clear of the question of redistribution between groups. Future research might focus on 'tagging', the idea of using observable correlates of income (or needs) to achieve redistribution more efficiently than basing it on income alone. Despite widespread awareness of, and acclaim for, Akerlof's (1978) seminal paper on the subject, little account has been taken of tagging in the optimal taxation literature (Kremer, 1997, Rowe and Wolley, 1998, Immonen et al, 1998, and Boadway and Pestiau, 2004, are honourable exceptions). I am aware of nothing at all attempting to integrate tagging with estimates of the MECR. Comparing the MECR for a tax-financed increase in child benefit, say, with the demogrant and the in-work benefit, would be an interesting exercise. More ambitious still would be to integrate this with behavioural developments in the model by, for example, introducing elasticities associated with fertility.

8. Conclusions

The central finding of this paper is that the marginal efficiency cost of redistribution in the UK is much lower for an in-work benefit policy than for a demogrant. The efficiency loss associated with a marginal in-work benefit has consistently been low (and occasionally negative): even at its current 25-year high, the policy would cost losers only £1.30 per pound that the gainers gained. By contrast, losers from a demogrant would currently lose £4.30 per pound that gainers received, higher than at other times over the last 15 years but still well short of the peak of £8.02 seen in 1981. The in-work benefit policy looks even more favourable if paid to (and financed by) only singles; it looks less favourable if implemented only for childless couples. Increasing in in-work benefits and/or cutting tax rates for lone parents have provided opportunities for Pareto-improving reforms to the tax and benefit system for most of the period since 1979.

The finding that these estimates of the MECR are highly sensitive to the overall levels of tax rates and elasticities is hardly original. Perhaps less widely recognised is the importance of the composition of the overall labour supply elasticity, in terms of the relative importance of the intensive and extensive margins and the variation in both across the population. An entirely new finding of this paper is that, at least with the tax rates I estimate, disaggregating tax rates to the individual level makes a substantial difference to the results, something which needs to be incorporated in future work. Allowing for heterogeneity in consumption tax rates, which make up a large part of the overall tax wedge, is a further methodological development which should improve the accuracy of future estimates of the MECR. In a field where it has been common practice to conduct "simulations" based on a single elasticity and a single tax rate, or at best a relatively small number, this focus on the importance of heterogeneity is long overdue.

Notwithstanding the sensitivity of my results to assumed labour supply elasticities, the finding that the MECR for a demogrant is substantially higher than that for an in-work benefit is quite robust. This should be of interest to policy-makers. However, to provide a genuinely credible basis for policy-

making, future research must concentrate on attacking the numerous assumptions that continue to make the models underlying results such as these look implausible.

References

Abel, A.B. (2003), "Optimal Taxation When Consumers Have Endogenous Benchmark Levels of Consumption", NBER Working Paper No. 10099, National Bureau of Economic Research.

Adam, S. (2004), *A Survey of the UK Tax System*, IFS Briefing Note No. 9, London: Institute for Fiscal Studies.

Adam, S., Brewer, M. and Shephard, A. (forthcoming), *Can Governments Reduce Poverty and Improve Work Incentives?*, Institute for Fiscal Studies.

Akerlof, G. (1978), "The Economics of 'Tagging' as Applied to the Optimal Income Tax, Welfare Programs, and Manpower Planning", *American Economic Review* 68, pp.8-19.

Ballard, C.L. (1988), "The Marginal Efficiency Cost of Redistribution", *American Economic Review* 78(3), pp.1019-1033.

Besley, T. and Coate, S. (1992), "Workfare versus Welfare: Incentive Arguments for Work Requirements in Poverty Alleviation Programs", *American Economic Review* 82, pp.249-261

Besley, T. and Coate, S. (1994), "The Design of Income Maintenance Programmes", *Review of Economic Studies* 62, pp.187-221.

Blomquist, S. and Hansson-Brusewitz, U. (1990), "The Effect of Taxes on Male and Female Labour Supply in Sweden", *Journal of Human Resources* 25, pp.317-357.

Blow, L., Leicester, A. and Oldfield, Z., *Consumption Trends in the UK, 1975-99*, London: Institute for Fiscal Studies.

Blow, L. and Preston, I. (2002), *Deadweight Loss and Taxation of Earned Income: Evidence from Tax Records of the UK Self Employed*, IFS Working Paper No. W02/15, London: Institute for Fiscal Studies.

Blundell, R.W. (1995), "The Impact of Taxation on Labor Force Participation and Labor Supply", in *OECD Job Study: Taxation, Employment and Unemployment*, Paris: OECD.

Blundell, R.W., Ham, J. and Meghir, C. (1987), "Unemployment and Female Labour Supply", *Economic Journal* 97, pp.44-64.

Blundell, R. and MaCurdy, T. (1999), "Labor Supply: A Review of Alternative Approaches", in O. Ashenfelter and D. Card (eds.), *Handbook of Labour Economics*, Vol. 3A, Elsevier Science B.V: Amsterdam.

Boadway, R. and Pestieau, P. (2004), *Tagging and Redistributive Taxation*, paper presented at the Third Journées d'Economie Publique Louis-André Gérard-Varet.

Boskin, M.J. and Sheshinski, E. (1978), "Optimal Redistributive Taxation When Individual Welfare Depends on Relative Income", *Quarterly Journal of Economics* 92(4), pp.589-601.

Browning, E. (1995) "Effects of the Earned Income Tax Credit on Income and Welfare", *National Tax Journal*, 48(1), pp.23-43.

Browning, E. and Johnson, W.R. (1984), "The Trade-Off between Equality and Efficiency", *Journal of Political Economy* 92(2), pp. 175-203.

Choné, P. and Laroque, G. (2001), *Optimal Incentives for Labour Force Participation*, Série des Documents de Travail du Centre de Recherche en Economie et Statistique No. 2001-25, INSEE-CREST.

Clark, T. and Leicester, A. (2004), "Inequality and Two Decades of British Tax and Benefit Reforms", *Fiscal Studies* 25(2), pp.129-158.

Cogan, J.F. (1981), "Fixed Costs and Labour Supply", *Econometrica* 49(4), pp. 945-963.

Crawford, C. and Shaw, J. (2004), *A Survey of the UK Benefit System*, IFS Briefing Note No. 13, London: IFS.

Diamond, P. (1980), "Income Taxation with Fixed Hours of Work", *Journal of Public Economics* 12, pp.101-110.

Eissa, N., Kleven, H.J. and Kreiner, C.T. (2004), "Evaluation of Four Tax Reforms in the United States: Labor Supply and Welfare Effects for Single Mothers", NBER Working Paper No. W10935, National Bureau of Economic Research.

Eissa, N. and Liebman, J.B. (1996), "Labor Supply Response to the Earned Income Tax Credit", *Quarterly Journal of Economics* 111(2), pp.605-637.

Feldstein, M. (1995), "The Effect of Marginal Tax Rates on Taxable Income: a Panel Study of the 1986 Tax Reform Act", *Journal of Political Economy* 103(3), pp.551-572.

Feldstein, M. (1999), "Tax Avoidance and the Deadweight Loss of the Income Tax", *Review of Economics and Statistics* 81(4), pp.674-680.

Fullerton, D. and Gan, L. (2003), "A Simulation-Based Welfare Loss Calculation for Labor Taxes with Piecewise-Linear Budgets", NBER Working Paper No. W10139, National Bureau of Economic Research.

Galbraith, J.K. (1958), *The Affluent Society*, Boston: Houghton Mifflin.

Giles, C. and McCrae, J. (1995), *TAXBEN: The IFS Microsimulation Tax and Benefit Model*, IFS Working Paper No. WP95/19, London: Institute for Fiscal Studies.

Goolsbee, A. (2000), "What Happens When You Tax the Rich? Evidence from Excutive Compensation", *Journal of Political Economy* 108(2), pp.352-378.

Gruber, J. and Saez, E. (2002), "The Elasticity of Taxable Income: Evidence and Implications", *Journal of Public Economics* 84, pp.1-32.

Heckman, J. (1993), "What Has Been Learned About Labour Supply in the Past Twenty Years?", *American Economic Review Papers and Proceedings* 83(2), pp.116-121.

Homburg, S. (2002), *Optimal Marginal Tax Rates for Low Incomes: Positive, Negative, or Zero?*, Discussion Paper No. 255, University of Hanover

Hotz, V.J., Mullin, C.H. and Scholz, J.K. (2003), "The Earned Income Tax Credit and Labor Market Participation of Families on Welfare", mimeo, UCLA, Vanderbilt and University of Wisconsin – Madison.

Immervol, H., Kleven, H.J., Kreiner, C.T. and Saez, E. (2004), *Welfare Reform in European Countries: A Micro-Simulation Analysis*, Centre for Economic Policy Research Discussion Paper No. 4324, London: CEPR.

Immonen, R., Kanbur, R., Keen, M. and Tuomala, M. (1998), "Tagging and Taxing: The Optimal Use of Categorical and Income Information in Designing Tax/Transfer Schemes", *Economica* 65, pp.179-192.

Kanbur, R., Keen, M. and Tuomala, M. (1994), "Optimal Non-Linear Income Taxation for the Alleviation of Income Poverty", *European Economic Review* 38, pp.1613-1632.

Kremer, M. (1997), "Should Taxes be Independent of Age?", NBER Working Paper No. 6304, National Bureau of Economic Research.

Krueger, A.B. and Meyer, B.D. (2002), "Labour Supply Effects of Social Insurance", in A.J. Auerbach and M. Feldstein (eds.), *Handbook of Public Economics* 4, Amsterdam: North-Holland.

Layard, R. (2005), *Happiness: Lessons from a New Science*, London: Allen Lane

Liebman, J. (2002), "The Optimal Design of the Earned Income Tax Credit", in B. Meyer and D. Hotz-Eakin (eds.), *Making Work Pay: The Earned Income Tax Credit and Its Impact on American Families*, New York: Russell Sage Foundation.

MaCurdy, T., Green, D. and Paarsch, H. (1990), "Assessing Empirical Approaches for Analyzing Taxes and Labour Supply", *Journal of Human Resources* 25, pp.415-490.

Mendoza, E.G., Razin, A., and Tesar, L.L. (1994), "Effective Tax Rates in Macroeconomics. Cross-Country Estimates of Tax Rates on Factor Incomes and Consumption", *Journal of Monetary Economics* 34, pp.297-323.

Mirrlees, J.A. (1971), "An Exploration in the Theory of Optimal Income Taxation", *Review of Economic Studies* 38, pp.175-208.

Moffitt, R. (1983), "An Economic Model of Welfare Stigma", *American Economic Review*, 73(5), pp.1023-1035.

Mroz, T.A. (1987), "The Sensitivity of an Empirical Model of Married Women's Hours of Work to Economic and Statistical Assumptions", *Econometrica* 55(4), pp.765-799.

ONS (Office for National Statistics) (2001a), *Family Expenditure Survey 2000-2001, Volume 1: User Guide*, London: The Stationery Office

ONS (2001b), *Family Spending: A Report on the 2000-2001 Family Expenditure Survey*, London: The Stationery Office.

ONS (2002), *Family Spending: A Report on the 2001-2002 Expenditure and Food Survey*, London: The Stationery Office.

Okun, A. (1975), *Equality and Efficiency: The Big Tradeoff*, Washington: Brookings Institution.

Robins, P.K. (1985), "A Comparison of the Labour Supply Findings from the Four Negative Income Tax Experiments", *Journal of Human Resources* 20, pp.567-582.

Rowe, N. and Woolley, F. (1999), "The Efficiency Case for Universality", *Canadian Journal of Economics* 32, pp.613-629.

Saez, E. (2002), "Optimal Income Transfer Programs: Intensive Versus Extensive Labor Supply Responses", *Quarterly Journal of Economics* 117(3), pp.1039-1073.

Saez, E. (2004), "Reported Incomes and Marginal Tax Rates, 1960-2000: Evidence and Policy Implications", NBER Working Paper No.10273, National Bureau of Economic Research.

Tanner, S. (1998), "How Much Do Consumers Spend? Comparing the FES and National Accounts", in J. Banks and P. Johnson (eds.), *How Reliable is the Family Expenditure Survey?*, London: Institute for Fiscal Studies.

Triest, R.K. (1990), "The Effect of Income Taxation on Labor Supply in the United States", *Journal of Human Resources* 25, pp.491-516.

Triest, R.K. (1994), "The Efficiency Cost of Increased Progressivity", in J. Slemrod (ed.), *Tax Progressivity and Income Inequality*, Cambridge: Cambridge University Press.

Tuomala, M. (1990), *Optimal Income Tax and Redistribution*, Oxford: Clarendon Press.

Young, H.P. (1990), "Progressive Taxation and Equal Sacrifice", *American Economic Review* 80, pp.253-266.

Zabel, J.E. (1993), "The Relationship Between Hours of Work and Labor Force Participation in Four Models of Labor Supply Behaviour", *Journal of Labor Economics* 11, pp.387-416.

Appendix A. Full sensitivity analysis for elasticities

This Appendix explores how the results of Section 6.1 change if different values are chosen for the labour supply elasticities. In each case, values were chosen to be towards, but not at, the extremes of findings in the literature (or rather, in that literature which allows for an extensive as well as an intensive margin of labour supply). The vertical scales on graphs are kept constant across specifications so that the different cases can easily be compared.

The average intensive elasticity

The baseline case (Table 5) has intensive elasticities averaging 0.1 across the population. Figure 12 and Figure 13 show the MECRs for the two policies if the average intensive elasticity is higher (0.2) or lower (0.05) than that. Each individual's intensive elasticity is scaled by the same factor relative to the baseline case (ie doubled in the high case, halved in the low case); extensive elasticities are unchanged from the baseline case. The elasticities are shown in full in Table 7 and Table 8.

The Figures show that a higher intensive elasticity makes both policies look less efficient, as one would expect. It has a bigger proportionate effect on Ψ_w: for the demogrant, a higher intensive elasticity just adds to an already high level of inefficiency caused primarily by distortions on the extensive margin; but for the in-work benefit, the extensive margin has ambiguous properties and it is distortions to working hours in raising the revenue that unambiguously drive up the efficiency cost of redistribution, putting Ψ_w on the same kind of scale as Ψ_d.

Figure 12. ψ_d with different average intensive elasticities[26]

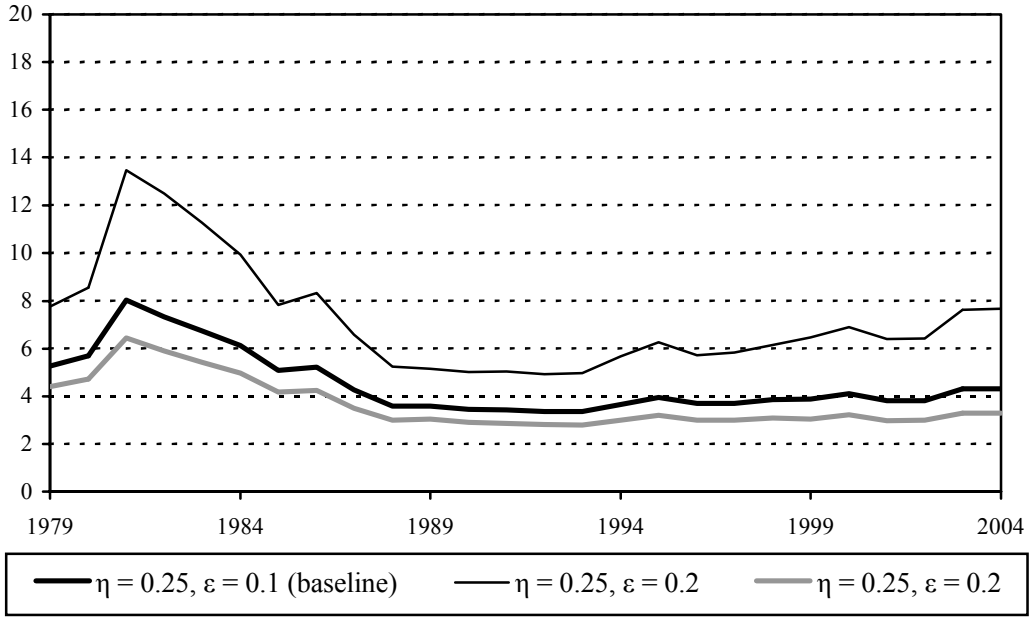
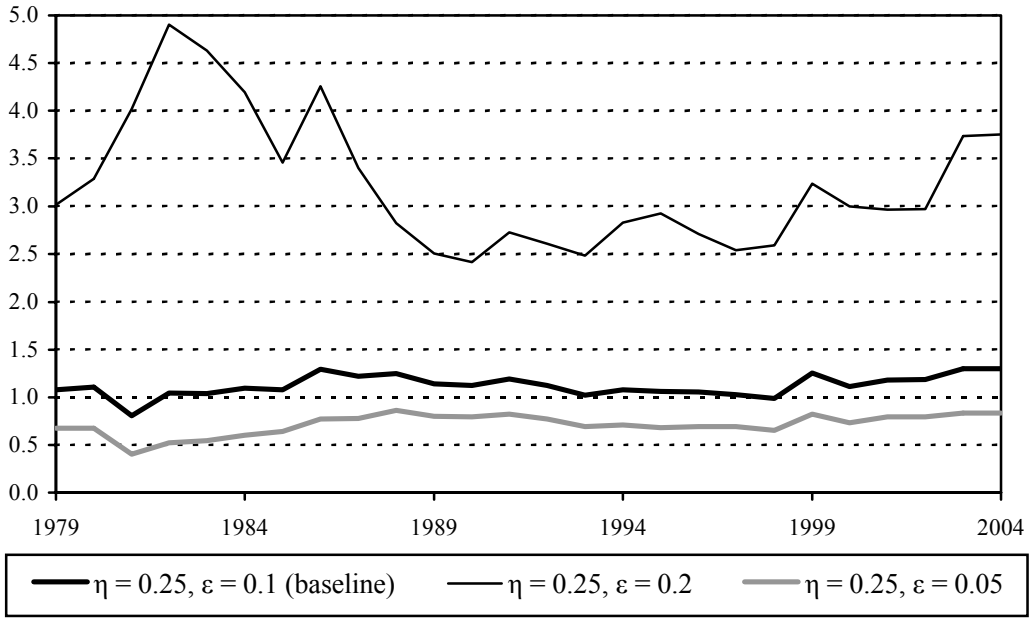


Figure 13. ψ_w with different average intensive elasticities



The average extensive elasticity

Figure 14 and Figure 15 respectively show the MECRs for high and low average extensive elasticities, keeping the intensive elasticities as in the baseline case.

[26] η and ε in the legends of this and subsequent Figures denote *average* extensive and intensive elasticities – variation around these averages is described in the text and relevant Tables.

Figure 14. ψ_d with different average extensive elasticities

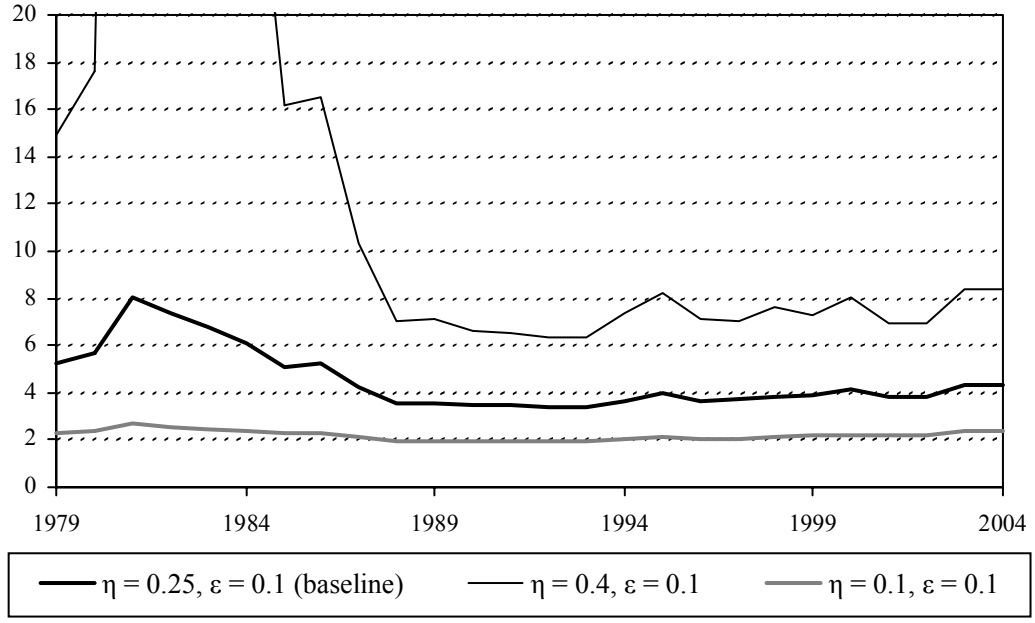
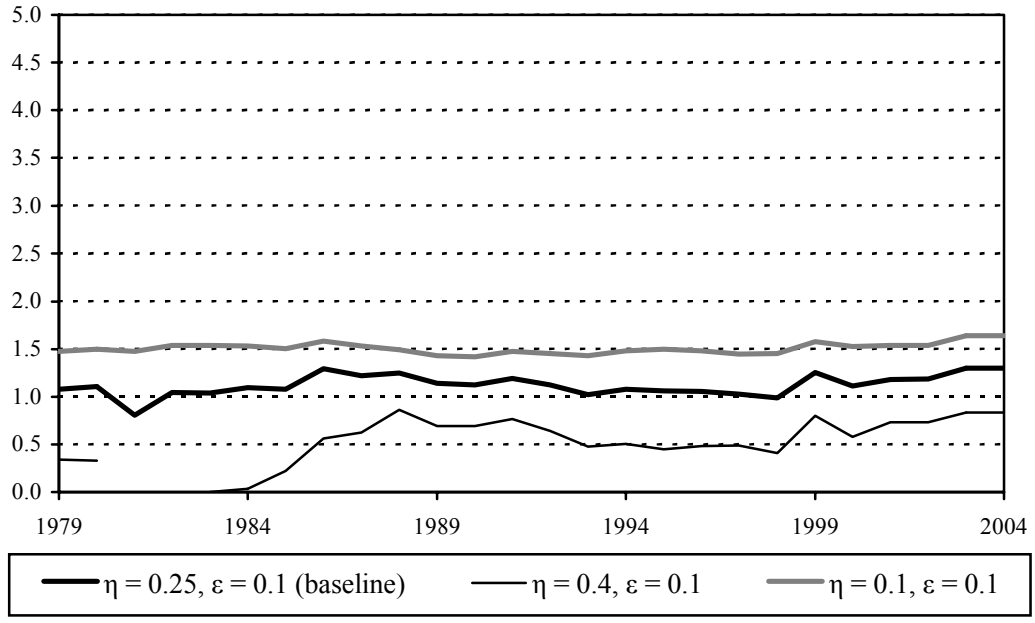


Figure 15. ψ_w with different average extensive elasticities



The high case is 0.4 and the low case 0.1, compared with a baseline of 0.25; Table 9 and Table 10 show them in full.

A higher extensive elasticity worsens the MECR associated with a demogrant. This sensitivity is rather greater than for the intensive elasticity shown in Figure

12, essentially because participation tax rates are higher than marginal tax rates. For an average elasticity of 0.4 the MECR is off the scale from 1981 to 1984, peaking in 1981 at a value of 94 (meaning that gainers from the reform receive barely 1 per cent of the cost to the losers).

The effect of the extensive elasticity on Ψ_w is theoretically ambiguous. Figure 15 shows that in this case, a higher extensive elasticity is associated with a lower MECR: the positive participation response to the benefit outweighs the negative participation response to the tax. Indeed, if the scenario with an average elasticity of 0.4 was correct, then 1981 and 1982 are cases in which a lump-sum payment to workers in fact raises revenue and the MECR is undefined. The policy implications of this are discussed in Section 7.

The overall average elasticities

Having examined the robustness of the results to the elasticity on each margin, we can now look at the kind of debate prevalent in the literature. First, the simple question of the overall elasticity of labour supply. Figure 16 and Figure 17 show cases where both the average intensive elasticity and the average extensive elasticity are higher (0.2 and 0.4 respectively) or lower (0.05 and 0.1) than the baseline case (0.1 and 0.25); these are the scenarios in Table 11 and Table 12 respectively.

The results for the demogrant should by now be no surprise: Ψ_d is highly sensitive to overall elasticities. In the high elasticity scenario, Ψ_d is off the scale before 1987; what cannot be seen from Figure 16, therefore, is that for this specification 1981-1984 are years in which tax rates exceeded the Laffer bound and so the MECR is undefined. The policy implications of this are discussed in Section 7.

Figure 17 is extremely interesting. We saw in Figure 13 and Figure 15 that a higher average intensive elasticity increased the MECR for the in-work benefit policy, while a higher average extensive elasticity reduced the MECR. The pattern when both average elasticities are reduced is thus to be expected: the effect on Ψ_w is small and of variable sign, with the main effect being to reduce

Figure 16. ψ_d with different average elasticities

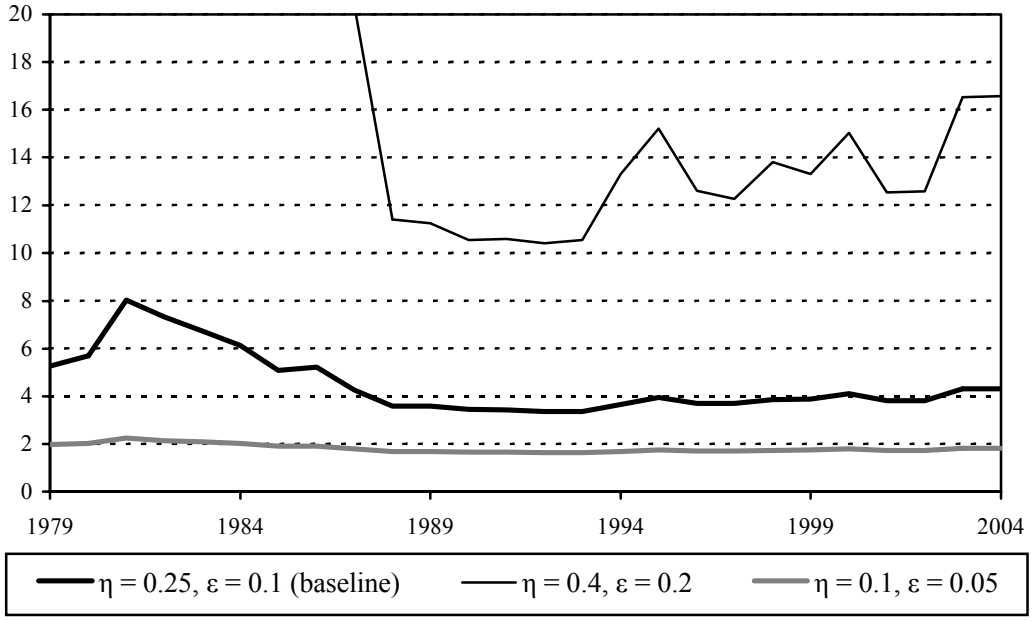
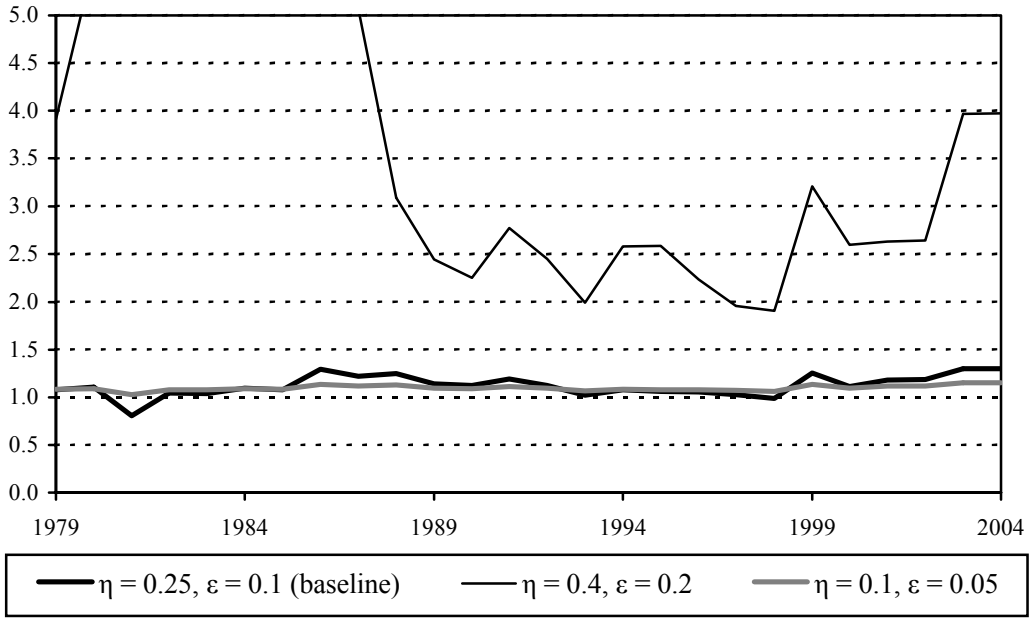


Figure 17. ψ_w with different average elasticities



fluctuations. But when both average elasticities are increased, the MECR rises dramatically – in some years, more than when just the intensive elasticity is increased. That implies that the effect of a higher extensive elasticity – theoretically ambiguous, but seen to reduce Ψ_w in Figure 15 – can have a different sign depending on the intensive elasticity. With an intensive elasticity

of 0.1 or 0.05, a higher extensive elasticity reduces the MECR associated with an in-work benefit, but with an intensive elasticity of 0.2, a higher extensive elasticity sometimes reduces and sometimes increases the MECR.

Ψ_w, like Ψ_d, is undefined from 1981-1984 in the high elasticity scenario since there is no revenue available for distribution. As with Figure 15, however, 1981 and 1982 are years in which an in-work benefit would have been revenue-raising. Thus we have the perverse case discussed in Section 2.3 in which it would be theoretically possible to introduce a revenue-raising in-work benefit to pay for a revenue-reducing rise in tax rates.

Responses concentrated on different margins

A second active debate in the literature is over the relative importance of the intensive and extensive margins of labour supply response. Figure 18 and Figure 19 show cases with elasticities more weighted towards the extensive margin (extensive averaging 0.4, intensive 0.05) and towards the intensive margin (0.1 and 0.2) than the baseline case; the full specifications are in Table 13 and Table 14.

The MECR for an in-work benefit is lower if responses are more focussed on the extensive margin, of course – that is the reason for focussing on the two margins in the first place. The effect for a demogrant is theoretically ambiguous, but Figure 18 shows that in practice a more prominent extensive margin increases the MECR here too, essentially because participation tax rates are higher than marginal tax rates.

Figure 18 and Figure 19 also show the extreme case in which there is no extensive margin at all – the original Mirrlees-type model as analysed by Browning and Johnson (1984) and Ballard (1988). For this scenario (shown in Table 15), I increase the average intensive elasticity to 0.3 and transfer all the variation by income and demographic type previously embodied in extensive elasticities to the intensive margin. In this case there is no positive participation response to the in-work benefit, so the deadweight cost of the two policies are the

Figure 18. ψ_d with average elasticities weighted towards different margins

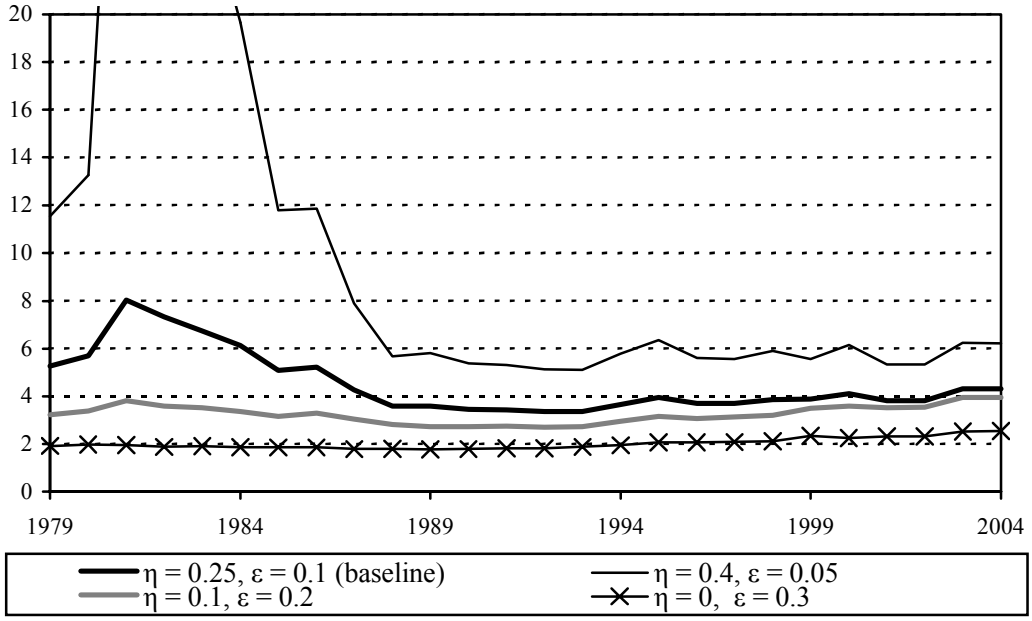
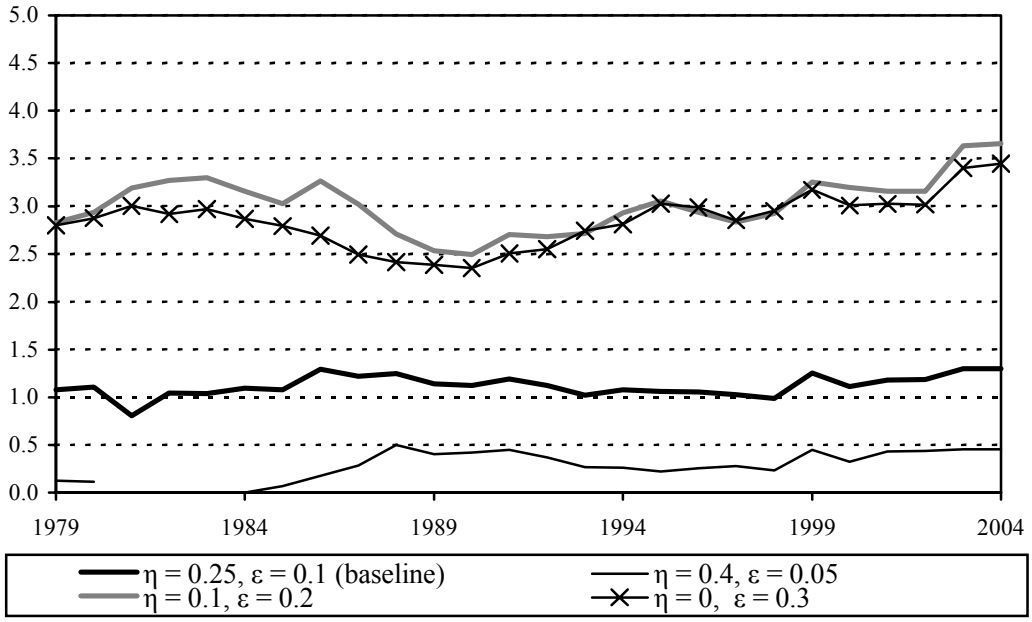


Figure 19. ψ_w with average elasticities weighted towards different margins



same, simply the cost of raising revenue from a marginal rate increase in the absence of a participation response

$$D_w = D_d = \sum_{j=1}^{J} \frac{\tau}{1-\tau} \varepsilon_j s_j; \tag{20}$$

but, as the Figures illustrate, the MECR for the in-work benefit is higher because restricting the payment to workers achieves less redistribution for the same level of deadweight loss. This is the standard finding of a long literature (eg Browning, 1995) which concludes that negative income taxes are a superior form of redistribution to in-work benefits, in line with the Mirrlees (1971) model in which negative marginal rates are always sub-optimal; but this is in fact the only case I examine in which Ψ_w is greater than Ψ_d.

The elasticity of the highest-income decile group

The highest-income decile group are potentially vital because their income share is very high, particularly in recent years: the top 10% of UK income tax payers now account for 52% of receipts, up from 35% in 1978-79.[27] This means that their labour supply responses can be crucial for determining the revenue effect of reforms and thus how much redistribution can be achieved. However, the responsiveness of this group is complex and disputed (see footnote 19). To cater for the uncertainty surrounding this group, I therefore present results using different elasticities (shown in Table 16 and Table 17) for the top decile group. The high case has an intensive elasticity for the top decile of 0.273, three times that for other deciles (rather than twice as in the baseline case), and extensive elasticities averaging 0.167, equal to (rather than half of) those for the 7th and 8th deciles. The low case has an intensive elasticity of 0.091, equal to that for the other decile groups, and extensive elasticities set to zero. Elasticities for the other nine decile groups remain as in the baseline case throughout.

Figure 20 shows yet again that higher elasticities increase the MECR for a demogrant policy. In contrast with the ambiguous findings for the whole population shown in Figure 17, Figure 21 shows that higher elasticities for just the top decile group increase the MECR for an in-work benefit. The extent of variation in the MECRs is obviously not as great as that from varying elasticities

[27] Source: Inland Revenue Statistics. This group does not quite correspond to the top decile group in my analysis because my analysis includes some working non-taxpayers and excludes some working taxpayers (the self-employed etc) and all non-working taxpayers.

Figure 20. ψ_d with different average elasticities for the richest decile group

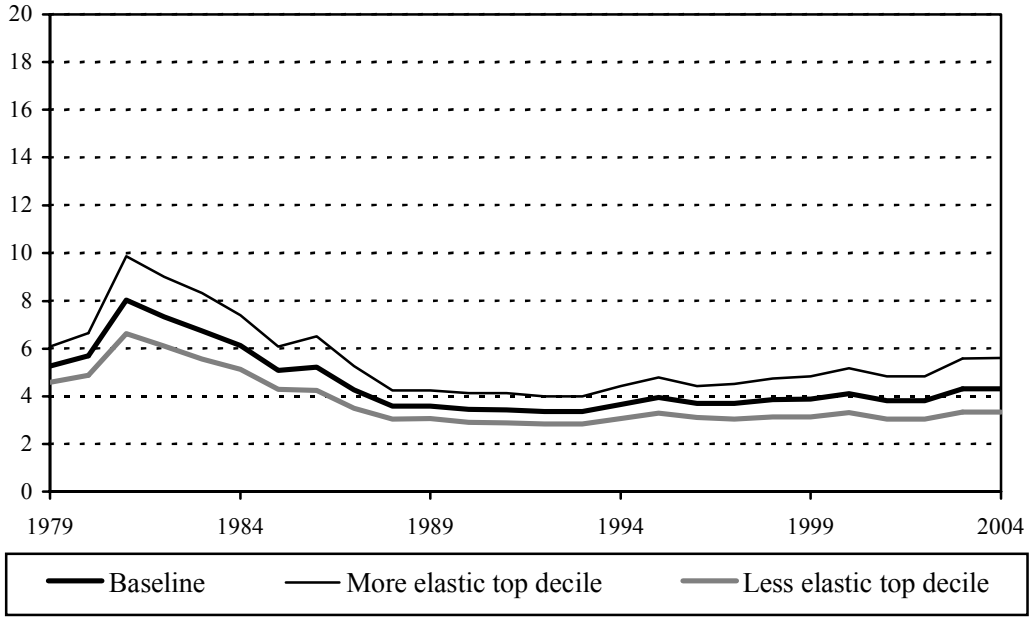
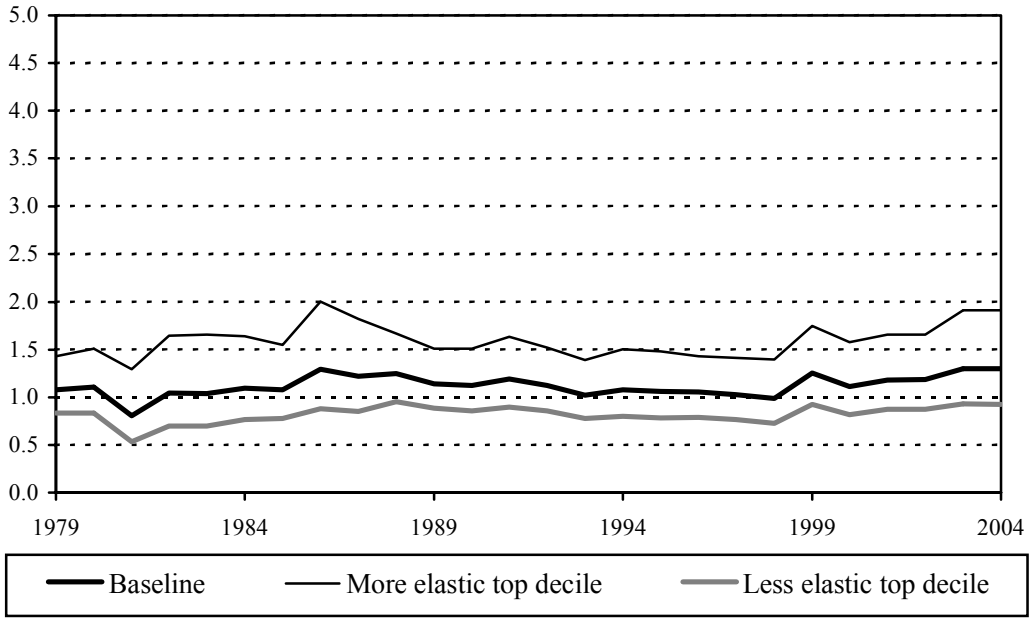


Figure 21. ψ_w with different average elasticities for the richest decile group



across the whole population. But the magnitude of these effects is quite large considering only a tenth of the working population changes, despite starting from a baseline of a low extensive elasticity for the top decile group in a context of high participation tax rates. The sizes of the effects are also quite large in absolute terms: in 2004, the level of elasticities for the richest tenth determines

whether a policy-maker must be willing to accept a loss to losers of £3.34 or £5.59 to transfer a marginal pound to the gainers from a demogrant, and whether he/she must accept a loss of £0.93 or £1.91 to transfer a marginal pound to the gainers from an in-work benefit. Which of these magnitudes is correct could be a decisive factor in a policy decision.

Variation across the whole population

Figure 22 and Figure 23 look more generally at the issue of how far elasticities vary with income and demographic type. While keeping the average intensive elasticity at 0.1 and the average extensive elasticity at 0.25 as in the baseline case, the Figures show the effect of greater or lesser departure from these averages across the population. The full specifications are given in Table 18 and Table 19.

The result is that a greater degree of variation is associated with a lower MECR in both cases. It is difficult to be confident about what is driving these results, since a number of different changes to the elasticities have been made simultaneously with a view to obtaining scenarios that look reasonable overall. Perhaps the most plausible explanation is that the revenue effects of in increase in elasticities for rich singles etc outweigh the effects of a reduction in elasticities for poor second earners, with changes to the top decile group a particularly important factor as indicated by the earlier findings.

Figure 22. ψ_d with different extent of variation in elasticities across income decile groups and demographic types

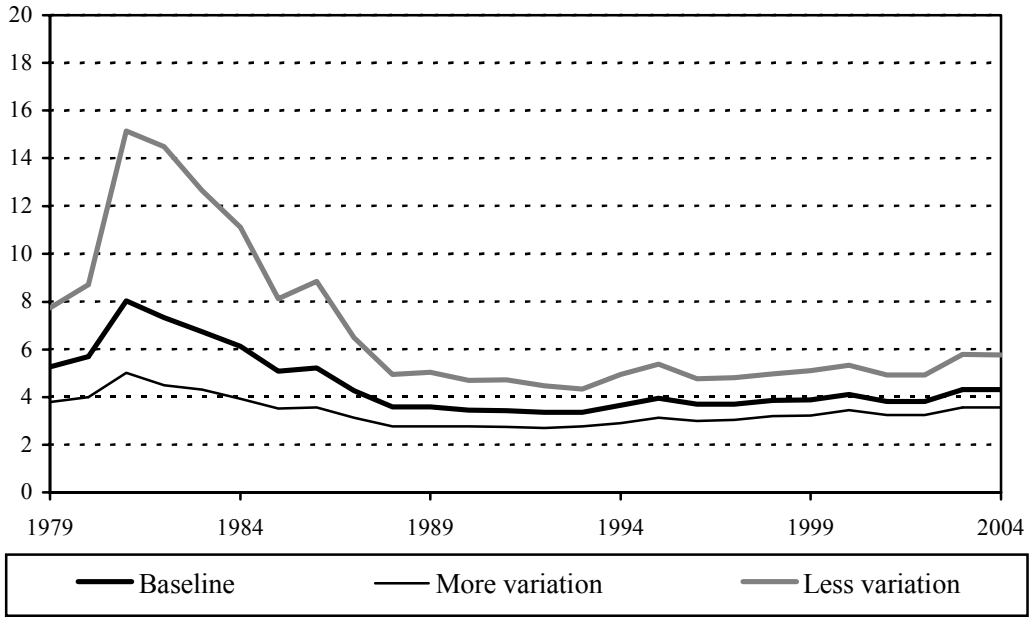
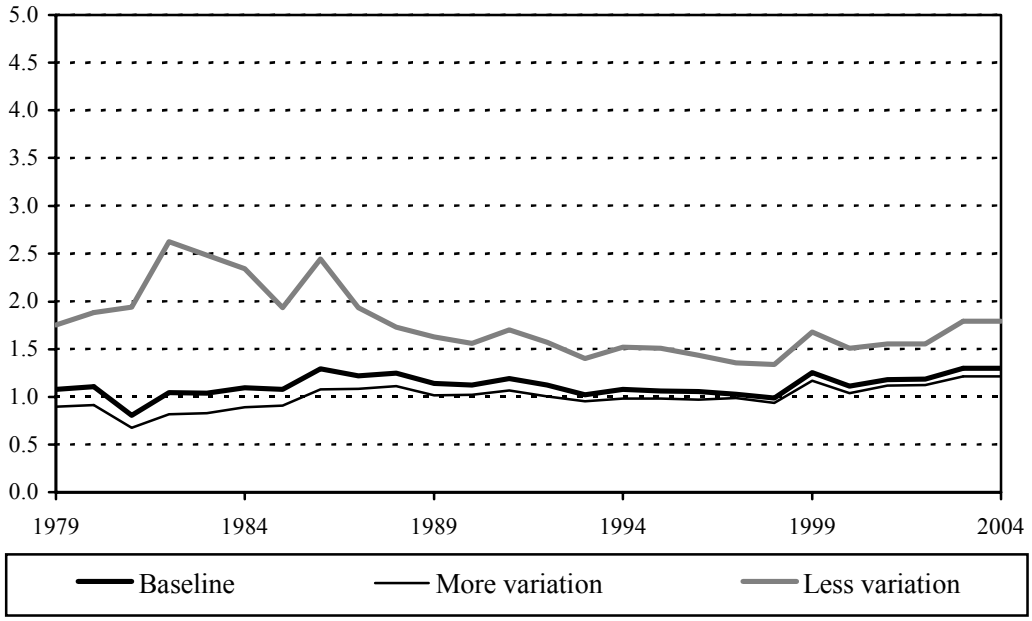


Figure 23. ψ_w with different extents of variation in elasticities across income groups and demographic types



Appendix B. Methodology for calculating tax rates and limitations in the modelling

Tax rates are calculated for each working individual in the sample using the TAXBEN microsimulation model. The tax and benefit system in place when each family was interviewed is applied to them (taking account of mid-year changes to the tax and benefit system where possible) to calculate the family's net income. Each individual's marginal tax rate is calculated by increasing his/her earnings by a penny, then applying the tax and benefit system again and measuring the change in the family's net income. Similarly, each individual's participation tax rate is calculated by setting his/her earnings to zero and measuring the change in net family income. Once these calculations have been made, it is a trivial task to calculate the marginal and participation tax rates defined in equations (3) and (4). Around 2 per cent of the sample (112 individuals per year, on average) were removed because their modelled tax rates were extremely high (above 0.99) or extremely low (below –2 for the marginal tax rate, below –10 for the participation tax rate).[28] Most of these cases represent either measurement/modelling error or people located at discontinuities in the budget constraint, and in any case the formulae are ill-defined for tax rates of 1 or above.

TAXBEN models most major personal taxes, tax credits and benefits – the main exceptions being stamp duties, inheritance tax and capital gains tax, which in any case do not fit easily into a static framework – and the effective incidence of all of them is assumed to be on the family.[29] The procedure above removes the need to deal directly with the interactions between different programmes. Two, however, do require special attention.

Elementary economic theory shows that (barring outright misperception) the long-run effective incidence of payroll taxes should be the same regardless of whether they are formally incident on the employee or the employer. Employer National Insurance Contributions (NICs), therefore, must be included in the

[28] The exact cut-off points made little difference to results.
[29] Corporate taxes also cause distortions, of course, but any ultimate incidence on individuals' labour supply margins is too tenuous and difficult to assign for these to be included in the model.

measure of earnings used in this paper (including the penny increment used to calculate marginal tax rates) and taken into account when calculating tax rates.

Consumption taxes (principally VAT and excise duties), too, should distort labour supply in a similar way to income taxes, especially in a model without saving such as the present one. The calculation of consumption tax rates is discussed in Section 4, but once calculated, they must be added to both the numerator and the denominator of the tax rate calculation.

Both policy reforms to be analysed involve a marginal increase in marginal tax rates. Because of the presence of employer NICs and consumption taxes, this should *not* be thought of as an increase of the same size in income tax rates. A one percentage point increase in income tax rates in fact equates to an increase in the marginal tax rate of only $(1+\textit{employer NICs rate})(1+\textit{consumption tax rate})$, even ignoring possible interactions with other parts of the tax and benefit system (such as benefits that are means-tested against net income).

Limitations in the data necessitate three important simplifications in the tax and benefit modelling process that affect the calculation of tax rates:

- TAXBEN models entitlement to programmes, not receipt, so in effect it assumes all entitlements are fully taken up. This will lead us to overestimate marginal tax rates for people who do not claim means-tested benefits or tax credits to which they are entitled. The effect on participation tax rates is more complicated, however, for two reasons: first, it depends on counterfactual take-up of out-of-work benefits as well as take-up of those to which workers are actually entitled; and second, if entitlements are not taken up because doing so is costly in terms of time, effort or stigma (this now standard view of take-up comes from Moffitt, 1983), the net benefit of taking up will be smaller than the monetary award: if a person is indifferent towards taking up an in-work benefit because the utility cost of claiming is equal to the value of the benefit, their net utility is unaffected by whether they receive the benefit and we might wish to say that their participation tax rate is unaffected too. Incorporating take-up in the model would therefore require rethinking the structure of utility as well.

- We do not model the locally varying rent restrictions that apply to housing benefit. This means housing benefit is modelled overly generously, and tax rates are overestimated.
- We ignore the various phase-outs and transitional protections that are often introduced when benefits are made less generous. This will generally lead to underestimating marginal tax rates, but have an ambiguous effect on participation tax rates.

Three sources of mis-measurement and possible bias which are specific to the calculation of consumption tax rates are worth noting:

- The FES is known to under-record household expenditure levels (see Figure 3.7 of Blow et al, 2004). Equal proportionate under-recording of all spending would not matter, since the average rate of tax would be unaffected; but in fact we know that spending on highly-taxed excisable goods (especially cigarettes and alcohol) is particularly under-reported (see Tanner, 1998, or Part 4, p. 5 of ONS, 2001a), and this will lead us to underestimate tax rates.
- Certain expenditure taxes are not modelled, again leading to an underestimate of tax rates. Betting taxes and air passenger duty are not modelled at all; vehicle excise duty is partly modelled (it is taken into account for calculation of net income, but the number of vehicles in the household is assumed not to change with income).
- Certain types of expenditure on housing – principally house purchases, rent, mortgage payments and water and other charges – are excluded since they are broadly independent of income for existing properties and it is hard to predict who would move house and to where in response to income changes, and so what stamp duty and changes in mortgage payments, council tax, housing benefit etc they would face. (Spending that is variable within the existing property – on insurance, repairs, DIY materials etc – is included.) This means we assume either that additional income is not spent on increasing housing quality, or more broadly that the household pays extra taxes at the same rate as on other goods.

It is also worth pointing out that public services which are provided differentially by income (such as benefits in kind, health services and council housing) might affect incentives to work, so by ignoring them we might be thought of as underestimating effective tax rates (assuming the public services are provided progressively). This is an omission throughout the literature, and remedying it would be a major research project in its own right.

Appendix C. Tables

Table 1: Number of working individuals by demographic type and income decile group, and employment rates, all years

	Income decile group											*Employment*
Demographic type	Poorest	2	3	4	5	6	7	8	9	Richest	*Total*	*Rate*
Single	1,468	3,827	5,086	4,616	4,231	3,622	3,237	2,787	2,493	1,920	33,287	*85.0%*
Lone parent	852	748	508	389	364	299	244	245	201	132	3,982	*47.2%*
Man, no children, working partner	161	300	764	1,314	1,735	2,242	2,525	2,505	2,703	2,661	16,910	*96.6%*
Man, no children, non-working partner	43	65	130	219	260	301	366	378	399	679	2,840	*78.3%*
Man, children, working partner	149	251	586	1,129	1,766	2,481	2,869	3,179	3,719	3,914	20,043	*96.5%*
Man, children, non-working partner	116	231	368	515	751	999	1,233	1,593	1,850	2,879	10,535	*81.0%*
Woman, no children, working partner	2,901	2,969	2,512	2,395	2,022	1,590	1,290	1,251	928	604	18,462	*86.4%*
Woman, no children, non-working partner	236	267	217	163	125	113	95	94	63	54	1,427	*50.5%*
Woman, children, working partner	7,830	4,216	2,203	1,581	1,140	845	808	827	608	333	20,391	*67.0%*
Woman, children, non-working partner	157	161	101	80	58	50	39	41	40	22	749	*27.2%*
Total	*13,913*	*13,035*	*12,475*	*12,401*	*12,452*	*12,542*	*12,706*	*12,900*	*13,004*	*13,198*	*128,626*	*78.8%*

Table 2: Means and standard deviations of consumption tax rates among workers

Consumption tax rate	*Income decile group*										
Demographic type	Poorest	2	3	4	5	6	7	8	9	Richest	*All*
Single	20.1% 0.100	20.3% 0.085	20.5% 0.083	20.4% 0.088	20.9% 0.084	20.6% 0.081	20.6% 0.082	20.4% 0.087	20.6% 0.083	19.8% 0.080	*20.5%* *0.085*
Lone parent	17.3% 0.085	16.9% 0.073	17.2% 0.074	17.9% 0.074	17.3% 0.074	16.9% 0.061	17.7% 0.080	16.4% 0.058	16.4% 0.055	17.3% 0.051	*17.2%* *0.073*
Man, no children, working partner	21.4% 0.077	20.5% 0.078	22.1% 0.090	21.0% 0.086	20.6% 0.079	20.7% 0.073	20.1% 0.071	20.0% 0.069	19.3% 0.063	18.8% 0.058	*20.1%* *0.072*
Man, no children, non-working partner	20.5% 0.127	21.9% 0.165	21.4% 0.100	23.0% 0.114	20.2% 0.109	20.3% 0.078	19.7% 0.083	20.4% 0.084	19.0% 0.079	18.8% 0.096	*20.0%* *0.096*
Man, children, working partner	19.5% 0.076	21.1% 0.083	19.2% 0.073	18.6% 0.070	18.5% 0.070	18.2% 0.066	18.1% 0.070	17.6% 0.062	17.3% 0.058	16.7% 0.051	*17.8%* *0.064*
Man, children, non-working partner	20.1% 0.082	18.2% 0.088	18.8% 0.085	17.8% 0.076	17.5% 0.076	16.8% 0.070	16.6% 0.069	16.5% 0.065	15.9% 0.059	15.7% 0.053	*16.5%* *0.065*
Woman, no children, working partner	20.1% 0.076	20.6% 0.080	20.4% 0.074	20.3% 0.071	19.9% 0.068	19.5% 0.067	19.4% 0.066	19.0% 0.059	19.2% 0.063	18.8% 0.053	*20.0%* *0.071*
Woman, no children, non-working partner	19.4% 0.083	21.3% 0.091	21.7% 0.087	21.0% 0.084	19.8% 0.075	22.9% 0.100	21.5% 0.074	19.7% 0.070	17.8% 0.063	19.1% 0.067	*20.7%* *0.084*
Woman, children, working partner	17.5% 0.067	17.8% 0.065	18.2% 0.062	18.3% 0.061	17.7% 0.061	17.7% 0.054	18.0% 0.060	16.9% 0.052	17.3% 0.050	16.9% 0.048	*17.7%* *0.063*
Woman, children, non-working partner	20.3% 0.089	20.7% 0.096	20.9% 0.087	18.5% 0.064	20.1% 0.148	18.7% 0.062	19.0% 0.045	17.3% 0.056	17.3% 0.052	17.8% 0.083	*19.7%* *0.088*
All	*18.6%* *0.077*	*19.5%* *0.080*	*20.1%* *0.079*	*20.0%* *0.081*	*19.9%* *0.079*	*19.6%* *0.074*	*19.4%* *0.075*	*18.9%* *0.072*	*18.5%* *0.068*	*17.8%* *0.064*	*19.2%* *0.075*

Table 3: Means and standard deviations of marginal tax rates among workers

Marginal tax rate	*Income decile group*										
Demographic type	Poorest	2	3	4	5	6	7	8	9	Richest	*All*
Single	38.1% 0.216	50.4% 0.091	50.5% 0.065	50.1% 0.054	50.2% 0.050	50.0% 0.051	49.6% 0.043	49.4% 0.046	47.4% 0.058	50.8% 0.070	*49.4%* *0.077*
Lone parent	45.2% 0.320	68.2% 0.200	70.5% 0.161	65.6% 0.165	60.2% 0.154	52.9% 0.115	51.1% 0.094	47.8% 0.060	44.1% 0.045	49.8% 0.072	*57.1%* *0.223*
Man, no children, working partner	38.3% 0.172	48.6% 0.072	50.1% 0.054	49.7% 0.045	49.8% 0.038	49.6% 0.036	49.3% 0.037	49.1% 0.036	46.9% 0.053	50.6% 0.065	*49.1%* *0.052*
Man, no children, non-working partner	56.8% 0.230	63.0% 0.208	56.1% 0.146	53.7% 0.098	51.9% 0.084	50.9% 0.056	49.3% 0.041	49.5% 0.041	47.0% 0.058	50.6% 0.073	*50.8%* *0.088*
Man, children, working partner	51.6% 0.237	57.5% 0.160	55.4% 0.128	51.6% 0.094	50.3% 0.071	49.7% 0.060	48.7% 0.043	48.3% 0.039	45.8% 0.052	49.3% 0.071	*49.0%* *0.072*
Man, children, non-working partner	69.8% 0.262	76.9% 0.176	77.8% 0.136	68.1% 0.157	59.0% 0.144	53.4% 0.107	50.2% 0.079	48.7% 0.048	46.2% 0.053	47.9% 0.078	*52.3%* *0.127*
Woman, no children, working partner	27.2% 0.142	47.8% 0.054	49.1% 0.041	49.1% 0.039	48.9% 0.035	48.7% 0.035	48.6% 0.036	48.5% 0.038	46.6% 0.054	51.5% 0.062	*45.4%* *0.103*
Woman, no children, non-working partner	31.2% 0.207	49.1% 0.163	50.2% 0.128	48.3% 0.071	49.6% 0.063	50.3% 0.062	48.9% 0.036	48.0% 0.042	45.2% 0.052	49.7% 0.071	*46.2%* *0.143*
Woman, children, working partner	25.6% 0.161	47.2% 0.065	48.4% 0.052	48.4% 0.047	48.2% 0.036	48.0% 0.035	48.1% 0.036	47.4% 0.037	45.5% 0.052	52.0% 0.060	*39.4%* *0.152*
Woman, children, non-working partner	44.6% 0.312	66.7% 0.242	63.0% 0.202	61.0% 0.161	55.4% 0.134	54.6% 0.129	50.8% 0.100	47.7% 0.043	44.5% 0.041	50.2% 0.084	*55.6%* *0.228*
All	*29.8%* *0.198*	*50.4%* *0.113*	*51.5%* *0.095*	*50.9%* *0.080*	*50.5%* *0.068*	*49.9%* *0.057*	*49.2%* *0.047*	*48.8%* *0.042*	*46.5%* *0.055*	*49.9%* *0.071*	*47.8%* *0.112*

Table 4: Means and standard deviations of participation tax rates among workers

Participation tax rate	*Income decile group*										
Demographic type	Poorest	2	3	4	5	6	7	8	9	Richest	*All*
Single	66.1% 0.208	67.1% 0.114	67.3% 0.099	67.2% 0.098	67.9% 0.095	67.9% 0.095	67.4% 0.092	67.0% 0.094	66.5% 0.089	64.9% 0.080	*67.1%* *0.104*
Lone parent	36.1% 0.256	63.5% 0.188	69.8% 0.163	72.0% 0.146	71.4% 0.148	71.4% 0.124	72.2% 0.104	69.7% 0.104	67.4% 0.086	66.7% 0.084	*61.9%* *0.223*
Man, no children, working partner	37.3% 0.201	47.1% 0.135	52.5% 0.113	54.0% 0.098	55.5% 0.081	56.1% 0.076	56.0% 0.069	56.3% 0.063	56.1% 0.056	57.6% 0.048	*55.6%* *0.079*
Man, no children, non-working partner	61.8% 0.245	77.1% 0.184	75.1% 0.172	73.5% 0.148	77.5% 0.119	72.4% 0.120	70.1% 0.123	69.4% 0.103	66.4% 0.097	63.9% 0.085	*69.5%* *0.127*
Man, children, working partner	50.7% 0.251	63.3% 0.188	66.2% 0.153	65.4% 0.137	66.0% 0.127	66.3% 0.119	64.7% 0.110	63.5% 0.102	61.7% 0.091	61.0% 0.075	*63.5%* *0.111*
Man, children, non-working partner	75.8% 0.180	81.7% 0.129	85.8% 0.110	86.3% 0.115	85.5% 0.123	83.5% 0.123	81.1% 0.122	79.0% 0.113	75.1% 0.116	69.2% 0.105	*77.4%* *0.130*
Woman, no children, working partner	24.5% 0.115	40.4% 0.082	46.2% 0.065	48.5% 0.055	50.3% 0.050	51.3% 0.046	52.2% 0.045	52.9% 0.040	53.9% 0.039	55.4% 0.040	*44.8%* *0.118*
Woman, no children, non-working partner	38.9% 0.240	59.7% 0.204	65.9% 0.179	62.2% 0.147	63.6% 0.128	61.8% 0.127	59.7% 0.114	60.1% 0.102	58.5% 0.082	59.9% 0.074	*58.1%* *0.192*
Woman, children, working partner	24.6% 0.157	39.9% 0.102	45.9% 0.082	48.7% 0.070	50.8% 0.067	51.2% 0.051	51.8% 0.043	52.5% 0.041	53.1% 0.039	56.2% 0.040	*38.3%* *0.162*
Woman, children, non-working partner	38.8% 0.408	72.8% 0.227	69.9% 0.222	71.2% 0.176	76.1% 0.157	71.6% 0.158	69.7% 0.154	67.2% 0.133	66.4% 0.111	58.8% 0.079	*63.9%* *0.284*
All	*31.7%* *0.225*	*52.4%* *0.178*	*59.4%* *0.150*	*60.8%* *0.138*	*62.8%* *0.133*	*63.4%* *0.128*	*63.2%* *0.121*	*63.0%* *0.116*	*62.4%* *0.105*	*62.3%* *0.088*	*58.1%* *0.171*

Table 5: Baseline elasticities

Extensive elasticity	*Income decile group*										
Demographic type	Poorest	2	3	4	5	6	7	8	9	Richest	*Average*
Single	0.299	0.299	0.239	0.239	0.179	0.179	0.120	0.120	0.060	0.060	*0.179*
Lone parent	0.448	0.448	0.359	0.359	0.269	0.269	0.179	0.179	0.090	0.090	*0.269*
Man, no children, working partner	0.299	0.299	0.239	0.239	0.179	0.179	0.120	0.120	0.060	0.060	*0.179*
Man, no children, non-working partner	0.299	0.299	0.239	0.239	0.179	0.179	0.120	0.120	0.060	0.060	*0.179*
Man, children, working partner	0.299	0.299	0.239	0.239	0.179	0.179	0.120	0.120	0.060	0.060	*0.179*
Man, children, non-working partner	0.299	0.299	0.239	0.239	0.179	0.179	0.120	0.120	0.060	0.060	*0.179*
Woman, no children, working partner	0.598	0.598	0.478	0.478	0.359	0.359	0.239	0.239	0.120	0.120	*0.359*
Woman, no children, non-working partner	0.299	0.299	0.239	0.239	0.179	0.179	0.120	0.120	0.060	0.060	*0.179*
Woman, children, working partner	0.598	0.598	0.478	0.478	0.359	0.359	0.239	0.239	0.120	0.120	*0.359*
Woman, children, non-working partner	0.448	0.448	0.359	0.359	0.269	0.269	0.179	0.179	0.090	0.090	*0.269*
Average	*0.417*	*0.417*	*0.333*	*0.333*	*0.250*	*0.250*	*0.167*	*0.167*	*0.083*	*0.083*	*0.250*

Intensive elasticity	*Income decile group*										
Demographic type	Poorest	2	3	4	5	6	7	8	9	Richest	*Average*
Single	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.182	*0.100*
Lone parent	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.182	*0.100*
Man, no children, working partner	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.182	*0.100*
Man, no children, non-working partner	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.182	*0.100*
Man, children, working partner	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.182	*0.100*
Man, children, non-working partner	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.182	*0.100*
Woman, no children, working partner	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.182	*0.100*
Woman, no children, non-working partner	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.182	*0.100*
Woman, children, working partner	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.182	*0.100*
Woman, children, non-working partner	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.182	*0.100*
Average	*0.091*	*0.091*	*0.091*	*0.091*	*0.091*	*0.091*	*0.091*	*0.091*	*0.091*	*0.182*	*0.100*

Table 6: IKKS's baseline elasticities

Extensive elasticity	*Income decile group group*										
Demographic type	Poorest	2	3	4	5	6	7	8	9	Richest	*Average*
Single	0.4	0.4	0.3	0.3	0.2	0.2	0.1	0.1	0	0	*0.2*
Lone parent	0.4	0.4	0.3	0.3	0.2	0.2	0.1	0.1	0	0	*0.2*
Man, no children, working partner	0.4	0.4	0.3	0.3	0.2	0.2	0.1	0.1	0	0	*0.2*
Man, no children, non-working partner	0.4	0.4	0.3	0.3	0.2	0.2	0.1	0.1	0	0	*0.2*
Man, children, working partner	0.4	0.4	0.3	0.3	0.2	0.2	0.1	0.1	0	0	*0.2*
Man, children, non-working partner	0.4	0.4	0.3	0.3	0.2	0.2	0.1	0.1	0	0	*0.2*
Woman, no children, working partner	0.4	0.4	0.3	0.3	0.2	0.2	0.1	0.1	0	0	*0.2*
Woman, no children, non-working partner	0.4	0.4	0.3	0.3	0.2	0.2	0.1	0.1	0	0	*0.2*
Woman, children, working partner	0.4	0.4	0.3	0.3	0.2	0.2	0.1	0.1	0	0	*0.2*
Woman, children, non-working partner	0.4	0.4	0.3	0.3	0.2	0.2	0.1	0.1	0	0	*0.2*
Average	*0.4*	*0.4*	*0.3*	*0.3*	*0.2*	*0.2*	*0.1*	*0.1*	*0*	*0*	*0.2*

Intensive elasticity	*Income decile group group*										
Demographic type	Poorest	2	3	4	5	6	7	8	9	Richest	*Average*
Single	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	*0.1*
Lone parent	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	*0.1*
Man, no children, working partner	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	*0.1*
Man, no children, non-working partner	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	*0.1*
Man, children, working partner	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	*0.1*
Man, children, non-working partner	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	*0.1*
Woman, no children, working partner	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	*0.1*
Woman, no children, non-working partner	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	*0.1*
Woman, children, working partner	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	*0.1*
Woman, children, non-working partner	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	*0.1*
Average	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*

Table 7: High average intensive elasticity

Extensive elasticity	*Income decile group*										
Demographic type	Poorest	2	3	4	5	6	7	8	9	Richest	*Average*
Single	0.299	0.299	0.239	0.239	0.179	0.179	0.120	0.120	0.060	0.060	*0.179*
Lone parent	0.448	0.448	0.359	0.359	0.269	0.269	0.179	0.179	0.090	0.090	*0.269*
Man, no children, working partner	0.299	0.299	0.239	0.239	0.179	0.179	0.120	0.120	0.060	0.060	*0.179*
Man, no children, non-working partner	0.299	0.299	0.239	0.239	0.179	0.179	0.120	0.120	0.060	0.060	*0.179*
Man, children, working partner	0.299	0.299	0.239	0.239	0.179	0.179	0.120	0.120	0.060	0.060	*0.179*
Man, children, non-working partner	0.299	0.299	0.239	0.239	0.179	0.179	0.120	0.120	0.060	0.060	*0.179*
Woman, no children, working partner	0.598	0.598	0.478	0.478	0.359	0.359	0.239	0.239	0.120	0.120	*0.359*
Woman, no children, non-working partner	0.299	0.299	0.239	0.239	0.179	0.179	0.120	0.120	0.060	0.060	*0.179*
Woman, children, working partner	0.598	0.598	0.478	0.478	0.359	0.359	0.239	0.239	0.120	0.120	*0.359*
Woman, children, non-working partner	0.448	0.448	0.359	0.359	0.269	0.269	0.179	0.179	0.090	0.090	*0.269*
Average	*0.417*	*0.417*	*0.333*	*0.333*	*0.250*	*0.250*	*0.167*	*0.167*	*0.083*	*0.083*	*0.250*

Intensive elasticity	*Income decile group*										
Demographic type	Poorest	2	3	4	5	6	7	8	9	Richest	*Average*
Single	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.364	*0.200*
Lone parent	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.364	*0.200*
Man, no children, working partner	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.364	*0.200*
Man, no children, non-working partner	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.364	*0.200*
Man, children, working partner	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.364	*0.200*
Man, children, non-working partner	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.364	*0.200*
Woman, no children, working partner	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.364	*0.200*
Woman, no children, non-working partner	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.364	*0.200*
Woman, children, working partner	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.364	*0.200*
Woman, children, non-working partner	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.364	*0.200*
Average	*0.182*	*0.182*	*0.182*	*0.182*	*0.182*	*0.182*	*0.182*	*0.182*	*0.182*	*0.364*	*0.200*

Table 8: Low average intensive elasticity

Extensive elasticity	*Income decile group*										
Demographic type	Poorest	2	3	4	5	6	7	8	9	Richest	*Average*
Single	0.299	0.299	0.239	0.239	0.179	0.179	0.120	0.120	0.060	0.060	*0.179*
Lone parent	0.448	0.448	0.359	0.359	0.269	0.269	0.179	0.179	0.090	0.090	*0.269*
Man, no children, working partner	0.299	0.299	0.239	0.239	0.179	0.179	0.120	0.120	0.060	0.060	*0.179*
Man, no children, non-working partner	0.299	0.299	0.239	0.239	0.179	0.179	0.120	0.120	0.060	0.060	*0.179*
Man, children, working partner	0.299	0.299	0.239	0.239	0.179	0.179	0.120	0.120	0.060	0.060	*0.179*
Man, children, non-working partner	0.299	0.299	0.239	0.239	0.179	0.179	0.120	0.120	0.060	0.060	*0.179*
Woman, no children, working partner	0.598	0.598	0.478	0.478	0.359	0.359	0.239	0.239	0.120	0.120	*0.359*
Woman, no children, non-working partner	0.299	0.299	0.239	0.239	0.179	0.179	0.120	0.120	0.060	0.060	*0.179*
Woman, children, working partner	0.598	0.598	0.478	0.478	0.359	0.359	0.239	0.239	0.120	0.120	*0.359*
Woman, children, non-working partner	0.448	0.448	0.359	0.359	0.269	0.269	0.179	0.179	0.090	0.090	*0.269*
Average	*0.417*	*0.417*	*0.333*	*0.333*	*0.250*	*0.250*	*0.167*	*0.167*	*0.083*	*0.083*	*0.250*

Intensive elasticity	*Income decile group*										
Demographic type	Poorest	2	3	4	5	6	7	8	9	Richest	*Average*
Single	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.091	*0.050*
Lone parent	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.091	*0.050*
Man, no children, working partner	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.091	*0.050*
Man, no children, non-working partner	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.091	*0.050*
Man, children, working partner	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.091	*0.050*
Man, children, non-working partner	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.091	*0.050*
Woman, no children, working partner	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.091	*0.050*
Woman, no children, non-working partner	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.091	*0.050*
Woman, children, working partner	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.091	*0.050*
Woman, children, non-working partner	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.091	*0.050*
Average	*0.045*	*0.045*	*0.045*	*0.045*	*0.045*	*0.045*	*0.045*	*0.045*	*0.045*	*0.091*	*0.050*

Table 9: High average extensive elasticity

Extensive elasticity	*Income decile group*										
Demographic type	Poorest	2	3	4	5	6	7	8	9	Richest	*Average*
Single	0.478	0.478	0.383	0.383	0.287	0.287	0.191	0.191	0.096	0.096	*0.287*
Lone parent	0.717	0.717	0.574	0.574	0.430	0.430	0.287	0.287	0.143	0.143	*0.430*
Man, no children, working partner	0.478	0.478	0.383	0.383	0.287	0.287	0.191	0.191	0.096	0.096	*0.287*
Man, no children, non-working partner	0.478	0.478	0.383	0.383	0.287	0.287	0.191	0.191	0.096	0.096	*0.287*
Man, children, working partner	0.478	0.478	0.383	0.383	0.287	0.287	0.191	0.191	0.096	0.096	*0.287*
Man, children, non-working partner	0.478	0.478	0.383	0.383	0.287	0.287	0.191	0.191	0.096	0.096	*0.287*
Woman, no children, working partner	0.957	0.957	0.765	0.765	0.574	0.574	0.383	0.383	0.191	0.191	*0.574*
Woman, no children, non-working partner	0.478	0.478	0.383	0.383	0.287	0.287	0.191	0.191	0.096	0.096	*0.287*
Woman, children, working partner	0.957	0.957	0.765	0.765	0.574	0.574	0.383	0.383	0.191	0.191	*0.574*
Woman, children, non-working partner	0.717	0.717	0.574	0.574	0.430	0.430	0.287	0.287	0.143	0.143	*0.430*
Average	*0.667*	*0.667*	*0.533*	*0.533*	*0.400*	*0.400*	*0.267*	*0.267*	*0.133*	*0.133*	*0.400*

Intensive elasticity	*Income decile group*										
Demographic type	Poorest	2	3	4	5	6	7	8	9	Richest	*Average*
Single	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.182	*0.100*
Lone parent	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.182	*0.100*
Man, no children, working partner	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.182	*0.100*
Man, no children, non-working partner	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.182	*0.100*
Man, children, working partner	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.182	*0.100*
Man, children, non-working partner	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.182	*0.100*
Woman, no children, working partner	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.182	*0.100*
Woman, no children, non-working partner	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.182	*0.100*
Woman, children, working partner	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.182	*0.100*
Woman, children, non-working partner	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.182	*0.100*
Average	*0.091*	*0.091*	*0.091*	*0.091*	*0.091*	*0.091*	*0.091*	*0.091*	*0.091*	*0.182*	*0.100*

Table 10: Low average extensive elasticity

Extensive elasticity	*Income decile group*										
Demographic type	Poorest	2	3	4	5	6	7	8	9	Richest	*Average*
Single	0.120	0.120	0.096	0.096	0.072	0.072	0.048	0.048	0.024	0.024	*0.072*
Lone parent	0.179	0.179	0.143	0.143	0.108	0.108	0.072	0.072	0.036	0.036	*0.108*
Man, no children, working partner	0.120	0.120	0.096	0.096	0.072	0.072	0.048	0.048	0.024	0.024	*0.072*
Man, no children, non-working partner	0.120	0.120	0.096	0.096	0.072	0.072	0.048	0.048	0.024	0.024	*0.072*
Man, children, working partner	0.120	0.120	0.096	0.096	0.072	0.072	0.048	0.048	0.024	0.024	*0.072*
Man, children, non-working partner	0.120	0.120	0.096	0.096	0.072	0.072	0.048	0.048	0.024	0.024	*0.072*
Woman, no children, working partner	0.239	0.239	0.191	0.191	0.143	0.143	0.096	0.096	0.048	0.048	*0.143*
Woman, no children, non-working partner	0.120	0.120	0.096	0.096	0.072	0.072	0.048	0.048	0.024	0.024	*0.072*
Woman, children, working partner	0.239	0.239	0.191	0.191	0.143	0.143	0.096	0.096	0.048	0.048	*0.143*
Woman, children, non-working partner	0.179	0.179	0.143	0.143	0.108	0.108	0.072	0.072	0.036	0.036	*0.108*
Average	*0.167*	*0.167*	*0.133*	*0.133*	*0.100*	*0.100*	*0.067*	*0.067*	*0.033*	*0.033*	*0.100*

Intensive elasticity	*Income decile group*										
Demographic type	Poorest	2	3	4	5	6	7	8	9	Richest	*Average*
Single	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.182	*0.100*
Lone parent	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.182	*0.100*
Man, no children, working partner	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.182	*0.100*
Man, no children, non-working partner	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.182	*0.100*
Man, children, working partner	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.182	*0.100*
Man, children, non-working partner	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.182	*0.100*
Woman, no children, working partner	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.182	*0.100*
Woman, no children, non-working partner	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.182	*0.100*
Woman, children, working partner	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.182	*0.100*
Woman, children, non-working partner	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.182	*0.100*
Average	*0.091*	*0.091*	*0.091*	*0.091*	*0.091*	*0.091*	*0.091*	*0.091*	*0.091*	*0.182*	*0.100*

Table 11: High average intensive and extensive elasticities

Extensive elasticity	*Income decile group*										
Demographic type	Poorest	2	3	4	5	6	7	8	9	Richest	*Average*
Single	0.478	0.478	0.383	0.383	0.287	0.287	0.191	0.191	0.096	0.096	*0.287*
Lone parent	0.717	0.717	0.574	0.574	0.430	0.430	0.287	0.287	0.143	0.143	*0.430*
Man, no children, working partner	0.478	0.478	0.383	0.383	0.287	0.287	0.191	0.191	0.096	0.096	*0.287*
Man, no children, non-working partner	0.478	0.478	0.383	0.383	0.287	0.287	0.191	0.191	0.096	0.096	*0.287*
Man, children, working partner	0.478	0.478	0.383	0.383	0.287	0.287	0.191	0.191	0.096	0.096	*0.287*
Man, children, non-working partner	0.478	0.478	0.383	0.383	0.287	0.287	0.191	0.191	0.096	0.096	*0.287*
Woman, no children, working partner	0.957	0.957	0.765	0.765	0.574	0.574	0.383	0.383	0.191	0.191	*0.574*
Woman, no children, non-working partner	0.478	0.478	0.383	0.383	0.287	0.287	0.191	0.191	0.096	0.096	*0.287*
Woman, children, working partner	0.957	0.957	0.765	0.765	0.574	0.574	0.383	0.383	0.191	0.191	*0.574*
Woman, children, non-working partner	0.717	0.717	0.574	0.574	0.430	0.430	0.287	0.287	0.143	0.143	*0.430*
Average	*0.667*	*0.667*	*0.533*	*0.533*	*0.400*	*0.400*	*0.267*	*0.267*	*0.133*	*0.133*	*0.400*

Intensive elasticity	*Income decile group*										
Demographic type	Poorest	2	3	4	5	6	7	8	9	Richest	*Average*
Single	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.364	*0.200*
Lone parent	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.364	*0.200*
Man, no children, working partner	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.364	*0.200*
Man, no children, non-working partner	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.364	*0.200*
Man, children, working partner	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.364	*0.200*
Man, children, non-working partner	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.364	*0.200*
Woman, no children, working partner	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.364	*0.200*
Woman, no children, non-working partner	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.364	*0.200*
Woman, children, working partner	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.364	*0.200*
Woman, children, non-working partner	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.364	*0.200*
Average	*0.182*	*0.182*	*0.182*	*0.182*	*0.182*	*0.182*	*0.182*	*0.182*	*0.182*	*0.364*	*0.200*

Table 12: Low average intensive and extensive elasticities

Extensive elasticity	*Income decile group*										
Demographic type	Poorest	2	3	4	5	6	7	8	9	Richest	*Average*
Single	0.120	0.120	0.096	0.096	0.072	0.072	0.048	0.048	0.024	0.024	*0.072*
Lone parent	0.179	0.179	0.143	0.143	0.108	0.108	0.072	0.072	0.036	0.036	*0.108*
Man, no children, working partner	0.120	0.120	0.096	0.096	0.072	0.072	0.048	0.048	0.024	0.024	*0.072*
Man, no children, non-working partner	0.120	0.120	0.096	0.096	0.072	0.072	0.048	0.048	0.024	0.024	*0.072*
Man, children, working partner	0.120	0.120	0.096	0.096	0.072	0.072	0.048	0.048	0.024	0.024	*0.072*
Man, children, non-working partner	0.120	0.120	0.096	0.096	0.072	0.072	0.048	0.048	0.024	0.024	*0.072*
Woman, no children, working partner	0.239	0.239	0.191	0.191	0.143	0.143	0.096	0.096	0.048	0.048	*0.143*
Woman, no children, non-working partner	0.120	0.120	0.096	0.096	0.072	0.072	0.048	0.048	0.024	0.024	*0.072*
Woman, children, working partner	0.239	0.239	0.191	0.191	0.143	0.143	0.096	0.096	0.048	0.048	*0.143*
Woman, children, non-working partner	0.179	0.179	0.143	0.143	0.108	0.108	0.072	0.072	0.036	0.036	*0.108*
Average	*0.167*	*0.167*	*0.133*	*0.133*	*0.100*	*0.100*	*0.067*	*0.067*	*0.033*	*0.033*	*0.100*

Intensive elasticity	*Income decile group*										
Demographic type	Poorest	2	3	4	5	6	7	8	9	Richest	*Average*
Single	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.091	*0.050*
Lone parent	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.091	*0.050*
Man, no children, working partner	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.091	*0.050*
Man, no children, non-working partner	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.091	*0.050*
Man, children, working partner	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.091	*0.050*
Man, children, non-working partner	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.091	*0.050*
Woman, no children, working partner	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.091	*0.050*
Woman, no children, non-working partner	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.091	*0.050*
Woman, children, working partner	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.091	*0.050*
Woman, children, non-working partner	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.091	*0.050*
Average	*0.045*	*0.045*	*0.045*	*0.045*	*0.045*	*0.045*	*0.045*	*0.045*	*0.045*	*0.091*	*0.050*

Table 13: Responses focussed on extensive margin

Extensive elasticity	*Income decile group*										
Demographic type	Poorest	2	3	4	5	6	7	8	9	Richest	*Average*
Single	0.478	0.478	0.383	0.383	0.287	0.287	0.191	0.191	0.096	0.096	*0.287*
Lone parent	0.717	0.717	0.574	0.574	0.430	0.430	0.287	0.287	0.143	0.143	*0.430*
Man, no children, working partner	0.478	0.478	0.383	0.383	0.287	0.287	0.191	0.191	0.096	0.096	*0.287*
Man, no children, non-working partner	0.478	0.478	0.383	0.383	0.287	0.287	0.191	0.191	0.096	0.096	*0.287*
Man, children, working partner	0.478	0.478	0.383	0.383	0.287	0.287	0.191	0.191	0.096	0.096	*0.287*
Man, children, non-working partner	0.478	0.478	0.383	0.383	0.287	0.287	0.191	0.191	0.096	0.096	*0.287*
Woman, no children, working partner	0.957	0.957	0.765	0.765	0.574	0.574	0.383	0.383	0.191	0.191	*0.574*
Woman, no children, non-working partner	0.478	0.478	0.383	0.383	0.287	0.287	0.191	0.191	0.096	0.096	*0.287*
Woman, children, working partner	0.957	0.957	0.765	0.765	0.574	0.574	0.383	0.383	0.191	0.191	*0.574*
Woman, children, non-working partner	0.717	0.717	0.574	0.574	0.430	0.430	0.287	0.287	0.143	0.143	*0.430*
Average	*0.667*	*0.667*	*0.533*	*0.533*	*0.400*	*0.400*	*0.267*	*0.267*	*0.133*	*0.133*	*0.400*

Intensive elasticity	*Income decile group*										
Demographic type	Poorest	2	3	4	5	6	7	8	9	Richest	*Average*
Single	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.091	*0.050*
Lone parent	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.091	*0.050*
Man, no children, working partner	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.091	*0.050*
Man, no children, non-working partner	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.091	*0.050*
Man, children, working partner	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.091	*0.050*
Man, children, non-working partner	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.091	*0.050*
Woman, no children, working partner	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.091	*0.050*
Woman, no children, non-working partner	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.091	*0.050*
Woman, children, working partner	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.091	*0.050*
Woman, children, non-working partner	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.091	*0.050*
Average	*0.045*	*0.045*	*0.045*	*0.045*	*0.045*	*0.045*	*0.045*	*0.045*	*0.045*	*0.091*	*0.050*

Table 14: Responses focussed on intensive margin

Extensive elasticity	*Income decile group*										
Demographic type	Poorest	2	3	4	5	6	7	8	9	Richest	*Average*
Single	0.120	0.120	0.096	0.096	0.072	0.072	0.048	0.048	0.024	0.024	*0.072*
Lone parent	0.179	0.179	0.143	0.143	0.108	0.108	0.072	0.072	0.036	0.036	*0.108*
Man, no children, working partner	0.120	0.120	0.096	0.096	0.072	0.072	0.048	0.048	0.024	0.024	*0.072*
Man, no children, non-working partner	0.120	0.120	0.096	0.096	0.072	0.072	0.048	0.048	0.024	0.024	*0.072*
Man, children, working partner	0.120	0.120	0.096	0.096	0.072	0.072	0.048	0.048	0.024	0.024	*0.072*
Man, children, non-working partner	0.120	0.120	0.096	0.096	0.072	0.072	0.048	0.048	0.024	0.024	*0.072*
Woman, no children, working partner	0.239	0.239	0.191	0.191	0.143	0.143	0.096	0.096	0.048	0.048	*0.143*
Woman, no children, non-working partner	0.120	0.120	0.096	0.096	0.072	0.072	0.048	0.048	0.024	0.024	*0.072*
Woman, children, working partner	0.239	0.239	0.191	0.191	0.143	0.143	0.096	0.096	0.048	0.048	*0.143*
Woman, children, non-working partner	0.179	0.179	0.143	0.143	0.108	0.108	0.072	0.072	0.036	0.036	*0.108*
Average	*0.167*	*0.167*	*0.133*	*0.133*	*0.100*	*0.100*	*0.067*	*0.067*	*0.033*	*0.033*	*0.100*

Intensive elasticity	*Income decile group*										
Demographic type	Poorest	2	3	4	5	6	7	8	9	Richest	*Average*
Single	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.364	*0.200*
Lone parent	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.364	*0.200*
Man, no children, working partner	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.364	*0.200*
Man, no children, non-working partner	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.364	*0.200*
Man, children, working partner	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.364	*0.200*
Man, children, non-working partner	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.364	*0.200*
Woman, no children, working partner	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.364	*0.200*
Woman, no children, non-working partner	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.364	*0.200*
Woman, children, working partner	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.364	*0.200*
Woman, children, non-working partner	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.364	*0.200*
Average	*0.182*	*0.182*	*0.182*	*0.182*	*0.182*	*0.182*	*0.182*	*0.182*	*0.182*	*0.364*	*0.200*

Table 15: No extensive margin

Extensive elasticity	*Income decile group*										
Demographic type	Poorest	2	3	4	5	6	7	8	9	Richest	*Average*
Single	0	0	0	0	0	0	0	0	0	0	*0*
Lone parent	0	0	0	0	0	0	0	0	0	0	*0*
Man, no children, working partner	0	0	0	0	0	0	0	0	0	0	*0*
Man, no children, non-working partner	0	0	0	0	0	0	0	0	0	0	*0*
Man, children, working partner	0	0	0	0	0	0	0	0	0	0	*0*
Man, children, non-working partner	0	0	0	0	0	0	0	0	0	0	*0*
Woman, no children, working partner	0	0	0	0	0	0	0	0	0	0	*0*
Woman, no children, non-working partner	0	0	0	0	0	0	0	0	0	0	*0*
Woman, children, working partner	0	0	0	0	0	0	0	0	0	0	*0*
Woman, children, non-working partner	0	0	0	0	0	0	0	0	0	0	*0*
Average	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	0

Intensive elasticity	*Income decile group*										
Demographic type	Poorest	2	3	4	5	6	7	8	9	Richest	*Average*
Single	0.350	0.350	0.280	0.280	0.210	0.210	0.140	0.140	0.070	0.140	*0.217*
Lone parent	0.525	0.525	0.420	0.420	0.315	0.315	0.210	0.210	0.105	0.210	*0.325*
Man, no children, working partner	0.350	0.350	0.280	0.280	0.210	0.210	0.140	0.140	0.070	0.140	*0.217*
Man, no children, non-working partner	0.350	0.350	0.280	0.280	0.210	0.210	0.140	0.140	0.070	0.140	*0.217*
Man, children, working partner	0.350	0.350	0.280	0.280	0.210	0.210	0.140	0.140	0.070	0.140	*0.217*
Man, children, non-working partner	0.350	0.350	0.280	0.280	0.210	0.210	0.140	0.140	0.070	0.140	*0.217*
Woman, no children, working partner	0.699	0.699	0.559	0.559	0.420	0.420	0.280	0.280	0.140	0.280	*0.434*
Woman, no children, non-working partner	0.350	0.350	0.280	0.280	0.210	0.210	0.140	0.140	0.070	0.140	*0.217*
Woman, children, working partner	0.699	0.699	0.559	0.559	0.420	0.420	0.280	0.280	0.140	0.280	*0.434*
Woman, children, non-working partner	0.525	0.525	0.420	0.420	0.315	0.315	0.210	0.210	0.105	0.210	*0.325*
Average	*0.484*	*0.484*	*0.387*	*0.387*	*0.290*	*0.290*	*0.194*	*0.194*	*0.097*	*0.194*	0.300

Table 16: High elasticities for top decile group

Extensive elasticity	*Income decile group*										
Demographic type	Poorest	2	3	4	5	6	7	8	9	Richest	*Average*
Single	0.299	0.299	0.239	0.239	0.179	0.179	0.120	0.120	0.060	0.120	*0.185*
Lone parent	0.448	0.448	0.359	0.359	0.269	0.269	0.179	0.179	0.090	0.179	*0.278*
Man, no children, working partner	0.299	0.299	0.239	0.239	0.179	0.179	0.120	0.120	0.060	0.120	*0.185*
Man, no children, non-working partner	0.299	0.299	0.239	0.239	0.179	0.179	0.120	0.120	0.060	0.120	*0.185*
Man, children, working partner	0.299	0.299	0.239	0.239	0.179	0.179	0.120	0.120	0.060	0.120	*0.185*
Man, children, non-working partner	0.299	0.299	0.239	0.239	0.179	0.179	0.120	0.120	0.060	0.120	*0.185*
Woman, no children, working partner	0.598	0.598	0.478	0.478	0.359	0.359	0.239	0.239	0.120	0.239	*0.371*
Woman, no children, non-working partner	0.299	0.299	0.239	0.239	0.179	0.179	0.120	0.120	0.060	0.120	*0.185*
Woman, children, working partner	0.598	0.598	0.478	0.478	0.359	0.359	0.239	0.239	0.120	0.239	*0.371*
Woman, children, non-working partner	0.448	0.448	0.359	0.359	0.269	0.269	0.179	0.179	0.090	0.179	*0.278*
Average	*0.417*	*0.417*	*0.333*	*0.333*	*0.250*	*0.250*	*0.167*	*0.167*	*0.083*	*0.167*	*0.258*

Intensive elasticity	*Income decile group*										
Demographic type	Poorest	2	3	4	5	6	7	8	9	Richest	*Average*
Single	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.273	*0.109*
Lone parent	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.273	*0.109*
Man, no children, working partner	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.273	*0.109*
Man, no children, non-working partner	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.273	*0.109*
Man, children, working partner	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.273	*0.109*
Man, children, non-working partner	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.273	*0.109*
Woman, no children, working partner	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.273	*0.109*
Woman, no children, non-working partner	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.273	*0.109*
Woman, children, working partner	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.273	*0.109*
Woman, children, non-working partner	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.273	*0.109*
Average	*0.091*	*0.091*	*0.091*	*0.091*	*0.091*	*0.091*	*0.091*	*0.091*	*0.091*	*0.273*	*0.109*

Table 17: Low elasticities for top decile group

Extensive elasticity	*Income decile group*										
Demographic type	Poorest	2	3	4	5	6	7	8	9	Richest	*Average*
Single	0.299	0.299	0.239	0.239	0.179	0.179	0.120	0.120	0.060	0.000	*0.173*
Lone parent	0.448	0.448	0.359	0.359	0.269	0.269	0.179	0.179	0.090	0.000	*0.260*
Man, no children, working partner	0.299	0.299	0.239	0.239	0.179	0.179	0.120	0.120	0.060	0.000	*0.173*
Man, no children, non-working partner	0.299	0.299	0.239	0.239	0.179	0.179	0.120	0.120	0.060	0.000	*0.173*
Man, children, working partner	0.299	0.299	0.239	0.239	0.179	0.179	0.120	0.120	0.060	0.000	*0.173*
Man, children, non-working partner	0.299	0.299	0.239	0.239	0.179	0.179	0.120	0.120	0.060	0.000	*0.173*
Woman, no children, working partner	0.598	0.598	0.478	0.478	0.359	0.359	0.239	0.239	0.120	0.000	*0.347*
Woman, no children, non-working partner	0.299	0.299	0.239	0.239	0.179	0.179	0.120	0.120	0.060	0.000	*0.173*
Woman, children, working partner	0.598	0.598	0.478	0.478	0.359	0.359	0.239	0.239	0.120	0.000	*0.347*
Woman, children, non-working partner	0.448	0.448	0.359	0.359	0.269	0.269	0.179	0.179	0.090	0.000	*0.260*
Average	*0.417*	*0.417*	*0.333*	*0.333*	*0.250*	*0.250*	*0.167*	*0.167*	*0.083*	*0.000*	*0.242*

Intensive elasticity	*Income decile group*										
Demographic type	Poorest	2	3	4	5	6	7	8	9	Richest	*Average*
Single	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	*0.091*
Lone parent	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	*0.091*
Man, no children, working partner	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	*0.091*
Man, no children, non-working partner	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	*0.091*
Man, children, working partner	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	*0.091*
Man, children, non-working partner	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	*0.091*
Woman, no children, working partner	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	*0.091*
Woman, no children, non-working partner	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	*0.091*
Woman, children, working partner	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	*0.091*
Woman, children, non-working partner	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	0.091	*0.091*
Average	*0.091*	*0.091*	*0.091*	*0.091*	*0.091*	*0.091*	*0.091*	*0.091*	*0.091*	*0.091*	*0.091*

Table 18: Pronounced variation by income decile group and demographic type

Extensive elasticity	*Income decile group*										
Demographic type	Poorest	2	3	4	5	6	7	8	9	Richest	*Average*
Single	0.258	0.258	0.194	0.194	0.129	0.129	0.065	0.065	0.032	0.032	*0.136*
Lone parent	0.517	0.517	0.388	0.388	0.258	0.258	0.129	0.129	0.065	0.065	*0.271*
Man, no children, working partner	0.258	0.258	0.194	0.194	0.129	0.129	0.065	0.065	0.032	0.032	*0.136*
Man, no children, non-working partner	0.258	0.258	0.194	0.194	0.129	0.129	0.065	0.065	0.032	0.032	*0.136*
Man, children, working partner	0.258	0.258	0.194	0.194	0.129	0.129	0.065	0.065	0.032	0.032	*0.136*
Man, children, non-working partner	0.258	0.258	0.194	0.194	0.129	0.129	0.065	0.065	0.032	0.032	*0.136*
Woman, no children, working partner	0.775	0.775	0.581	0.581	0.388	0.388	0.194	0.194	0.097	0.097	*0.407*
Woman, no children, non-working partner	0.258	0.258	0.194	0.194	0.129	0.129	0.065	0.065	0.032	0.032	*0.136*
Woman, children, working partner	0.775	0.775	0.581	0.581	0.388	0.388	0.194	0.194	0.097	0.097	*0.407*
Woman, children, non-working partner	0.517	0.517	0.388	0.388	0.258	0.258	0.129	0.129	0.065	0.065	*0.271*
Average	*0.476*	*0.476*	*0.357*	*0.357*	*0.238*	*0.238*	*0.119*	*0.119*	*0.060*	*0.060*	*0.250*

Intensive elasticity	*Income decile group*										
Demographic type	Poorest	2	3	4	5	6	7	8	9	Richest	*Average*
Single	0.066	0.066	0.066	0.066	0.066	0.066	0.066	0.066	0.066	0.197	*0.079*
Lone parent	0.098	0.098	0.098	0.098	0.098	0.098	0.098	0.098	0.098	0.295	*0.118*
Man, no children, working partner	0.066	0.066	0.066	0.066	0.066	0.066	0.066	0.066	0.066	0.197	*0.079*
Man, no children, non-working partner	0.066	0.066	0.066	0.066	0.066	0.066	0.066	0.066	0.066	0.197	*0.079*
Man, children, working partner	0.066	0.066	0.066	0.066	0.066	0.066	0.066	0.066	0.066	0.197	*0.079*
Man, children, non-working partner	0.066	0.066	0.066	0.066	0.066	0.066	0.066	0.066	0.066	0.197	*0.079*
Woman, no children, working partner	0.131	0.131	0.131	0.131	0.131	0.131	0.131	0.131	0.131	0.394	*0.158*
Woman, no children, non-working partner	0.066	0.066	0.066	0.066	0.066	0.066	0.066	0.066	0.066	0.197	*0.079*
Woman, children, working partner	0.131	0.131	0.131	0.131	0.131	0.131	0.131	0.131	0.131	0.394	*0.158*
Woman, children, non-working partner	0.098	0.098	0.098	0.098	0.098	0.098	0.098	0.098	0.098	0.295	*0.118*
Average	*0.083*	*0.083*	*0.083*	*0.083*	*0.083*	*0.083*	*0.083*	*0.083*	*0.083*	*0.250*	*0.100*

Table 19: Limited variation by income decile group and demographic type

Extensive elasticity	*Income decile group*										
Demographic type	Poorest	2	3	4	5	6	7	8	9	Richest	*Average*
Single	0.284	0.284	0.248	0.248	0.213	0.213	0.177	0.177	0.142	0.142	*0.213*
Lone parent	0.355	0.355	0.310	0.310	0.266	0.266	0.222	0.222	0.177	0.177	*0.266*
Man, no children, working partner	0.284	0.284	0.248	0.248	0.213	0.213	0.177	0.177	0.142	0.142	*0.213*
Man, no children, non-working partner	0.284	0.284	0.248	0.248	0.213	0.213	0.177	0.177	0.142	0.142	*0.213*
Man, children, working partner	0.284	0.284	0.248	0.248	0.213	0.213	0.177	0.177	0.142	0.142	*0.213*
Man, children, non-working partner	0.284	0.284	0.248	0.248	0.213	0.213	0.177	0.177	0.142	0.142	*0.213*
Woman, no children, working partner	0.425	0.425	0.372	0.372	0.319	0.319	0.266	0.266	0.213	0.213	*0.319*
Woman, no children, non-working partner	0.284	0.284	0.248	0.248	0.213	0.213	0.177	0.177	0.142	0.142	*0.213*
Woman, children, working partner	0.425	0.425	0.372	0.372	0.319	0.319	0.266	0.266	0.213	0.213	*0.319*
Woman, children, non-working partner	0.355	0.355	0.310	0.310	0.266	0.266	0.222	0.222	0.177	0.177	*0.266*
Average	*0.333*	*0.333*	*0.292*	*0.292*	*0.250*	*0.250*	*0.208*	*0.208*	*0.167*	*0.167*	*0.250*

Intensive elasticity	*Income decile group*										
Demographic type	Poorest	2	3	4	5	6	7	8	9	Richest	*Average*
Single	0.095	0.095	0.095	0.095	0.095	0.095	0.095	0.095	0.095	0.143	*0.100*
Lone parent	0.095	0.095	0.095	0.095	0.095	0.095	0.095	0.095	0.095	0.143	*0.100*
Man, no children, working partner	0.095	0.095	0.095	0.095	0.095	0.095	0.095	0.095	0.095	0.143	*0.100*
Man, no children, non-working partner	0.095	0.095	0.095	0.095	0.095	0.095	0.095	0.095	0.095	0.143	*0.100*
Man, children, working partner	0.095	0.095	0.095	0.095	0.095	0.095	0.095	0.095	0.095	0.143	*0.100*
Man, children, non-working partner	0.095	0.095	0.095	0.095	0.095	0.095	0.095	0.095	0.095	0.143	*0.100*
Woman, no children, working partner	0.095	0.095	0.095	0.095	0.095	0.095	0.095	0.095	0.095	0.143	*0.100*
Woman, no children, non-working partner	0.095	0.095	0.095	0.095	0.095	0.095	0.095	0.095	0.095	0.143	*0.100*
Woman, children, working partner	0.095	0.095	0.095	0.095	0.095	0.095	0.095	0.095	0.095	0.143	*0.100*
Woman, children, non-working partner	0.095	0.095	0.095	0.095	0.095	0.095	0.095	0.095	0.095	0.143	*0.100*
Average	*0.095*	*0.095*	*0.095*	*0.095*	*0.095*	*0.095*	*0.095*	*0.095*	*0.095*	*0.143*	*0.100*