Deadweight Loss and Taxation of Earned Income: Evidence from Tax Records of the UK Self Employed *

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Abstract

Very preliminary - comments welcome

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1. Introduction

Recognition that deadweight loss from marginal taxation of labour income can arise from dimensions of response other than simply hours of work has become increasingly widespread. The possible quantitative importance of such effects has been emphasised by the evidence of Lindsey (1987) and Feldstein (1995a,b), for example, that taxable income in the US may be highly responsive to marginal tax rates. Althought the empirical basis for some of these results is contentious (see Slemrod 1995, Goolsbee 2000, Moffitt and Wilhelm 2000, for example), Feldstein's (1999) observation that taxable income responses make a sounder basis for an inclusive assessment of deadweight loss remains compelling. An increasing number of papers have sought to determine the size of such effects both for the US (Auten and Caroll 1999, Gruber and Saez 2000) and elsewhere (Aarbu and Thoresen 2001, Sillamaa and Veall 2001).

Many of these studies use evidence from panels of tax records in periods of tax reform. No such panel exists in the public domain for the UK. However there do exist repeated cross sectional samples of information drawn from tax records. In this paper, we apply a grouping estimator to such data to assess the empirical magnitude of taxable income responses in the UK. The UK offers a particularly interesting context in which to assess such effects given the intensity of tax reform over the last two decades.

We choose to focus on the self employed as a group of taxpayers of particular interest. For employed workers the idea that hours of work are the main dimension of response to changing rates of labour taxation seems plausible. On the other hand, the conventional labour supply model of an individual choosing work time given a fixed hourly remuneration seems a poor description of the self employed. For such people choices can involve such considerations as effort, employment-related expenses, forms of remuneration and openness with tax authorities[1]. All of these have implications for the magnitude of deadweight loss and all of them seem to call for an empirical analysis based on responsiveness of taxable income.

We focus on group-mean responses of taxable earned income to tax rate changes across a period of reform both in the structure and in the rates of taxation on earned income. Responsiveness of asset income is ignored both for reasons of theory and of data comparability.

[1] For consideration of the extent of tax evasion on earned income in the UK see Dilnot and Morris (1981), Brown, Levin, Rosa and Ulph (1984) and Smith (1986).

The paper is organised as follows. Section 2 reviews the theoretical literature on deadweight loss in the context of a general model of behavioural response under uncertainty. Taxable income elasticities are shown to be determinants of a component - typically the main or exclusive component - of the loss in a wide variety of models. Section 3 outlines the empirical strategy. Section 4 describes the data and relevant points about the UK tax system. Section 5 presents results and Section 6 concludes.

2. Deadweight loss in income tax models with exemptions, avoidance and evasion

We outline below a general model of behavioural response to taxation in order to identify components of deadweight loss and to make precise the role of taxable income responses in determining its magnitude.

Consider a taxpayer receiving risk free lump sum untaxed income of Y. The taxpayer engages in economic activity $\mathbf{z}$ returning an uncertain increment to before tax income $R(\mathbf{z}, t)$ and leading to an uncertain tax bill $T(\mathbf{z}, t)$ where t is the tax rate.

Given direct von Neumann Morgenstern utility $V(Y + R(\mathbf{z}, t) - T(\mathbf{z}, t), \mathbf{z})$, define the indirect expected utility function by the maximum expected utility attainable through choice of $\mathbf{z}$:

$$\psi(Y, t) \equiv \max_{\mathbf{z}} \mathrm{E}V(Y + R(\mathbf{z}, t) - T(\mathbf{z}, t), \mathbf{z}). \tag{2.1}$$

Correspondingly define an uncompensated economic activity function by the optimum value of $\mathbf{z}$ in this problem:

$$\mathbf{h}(Y, t) \equiv \arg\max_{\mathbf{z}} \mathrm{E}V(Y + R(\mathbf{z}, t) - T(\mathbf{z}, t), \mathbf{z}). \tag{2.2}$$

Now define an expenditure function as the lowest value of Y allowing an expected utility of u to be reached given t:

$$g(u, t) \equiv \min_{Y}\{Y|\psi(Y, t) \geq u\} \tag{2.3}$$

and define a compensated economic activity function by

$$\boldsymbol{\zeta}(u, t) \equiv \mathbf{h}(g(u, t), t). \tag{2.4}$$

Finally define an uncompensated risk premium conditionally on $\mathbf{z}$, $r(Y, \mathbf{z}, t)$, by

$$\mathrm{E}V(Y + R(\mathbf{z}, t) - T(\mathbf{z}, t), \mathbf{z}) \equiv V(Y - r(y, \mathbf{z}, t) + \mathrm{E}R(\mathbf{z}, t) - \mathrm{E}T(\mathbf{z}, t), \mathbf{z}) \quad (2.5)$$

and a compensated risk premium by

$$\pi(u, \mathbf{z}, t) \equiv r(g(u, t), \mathbf{z}, t). \quad (2.6)$$

By appropriate substitution

$$u \equiv V(g(u, t) - \pi(u, \boldsymbol{\zeta}(u, t), t) + \mathrm{E}R(\boldsymbol{\zeta}(u, t), t) - \mathrm{E}T(\boldsymbol{\zeta}(u, t), t), \boldsymbol{\zeta}(u, t)). \quad (2.7)$$

Thus, assuming differentiability of the appropriate functions in t and using the envelope theorem,

$$\frac{\partial g(u, t)}{\partial t} = \mathrm{E}\frac{\partial T(\boldsymbol{\zeta}(u, t), t)}{\partial t} - \mathrm{E}\frac{\partial R(\boldsymbol{\zeta}(u, t), t)}{\partial t} + \frac{\partial \pi(u, \boldsymbol{\zeta}(u, t), t)}{\partial t}. \quad (2.8)$$

There are three terms here.

- For a linear tax the derivative $\partial T(\boldsymbol{\zeta}(u, t), t)/\partial t$ is taxable income, in which case the first term is simply expected (compensated) taxable income.
- The second term covers any further effect of the tax rate on the individual's expected resources after taxation such as through compliance costs.
- The final element covers the impact on the risk premium $\pi(u, \boldsymbol{\zeta}(u, t), t)$.

If we define deadweight loss $l(u, t)$ as the difference between the tax that could have been raised through a risk-free lump sum tax without harming expected utility and the expected tax revenue under the existing tax system then

$$\begin{aligned} l(u, t) &= g(u, t) - g(u, 0) - \mathrm{E}T(\boldsymbol{\zeta}(u, t), t) \\ &= \mathrm{E}\left[\int_0^t \frac{\partial T(\boldsymbol{\zeta}(u, t'), t')}{\partial t} dt' - T(\boldsymbol{\zeta}(u, t), t)\right] \\ &\quad + \mathrm{E}\int_0^t \frac{\partial R(\boldsymbol{\zeta}(u, t'), t')}{\partial t} dt' \\ &\quad + \int_0^t \frac{\partial \pi(u, \boldsymbol{\zeta}(u, t'), t')}{\partial t} dt' \end{aligned} \quad (2.9)$$

(assuming $\mathrm{E}T(\boldsymbol{\zeta}(u,0),0)=0$).

This gives a three-term decomposition for the expression for deadweight loss. Under a linear tax, the first term is a Harberger triangle on a taxable income diagram (see, for example, Auerbach and Hines 2002, Slemrod and Yitzhaki 2002). The second captures deadweight loss from, for example, compliance costs. The third term arises from the effect of taxation on the taxpayer cost of income risk.

Two special cases deserve mention.

- Firstly, in the absence of risk, the first two terms comprise the whole of the deadweight loss. If $R(\mathbf{z},t)=R(\mathbf{z})$, so that taxes lower expected resources only through the tax payment, then the excess burden arises solely from the induced substitution responses and is measured accurately by an appropriate Harberger triangle.

- Secondly, suppose $\mathbf{z}$ has no direct effect on utility and the taxpayer is therefore simply maximising $\mathrm{E}V(y+R(\mathbf{z},t)-T(\mathbf{z},t))$. Then it follows directly from (2.7) that[2]

$$\begin{aligned}
& g(u,t)-\pi(u,\boldsymbol{\zeta}(u,t),t)+\mathrm{E}R(\boldsymbol{\zeta}(u,t),t)-\mathrm{E}T(\boldsymbol{\zeta}(u,t),t) \\
= \;& g(u,0)-\pi(u,\boldsymbol{\zeta}(u,0),0)+\mathrm{E}R(\boldsymbol{\zeta}(u,0),0) \\
\Rightarrow \;& l(u,t)=[\pi(u,\boldsymbol{\zeta}(u,t),t)-\pi(u,\boldsymbol{\zeta}(u,0),0)] \\
& -\mathrm{E}\left[R(\boldsymbol{\zeta}(u,t),t)-R(\boldsymbol{\zeta}(u,0),0)\right] \qquad (2.10)
\end{aligned}$$

  There is now no deadweight loss from induced substitution between the components of $\mathbf{z}$ and after tax income. The deadweight loss is the additional risk premium and the expected loss in before tax income as a result of the tax.

We proceed in what follows to illustrate the role of taxable income responses as determinants of deadweight loss in several examples..

[2] The derivation here needs no differentiability assumption. However if the functions are differentiable the same result follows from (2.9) after noting that optimum choice of $\mathbf{z}$ implies

$$\mathrm{E}\left[\frac{\partial R(\boldsymbol{\zeta}(u,t),t)}{\partial \mathbf{z}}-\frac{\partial T(\boldsymbol{\zeta}(u,t),t)}{\partial \mathbf{z}}\right]-\frac{\partial \pi(u,\boldsymbol{\zeta}(u,t),t)}{\partial \mathbf{z}}=\mathbf{0}$$

and making the appropriate substitution.

2.1. Examples

2.1.1. Exemptions

Suppose a taxpayer faces a linear tax at rate t on taxable labour income in excess of an allowance E. The taxpayer has a wage of w, works for h hours to earn wh and has untaxed income of Y from other sources. Certain forms of remuneration are exempt from tax and certain sorts of expenditure attract relief against taxed labour income. Consumption of the goods concerned $\mathbf{x}$, priced at $\mathbf{p}$, has total value $\mathbf{p}'\mathbf{x}$. The taxpayer's utility function is $V(C, h, \mathbf{x})$ where C is consumption out of income after tax. (These sorts of means of avoiding tax are considered by Feldstein 1999).

In the notation used above, $\mathbf{z} = (h, \mathbf{x}')'$, $R(\mathbf{z}, t) = wh - \mathbf{p}'\mathbf{x}$, $T(\mathbf{z}, t) = t(wh - \mathbf{p}'\mathbf{x} - E)$. This is a case where $R(\mathbf{z}, t)$ does not depend on t and there is no uncertainty so a Harberger triangle should capture the whole of the deadweight loss.

The deadweight loss arises solely from the induced substitution responses in labour supply and consumption of tax-exempt forms of remuneration.

Define

$$\psi(Y, t) \equiv \max_{h,\mathbf{x}} V(Y + (wh - \mathbf{p}'\mathbf{x})(1 - t) + Et, h, \mathbf{x}) \tag{2.11}$$

and

$$g(u, t) \equiv \min_{Y}\{Y | \psi(Y, t) \geq u\}.$$

By application of Shephard's lemma, the derivative of $g(u, t)$ with respect to $(1-t)$ gives the compensated demand for tax-exempt goods plus the allowance less the pretax value of compensated labour supply $(\mathbf{p}'\mathbf{x}+E-wh)$. Define a compensated taxable income function $\chi(u, t) \equiv \partial g(u, t)/\partial t = (wh - \mathbf{p}'\mathbf{x} - E)$. A conventional deadweight loss formula would apply

$$l(u, t) \equiv g(u, t) - g(u, 0) - t\chi(u, t)$$

and this would be evaluated by a Harberger triangle on a compensated taxable income diagram

$$l(u, t) = \int_0^t \chi(u, t')dt' - t\chi(u, t). \tag{2.12}$$

This is essentially the point made by Feldstein (1999).

The value of the deadweight loss is obviously not simply determined by the tax rate t but also by the policy choice regarding which sorts of expenditure qualify for exemption - an illustration of a point made by Slemrod (1998).

2.1.2. Avoidance

The taxpayer faces a linear tax at rate t on taxable income x in excess of an allowance E but has access to means of avoiding tax with no direct impact on utility except through the reduction in tax liability produced. To reduce taxable income by a further amount A we assume the taxpayer has to spend an amount $D(A,t)$ in terms of personal effort or legal fees. The cost $D(A,t)$ is assumed increasing and convex in A with $D(0,t)=0$. Utility is therefore $V(Y+x-(x-A-E)t-D(A,t))$. (This sort of formulation of avoidance decisions is similar to Slemrod (2001)).

In the notation used above, $\mathbf{z}=A$, $R(\mathbf{z},t)=x-D(A,t)$, $T(\mathbf{z},t)=t(x-A-E)$. There is no uncertainty and if $R(\mathbf{z},t)$ does not depend on t then a Harberger triangle should capture the whole of the deadweight loss.

Avoidance is determined by

$$t=\frac{\partial D(A,t)}{\partial A} \tag{2.13}$$

and denote the solution to this condition by $A=\alpha(t)$. We can now define

$$\psi(Y,t)\equiv\max_{A}V(Y+x(1-t)+(A+E)t-D(A,t)) \tag{2.14}$$

and

$$\begin{aligned} g(u,t) &\equiv \min_{Y}\{Y|\psi(Y,t)\geq u\} \\ &= g(u,0)-t\alpha(t)+D(\alpha(t),t). \end{aligned}$$

Deadweight loss is then

$$\begin{aligned} l(u,t) &\equiv g(u,t)-g(u,0)+t\alpha(t) \\ &= D(\alpha(t),t). \end{aligned} \tag{2.15}$$

The deadweight loss consists of the effort expended and fees paid to lawyers[3] as a consequence of the tax avoidance. Furthermore we may note, using the envelope

[3] To interpret this as the social loss requires that this be an accurate valuation of the best alternative use of the lawyers' time, which will of course be true under appropriate competitive conditions.

theorem, that

$$\frac{\partial}{\partial t}g(u,t) = -\alpha(t) + \frac{\partial D(A,t)}{\partial t}.$$

Thus, if $D(A,t) = D(A)$ so that legal fees depend only on the amount by which taxable income is reduced independently of the rate at which the income is taxed, then a Harberger triangle representation is valid despite the nonlinearity in avoidance costs[4]

$$l(u,t) = \alpha(t) - \int_0^t \alpha(t')dt'. \tag{2.16}$$

2.1.3. Evasion

Another means of evading tax is illegality. Suppose the structure of tax is as in the avoidance example just discussed. The taxpayer can choose to conceal an amount K of taxable income from the tax authority by misreporting. This enhances income if successful but runs the risk of discovery with probability p in which case the taxpayer pays not only the true liability but also a fine of f per unit of income undeclared. Modelling the evasion decision as an expected utility maximisation accords with the standard model of such behaviour due to Allingham and Sandmo (1972) and Srinivasan (1973).

Let us count the fines paid as part of government revenue. In the notation used above, $\mathbf{z} = K$, $R(\mathbf{z},t) = x$, $T(\mathbf{z},t) = t(x-K-E)$.with probability $(1-p)$ and $t(x-E) - fK$ with probability p.

Say that expected utility is

$$\begin{aligned}\psi(Y,t) &= \max_K (1-p)V(Y + x(1-t) + (K+E)t, K) \\ &\quad + pV(Y + x(1-t) + Et - Kf, K).\end{aligned} \tag{2.17}$$

By allowing $V(.)$ to depend directly on K we allow for the possibility that dishonesty troubles the taxpayer's conscience, a feature omitted from simpler models in this tradition.

There are two aspects to deadweight loss. In the standard model without dependence of $V(.)$ on K, the deadweight loss is solely a consequence of the increased risk borne by an evading taxpayer. The only behavioural response to taxation here is the gamble of evasion and the deadweight loss is measured by

[4] Feldstein is careful to note that his analysis applies only where avoidance reduces spendable income in a linear way.

the associated risk premium as in (2.10). (This point is made by Yitzhaki 1987). If $V(.)$ does depend on K then there is also deadweight loss associated with the substitution towards dishonesty. Higher tax rates make honesty more expensive and the taxpayer will substitute inefficiently away from clarity of conscience.

Note that deadweight loss depends on the other policy parameters p and f - another illustration of the point stressed by Slemrod (1988).

3. Empirical specification

We observe individuals in periods before and after a tax reform. Suppose taxable earned income y_{it} declared by the ith individual in period t is

$$y_{it} = \alpha_i + \boldsymbol{\beta}\boldsymbol{\rho}_{it} + v_{it} \tag{3.1}$$

where $\boldsymbol{\rho}_{it}$ denotes a vector of tax-related variables, α_i is an individual specific intercept (capturing, say, preference heterogeneity), $\boldsymbol{\beta}$ is the vector of tax responsiveness parameters to be estimated and v_{it} is a disturbance term (capturing, say, shocks to earnings from sources unrelated to tax-influenced decisions). A dynamic specification of joint earnings and savings decisions is beyond the scope of our present static model, and so we take investment income as given in the current period and focus on earned income as our dependent variable. In practice, $\boldsymbol{\rho}_{it}$ comprises transformations of the marginal tax rate τ_{it} and virtual income μ_{it} defined by $\mu_{it} = \tau_{it}y_{it} - T_{it} + I_{it}$ where I_{it} is the individual's investment income in period t and T_{it} is tax liability (which depends on earned and investment income). To be specific, in the empirical application below we choose $\boldsymbol{\rho}_{it} = (\ln(1-\tau_{it}), \mu_{it})'$ so that taxable income depends linearly on log of the marginal retention rate (or "net of tax rate") and on virtual income. Such a specification is suggested by the popular semilog formulation for labour supply (see, for example, Blundell, Duncan and Meghir 1998).

Unless the tax function in each period is linear, $\boldsymbol{\rho}_{it}$ is a period-specific function of taxable income, say $\boldsymbol{\rho}_{it} = \mathbf{f}_t(y_{it})$, and therefore correlated with α_i and v_{it}. OLS estimates of (3.1) will therefore yield biased estimates of $\boldsymbol{\beta}$.

Differencing (3.1) removes the fixed individual terms α_i

$$\Delta y_{it} = \boldsymbol{\beta}\Delta\boldsymbol{\rho}_{it} + \Delta v_{it}. \tag{3.2}$$

The change in $\boldsymbol{\rho}_{it}$ can be decomposed into a part due to the tax reform at initial taxable income and due to the change in taxable income

$$\begin{aligned} \Delta\boldsymbol{\rho}_{it} &= [\mathbf{f}_t(y_{it-1}) - \mathbf{f}_{t-1}(y_{it-1})] + [\mathbf{f}_t(y_{it}) - \mathbf{f}_t(y_{it-1})] \\ &\equiv \Delta\boldsymbol{\rho}_{it}^0 + \boldsymbol{\varepsilon}_{it}. \end{aligned} \tag{3.3}$$

Without a panel we cannot observe changes at the individual level. However, if we assume that the population is divided into groups, $g = 1, ..., G$, by certain permanent characteristics a grouping estimator becomes feasible. Letting $\tilde{X}_{gt}$ denote $\mathrm{E}(X_{it}|i \in g) - \mathrm{E}(X_{it})$ for arbitrary variable X_{it}, we can aggregate (3.2) and (3.3) to group level and remove the time mean to get

$$\begin{aligned} \Delta\tilde{y}_{gt} &= \boldsymbol{\beta}\Delta\tilde{\boldsymbol{\rho}}_{gt} + \Delta\tilde{v}_{gt} \\ \Delta\tilde{\boldsymbol{\rho}}_{gt} &= \Delta\tilde{\boldsymbol{\rho}}_{gt}^0 + \tilde{\boldsymbol{\varepsilon}}_{gt}, \end{aligned} \tag{3.4}$$

noting that $\Delta\tilde{y}_{gt}$, $\Delta\tilde{\boldsymbol{\rho}}_{gt}$ and $\Delta\tilde{\boldsymbol{\rho}}_{gt}^0$ are all estimable from the repeated cross section. We can then estimate $\boldsymbol{\beta}$ using an appropriate group-level moment condition.

Let us suppose that individual taxable income shocks v_{it} take a permanent transitory form $\Delta v_{it} = v_{it}^P + \Delta v_{it}^T$ where v_{it}^P is a permanent shock and v_{it}^T is a transitory shock. Under the assumptions that $\mathrm{E}(v_{it}^P|i \in g) = v_t^P$ and $\mathrm{E}(v_{it}^T|i \in g) = v_g^T + v_t^T$ we could use the moment condition

$$\mathrm{E}(\Delta\tilde{\boldsymbol{\rho}}_{gt}\Delta\tilde{v}_{gt}) = 0. \tag{3.5}$$

Such an estimator could be implemented by weighted OLS regression on grouped differenced data or by unweighted IV regression in the pooled data including group and year dummies among the regressors and instrumenting with group-year interactions[5]. The assumption of no group level deviation from aggregate permanent shocks is a strong one however and could lead to serious bias if incorrect. In particular, if marginal tax rates increase with income then responsiveness of taxable income would typically be downwardly biased if estimated in this way.

A better basis for estimation would be the moment condition

$$\mathrm{E}(\Delta\tilde{\boldsymbol{\rho}}_{gt}^0\Delta\tilde{v}_{gt}) = 0. \tag{3.6}$$

[5] We prefer the latter approach, calculating standard errors allowing for group-year clustering.

Assuming that $\tilde{v}^P_{gt}$ is uncorrelated with $\Delta\tilde{\boldsymbol{\rho}}^0_{gt}$ would be justified by assuming that permanent shocks are independent of lagged incomes, since $\Delta\tilde{\boldsymbol{\rho}}^0_{gt}$ depends only on income in the previous period. However since transitory shocks in period $t-1$ will be correlated with taxable income in $t-1$ we might expect Δv^T_{it} to be correlated with $\Delta\boldsymbol{\rho}^0_{it}$ if tax changes are correlated with initial period taxable income. (This is the "mean reversion" point made by Gruber and Saez 2000). Applying (3.6) would nonetheless be acceptable if $\mathrm{E}(v^T_{it}|i \in g) = v^T_t$ so that there are no group level deviations from aggregate transitory shocks. (Although investment income is almost certainly dependent on past earned income decisions and may, therefore, be correlated with past shocks, we assume also that I_{it-1} is not correlated with v^P_{it} or Δv^T_{it}).

There are several equivalent means to implement this estimator. This is implemented below by regressing y_{it} on $\boldsymbol{\rho}_{it}$ in the pooled data including group and year dummies, with instruments taking group-year mean values $\tilde{\boldsymbol{\rho}}_{gt-1}$ in year $t-1$ and $\tilde{\boldsymbol{\rho}}_{gt-1} + \Delta\tilde{\boldsymbol{\rho}}^0_{gt}$ in year t, and allowing for group-year clustering in calculating standard errors[6].

4. UK Income Taxation and the Self Employed

4.1. Data

Our intention is to investigate determination of taxable income as a response to parameters of the tax system. Many surveys, such as the Family Expenditure Survey, General Household Survey or Labour Force Survey, contain cross sectional information on individual and household incomes. Since none of these however are explicitly focussed on calculation of individual tax liabilities, none collect information on tax exemptions or tax declaration, and use of these data would risk missing interesting dimensions of response relevant in the context of the current exercise. While they might be useful for a study of labour supply responses, this aspect of tax responsiveness has already been extensively studied using these sources (see for example Blundell, Duncan and Meghir 1998).

The Survey of Personal Incomes is a series of cross sectional data sets compiled by the Inland Revenue from income tax returns. The principal motive for conducting the survey is to cost proposed changes to tax rates, personal allowances

[6] The resulting coefficient estimates are numerically identical to those obtained by running a weighted IV regression on grouped differenced data.

and other tax reliefs for Treasury Ministers. Although collected annually, data is currently available in the public domain only for tax year 1985/6 and for years after and including 1995/6. In the current paper we use the data for 1985/6 and 1995/6. The survey covers on a stratified sample basis all individuals for whom income tax records are held by the Inland Revenue and includes over 50000 individuals in each of the years used. Information included comprises largely that which is necessary to calculate individual tax liabilities less any information which would compromise anonymity. This means that there is copious detail on individual taxable income but very limited information on untaxd income sources or other individual characteristics. Sex and marital status, for example, are recorded since they are formally relevant to tax bill but not, for example, age (unless aged 65-74 or 75 and over, since personal allowances vary across these age groups) or number of children since they are not. Two important pieces of information included although not relevant to tax bill are region of residence, since this determines the tax office dealing with the individual's affairs, and, in the case of the self-employed, sector of occupation.

4.2. UK taxes on earned income

Three main taxes impinge on earned income in the UK - income tax, national insurance and value added tax. These are explained, for the years relevant to this study, in formal detail by Saunders and Smailes (1995) and less formally by Kay and King (1990).

4.2.1. Income tax

Income tax is a tax levied both on earned income and certain forms of unearned income. It works through a system of bands and allowances. Every taxpayer has a personal allowance - dependent upon marital status - and pays income tax only on the excess of income over this amount. Tax liability rises with income according to marginal rates which increase according to the income band into which an individual falls. Certain sorts of unearned income attract tax at rates which may differ from that applied to earned income, often as a consequence of the Inland Revenue's preference for deducting tax at source wherever possible.

Most tax on earned income for employees in the UK is deducted at source by their employers under a cumulative system known as PAYE (Pay–As-You-Earn). Evasion of these liabilities for such individuals is almost impossible except through collusive fraud with their employer. Negotiation over means of remuneration may nonetheless permit avoidance behaviour in response to income taxation but again only with the involvement of their employer. Since the introduction of the self-assessment system in 1996 some employees are required to complete tax returns, but usually only if paying taxes at higher rates (in order to permit correct calculation of liabilities on unearned income) or if receiving untaxed earned income other than through their main employer.

Self-employed individuals, on the other hand, pay taxes based on submission of self-completed tax returns and might be expected to have far greater scope to avoid or evade taxes due on income. We concentrate attention in what follows on these individuals. The taxation of earnings for self-employed individuals in the UK is discussed, for example, in Macdonald and Whitehouse (1993).

4.2.2. National insurance

Payment of national insurance contributions formally entitles an individual to claim certain social security benefits although in practice the link between contributions and receipt is so tenuous that one can only sensible regard this as another part of the general income tax system. For self employed people the system is as follows. Those with very low earnings are exempt from payments. Once earnings pass a small exception, national insurance contributions are made at a flat weekly rate. Once they pass another threshold known as the lower profits limit, taxes are then paid as a fixed proportion of profits up to an upper limit in addition to the flat rate amount. The fact that no further contributions are liable beyond this upper limit means that the combined marginal rate from income tax and national insurance actually falls over a certain range of incomes.

4.2.3. Indirect tax

Earnings attract further taxes when spent. The main tax here is value added tax which applies at the same rate to most forms of spending. There are some exempt and lower-rated forms of spending (for example, food at home, books, energy) and there are some goods which attract additional duties (alcoholic beverages, tobacco, motor fuel). Since we do not wish to enter into modelling commodity demands we assume that marginal earnings are spent on goods taxed at the standard rate of value added tax (as, for example, in Blundell, Duncan and Meghir 1998).

These three taxes combine to give a total marginal tax rate faced by the taxpayer that is equal to $(i_t + n_t + v_t) / (1 + v_t)$, where i is the income tax rate, n is the national insurance contributions rate, and v is the rate of value added tax.

4.3. UK tax reforms

This system of taxation underwent several reforms between 1985/6 and 1995/6.

4.3.1. Changes in tax rates and allowances

The schedule of income taxation was simplified with the reduction of five higher rate bands (with rates of 40% to 60% in 5% steps) to only one, with the marginal rate in that band equal to that in the lowest of the previous five. Offsetting this was the introduction of a lower rate band of 20% at the other end of the range of taxable income.

Governments over this period aimed to reduce rates of taxation while transferring tax from direct to indirect. The standard rate of income tax - that paid by the bulk of taxpayers - was reduced over the period from 30% to 25% while the rate of value added tax was incresed from 15% to 17.5%.

4.3.2. Independent taxation

Another large change was the switch from a system of joint taxation to independent taxation for married couples. In 1985/6, unless a household were to opt for a scheme of separate taxation financially appealing to very few, a wife's unearned income was treated as her husband's for tax purposes, as was the excess of her earned income over a personal wife's earned income allowance. A married man was also entitled to an additional allowance[7]. By 1995/6 this had been abolished and the couple were taxed independently with a transferable "married couple's allowance" introduced to avoid consequential redistribution towards single people.

This has implications also for availability of data. In the later year's data, all information on spouse's earnings is absent. For consistency we therefore need to treat the spouse of interest as a separate individual with isolable income in each

[7] As Kay and King (1990) remark, reflecting on the history of the system, this is "in recognition of the burden [his wife] imposes on him ... The underlying concept is self-evidently anachronistic; it dates from a time when Soames Forsyte was the representative taxpayer."

year, whose tax rate and tax payments just happen to depend on spouse's income in the earlier year.

4.4. Other issues

4.4.1. Sample selection

The validity of this method depends crucially on the constancy of the chosen grouping so that in each period our group mean estimates are based on samples from the same populations. The chosen grouping is based on region of residence and sector of occupation. This raises a number of issues.

Firstly, since information on age is absent, it is impossible for us to follow a fixed date-of-birth cohort. The group populations from which the SPI samples are drawn therefore differ in terms of range of dates of birth. Older individuals in the earlier year and younger ones in the later year will not be in the sampled population throughout the period of investigation. Secondly, region and occupation are not in fact fixed and can change at the individual level. This is likely to be of concern however only if migration between groups is systematically related to changes in taxation of earnings.

Perhaps most worrying is the endogeneity of the self-employment decision itself. If changes in taxation encourage entrepreneurship or encourage self-employment as a means to exploit tax exemptions which that makes available then this would provide another reason why the populations of self employed would not be the same in the two years. We do not observe occupational sector for employees and cannot therefore investigate responsiveness of self-employment status to taxes for the chosen grouping but can look for evidence of responsiveness at the more aggregated regional level.

4.4.2. Returns to labour

Tax reforms over the period considered tended to lower tax rates for the better off. At the same time it is well known that growing dispersion of incomes was experienced in many western economies for reasons which almost certainly go beyond responses to tax changes. Skill biased technological change, globalisation of world trade, changes in supply of skills and many other explanations have been offered as reasons for widening income gaps (see Katz and Autor 1999) and omission of variables capturing these influences could be a source of bias in estimated tax effects if they are correlated with tax changes at the level of the chosen groups. In particular we wish to capture the influence of sectoral or regional shifts in demand or supply of human capital which manifest themselves, say, in the return to labour within the sector or region.

Since the SPI has no data on hours it is impossible to calculate wages. It is not clear that this is well defined for the self employed in any case and, even if it were, changes in the form of remuneration are part of the response that we are seeking to pick up. We therefore use data from another source and for the employed to construct a measure of change in gross labour returns within the sector and region. To be specific, we take all employed individuals working in the same region and sector in the General Household Survey.

4.4.3. Incorporation and mode of income receipt

Self-employed individuals have the option, if they wish, to incorporate their business as a self-owned limited company. This has tax consequences because the income of the business will typically then be received in a different form. It will almost certainly remain advantageous to receive some remuneration in the form of earned income as managerial salary, in order to pay national insurance contributions and establish benefit entitlements and probably most importantly in order to make tax favoured private pension contributions. However some of the business income will be received in the form of distribution of dividends. During the period concerned these dividends would attract corporate taxation which would then establish a tax credit for the individual when received as income. In 1995/6 the rates were such that dividend income itself would be subject to income tax at a rate slightly lower than the rate of tax on earned income. More importantly, in both years dividend income, unlike earned income, would not be subject to national insurance contributions. If changes in the tax on earned income increase any incentive to opt for incorporation and therefore change mode of income receipt then the sort of empirical exercise pursued here may be seriously misleading. Gordon and Slemrod (2000) draw attention to this sort of issue in the context of US studies.

We choose to focus below on earned income. It would be possible to calculate a dividend-inclusive measure of income and to an extent this could avoid problems of this sort However the data draws no distinction between dividends received from one's own company and dividends from other companies. More seriously there is concern that it could be tax-advantageous to pay dividend's to a spouse if they fall into a lower tax bracket - any such payments will be missed in the second year's data as a consequence of independent taxation. For the purpose of checking robustness we investigate whether there is any evidence that tax rate changes are associated with changes in the share of earnings plus dividiends received as dividends.

While we appreciate that we cannot wholly address the issues raised here, the views of tax professionals - reflected in discussion of recent proposed tax changes which may indeed aggravate the incentives to incorporate - suggest that tax advantages of incorporation are unlikely to have been significant in the years which we investigate.

4.5. Summary of final sample

As discussed above, given the fairly limited information we have, we choose our groups on the basis of occupational sector and region and focus on the self-employed. The information on occupation sector is not present for the employees, and, again as mentioned above, the self-employed are likely to have greater scope for tax avoidance or evasion than employees. Since joint taxation is in operation in 1985/6, we only have occupation information for a very few women (24, to be precise) and so we focus on men only in both years. In addition we only focus on those of working age (below 65, as this is the extent of the age information available to us). After this selection, we have 10,491 observations in 1985/6 and 10,461 in 1995/6. We have nine regions and seven industries giving us a total of 63 groups in each year. A summary of estimated population proportions (recognising sample stratification) is given by region and sector across the two sample years in tables 4.1 and A.1 below (standard errors are in parentheses).

Table 4.3 shows the proportions of men aged below 65 that are self-employed across region and the same information is represented for the later year in Figure 4.1. (Information on occupation sector is absent for employees). This proportion increased for all regions across the two periods. However, we could find no evidence of association between changes in proportions within region and either change in tax rate or virtual income[8].

[8]Coefficient estimates were insignificant in region level regressions, either using OLS or instrumenting as in the results below.

Table 4.1: Estimated population proportions by occupation sector for 1985/6 and 1995/6

	Year			
Sector	1985/6		1995/6	
Agriculture	0.087	(0.003)	0.059	(0.002)
Manufacturing	0.075	(0.003)	0.060	(0.002)
Construction	0.334	(0.004)	0.369	(0.005)
Distribution	0.213	(0.004)	0.173	(0.004)
Transport	0.048	(0.002)	0.062	(0.002)
Finance	0.095	(0.003)	0.131	(0.003)
Other	0.148	(0.003)	0.146	(0.003)

Table 4.2: Estimated population proportions by region for 1985/6 and 1995/6

	Year			
Region	1985/6		1995/6	
North East	0.040	(0.002)	0.029	(0.002)
Yorks & Humber	0.084	(0.003)	0.080	(0.003)
North West	0.101	(0.003)	0.108	(0.003)
East Midlands	0.074	(0.003)	0.078	(0.003)
West Midlands	0.080	(0.003)	0.083	(0.003)
South East	0.382	(0.005)	0.382	(0.005)
South West	0.121	(0.003)	0.103	(0.003)
Wales	0.048	(0.002)	0.057	(0.002)
Scotland	0.070	(0.002)	0.079	(0.003)

Table 4.3: Estimated population proportions of self-employed by region

	Year			
Region	1985/6		1995/6	
North East	0.073	(0.006)	0.119	(0.010)
Yorks & Humber	0.097	(0.005)	0.164	(0.007)
North West	0.090	(0.004)	0.166	(0.006)
East Midlands	0.103	(0.006)	0.180	(0.008)
West Midlands	0.087	(0.005)	0.152	(0.007)
South East	0.133	(0.009)	0.209	(0.007)
South West	0.156	(0.006)	0.207	(0.007)
Wales	0.104	(0.006)	0.207	(0.011)
Scotland	0.073	(0.004)	0.157	(0.007)

The choropleth maps in Figures 4.2 to 4.4 show some more information about our sample by region (further tables are given in the appendix). In particular, we show the change in taxable income and the change both in actual marginal tax rates and in marginal tax rates at initial (1985/6) income. There is a clear positive association at regional level between changes in taxable income and in actual tax rate but much less clearly any such relationship with tax rate changes at fixed income.

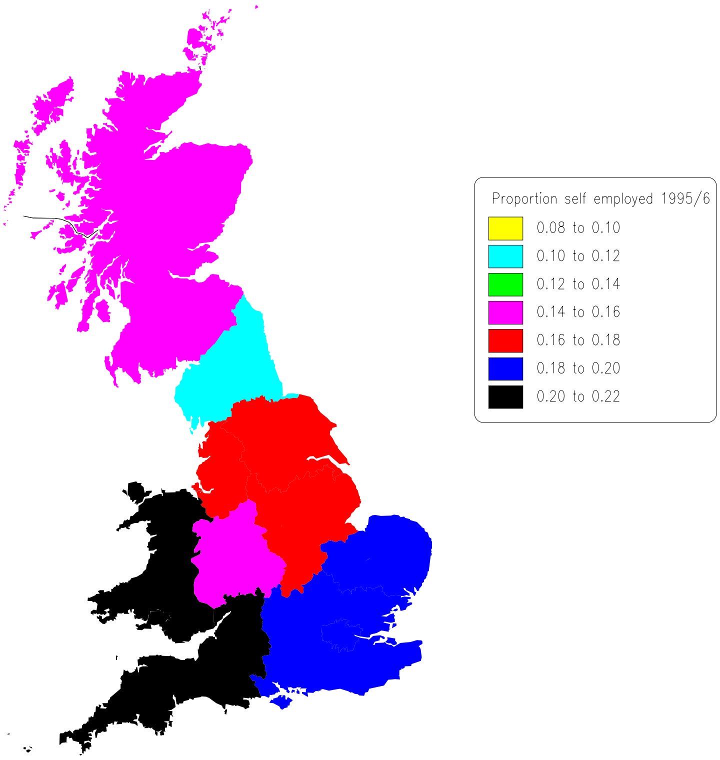

Figure 4.1: Proportion self employed 1995/6

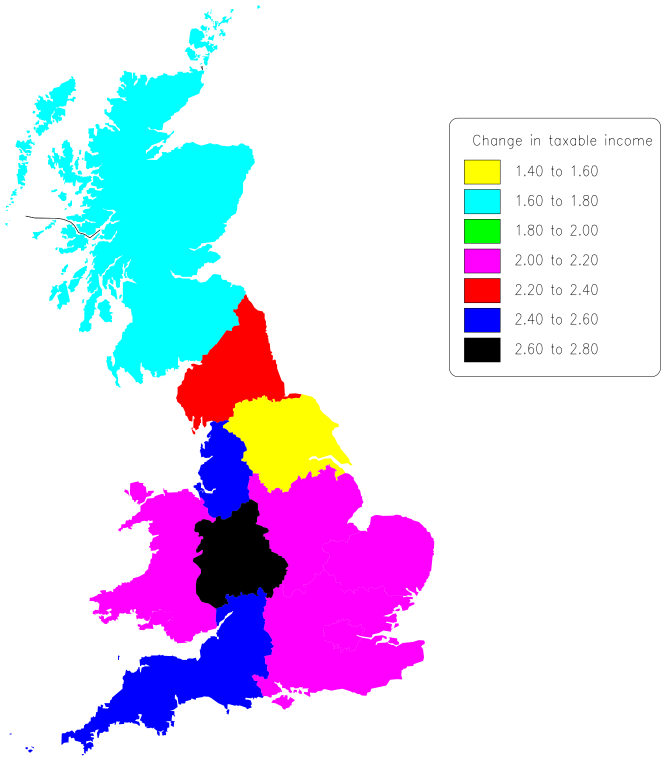

Figure 4.2: Change in taxable income 1985/6-1995/6

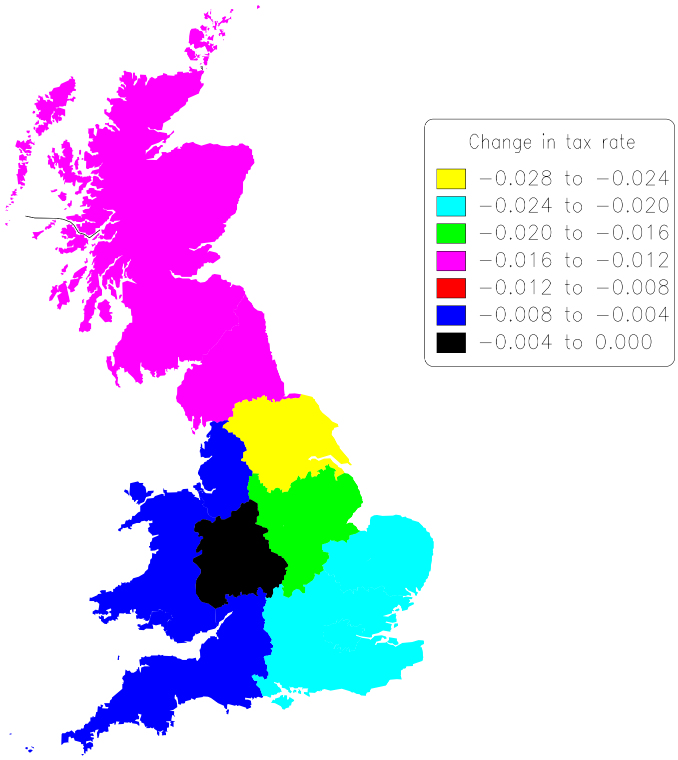

Figure 4.3: Change in marginal tax rate 1985/6-1995/6

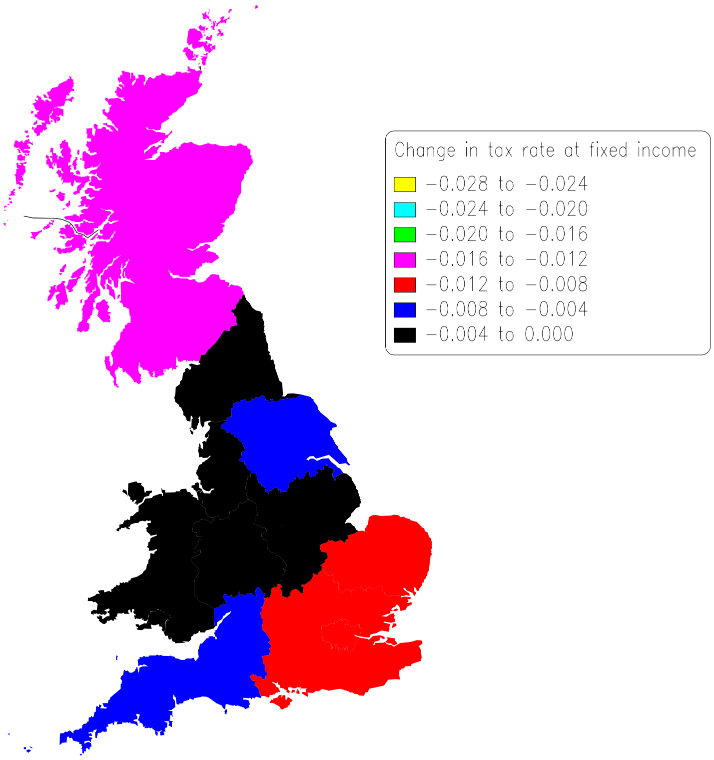

Figure 4.4: Change in marginal tax rate at fixed taxable income 1985/6-1995/6

4.6. Construction of variables

The construction of the variables used in the regressions below requires some discussion. Since we observe only individual tax data in 1995/6 we cannot model the joint behaviour of married couples. For married couples in 1985/6 we must, therefore, construct variables from the joint tax data that will be comparable to the 1995/6 information. (Obviously, there is no difficulty in the case of single men). The construction of husband's own taxable earnings is straightforward since wife's earnings are listed and can simply be subtracted from the total. Since only joint deductions are given, we allocate these in the proportions of each spouse's income to joint income. Similarly, wife's investment income is also listed separately and can be subtracted from joint investment income. The construction of husband's virtual income requires the calculation of husband's share of total tax paid. Since the counterfactual is that spouses' actions are taken as given, we calculate the tax that would be paid if only the wife's (earned and unearned) income were present, and subtract this from the total tax paid to give the husband's tax. To construct our instrumental variables we need to calculate $\mathbf{f}_t(y_{it-1})$ in the 1985/6 sample, and do this by applying the 1995/6 tax system to our calculated husband's own income (or straightforwardly to given income in the data for single men) in 1985/6.

5. Results

Table 5.1 shows the results from the estimation of equation (3.1) using the moment conditions (3.5) and (3.6). As explained earlier these are calculated by regressions in the pooled data with group and year dummies, instrumenting appropriately and allowing for group-year clustering in calculating standard errors. Huber-White robust estimates of standard errors are given in parentheses and allow for the stratification in the SPI sample.

Estimates in the first two columns apply (3.5) and show a negative effect of an increase in the retention rate (or decrease in the tax rate) on taxable income – the opposite effect to that which we would expect. .Estimates in the latter two columns apply (3.6) and, by contrast, give a positive coefficient significant at standard significance levels. Corresponding F-tests for joint significance of the instruments in the reduced form regressions are shown in table 5.2 and suggest that the tax changes at fixed income are very strong predictors for the actual changes. The second column of results for each estimation technique shows the effects of the inclusion of the change in log wages for employees in the same region/sector groups from the General Household Survey, as described in section 4.4.2, to account for differing changes in the returns to labour across groups. The inclusion of this variable does not significantly alter the magnitude of the other coefficients, and, in the second two columns, the coefficient on change in log wage is not significant.

Table 5.1: Regression results for change in taxable income

Variable	**Coefficient**			
$\Delta \ln(1 - \text{tax rate})$	−10.300	−9.631	22.248	21.553
	(4.370)	(4.428)	(8.890)	(8.941)
Δ virtual income	4.150	4.196	2.554	2.706
	(0.789)	(0.775)	(1.880)	(1.820)
$\Delta \ln(\text{wage})$		−0.990		−1.391
		(0.361)		(0.817)
Number of groups	63	62	63	62
Number of individuals	20952	20791	20952	20791

Table 5.2: F-tests for reduced forms for endogenous regressors.

$\Delta \ln(\text{retention rate})$	$F(2, 60) = 23.16$
Δ virtual income	$F(2, 60) = 9.56$

Since tax rates are not typically changed holding virtual income constant, these numbers can be difficult to interpret. It may help to consider the implied effect of an actual tax change. Over the period considered the tax rate on a basic rate taxpayer fell from 0.470 to 0.438. If we suppose that this were to have happened holding the married man's tax allowance constant at its 1985/6 value of £3455 then virtual income for a married basic rate taxpayer would have had to fall by £110.56. The combined effect of these two changes would have been an estimated increase of £964.33 in taxable earned income (with a standard error of 524.86). Since any taxpayer with income above £3455 would have benefited from such a change, the compensated change would have been lower. For someone on average 1985/6 taxable income of £11046, the Slutsky compensated change would have been a rise of only £306.90 (with a standard error of 749.33).

Table 5.3 shows the results of the regression with the proportion of dividend income to earned plus dividend income as the dependent variable. Recall from section 4.4.3 that one concern is that the self-employed may have an incentive to incorporate their business and pay themselves in the form of dividend income if this is advantageous for the purpose of reducing their tax bill. Whilst income tax rates generally went down between 1985/6 and 1995/6, dividend income also became more tax favoured. We report results in two columns, contrasting in the same way as those of Table 5.2. That is to say, the first column uses general group year interactions as instruments while the second instruments with group level tax changes at fixed income. Results in the second column are the more robust and show no evdence of any effect.

Table 5.3: Regression results for dividend to earnings ratio

Variable	**Coefficient**	
Δ ln (1 - tax rate)	0.203	-0.038
	(0.068)	(0.112)
Δ virtual income	0.044	-0.007
	(0.008)	(0.025)
Number of groups	63	
Number of individuals	20952	

6. Conclusion

We have drawn on evidence from UK tax records to assess the extent of responsiveness in taxable earned income to rates of taxation for the self employed. More specifically, we have used a grouping estimator to exploit the information in the repeated cross sections of the Survey of Personal Incomes. These point to a modest degree of deadweight loss.

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A. Appendix: Data summary

Table A.1: Average taxable income by sector and year (1985/6 £000s)

	Year			
Sector	1985/6		1995/6	
Agriculture	2.980	(0.222)	5.381	(0.361)
Manufacturing	3.955	(0.271)	5.489	(0.328)
Construction	3.174	(0.083)	4.201	(0.091)
Distribution	3.238	(0.135)	5.120	(0.193)
Transport	3.283	(0.228)	3.735	(0.255)
Finance	9.953	(0.409)	13.324	(0.408)
Other	4.910	(0.229)	9.292	(0.344)

Table A.2: Average marginal tax rate by sector and year.

	Year			
Sector	1985/6		1995/6	
Agriculture	0.344	(0.005)	0.351	(0.004)
Manufacturing	0.360	(0.005)	0.353	(0.004)
Construction	0.384	(0.002)	0.362	(0.002)
Distribution	0.355	(0.003)	0.345	(0.003)
Transport	0.377	(0.006)	0.335	(0.005)
Finance	0.412	(0.003)	0.392	(0.002)
Other	0.361	(0.003)	0.356	(0.002)

Table A.3: Average taxable income by region and year (1985/6 £000s)

	Year			
Region	1985/6		1995/6	
North East	3.955	(0.369)	6.194	(0.626)
Yorks & Humber	3.289	(0.225)	6.114	(0.354)
North West	3.668	(0.217)	6.078	(0.310)
East Midlands	3.663	(0.245)	5.705	(0.342)
West Midlands	3.418	(0.248)	6.191	(0.338)
South East	4.859	(0.143)	7.029	(0.193)
South West	3.387	(0.218)	5.799	(0.312)
Wales	3.145	(0.287)	5.221	(0.374)
Scotland	5.225	(0.341)	6.937	(0.329)

Table A.4: Average marginal tax rate by region and year

	Year			
Region	1985/6		1995/6	
North East	0.366	(0.006)	0.351	(0.007)
Yorks & Humber	0.358	(0.004)	0.359	(0.004)
North West	0.364	(0.004)	0.360	(0.003)
East Midlands	0.374	(0.004)	0.355	(0.004)
West Midlands	0.361	(0.005)	0.362	(0.004)
South East	0.384	(0.002)	0.362	(0.002)
South West	0.359	(0.004)	0.353	(0.004)
Wales	0.349	(0.006)	0.342	(0.005)
Scotland	0.379	(0.005)	0.366	(0.004)