LABOUR SUPPLY AND TAXES

Costas Meghir
David Phillips

THE INSTITUTE FOR FISCAL STUDIES
WP08/04

Labour Supply and Taxation
Executive Summary

This paper provides an overview of the voluminous literature relating tax and and the supply of effort that has developed since the Meade report on the UK tax system 30 years ago, with a focus on presenting the empirical consensus on how taxes and benefits affect incentives.

Our starting point is the traditional labour supply model, where hours of work and participation in work are the key measures of effort supplied by individuals. We discuss the way labour supply is modelled. We begin with a basic continuous hours model, where individuals have completely free choice over their hours of work. We then add important real-world features of the labour supply choice including fixed costs of labour-force participation, the complications introduced by the benefits system, dynamic aspects of labour supply and place the analysis in the context of the family. We discuss how what such models tell us about the effects of tax reform on work behaviour.

We then discuss the "new Tax Responsiveness" literature which takes a more general view of effort and does not assume that it can be perfectly measured by hours of work supplied. Here the focus is on the response of taxable income to the marginal tax rate as a summary statistic of the behavioural response to taxation. Underlying this approach is the unsatisfactory nature of using hours as a proxy for labour effort for those with high levels of autonomy on the job and who already work long hours, such as the self employed or senior executives. The literature typically uses a difference-in-differences approach, comparing the taxable income of treatment and control groups, before and after a reform. This leads to several problems because of the confounding impact of temporary income shocks, secular trends in the income distribution and general equilibrium wage effects, and the direction of the bias is unknown. Efforts to control for these factors are important, but because the specifics of each tax reform are different, it is difficult to generalise from one reform, as can be seen by applying a consistent methodology across the full range of tax reforms in the 20th century.

Finally, we discuss the impact that taxes and benefits can have on longer run outcomes, which affect standards of living, such as education and training choices. Taking these effects into account should be a central consideration of any tax and benefit system.

After discussing relevant theory we then provide a summary of the relevant empirical estimates and the methodology underlying the studies. We use this work to formulate our overall view of the responsiveness of labour supply and place by far the greatest weight on work that avoids making overly strong assumptions, but that nevertheless has a structural interpretation in order to make it generalisable. It is important to study the right margin when analysing labour supply, and the paper considers hours, participation and taxable income.

Our conclusion is that hours of work are relatively inelastic for men, but are a little more responsive for married women and lone mothers. On the other hand, participation is quite sensitive to taxation and benefits for women. Within this paper we present new estimates form a discrete participation model for both married and single men based on the numerous reforms over the past two decades in the UK. We find that the participation of low education men is somewhat more responsive to incentives than previously thought. For men with high levels of education, participation is virtually unresponsive; here the literature on taxable income suggests that there may be significant welfare costs of taxation, although much of this seems to be a result of shifting income and consumption to non-taxable forms as opposed to actual reductions in work effort.

Labour Supply and Taxes*

Costas Meghir†, David Phillips‡

March 20, 2008

Abstract

In this paper we provide an overview of the literature relating labour supply to taxes and welfare benefits with a focus on presenting the empirical consensus. We begin with a basic continuous hours model, where individuals have completely free choice over their hours of work. We then consider fixed costs of work, the complications introduced by the benefits system, dynamic aspects of labour supply and we place the analysis in the context of the family. The key conclusion of this work is that in order to estimate the impact of tax reform and be able to generalise results, a structural approach that takes account of many of these issues is desirable. We then discuss the "new Tax Responsiveness" literature which uses the response of taxable income to the marginal tax rate as a summary statistic of the behavioural response to taxation. Underlying this approach is the unsatisfactory nature of using hours as a proxy for labour effort for those with high levels of autonomy on the job and who already work long hours, such as the self employed or senior executives. After discussing relevant theory we then provide a summary of empirical estimates and the methodology underlying the studies. Our conclusion is that hours of work are relatively inelastic for men, but are a little more responsive for married women and lone mothers. On the other hand, participation is quite sensitive to taxation and benefits for women. Within this paper we present new estimates form a discrete participation model for both married and single men based on the numerous reforms over the past two decades in the UK. We find that the participation of low education men is somewhat more responsive to incentives than previously thought. For men with high levels of education, participation is virtually unresponsive; here the literature on taxable income suggests that there may be significant welfare costs of taxation, although much of this seems to be a result of shifting income and consumption to non-taxable forms as opposed to actual reductions in work effort.

*Acknowledgements. This paper is a chapter prepared for the The Mirrlees Review: Reforming the Tax System for the 21st Century, conducted at the Institute for Fiscal Studies. We would like to thank the contributors to this volume and in particular Stuart Adam, Richard Blundell, Mike Brewer, Eric French and Guy Laroque for their comments. Financial support by the ESRC is gratefully acknowledged.

JEL Codes: J22, H24, H31.

Keywords: Labour Supply, Income taxation, Welfare Benefits, Tax Credits, Incentive Effects

†IFS, UCL and IZA, c.meghir@ucl.ac.uk

‡IFS, David_P@ifs.org.uk

1 Introduction

Since the original Meade (1978) report[1] and indeed for sometime before then, there has been an intensive research programme focussed on the way labour supply responds to incentives.[2] The impact of taxation on work effort is one of the main sources of inefficiency of a distortionary tax system. The magnitude of the inefficiency depends on how effort reacts to incentives as well as how the tax and transfer system changes the incentives to work and earn. More broadly, if one is to design a tax and benefit system with some element of optimality one needs to know how individuals react to taxes and benefits. This implies knowledge of how sensitive effort is to incentives at different education groups and for both men and women. This chapter reviews the main issues that have arisen in this voluminous research agenda and offers what we view are the central empirical conclusions about the impact of incentives on the supply of effort.

In the first part of the chapter we describe the modelling approaches to labour supply, and we discuss the main implications of these theoretical contributions. We explain how these are relevant to modelling and understanding the incentive effects of taxation and welfare benefits and demonstrate that policy analysis requires one to consider the incentives implied by the entire tax and benefit system as an integrated whole.

The key issue is how effort reacts to incentives. However, effort can be adjusted on many different margins: people can change their hours of work per week or per year, whether they work at all or not[3] and the amount of effort they put into working. Some may also be able to change the way earn income (salary, dividends, capital gains) or how they consume so as to change the tax liability. For many people hours worked is quite a good approximation to effort and the study of the incentive effects of taxation is a study of how hours worked are affected by taxes and transfers. However, for some higher skill individuals in particular, hours worked is not a good measure of effort. They can adjust effort by working harder at ideas and being more creative within a particular time period. In addition, given the way the tax systems are designed, taxation may provide an incentive to over-consume items that are tax-deductible or to shift earnings to tax-favoured forms. Thus the tax incentives of the wealthy have other dimensions than hours of work and these can be an important source of distortions in the tax system. We explain the empirical issues relating to estimating the incentive effects on the various margins of labour/effort supply providing a critical review of the various empirical approaches.

[1] Meade (1978)

[2] Heckman (1974), Burtless and Hausman (1978) Hausman (1985),Mroz (1987), MaCurdy,Green and Paarsch (1990), Blundell and Walker (1986), Blundell, Meghir, Symons and Walker (1988), Blundell, Duncan and Meghir (1998) to mention but a few.

[3] We refer to this as participation or labour force participation. The way we use the term should not be confused with whether someone is in the labour force (searching for work or working). For us a participant is someone actually in work.

In the second part of the paper we review empirical results and offer a unified view of the consensus that has emerged. We base our description on elasticities, which reflect the sensitivity of labour supply to small changes in incentives. These measures are not necessarily sufficient for understanding the impact of reforms (as we explain in the paper) but they do offer a way of providing coherent comparisons across models.[4]

The review of the literature yields a very interesting picture. Incentives certainly matter, but the relevant margin differs by demographic and education group. For some groups such as women with young children taxes and benefits can affect whether to work or not as well as how many hours they work. For low education men tax and benefit incentives are also important, but only for the participation decision; their hours of work are insensitive to changes in taxes and benefits. These men either do not work at all (and up to 25% do not) or work full time – this margin is quite sensitive to how the tax and benefit system is structured. Among full time workers there is quite a dispersion of hours worked, but taxes and benefits have never been able to explain this effectively. For highly educated and wealthy men, taxes do not affect whether they work or not and how many hours they put in a week or even a year. They do however affect their total as well as their taxable income; they respond both by reorganising their affairs to benefit form the way different sources of income are taxed and by shifting consumption to deductible sources. They can also adjust the amount of effort they put into their work. Empirical approaches differ and data sets differ; however we believe there is a broad consensus in these issues, if not at the detail and at the precise numbers, definitely for the overall picture.

1.1 Taxes, Benefits and Labour Supply.

We start by considering the basic labour supply model which is at the heart of the large literature on the incentive effect of taxation. Labour supply models express the trade off between market work and leisure.[5] Under suitable conditions on preferences, the labour supply function depends on a measure of non-labour (or "unearned") income denoted by μ and the marginal wage rate w,which represents the amount earned in real terms for an extra hour of work. Non-labour income may include any source of income that is unrelated to the work decision of the person in question. Thus it cannot include means-tested transfers, but it can include universal benefits such as the UK's child benefit. Labour supply can also depend on a collection

[4] An elasticity of hours of work with respect to the wage, say, is the proportional change in hours of work caused by a proportional change in the wage. So an elasticity of 1 means that a 10% increase in the wage will lead to a 10% increase in hours. So suppose for the sake of argument that someone is facing a 20% tax rate and that his wage elasticity is 0.5. Suppose the tax rate is raised to 22%. This represents a 2.5% reduction in the after tax wage; with the 0.5 elasticity, this would imply a 1.25% reduction in hours worked. In Appendix 1 we define several terms that we will use many times throughout our paper.

[5] A a better and more accurate term for leisure might be non-market time. However we use these terms interchangeably.

of background and family characteristics which affect one's tastes for work and which we we summarise as Z. Thus the Z variables can include the number and ages of children, education level etc. The relationship expressed is just a reflection of the way individuals are willing to trade off leisure for pay at a given period of time. Now we need to see how the effects of taxes are incorporated within this framework. We will then discuss the role of fixed costs of work and dynamics or intertemporal trade-offs, making the framework richer for policy analysis.

1.1.1 Progressive taxes and tax reform with continuous hours of work

Taxes and means tested transfers affect the returns to work, often in complicated ways. A key purpose of a labour supply model is to provide a framework for understanding and measuring the way that tax and welfare systems affect incentives. In the simplest possible proportional tax system, the marginal tax rate is a constant; in most cases this will lead to less work, but when the income effect dominates the substitution effect at high hours of work it may increase effort. From an empirical/econometric point of view, ignoring taxes will lead to biased estimates of labour supply effects because we will have miss-measured the returns to work; from a policy point of view we will have no framework for understanding how taxes affect behaviour.

However, suppose instead that individuals face a tax on earnings (E) of the following form: no tax is paid up until earnings A_1, earnings between A_1 and A_2 are taxed at a rate of τ_1, earnings above A_2 but below A_3 are taxed at a rate τ_2 and earnings above A_3 are taxed at a rate τ_3 (and perhaps there are further tax brackets). With this structure and with the tax rates increasing we say that the budget set is *convex*.[6] Figure **??** shows how pre and post tax earnings relate under this standard tax system.

In this special case the labour supply decision can be expressed *as if* the tax system was proportional (not progressive) with the applicable tax rate being the actual marginal tax rate that the individual faces (τ_1, τ_2, τ_3 etc.) and a suitably adjusted non-labour income, which we call $m_k(\mu)$ where k denotes the tax bracket to which the person belongs. The value this adjusted non-labour income depends on all the tax rates up until the one facing the individual as well as on the thresholds (A_1, A_2 etc.). Thus if the individual is facing a zero marginal tax rate she behaves as if is relevant non-labour income is $m_0(\mu) = \mu$. If she is facing tax rate τ_1 she behaves as if her non labour income is $m_1(\mu) = \mu + \tau_1 A_1$; if she is facing tax rate τ_2 her adjusted non-labour income is $m_2(\mu) = \mu + \tau_1 A_1 + (\tau_2 - \tau_1)A_2$. Thus behaviour along the convex budget set (progressive tax system) can be characterised by increasing marginal rates *and* increasing non-labour

[6] There is a simple test of whether a budget set is convex or not. Take any two feasible hours income combinations and join them with a line; if all points on the joining line are also attainable then the budget set is convex. Otherwise it is non-convex and the underlying tax system is not progressive everywhere.

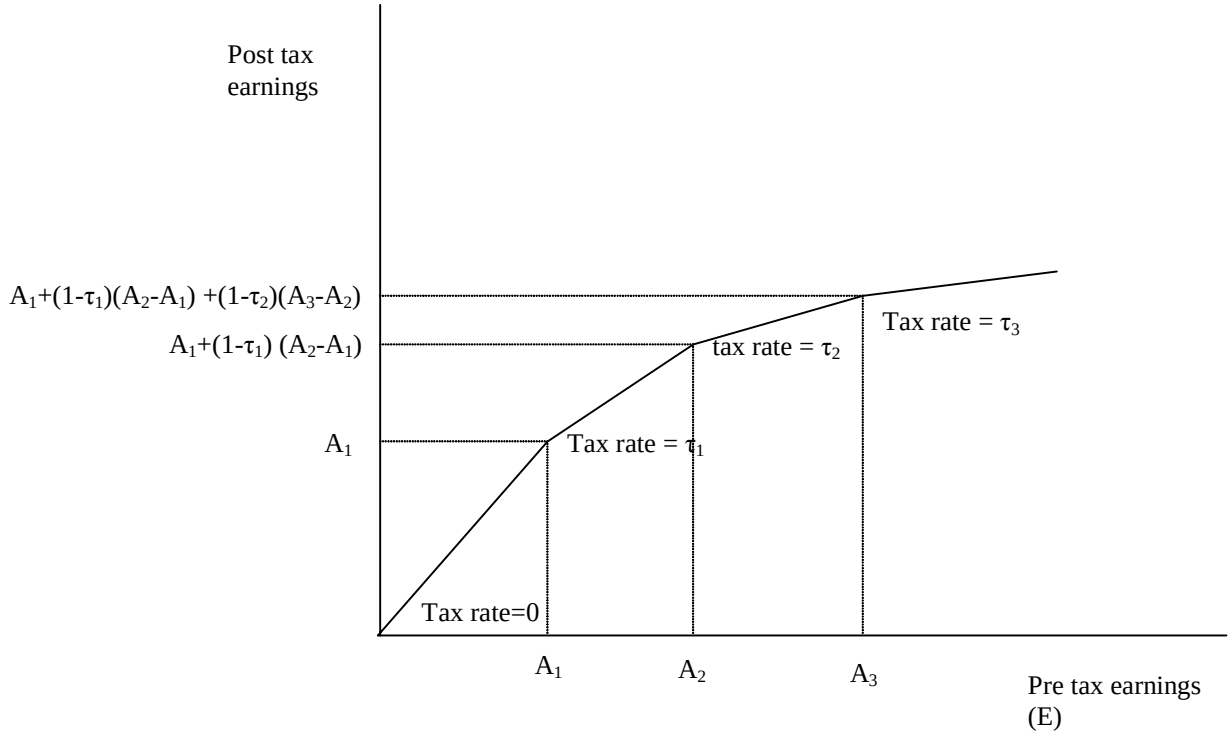
Post tax earnings
$A_1+(1-\tau_1)(A_2-A_1)+(1-\tau_2)(A_3-A_2)$
$A_1+(1-\tau_1)(A_2-A_1)$
A_1
Tax rate = τ_3
tax rate = τ_2
Tax rate = τ_1
Tax rate=0
A_1
A_2
A_3
Pre tax earnings (E)

Figure 1:

income. [7] As we explain below this structure of the tax system implies that changing marginal tax rates has stronger impacts than they would in a simple proportional tax system.

Box 1.

Modelling labour Supply with convex budget sets - a technical digression

More formally, suppose the hours of work someone is willing to supply can be written as $h(w, \mu \mid Z)$ with w being the marginal wage for an extra hour of work and μ non-labour income. The form of h and its sensitivity to w and μ depends on individual preferences, partly explained by Z. With progressive taxation, i.e. when the budget set is convex (as defined in the main text) labour supply can be shown to depend only on the marginal wage at the tax bracket where she is positioned and on the special measure of non-labour income, as described in the main text, which we denote by $m_k(\mu)$. Thus we can write $h = h((1-\tau_k)w, m_k(\mu)|Z)$, where the relevant tax rate τ_k is the one at the optimal point of labour supply; $w(1-\tau_k)$ is the slope of the budget constraint at that point. The relevant non-labour income $m_k(\mu)$ depends on the entire set of marginal tax rates and allowances up until and including the tax bracket k in which the individual is positioned as shown in the main text .

The behaviour of one group of individuals is not described by the approach above: These are individuals who chose hours of work exactly on the kink where the marginal tax rate changes. The reason this happens is because these individuals wish to work more than the tax threshold when facing the lower tax rate and less than the tax threshold when facing the higher tax rate; the only feasible point is then the king. In principle there is a mass of individuals at these points and they cannot be ignored when carrying out policy analysis. In practice, individuals are rarely found on such convex kinks, but the reason for this is not clear; it may be because people make small errors, or they cannot find precisely the job they wish, or perhaps we measure their hours with error.

Within this simple framework there are a number of econometric and policy issues to deal with. We will discuss the econometric issues later. Now we take the labour supply function as known, which is akin to saying that we know preferences (i.e. the utility function) and consider the implications for policy analysis. In particular take a decrease in the marginal tax rate at different points in the system. We can distinguish the following simple cases:[8]

- The tax rate being changed relates to earnings higher than those earned by the individual. In this case the tax rate change has no impact on her optimal hours of work. See Figure 2.

- The tax rate being changed is precisely the one faced by the individual. In this case the effect on labour supply comes about because both the marginal wage and the effective non-labour income changes: the decrease in the tax rate increases the slope of the budget constraint (the incentive effect of the wage

[7] Individuals may not always end up at the part of the tax schedule they planned to be. So the observed tax position may not be the desired one. The implication of this measurement or missclassification error, originally discussed by Burtless and Hausman (1978) is not discussed in this paper.

[8] In this discussion we will abstract from the possibility that income effects dominate and counteract substitution effects, leading to negative effects of wages on hours of work. Empirically this has not proved to be an important issue.

rate) and reduces its intercept, as if the individual had less non-labour income. Hence, the effects of reduction in taxation above the non-taxable allowance in the context of a nonlinear tax system can be understood as having the combined effect of increasing the after tax wage rate and taking away some of the persons "non-labour" income. Now suppose that increasing the after tax wage increases hours of work[9]. The effect of the tax decrease is going to be reinforced by the virtual decline in non-labour income which acts to encourage work. Figure 3 shows this. Thus it seems that a tax rate reduction above a threshold has a larger impact than the same tax rate reduction if it is applied to all income (for the same person). The intuition for this is as follows: the reduction in taxes causes a substitution in favour of work, because of improved incentives. It also leads to an increase in overall resources leading to a tendency to reduce work. However, a reduction in the tax rate that applies above a certain point only, involves a smaller rise in net earnings than if that tax rate applied to all income. Hence, the magnitude of the income effect that counteracts the substitution effect will be smaller than in the case of a simple proportional tax. The tax cut would therefore imply a larger rise in labour supply than if the reduction in the tax rate applied to all income.

- The tax rate being changed corresponds to a lower income bracket than the one in which our individual is positioned. In this case there is only an income effect - individuals receive a windfall increase in net earnings but without a change of in their marginal wage. In this case an increase in the tax rate unambiguously decreases labour supply if leisure is a normal good.

- Changes in the thresholds of taxation (A_k) will have pure income effects for individuals earning above that threshold, but whose marginal tax rate remains unchanged. However, for some individuals the change in thresholds will lead to changes in the tax rates faced and the effect on Labour supply will again be ambiguous, but will be more likely to involve an increase in labour supply than under a simple proportional tax system.

Thus, even in this simple framework it becomes apparent that the policy implications of tax reform cannot easily be summarised by one elasticity. In the simple world of a tax system with increasing marginal tax rates the implications of tax reform will depend on both income effects and wage effects, as well as on the way individuals are distributed over the entire budget constraint.

[9] This means that the standard substitution effect of improved incentives (that make one wish to work more) dominates the standard income effect of increased net earnings (which would make one want to work less provided leisure is a normal good i.e. one that you consume more as income rises).

In Figures 2-4 we show what happens to optimal hours of work when the tax rate changes. In these graphs the straight lines show how after tax income changes when hours increase and thus in work income increases. This part is just as in **??**, except that the horizontal axis depicts hours of work instead of pre-tax earnings and we have shifted the graph upwards by the amount of non-labour income μ.Thus, as hours (and hence pre-tax earnings) increase take home pay increases. When the individual earns above the tax exempt threshold the gradient of the budget line declines by the amount implied by the tax rate in force. The curved lines are the *indifference curves* and represent the rate at which the individual needs to be compensated to accept to work more. These curves underlie the labour supply functions we estimate from the data. In Figure 2 a tax rate is changed for individuals earning more than our worker. She has no incentive to change her work-plans. In Figure 3 the tax rate is decreased above the allowance A from t_a to t_b. In effect this can be interpreted as an increase in the marginal wage (the return to an extra hour of work) from $w(1-t_a)$ to $w(1-t_b)$ and a *decline* in non-labour income from $\mu + A \times t_a$ to $\mu + A \times t_b$. Given the current empirical results this will lead to an increase in hours of work. Finally in Figure 4 (case C) a tax rate is reduced for individuals earning less than our worker. For our worker this is as if non-labour income increased and the marginal return to work remain unchanged. The implication will be a reduction in hours of work for our worker. Thus the same type of reform (a decrease in the tax rate in one of the tax brackets) will have very different effects for individuals at different parts of the tax system. The final outcome will depend on how sensitive labour supply is to changes in the marginal return to work and in non-labour income as well as how individuals are distributed over the budget set.

1.1.2 Allowing for welfare benefits

The UK has a complex system of welfare benefits and tax credits, mostly means-tested, resulting in potentially large transfers to individuals. Their aim is to provide a safety net against poverty and sometimes to provide work incentives at the same time, such as the Working tax credit programme in the UK (and the Earned Income Tax Credit in the US). At the margin, welfare benefits may act as taxes on individuals, because in many cases the levels of entitlement vary with earnings or income; whilst this serves to limit the eligible population to a targeted group it also implies a marginal tax rate on earnings as benefits are withdrawn. Suppose an individual receives a means-tested transfer. When earnings increase, some of the transfer will be taken away. This is equivalent to an additional tax on these earnings on top of any regular income tax they pay. In some cases welfare benefits are associated with a subsidy over a range of earnings.

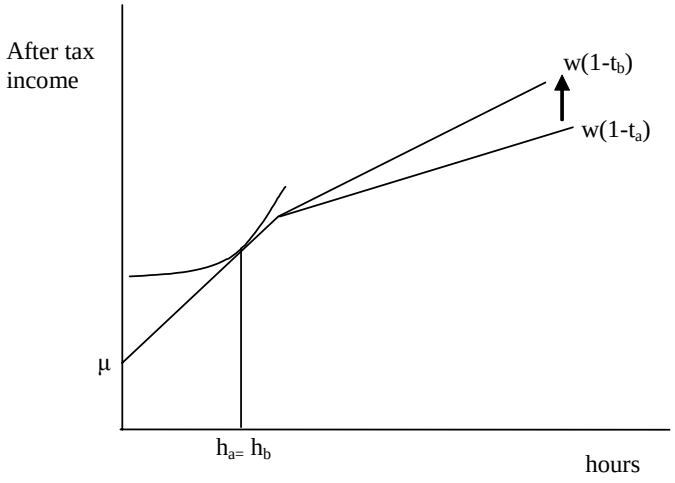

Figure 2:

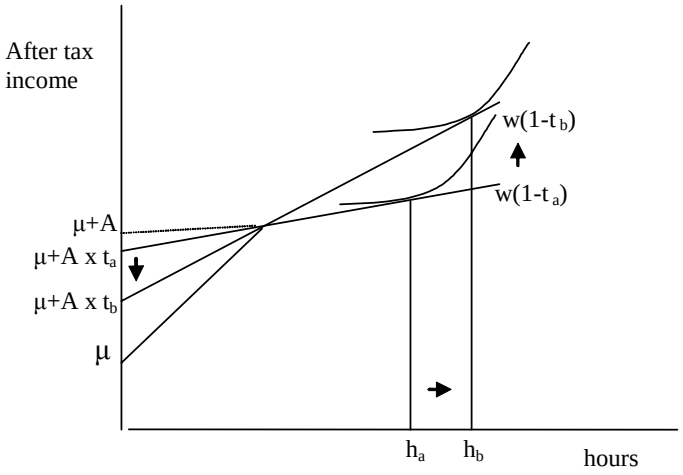

Figure 3:

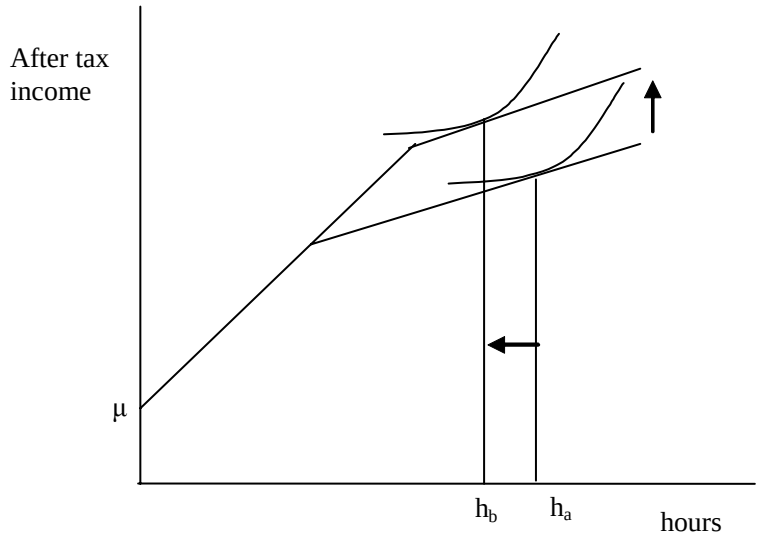

Figure 4:

This is the case of the US tax credit scheme, where an increase in earnings is associated with an increase in the benefit for very low earnings. In the UK tax credits offer a maximum benefit for those working above 16 hours of work with a means tested amount tapered at 39% for each extra pound earned. Thus understanding the effect of means-testing is equivalent to understanding how welfare benefits change the budget constraint and how changes to the latter affect labour supply behaviour.

The UK (as well as the US) system leads to a non-convex budget set as demonstrated in figure 5.[10] The jump up represents eligibility for the tax credit at 16 hours. The magnitude of the jump reflects the amount of the benefit. The gradient following that point reflects the taper rate. The budget constraint becomes steeper when all the benefit has been withdrawn and earnings increase at the rate of the actual hourly wage rate.

On the same figure we also show how a change in the taper rate form 39% to say 29%, say, may affect an individual originally in the system and receiving tax credits (continuous curve) and an individual originally earning too much to obtain tax credits (dotted curve). The budget set changes in the direction of the arrows

[10] The nature of the US system is completely different and has no condition attached to hours of work. The nonconvexity arises there only at thepoint where all the benefit has been withdrawn through the taper and earnings start increasing at a rate equal to the wage rate.

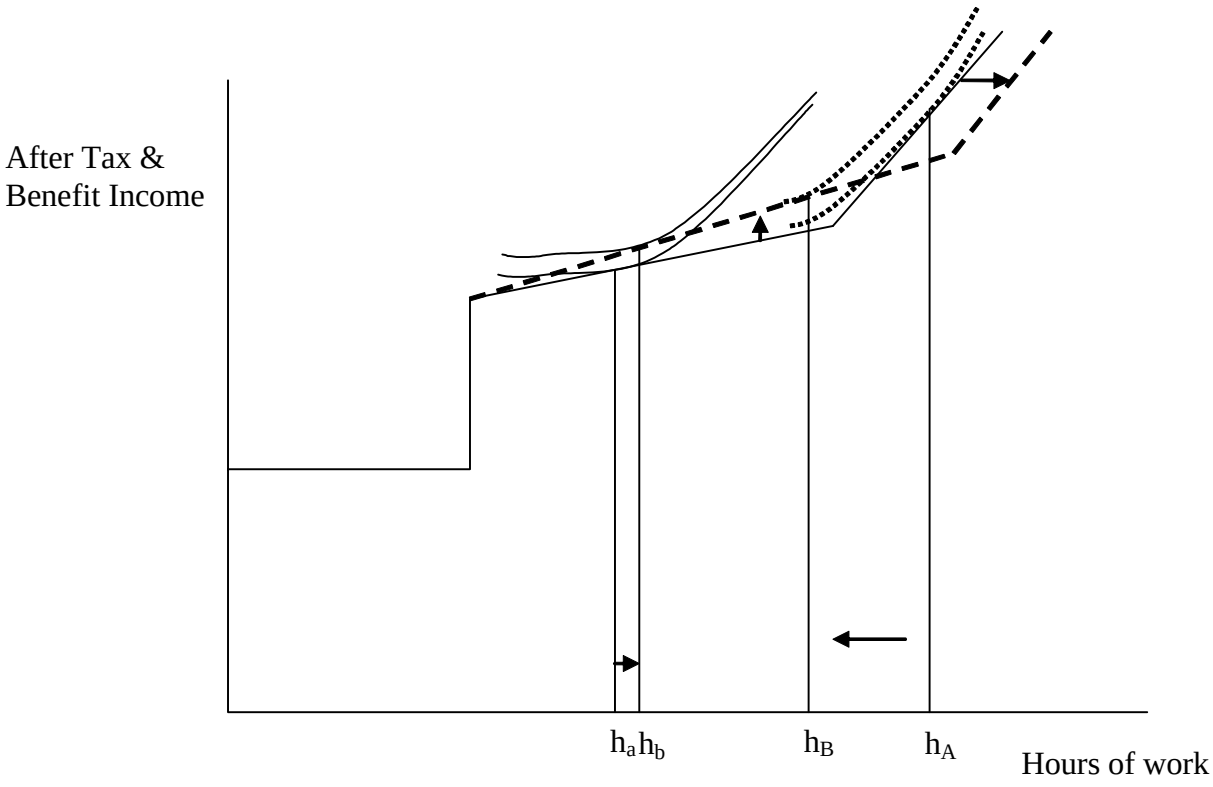

Figure 5:

to the dashed line. The person originally receiving the tax credit now has an incentive to increase hours of work from h_a to h_b, very much like the case where the tax rate is reduced. The person originally not receiving tax credits now finds it preferable to *reduce* hours of work from h_A to h_B and enjoy the increased entitlement of the reformed system. Thus, when budget sets are not convex it is quite possible that relatively small changes to benefits, tax credits or taxes leads to large changes in hours worked (e.g. from h_A to h_B). Thus the *non-convexities* in the budget set invalidate our ability to carry out marginal analysis of tax and benefit reforms based simply on the elasticity, or local sensitivity of hours to a small change in work incentives.

1.2 Family labour supply, taxes and programme participation

We now turn to describing an approach for modelling family labour supply and the take up of welfare benefits. This approaches addresses the complexities that arise in trying to model the incentive effects of taxation and welfare in a two person household and offer an insight in how models can simulate policy in this context.

Observing the distribution of weekly hours one gets the impression that hours of work are discrete with a number of focal points where people bunch together. While we are not able to explain why people bunch at certain points, the discrete labour supply approach at least allows us to recognise the existence of the phenomenon. And it is certainly convenient because we can use the apparatus of the so called *discrete choice* literature where the individual chooses among a number of specific alternatives. In this case each choice is a packet of hours for each household member and the resulting income.

Based on this idea, we outline a model of labour supply for a couple . Our model is going to be of the *unitary* type, i.e. where there is a single household utility function and we ignore the issues relating to intrahousehold allocations of income. However, we will also address one important policy concern, namely the take-up of means tested benefits; while taxation is compulsory, taking up benefits is usually not, making the entire shape of the budget constraint that an individual is facing a choice of the individual: individuals who do not take up a benefit, will not face the same budget constraint as those who do. Understanding the determinants of take-up is important for properly targeting benefits and for budgetary planning.

Suppose individuals derive satisfaction (utility) from leisure, disposable income and programme participation P; the latter entails dissatisfaction because the process of applying for benefits and receiving them may carry stigma or other indirect/psychic costs. By allowing for this in the model we are able to model

the decision to take up benefits and how this will depend on programme characteristics. It thus offers a mechanism for simulating tax reform, allowing for the effects on take up.[11]

The budget constraint defines household disposable income Y depending on the combination of hours chosen by the male and the female and on the tax and benefit system and its take-up. The budget constraint may also depend on household characteristics such as the number and ages of children and the type of housing occupied, because of the way the tax and benefit code is defined.

Now simplify the problem by assuming that individuals can work certain specific hours of work, say $(0, h^1, h^2, ..., h^k)$ where 0 allows for non-work, and suppose for illustrative purposes that there is just one means tested programme. Given a particular pair of hourly wage rates for the woman and her partner there are then $(k+1)^2$ possible values of income Y with welfare programme participation and another $(k+1)^2$ without (although some of the income points would overlap because not all hour/income combinations would be affected by the programme) The household chooses hours of work and programme participation by trading off income against the disutility of effort (hours of work) and monetary or psychological costs of programme participation; in other words it chooses the combination that maximises utility.

Apparently identical households facing identical options often make different decisions. As a result there is some chance (probability) of observing any feasible hours/income/programme participation combination for any individual with certain observable characteristics. The typical way that this is accounted for in empirical economic models is to allow for preferences to vary randomly in the population. The econometric problem of measuring preferences and stigma costs consists of choosing the parameters that will make the probabilities predicted by the model equal (or as close as possible) to frequencies of hours/income/programme participation combinations we see in the data. From an empirical point of view, identification (i.e. the ability to recover the actual parameters of the model) will depend on the existence of variations in the budget constraint and in the costs of programme participation, shifting the opportunities available to the households in a way that is unrelated to the unobserved taste components in the data. It is increasingly popular to use the differential impact of policy reforms across the population as such a source of variation.

To simulate alternative policy options we need to predict what the probabilities of each alternative hours/programme participation combination will be with the new tax parameters. Now that once we have parameter estimates, this involves recomputing the $2(k+1)^2$ income possibilities and finding the best combi-

[11] see Keane and Moffitt (1998).

nation for each type of household. We then need to aggregate these outcomes using as weights the frequency with which each type occurs in the population. These weights and the types of household are themselves an outcome of the estimation process mentioned above. This illustrates that the information required to understand the impact of tax reform is quite complex. Experience from observing what happened around one reform will typically not be useful for predicting the effects of another. We really need to understand the entire structure of preferences for work over a broad range of hours and incomes.

One of the key issues in family labour supply is understanding how intrahousehold allocations of time and consumption actually take place. The models used typically, including the one described above, work on the basis that the household is a unit with well defined preferences (hence the term unitary model). But this is brushes the issue under the carpet and more importantly does not allow us to understand how policies affect within household allocations. Indeed, one of the sources of inequality is within household and one would wish to know how policies target individual members. Beyond the couple the issue extends to resource allocations for children. Tax and welfare policy may well be designed with the aim of targeting children. But without knowing how different tax and benefit structures affect resource allocations it is not possible to know whether the policies are going to be effective. The empirical issue relates to the fact that we do not typically observe allocations of consumption within a household; we just observe total expenditures. So one needs to understand how much we can learn about intrahousehold allocations based on what is actually observed or at least observable with better data. Chiappori (1988, 1992) explored the possibilities using the Collective model, which assumes that whatever outcomes are observed are efficient; in other words any change in allocations would have to imply that improving one member's position can only be achieved at the expense of the other. In this context Chiappori (1988, 1992), followed by Blundell, Chiappori, Magnac and Meghir (2007) derived conditions under which observing individual labour supply and total household consumption would reveal the entire intrahousehold decision mechanism. Blundell, Chiappori and Meghir (2005) extended this framework to one where the household spends on public goods (such as children).[12] Once the mechanism has been estimated one can ask questions relating to how taxes and benefits affect not only labour supply but also consumption of children and within household inequality. This literature is currently better developed theoretically than empirically. Blundell et al. (2007) do provide possibly the only structural model of labour supply in a collective model. However, their households do not include

[12] There has been a growing literature in this field The papers of Thomas (1990) and Browning et al (1996) showed the empirical relevance of considering the household as a group of individuals, rather than one unit.

children. Moreover, they have not allowed for taxes and benefits. This is very much an active and important research area, that needs further development before we can be confident that we understand intrahousehold allocations and how they interact with policy.

1.3 Intertemporal Labour Supply decisions and Taxes

1.3.1 Continuous hours of work

The majority of work that has taken place in labour supply and taxes has been static. Introducing dynamics poses a number of interesting questions and allows us to extend the scope of the analysis of the impact of taxes on other important life-cycle decisions. Moreover, if we are to address the question of optimality of tax systems over time, we need to study how labour supply varies over the life-cycle and how this is affected by tax incentives and this involves considering people's saving decisions as well. Here our aim is, of course, much more circumscribed: we wish to discuss some of the empirical issues that arise when we view labour supply decisions in an intertemporal context.

What does the basic labour supply model look like when we allow for savings? To consider this, suppose preferences are separable over time, meaning that past choices do not affect current preferences or the budget constraint, and that within each period preferences just depend on current consumption and hours of work. Then the labour supply model takes exactly the same form as in the static case with an important difference in the interpretation of non labour income μ.[13] This is now defined by $\mu = c - wh$ where c is the value of consumption in the current period, which itself is a result of an intertemporal optimisation problem. The problem can be described by the following *two stage budgeting* procedure first discussed by Gorman (1959). Individuals first allocate consumption to a particular time period and given this choice, they then decide what should be the optimal hours of work.[14] Adding taxation when the budget set is convex is in principle simple and the labour supply model does not change in form from the one described earlier. In other words we simply replace the wage with the appropriate after tax wage rate and unearned income for the tax adjusted one, starting with μ defined above as the basis. Although the form of the relationship does not change, in that labour supply can still be expressed as depending from the marginal wage and some measure of non-labour income, substantively, things do change because consumption, which determines the relevant measure of non-labour income, will now depend on current taxes and future expectations of the tax system.

[13] See MaCurdy (1983), Blundell and Walker(1986), Arellano and Meghir (1992).

[14] More precisely the first stage takes place in the knowledge that the second stage will be optimal. There are a number conditions under which optimal consumer decisions can be thus broken down, but this is beyond the scope of this chapter.

Thus the simplicity of the problem stops in form and empirical characterisation. First a change in any aspect of the tax system will affect the optimal amount of saving, in general. This means that simulating a tax reform with a fixed μ will be insufficient for evaluating the behavioural impact of a reform. The change in the saving decision will reflect possible shifts in labour supply to future periods where tax liabilities are expected to be lower. For example, suppose the higher rate of tax is to be increased, and that one's wage rate is expected to decline with age. An increase in the current tax rate will make the difference between the current and the future after tax wage rate lower, implying that work effort now could decrease relative to the future, if we ignore income effects at least. In this simple model this will be reflected as an increase in the current value of μ induced by an decision to increase current consumption (remember $\mu = c - wh$) and a consequent decline in hours worked, over and above what would be implied by the static model. This also implies that to estimate the incentive effects of reforms in a reliable way we need to use consumption data to compute μ and estimate a model consistent with intertemporal optimisation.

In the case of convex budget sets the difficulties caused by intertemporal considerations are confined to simulation. The labour supply model can be estimated in a straightforward way, by using the suitable definition of μ, as defined above. However the situation is not as simple when the budget set is non-convex. In this case estimation as well as the evaluation of tax reform require simulating the impact of taxation on savings and hence μ.[15]

These issues may be very important for understanding labour supply effects. However, to our knowledge little or no work has been done in this direction, at least from the perspective of simulating tax reforms. Apart from the computational difficulties involved, the requirements for high quality data (particularly assets) has been an inhibiting factor in estimating complex intertemporal models that allow for the complete structure of the tax system.[16] An exception is the work of French (2005) who estimates a life-cycle model of labour supply, savings and retirement, accounting for key aspects of the US tax code including important non-convexities.

Which is the correct elasticity concept? Often labour supply sensitivity to incentives is summarised by elasticities. Indeed below we use them to summarise empirical results. However, there are several wage

[15] In order to evaluate the likelihood function we need to compare the utility achieved at different parts of the budget constraint. This involves solving the labour supply model in counterfactual situations, such as not-working.

[16] It is possible to simplify the problem by effectively ignoring savings and either assuming that consumption equals income or by assuming that individual utilities depend linearly in income. In this case individuals do not care when the income will arise. However, once taxes are introduced, which depend very much on when income arises, the simplicity provided by this last assumption is partly lost.

elasticity concepts, depending on what is being kept constant. In a static labour supply context we can define the wage elasticity that keeps utility constant (the substitution effect or compensated wage elasticity), the wage elasticity that keeps non-labour income constant and the one that keeps full income constant (total potential earnings plus non-labour income). Once we introduce intertemporal concerns there are a number of additional elasticities we could consider as well as modifications of the concepts already defined. In an intertemporal context, the direct analogy to the static wage elasticity, which holds constant non-labour income, is the one that keeps consumption based unearned income (μ) constant. Although useful for characterising the properties of the estimated labour supply function, this is clearly not the correct measure for understanding the effects of policy, when adjustments to savings are to be expected.

We can straightforwardly define at least three additional elasticity concepts in the intertemporal context, each with a different interpretation. First, we have a notion of compensated wage elasticity. However, in an intertemporal context this does not keep lifecycle welfare constant but only within period utility constant. Hence it does not have a direct welfare interpretation as the one we get in the static context. Nevertheless this elasticity is always positive. One can in principle define a lifetime utility constant elasticity, but this is not usually done. Second, we have the Frisch elasticity, which keeps the marginal utility of wealth constant. This elasticity reflects the impact of *anticipated* marginal changes in wages on hours of work. As such it is clearly not the elasticity of interest when considering changes in tax policy: considering the effects of tax policy would require to compare two alternative tax regimes. However, this elasticity is an upper bound to the wage elasticity which keeps unearned income constant. Finally we can also define an hours elasticity wth respect to an unanticipated change in wages. This will combine the effects of an anticipated change and the wealth effect of the change in the wage profile. Quite clearly, the magnitude of the effect will depend on whether the change in wages is perceived to be permanent and if not on the speed with which wages will revert to the original profile.

None of the above elasticity measures the impact of a small change in the marginal tax on current period labour supply, even in the context of a linear tax system. To achieve this we require the effect of taxes on μ, which must be added to the effect of taxes on hours of work, keeping μ constant.

1.3.2 Taxes and Human Capital

Taxes and welfare benefits affect more than labour supply. Of course, this is well understood and it may be thought that in addressing this issue we are going beyond the scope of this chapter. However, the reason

we wish to consider this issue now is because these decisions are intimately linked with labour supply and labour market behaviour more generally. In particular we have in mind choices relating to education and human capital investment.

Appropriate models along these lines should include decisions on education, and labour supply as well as wage formation. The seminal paper addressing the latter two is Eckstein and Wolpin (1989) who model employment and wages of women when wages depend on experience. Since then these models have been developed to greater levels of sophistication including other decision margins, such as occupational choice as in Keane and Wolpin (1997) and education and job mobility as in Adda et al. (2006). We use the latter as an illustration of some of the issues involved.

Adda et al. (2006) focus on the population who, having completed formal schooling, face the choice of following formal vocational training or entering directly the labor market.[17] At the start individuals choose whether they will join a formal vocational training programme, which offers on the job and classroom training at a reduced wage, or no formal training. In taking this decision they trade-off current earnings of a non-apprentice with working at a lower wage, while obtaining formal training and then obtaining an improved career path. Alternatively they enter the job market and obtain training informally on-the-job. Once the education choice has been made the individual starts up on his career, whether qualified through training or directly without a formal training component. All individuals receive job offers at some rate, which may differ depending on whether the worker is employed or not. Associated with an offer are fringe benefits and a wage which defines the initial pay level in a firm given the person's skills and experience as well as how well they fit in the firm. While the worker remains on the job pay may evolve due to random unaccounted factors. When out of work the individual has a stream of transfer income depending on the way unemployment insurance works. Individual choices include moving between jobs when the opportunity arises and between work and unemployment as well as the initial education choice.

This model, estimated on long run administrative data following individuals from the end of their schooling to mid-career, offers an empirical framework for considering the impact of taxes on life-cycle decisions: a tax or benefit may affect the decision to train, because future returns are changed. It could affect job mobility, because the benefits from moving job are in effect taxable. Finally, it can also affect the incentive to work in any given period. But more interestingly, the overall employment effect will be different when

[17] Utility is linear in earnings making risk and the timing of consumption irrelevant for decision making, thus bypassing the need to model savings.

we allow for the other effects, than when we condition on education and do not consider job mobility. This allows for a clear distinction between short run effects of taxes and benefits and long run ones, which can be very different. The latter certainly need a complex intertemporal model to analyse and cannot be measured based on simple experiments or by static labour supply studies. The empirical work mentioned above demonstrates that this can be an important issue.

1.4 Taxable and total income elasticities

For many individuals, particularly the self-employed and the high earners, hours of work is just one dimension of work effort. Take for example the executive who spends most of the week in the office and takes work home at the weekend. She does not have much margin of adjustment for her hours of work. However, with the right incentives, she may put in more thinking effort during these long hours, surf less on the internet, or find ways to become more creative. In these cases the output of an hour of work (or better an hour *at* work) may differ and hence hours supplied are not necessarily a good measure of effort. In some cases it is also difficult to measure hours of work in the first place, such as for the self-employed or individuals whose work may well be hard to distinguish from leisure time. In these cases the sensitivity of hours of work to changes in wages or taxes is only a part of the story; indeed it may be a small part only. In terms of work incentives the *total income elasticity* with respect to taxes is probably more relevant. However, in terms of revenue and possibly also in terms of welfare the *taxable income elasticity* would also be required. Both together would give a more complete picture as to how individuals change effort and rearrange their income and expenditure in response to taxes.

Key papers in this field, constituting, *the new tax responsiveness literature,* have been written by Feldstein (1995, 1999). He stresses the importance of considering taxable income for a number of reasons: taxation can distort not only effort but also the way one organises the sources of income and consumption to reduce tax liability. Such reallocations of income from one source to another (e.g. employee earnings to self-employment) or of consumption from one type to another that is tax deductible (e.g. from non-housing to housing in the US) affects government revenue and welfare. The latter is true because individuals are not indifferent to the type of consumption or even to the way that their income is generated. Thus, tax exempt consumption may not be a perfect substitute for ordinary consumption. The tax system may encourage individuals to consume more housing, say, than they intended when interest payments are tax deductible (as in the US) causing a welfare loss as behaviour is thus distorted. Hence, particularly for higher income individuals -

who, plausibly, have more opportunity to shift income and consumption to tax favoured forms and whose main labour supply response is not measured directly through hours of work - a good way of summarising the behavioural effects of taxation is through its effects on taxable income.

However, measuring these effects is fraught with problems, some of which we discuss now. Perhaps the key difficulty which prevents a structural economic modelling of these important dimensions is that we do not observe effort. If we cannot measure effort, we cannot measure the price of effort (termed the effective wage rate). As this is likely to differ across the various skill group of workers the unobservability of effort and its effective wage rate can become a very important confounding factor when measuring incentives. This does pose a challenge for policy analysis and evaluation.

The most common estimation approach for the taxable income and total income elasticities has been *difference in differences* comparing outcomes before and after reforms. To see how this works and to illustrate some important problems, consider a single period model where utility depends on income and effort.[18] For simplicity suppose we are interested in measuring the effect of taxes on earnings, the latter being the product of (unobserved) effort and the price per unit of effort. Conceptually the model is identical to the labour supply one, with effort substituted for hours. The appropriate wage rate is the after-tax marginal return to effort and the appropriate measure of non-labour income is the adjusted other income measure exactly as in the hours discussion earlier. This adjusted measure does not depend separately on the price of effort - so the relevant measure of other or non-labour income is observed. However the price of effort is not observed. The standard approach has taken a simplified model, where the price of effort is treated as an aggregate time effect, common across individuals (like a trend, which is the same for all) and where the income effect is ignored. The effect of taxes is estimated by considering what happens to different groups of individuals, depending on their marginal tax rates, following a reform. To fix ideas, suppose a higher rate of tax is reduced by a reform. Individuals are split up depending on whether in the period before the reform their marginal tax rate was the one to be reduced or not. In other words, they are split up by past income. The approach to estimating the taxable income elasticity[19], is then to compare the growth of earnings for the group that was subject to the tax reform on the basis of their pre-reform income (say the very high earners) to a group with earnings just below the level at which the tax cut took effect. The approach reports the proportional change in earnings due to a proportional change in the share of income retained after tax: the

[18] For further critical analysis of the Difference in Differences method and for examples of use and extensions see Blundell, Duncan and Meghir (1998), Blundell and MaCurdy (1999) and Moffitt and Wilhelm (2000).

[19] see Feldstein (1995, 1999) for example.

so-called taxable income elasticity.[20]

This approach is sensitive to three sources of bias The first is due to "mean reversion": the income of individuals is subject to temporary random changes. Following a large negative shock we can usually expect income to grow again towards its previous level. Thus among people selected because they have lower income, some have incomes that are only temporarily low and we can expect some positive income growth as this temporary negative shock works its way out; among those with higher income we can expect negative income growth as those who had only temporarily high income experience a similar reversion to their typical income. Both these movements would happen anyway, irrespective of the tax reform. In our empirical experiment this mean reversion will be attributed to the tax reform and will lead to an underestimate of the effect of lowering taxes. This source of bias is discussed at length by Gruber and Saez (2000).[21] The second source of bias relates to the possibility that growth in income can be different at different parts of the income distribution. This is particularly the case for some of the studies carried out using data from the 1980s when inequality was growing rapidly. This means that the incomes of those higher up in the distribution are growing faster than those lower down for reasons that may not be related to the tax reform directly and this will bias upwards the effect we wish to estimate. The final source of bias relates to the effect that a tax reform may have on skill prices and hence on earnings. In general one can show that a tax reform reducing higher tax rates will lead to a relative reduction in the skill price of those facing a lower tax rate. For example, cutting marginal tax rates of high skill individuals may increase their hours and effort, which may push down the price of their labour. This will bias the effect downwards. Thus these three sources of bias do not all go in the same direction, creating some ambiguity on the credibility of the results. In Appendix 2 we consider this issue in greater detail.

The above difficulties are compounded by the fact that reforms rarely involve the change of just one tax rate and moreover the impact of the change may depend on adjusted non-labour income, which is typically ignored by this approach. Thus, the results obtained, even if unbiased for a particular reform, are unlikely to have much external validity and are more of a description of what happened in one specific instance. This was illustrated clearly by Goolsbee (1999) who applied such a method to all major tax reforms in the 20th century for which data was available and demonstrated that the results differed widely from one reform to another. In order to derive more general conclusions we need an approach that allows for the issues discussed

[20] Note that this is not the same as (minus) the elasticity of earnings with respect to the tax rate. The latter is -$\beta\frac{t}{1-t}$.

[21] Note that Feldstein categorises people on the basis of the pre-reform marginal tx rate. This is a function of the pre-reform income. Hence although more complicated this is in effect a categorisation by initial income and the same arguments apply.

above as well as for income effects and other complexities of the tax system. A credible structural model is imperative in this as in many other areas of empirical economics.[22]

Moffitt and Wilhelm (2000), Gruber and Saez (2000) and Blow and Preston (2002) make the most serious attempt to overcome the numerous problems we have listed above. In particular they discuss many of the issues we raise here and they try to account for them, including allowing for income effects, taking into account of differential trends where possible, controlling for the mean reversion etc. In addition, Gruber and Saez (2000) use information from many tax reforms taking into account the complexity of the changes. Finally, they allow for differential trends to control for the change in inequality. Thus their approach is closest to a structural approach whilst at the same time using actual reforms to estimate the effects. They cannot, however, get round the issue of changing effort prices for different skill groups. Finally, they use two income measures; a broad income measure which reflects mainly changes in effort and a more narrow measure of taxable income, which also captures the effects of avoidance. Their estimates are probably the most credible available. Blow and Preston who consider the self-employed in the UK, also control for income effects and for mean reversion by grouping individuals by occupation and region. The key issue is whether their grouping is correlated with tax liability and it clearly is. We next review the results of this and other papers.

2 A Review of some Empirical Results on Labour Supply.

Much of the empirical analysis on labour supply concentrates on estimating wage elasticities. Some take account explicitly of taxes. Few only are directly designed to ask specific policy questions, such as the effect of benefits. The aim of this brief review of empirical results is to provide a picture of how sensitive labour supply is to changes in work incentives and to see if we can provide a sense of consensus on what is currently known about labour supply. Our aim is not a formal meta-analysis, due to, if anything, the methods used being very heterogeneous, making it difficult to provide a sensible weighted average. However, we hope that by providing information on the methods and a way of assessing reliability we can allow the reader to decide for themselves, whilst providing our own guidance.

Individuals who value leisure less and thus work longer hours than others are also likely to command higher hourly wage rates[23] and, abstracting from those with incomes low enough to be in receipt of means tested benefits, are likely to face higher marginal tax rates than those who work fewer hours (precisely

[22] see also the discussion of Goolsbee (1999) by Hall and Katz, which follow the article.
[23] They probably invested in education more when they were younger

because they like to work more and thus earn more). This creates a circularity between incentives and effort and constitutes the classic endogeneity (or reverse causality) problem that plagues our attempts to estimate the impact of incentives on hours of work.

We will illustrate these issues with some examples. Take someone who has a low preference for work and therefore works for few hours. This person is also likely to have invested less in human capital accumulation and is thus likely to have a low pre-tax wage. This causes a spurious positive correlation between hours and wages leading to an impression that incentives and hence taxes may matter more than they actually do. From a different perspective the progressive tax system will lead to an underestimate of incentive effects: individuals with a stronger preference for work will face higher tax rates and hence, all else equal, will have lower after tax wages. This will cause a negative correlation between hours and marginal wages, which if not accounted for may lead to a downward bias in wage elasticities and even reversal in signs, implying negative incentive effects. The picture is further complicated by the fact that some persons do not work. Typically those not working will have higher reservation wages. Ignoring such selection into the labour market will lead to underestimates of the incentives for work.

The above examples illustrate the difficulty of estimating wage effects for labour supply and emphasize that the direction of bias is not known *a priori* and cannot be inferred. A number of early labour supply studies[24] emphasised the issues of endogeneity of taxes and solved the problem by explicitly taking into account how work preferences affect the decision process that leads individuals to choose to work while facing a specific marginal tax rate. In other words they modelled the dependence of tax rates on individual unobserved preferences components. The most elaborate of these studies allow for measurement or optimisation errors - where the individual is observed working a number of hours that differs from that planned - as well as preference heterogeneity. Issues that have not been addressed by this generation of models include unobserved fixed costs of work (other than those implied by the tax system) and the endogeneity of the pre-tax (gross) wage rate. Ignoring these issues is likely to overstate the incentive effects. A further issue, which is equally important but a bit more esoteric in nature has been raised by MaCurdy, Green and Paarsch (1990): the combination of estimation methods that impose theoretical consistency of the labour supply model everywhere in the sample, with restrictive functional forms leads again to an overstatement of incentives.

Estimating incentive effects in a convincing way thus requires us to find solutions to all these problems

[24] e.g. Heckman (1974), Burtless and Hausman (1978), Hausman (1985), Moffitt (1984), MaCurdy, Green and Paarsch (1990).

at the same time. This calls for a sufficiently flexible approach, that allows for fixed costs of work, does not impose theory *a priori* everywhere in the sample (thus in a sense increasing model flexibility) uses exogenous changes to work incentives to identify their effect. and allows for taxes and benefits. This is of course a large set of requirements, but all have been shown to be important empirically; in our review of empirical results we will use these criteria to judge the value of the estimates. However, there will always be trade-offs in the way the model is implemented empirically. For example, Blundell, Duncan and Meghir (1998), rather than solving for the full solution to taxes simplify the problem substantially by exploiting the fact that most working women would find themselves paying a single basic rate of tax, once conditioning on having a working husband. This approximation allowed them to treat the marginal wage as a single endogenous variable; the cost of their approach is that the sample they use is selected and this has to be allowed for. They then exploit the change in the UK wage structure and the numerous tax reforms that occurred to control for the endogeneity of wages and taxes. Their approach uses the *differential* time series variation in after tax wages for different cohorts and different education groups. Their identifying assumption is that while preferences for work may be different between education groups and cohorts, these differences are permanent. Hence differential changes in the labour supply of these groups can be attributed to differential changes in the price of human capital that they face. They also illustrate that indeed the change in the wage structure across these groups is indeed important both in statistical terms and in magnitude.

Given the above discussion we can distinguish the studies by the way they treat non-linear taxes - namely by solving fully for the tax position or by some approximation and by the role of cross-sectional and time series comparisons in estimating wage effects. In our view using changes over time in prices, controlling suitably for aggregate changes in preferences (time shocks) is the most convincing way of controlling for unobserved heterogeneity in this context. The relative merits of treating taxation with a full solution approach or with approximations are less clear. Here there is a trade-off between putting more structure in the stochastic specification and accurately taking into account of all the details of the tax system.

2.1 Empirical Results on Female Labour Supply

There have been a large number of studies focussing on female hours of work in the US, the UK and many other developed economies. Research has focussed on women because of the greater variation in their hours and their lower participation rates, and a belief that their labour supply is most responsive to wage changes and hence an important source of distortions due to the tax system.

Table A1 presents some of the estimates for married women. It becomes immediately obvious that the range of estimates is very wide indeed. Very few estimates are, however, larger than 1 and all are positive. However, those estimates (except Cogan, 1981) that rely on annual hours of work tend to be higher and clustering close to 1. Those based on weekly hours tend to be much smaller. This is to be expected because on an annual basis individuals have more margins of adjustment, such weeks per year as well as hours per week than on a weekly basis.

A further important distinguishing feature of the studies is whether they allow for fixed costs of work. Ignoring fixed costs tends to increase the labour supply elasticities.[25] Taking all these issues into account we find that the annual labour supply elasticity for women is close to 1. However, the annual hours results that we report have to be regarded with some caution because they rely almost exclusively on cross sectional comparisons. Weekly hours respond much less to changes in wages with elasticities in the range of approximately 0.0 - 0.30. Arellano and Meghir, allow for endogeneity of taxes and pre-tax wages and non-labour income and they find elasticities in the range of 0.3-0.7 depending in the demographic group. However, their identification strategy, based on cross-sectional data relies on education not having an independent effect on hours of work. Several studies are based on some time-series variation. For instance, Blundell, Duncan and Meghir (1998) use long time series variation and allow for the endogeneity of pre and post-tax wages as well as for fixed costs. In this sense we take this to be the most reliable estimate. In this study the highest elasticity observed is found for those women who have young children. For all other married women the wage elasticity is around 0.13, which implies a very low responsiveness of hours to small changes in work incentives.

For the purposes of tax simulation and welfare analysis income elasticities are also very important both for measuring welfare effects and for obtaining the full behavioural effects of a reform. First, a large income effect will translate a modest wage elasticity to a large compensated wage elasticity, which is the source of deadweight loss. In addition the measure of unearned income will be a function of the tax rate when the tax system is nonlinear as shown earlier. Thus the change in the tax rate will also affect unearned income providing an additional channel for a response to a tax change reinforcing the effects of changes in marginal tax rates. The range of estimates we find in the literature is quite limited ranging from about -0.1 to -0.3

[25] In the presence of fixed costs of work the individual needs to decide whether to work at all or not. If she decides to work she works a sufficient number of hours to make it worth her while. Cogan (1981) termed this *reservion hours.* Thus wage fluctuations can lead to large jumps from zero hours to some large positive number, e.g. 20 hours. The same wage fluctuation for workers may lead to just a small hours adjustment. Thus under fixed costs the hours adjustment is driven by different factors than the adjustment of whether one works or not. By ignoring fixed costs one is forcing the model to explain hours and participation changes in the same way, biasing upwards the effect of wages on hours.

across all studies reported, again implying small behavioural effects.

Putting all these results together the picture is of small elasticities for hours worked per week. For most married women - other than those with pre-school children - working the mean 25 hours per week, it would take a 20% increase in the wage rate to induce an increase of 1 hour in the work week. An elasticity of 0.2 with the income effect at about the same level implies a compensated elasticity of 0.3. Thus if we just consider hours the welfare and incentive effects of wage/tax changes are quite small. As already emphasized in a nonlinear tax system the impact of a change in the marginal wage would be reinforced by the income effect. However, this is also small. Finally, with non-convex budget sets, such as those induced by tax-credits or other welfare benefits, some individuals may respond to quite small tax changes by a large repositioning in their hours of work decisions. Although low elasticities are likely to imply that the number of these individuals may be small, the final outcome depends very much on the overall shape of the budget constraint and on the distribution of hours of work.

The results on annual labour supply show greater responsiveness to wages. Annual labour supply can be viewed as combining the effect of adjustment across many different margins: These include hours per week, weeks per year as well as participation, the latter because annual hours of work will vary as the individual takes time off between jobs. So it follows that with similar methods the annual hours adjustments should be more sensitive to wages than any one of these margins, at least if leisure across all these margins is a normal good.

2.1.1 Female Participation Elasticities

Several studies allow us to look more closely at participation elasticities, and the results of these suggest that this is an important margin of adjustment (and may explain much of the difference between weekly and annual hours results). Table A2 presents the results of several of the main studies that look separately at participation responsiveness. Aaberge et al (1999) and Arrufat and Zabalza (1986) find results of 0.65, 1.41 respectively using cross-sectional datasets from Italy and the UK. Both these studies allow for taxes and their endogeneity but are based on a single cross section. Possibly the most comprehensive study here is by Pencavel (1998) which covers a long period of time, documenting changes in participation for different schooling groups and estimating participation effects of wages with various approaches and instrument sets. However, Pencavel does not allow for the tax system and use pre-tax wage rates. He finds a range of elasticities from 0.7-1.8 with various approaches. Devereux (2004) (who also ignores taxes), finds a lower

degree of responsiveness with the elasticity at the median family income equal to 0.17 As with Aaberge, he finds evidence that participation is more elastic amongst women from poorer families, and together their results suggest that participation is likely to be the key margin of adjustment for poorer women. We look at this issue below when considering lone mothers. Thus the overall consensus (with the exception of the result by Devereux) is that participation elasticities for married women are quite high and that this margin for adjustment is perhaps more important than weekly hours of work.

2.1.2 The Labour Supply of Lone Mothers

Lone mothers form a demographic group of special policy interest because they tend to be poor and because they face very high costs of work. Creating the right conditions and incentives for them to work and thus escape poverty has been a central concern of the UK government. The main tool for this purpose has been the Working Families Tax Credit (WFTC) and its successor Working Tax Credit (WTC). From the perspective of understanding how effective such interventions are likely to be we need to know the extent to which lone mothers are likely to respond to work incentives.

There have been a number of papers estimating directly the effect of in-work benefit programmes on lone mother labour supply as well as more conventional labour supply studies. A collection of some results is presented in Table A3. Eissa and Liebman (1996) estimate a participation elasticity for loan mothers of 1.16, using directly *difference-in-differences* based on a reform on the Earned Income Tax Credit in the US. Their approach has the advantage of using the variation induced by the reform. However, the control group (mothers without children) is sufficiently different from the treatment group and with such high participation rates that this puts into question the ability of the approach to control for overall trends and thus to credibly estimate the effects of the reform. A convincing alternative approach is given by Brewer et al (2005) who combine the use of a structural model of labour supply with the reform to the UK WFTC system to estimate the impact of the reform to the UK Working Families Tax Credit. Again the implied participation elasticity with respect to in-work income is 1.02. For the US, one of the most comprehensive studies, which is based on a long time series of cross sections and exploits the numerous reforms in the US over the 80s and 90s with cross state variability is that of Meyer and Rosenbaum (2001). From their specification it is difficult to compute an elasticity, because a change in pre-tax income say, would affect disposable income not only through after tax earnings, but also through benefit eligibility. However, they conclude that the incentive effects of taxation and benefits are substantial; over the period 1984-96 they attribute about 62% of the

change in employment of lone mothers relative to single women to changes in taxation; 25% of the change is attributed to changes in benefits over the same period.

The other participation elasticities presented in the Table are similarly quite large. It is reassuring that the ones based on actual reforms lead to similar conclusions as the ones based on comparing individuals facing different wages. Thus there is a strong consensus in the literature that the participation elasticity for lone mothers is among the highest of all demographic groups. This implies that thoughtfully designed policies should be able to attract quite a few into work thus improving substantially their long run standard of living.

Finally, Blundell, Duncan and Meghir (1992) estimate a structural model of lone mother labour supply and provide estimates for the elasticity of *hours* with respect to small changes in the wage rate. Although the credibility of these estimates is undermined by the fact that they rely on a single cross section, the results are quite similar to what we saw before, with the largest elasticity reported as 0.34, very much like the results on married female labour supply discussed above.

2.2 Male Labour Supply

There has been a consistent effort to measure male labour supply elasticities. One key characteristic of male labour supply in many countries is that men work primarily full time. Thus, although there is some variability in actual hours of work there is a clear lack of individuals working below a certain level such as 35 hours, as is clear in Figure 6 for the UK. In the US one also observes a great concentration of annual hours of work at the full time all year work. This does pose a number of generally unanswered questions, relating to why such a concentration exists and how it should be treated in practice. Most studies ignore these issues and attempt to estimate the labour supply curve with continuous hours.

The results obtained generally show low income and wage elasticities for hours of work (see Table A4). A variety of methods and datasets have been used and there is a consensus that the sensitivity of hours worked is very small. So although one can start discussing the relative merits of the approaches taken, existing research will lead to the conclusion that the wage elasticity of hours of work is close to zero. For example, MaCurdy, Green and Paarsch, which represents one of the most comprehensive and carefully carried out studies, report an elasticity of zero for the US. Pencavel reports a number of negative elasticities. At the same time the income elasticities reported are low and also close to zero. As we reported above, some groups of women, particularly those with young children, showed wage elasticities as high as 0.4. No male elasticity

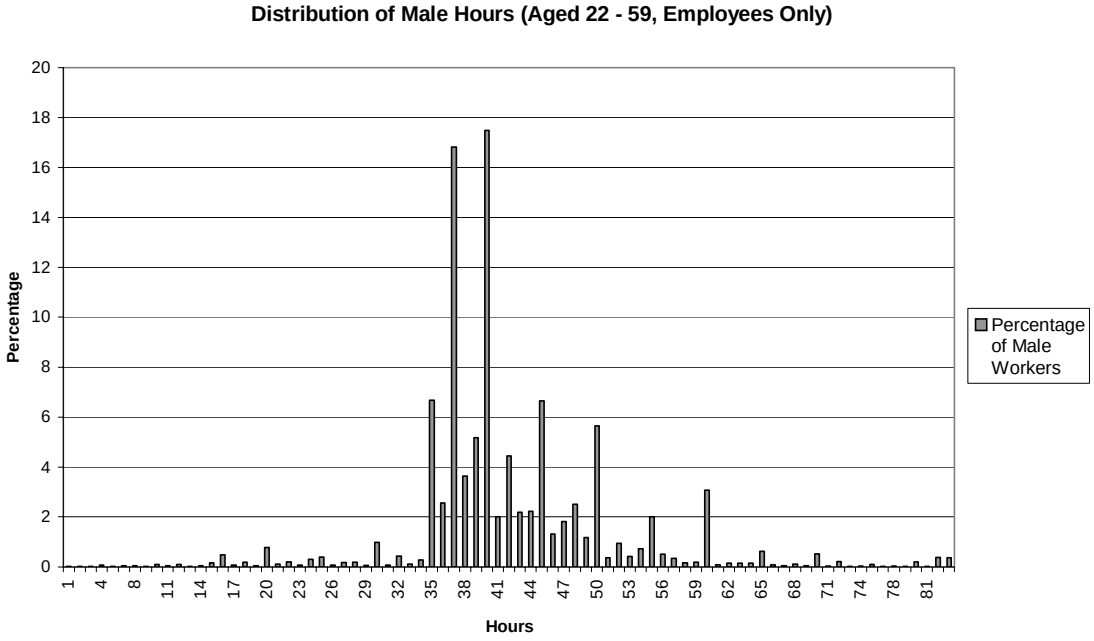

Figure 6:

is reported as high as that. It would be a fair description to say that male hours adjustment to changes in marginal wages is very low indeed and can almost be ignored for welfare purposes. However, this may not be the right margin to consider. We will thus also consider employment elasticities, which we will show are quite high for unskilled men and total income elasticities, which are quite high for high earning/high skill men (see Table A5).[26]

Due to historic very high rates of participation for males, most of the empirical literature has abstracted from the participation decision and there are very few estimates of the standard participation elasticity for men. However, Aaberge et al (1999) produce an estimate of approximately 0.05.

However, an extensive literature has also investigated the impact of unemployment insurance on the duration of employment and this has found significant evidence that a higher replacement rate (i.e. reduced incentives to work) have a significant effect on duration. Much of this work occurred in the 1970s and 1980s and has found elasticities in the range of 0.5 - 1.0 for the duration of unemployment. Taking an initial replacement rate of 50%, a 10% increase in net income when in employment would decrease unemployment duration by between 2.3% and 4.5%. Hill (1982) argues that estimates may be upwardly biased however,

[26] French (2005) sows that that male labor supply at certain ages is very elastic, with intertemporal elasticities as high as 1.2. However, for prime age men the elasticities seem to be consistently lower.

because many of those only unemployed for a short duration find jobs before benefit claims are made or processed, and if their replacement ratio is recorded as zero (as it would be based on actual receipts) this leads to a spurious positive correlation between duration and replacement ratio. However, if entitlement is calculated based on eligibility rules rather than using actual receipts, this problem can be overcome. Using this approach Nickell (1979) finds an elasticity of between 0.61 and 0.99, similar to previous results. If one assumes that of prime aged Males, a total of 10% are unemployed at any one time (including non-participants who would be willing to work), the uncompensated participation elasticity is approximately 0.04. This low estimate should not detract from the sizeable impact out-of-work benefits have on unemployment duration.

2.3 Family Labour Supply - The Collective Model

Family labour supply is a particularly difficult area for two reasons. First we need to deal with a joint tax system, which can be very complicated because benefits are often assessed on the basis of family income. As a result determining the incentive effects of a reform requires solving jointly over both labour supplies in the face of a budget "plane" which may be non-convex. Second, beyond this we also face the conceptual problem of how to model a household. Should we use the "unitary" framework where the household is viewed as a unit with a well defined preference ordering? Should we recognise the individuality of each member of the household, with their own preferences and define/model the way they share resources? And if so should we follow the collective approach, which assumes within household efficiency or should we admit inefficient outcomes? There has been a recent increase in interest in such models. Blundell, Chiappori, Magnac and Meghir (2007) estimate a collective model of family labour supply, where the male has the choice of working or not - hours are not modelled and where the female chooses hours and participation. The model does not take into account of taxes. The wage elasticity for female labour supply is estimated to be 0.66 and the non-labour income elasticity 0.72. Donni (2003, 2007) allows for taxes in a collective model. More recently Lise and Seitz (2007), use the collective model *with taxes* to account for changes in within household inequality, when considering overall inequality. The reported elasticity of substitution between consumption and labour supply is over 1, implying strong incentive effects. Although recent developments are encouraging, we believe a lot more needs to be done here before we can be confident that we have a reliable family labour supply model that can be used for public policy analysis. It is a clear case where better data on how families share resources and allocate time to various activities, is crucial.

2.4 Dynamic Models of Labour Supply

We now turn to models that recognise explicitly intertemporal linkages. In some cases these linkages are due to savings. In this context intertemporal substitution is reflected in the Frisch elasticity, which represents the willingness of individuals to postpone leisure in favour of work during periods of anticipated high wages. As we explained earlier the Frisch (or intertemporal substitution elasticity) does not have a direct policy implication but it is an upper bound for the standard Marshallian elasticity that we have been discussing. In Table A6 we present some results from the literature. Most of the results are for male hours, although we also present results by Heckman and MaCurdy (1980,1983) and Blundell, Meghir and Neves (1993) for women. As we may expect elasticities are higher than the equivalent within period ones.

A study that stands out in this literature because of the type of data used is that of Pistaferri (2003) on Italian data. He uses subjective expectations data to decompose actual wage changes in anticipated and unanticipated changes. He finds an intertemporal elasticity of substitution for men of 0.7, which is larger than usual. He also estimates the elasticity of a complete shift in the wage profile (i.e. allowing for wealth effects) of 0.5. This is perhaps the most relevant elasticity for tax reform analysis, if we are to assume that individuals perceive this to be permanent. Given the quality of the expectations data the estimate of the intertemporal elasticity of substitution should be quite robust, unless of course the human capital considerations raised by Imai and Keane are important. However, the Pistaferri appoach to estimating the effect of unanticipated changes to the wage profile, on hours of work relies on the assumption that any unaccounted changes to preferences for hours of work are not correlated with updates to wage expectations; this may be controversial. Moreover, comparing this to the paper by French (2005), while Pistaferri does allow for taxes, by using the after tax wage, he does not take into account explicitly the implications of nonlinearities in the tax code, as French does. Nevertheless, this potential criticism should not detract from the fact that this study uses unique data on expectations and as such adds a new dimension to this literature. His estimate is both reasonable and credible.

Beyond the intertemporal issues relating to savings there is a growing literature that introduces other important dimensions. These models, which include human capital accumulation on the job and education choices and highlight a number of important points, such as the possible propagation effects of taxation through its impact on job experience and wages.

Two studies have highlighted the importance of dynamics and "non-separabilities" over time, i.e. the

case where current choices affect future preferences for work or future wages (or both). Hotz et al. (1988) show convincingly that preferences are likely to be non-separble over time. This means that individuals working a lot today are likely to shift their preferences in the future and in the citation mentioned towards more work tomorrow. This may imply that incentive effects are reinforced by habits.

A further important example is provided by Imai and Keane (2004). In their paper current work hours enhance individual skills and thius lead to higher wages in the futureadding ot the work incentives. In ther empirical results the intertemporal elasticity of labour supply with respect to wages is 3.82, which is very much larger than anything previously estimated using microeconomic data. Theirs is a joint model of savings and labour supply, where past hours and accumulated human capital affects wages. The economic implication is that the opportunity cost of leisure for young low paid workers is very high. As the importance of training declines with the lifecycle this opportunity cost also declines, but wages increase. Thus despite the sensitivity of labour supply to wages, hours of work do not vary much over the lifecycle. Moreover, for the young the opportunity cost of leisure is so high, due to the loss of future earnings that it implies that the elasticity for the young is much lower. Indeed the labour supply elasticity, allowing for the implied effects of human capital accumulation is lower and depending on age ranges from 0.8 for a 20 year old to 3 for a 60 year old. Even allowing for this consideration hours would probably vary considerably as a response to a permanent shift in the life-cycle profile of wages, such as would be implied by a change in the tax rate, particularly for older individuals where human capital accumulation is less relevant. This analysis demonstrates the potential importance of allowing for dynamics in understanding the impact of policy. However, the specific results may be questionable because the authors do not allow for any persistent unobserved heterogeneity and all shocks are taken to be independent over time. All persistence is assumed to be state dependence in the jargon of this literature.[27] This casts serious doubt on the robustness of this empirical analysis and the credibility of this high elasticity.

A further example of important policy dimensions, beyond the work incentives is offered in Adda et al. (2006) who specify a model with human capital accumulation, job mobility (between firms) and labour force participation. The Adda et al. model is estimated using German administrative data, where individuals are

[27] Quite clearly people who work a lot in one period, also tend to work a lot in the next. Moreover people who work a lot now tend to have higher wages in the future. This phenomenon can be attributed to different causes: Perhaps some people are productive and always tend to work a lot - this is the unobserved heterogeneity story; or perhaps some people work a lot because (as in Imai and Keane) they realise that this will increase their skill and hence their wages, which of course then leads them to want to work more; this is the state dependence story. The policy implications are vastly different depending on which is the case. Distinguishing between these two phenomena is the holy grail of empirical labour economists.

observed from the point when they enter the labour market and followed up during their whole career.[28] This model also considers the choice to undertake vocational education and thus includes labour supply, training and job mobility in one integrated framework. This allows us to address directly the importance or otherwise of tax and benefit reforms on longer term training decisions, as well as labour supply.

Adda et al report the effects of introducing an EITC programme in Germany. The programme is assumed permanent and they estimate the effects on cohorts who have not yet completed their training decisions. They report that a programme characterised by the same parameters as the US one would increase overall participation by 1%. It would also reduce the proportion trained by about 6 percentage points as the policy reduces the life-cycle returns to training at the bottom of the earnings distribution. This demonstrates that policies designed to support low income individuals may well have other sizeable effects, which may be unwanted and may work against the original purpose of the policy design.

2.5 Taxable and Total Income Elasticities

We now present results found in the "New Tax Responsiveness" literature and which relate to the effects of taxation on taxable income. The elasticities relate either to some broad income measure that includes expenditure on tax deductible items or to taxable income. All elasticities are with respect to the share of income retained (i.e. the effect of a percentage change in $1-t$ as opposed to a percentage change in t). The distinction matters because away from a 50% tax rate a 10% percentage increase in the tax rate will not correspond to a 10% increase in the proportion of income retained.[29] We already discussed the theoretical and practical issues underlying this approach. The results in Table A7 need to be interpreted carefully and subject to the caveats already discussed.

In his seminal paper Feldstein (1995) uses a two-period (1985 and 1988) panel of married individuals with incomes exceeding $30,000 to analyse the impact of the 1986 tax reform on the taxable incomes of those with middle and high levels of income. Using a simple difference-in-differences methodology, he finds a significant elasticity of taxable income of between 1.1 and 3.05 (depending upon definition), and of broader "adjusted gross income" of between 0.75 and 1.3. Sillamaa & Veall (2000) use the 1988 Canadian tax reforms as their source of identifying variation, and break down results by source of income. For the whole sample, taxable income from employment has an elasticity of 0.22, whilst self-employment income has an elasticity of 1.12;

[28] To be specific they are dealing with German blue collar workers who have a choice to become qualified with an apprenticeship degree, or not.

[29] Hall, in his discussion of Goolsbee emphasises this point: To get to a tax elasticity and hence to a Laffer type result one needs to multiply the elasticities presented here $t/(1-t)$. For marginal tax rates less than 50% this implies that the tax elasticity is lower than the elasticity with respect to the share of earnings retained.

restricting the sample to those with high incomes increases gross taxable income elasticities considerably, but no separate elasticities by source are given.

Goolsbee (1999) demonstrates the fragility of the difference in difference approach. He used the same approach for a number of reforms in the 20th century. He shows that the elasticity varies considerably from one reform to another. This illustrates precisely the difficulty of the approaches being followed as well as the characterisation of the reform as consisting of a single tax rate. First the aggregate conditions may differ between each reform. If the estimator does not control for aggregate effects the biases will differ each time, sometimes increasing and sometimes decreasing the estimates. Second, reforms rarely affect just one relevant marginal rate; hence the estimates will be a function of other factors changing. Third, the constant elasticity assumption is likely to be invalid. Fourth, the GE effects we mentioned may be quite different each time, depending on which groups are being compared, for example.

As we already mentioned, three papers attempt to address the numerous issues raised above and allow for the economic structure of the problem. Interestingly all three papers support quite high elasticities of total or taxable income, although not all as high as one. (2000) using the Survey of Consumer Finances and based on the 1986 tax reform obtain an adjusted gross income elasticity (AGI) for the US of about 2, close to the Feldstein results when using a similar methodology. They then proceed to control for mean reversion of income by classifying people based on the pre-reform value of their house (which is unlikely to be subject to mean reversion in the short run). They also control for other characteristics; with these adjustments they obtain even higher elasticities of about 2.5, indeed as we would predict from our analysis of the *difference in differences* estimator. However, none of these approaches can control for the rising inequality, which could be driving part of the increase of the incomes for the richer versus the poorer individuals. Interestingly they find an annual hours elasticity of 0.2 for middle income individuals but zero for the "rich", which is consistent with all the studies we have been reporting. [30]

Gruber and Saez (2000) have presented probably the most comprehensive study in this literature. There are certain important differences with the Moffitt and Wilhelm (2000) paper, although not all represent improvements: first Gruber and Saez pool information from a large number of reforms using more information. Second, they match individuals on past income as a way of getting round the mean reversion problem

[30] "Adjusted gross income (AGI) is a United States tax term for an amount used in the calculation of an individual's income tax liability. AGI includes all gross income adjusted by certain allowed deductions, and is an important benchmark determining certain other allowed benefits. Gross income includes wages, interest income, dividend income, income from certain retirement accounts, capital gains, alimony received, rental income, royalty income, farm income, unemployment compensation, and certain other kinds of income." Source: Wikepedia http://en.wikipedia.org/wiki/Adjusted_Gross_Income

and they predict the tax position based on past income; this is an interesting approach to the problem, but not necessarily better to grouping individuals based on constant or slow moving characteristics that are correlated with income as Moffitt and Wilhelm do. Finally, they allow for income effects and take a more structural and theoretically coherent modelling approach. Probably as a result of pooling information from many reforms, they obtain a more modest taxable income elasticity of 0.4 overall. For those on incomes in excess of $100,000 the elasticity is 0.57 which is quite high but well below 1. They also consider a 'Broad-income' definition with an estimated elasticity of 0.12 for the whole sample. Both numbers are of course important, first and foremost because as Feldstein stressed reallocating income and consumption to avoid tax has welfare consequences. Indeed these numbers show that the largest of these effects is the income reallocation effect and not effort; this is consistent with the low hours elasticities we have reported. It is noteworthy that the elasticity for those with high income is as high as 0.57 showing that the revenue to be gained by high marginal tax rates for the "rich" are not very large, at least in the US, and the welfare consequences may be high.[31]

Finally, Blow and Preston (2002) use tax returns of the self-employed in the UK. They use grouped data by region and occupation to construct a pseudo panel over a period that includes major tax changes. By grouping the data in this way they get round the mean reversion problem and at the same time create groups that differ in their sensitivity to tax, simply because some occupations tend to be remunerated better than others. Their model is again inspired by the standard labour supply model and also allows for income effects. They find a range of elasticities depending on the group considered. These are mostly well over 1 implying that the taxable income of the self-employed is very sensitive to the tax rate and indeed increases in tax rates may lead to reductions in the revenue raised from this group. This group has most scope of reallocating income in the UK tax code. Unfortunately, their specification forces the elasticity to decline with income, which does go against the main intuition in this literature, namely that elasticities are higher at high income levels. The Blow and Preston results for the UK are not necessarily inconsistent with those of Gruber and Saez. The former consider the self-employed; the latter consider the entire population, which will have less opportunity to reallocate income to non-taxable activities.

In Table 7 we present numerous elasticities that have been estimated based on a number of different reforms. They present quite a diversity of results, consistent with the Goolsbee study. Our view is that the

[31] Note that Gruber and Saez (2000) find very low income effects, which implies that these elasticities can be taken as compensated ones.

Gruber and Saez study presents the most reliable set of estimates. In addition Brewer, Saez and Shephard (this volume) provides taxable income elasticities for the top 1% of UK earners, likely the group with the greatest potential for avoidance. They find a range of estimates with the lowest one being 0.46 and the highest close to 1. This set of numbers is consistent with the American literature discussed in more detail in this chapter.

3 Revisiting Male labour Supply

In reviewing the literature on labour supply it became apparent to us that there was no clear consensus of robust results. This led us to estimate a model of male labour force participation using the best methods available and relying on policy reforms to identify the effects. We thus combine the approaches of Blundell, Duncan and Meghir (1998) and Blundell, Reed and Stoker (2003) to identify the effect of wages, taxes and benefits on the male work decision.[32]

3.1 The Model

We specify a model of the probability that someone works. This depends on total income measures in and out of work. In deciding whether to work or not he considers what total income he would have if he did decide to work; this leads to some level of satisfaction while in work. He compares this to the satisfaction obtained if he decides not to work and obtains whatever income welfare and other sources will provide. This is a combination of various means-tested welfare benefits, including the Job Seeker's Allowance and Housing Benefit. The latter consists of payments towards rent and on certain occasions mortgage payments. The total amount of out of work income to which an individual is eligible will depend on housing costs and on family composition.

The in-work utility/satisfaction is complicated by the fact that whether out of choice or chance individuals can work a number of different hours of work. In this study we assume that individuals work a random number of hours and that the only decision they make is whether to work or not. We then evaluate in-work utility at the expected in-work income. The determination of actual hours of work will be disregarded here.[33] In work income is thus constructed as follows. We split hours in intervals from 0-60+ and we assign a probability for

[32] The approach we use is similar in spirit to that used by Meyer and Rosenbaum (2001) for lone mohers in the US. However, they use as explanatory variables predicted taxes and benefits if the person works and predicted benefits if the person does not, all as separate variables. we use total income in work and total income out of work as explanatory variables.

[33] Formally, the correct model would be to compute the in work probability as the average probability of working all possible hours. For the purpose of this study we simplified matters by computing one probability of working evaluated at the expected in-work income.

each interval consistent with what is actually observed in the data. We then evaluate income at the average hours of each interval depending on pre-tax earnings at that point and taking into account all taxes and benefits (including tax-credits) for which the individual is eligible if he were to work that many hours. The measure of in-work income is then the weighted average of post-tax and benefit income at all these points. It should be noted that where the individual has a spouse, both the in-work and out-of-work measures of income take account of the spouse's actual earnings, without considering the possibility that she may change her decision as a result of what he does.

Now consider the impact of a reform. If this reform changes earnings at a point where there is a high probability of observing a worker it will have a much larger impact on in-work income than if it changes them at a point with low probability. While this is realistic, it does not allow for the impact of a change in hours in response to a reform of taxes or benefits. Nevertheless, this may be less of a restriction than it sounds at least for reasonably small scale reforms, because the overall consensus is that hours are in fact quite insensitive, particularly for men.

Box 2.

Estimating a model of male employment

Here we discuss the more technical issue of identifying and estimating the effects of incentives of the work probability. We start by defining the utility from working to be

$$U^P = a^P + b^P Y^P + c^{P\prime} X$$

and similarly the utility from not working

$$U^{NP} = a^{NP} + b^{NP} Y^{NP} + c^{NP\prime} X + e$$

where Y^P are Y^{NP} are measures of total after tax income including any benefits when in work and out of work respectively. The X variables are taste-shifters which affect individual welfare differently when the individual works and when he does not. These include year dummies, to reflect changing preferences over time, education and age, as well as region. Similarly income has a different impact on utility depending on whether it is received in work or out of work; his reflects the fact that income my be valued differently when working and when out of work. Finally e is an unobserved term expressing the relative preference for work *vis a vis* non-work and which differs across individuals - this is the usual econometric "error term" . We will assume for simplicity that it is normally distributed. The work decision compares these two utilities allowing for the different incomes in and out of work as well as how they are valued

$$\text{work if } e < \left(a^P - a^{NP}\right) + b^P Y^P - b^{NP} Y^{NP} + (c^P - c^{NP})' X$$

Implementing the estimation of the work probability and identifying the effects of income in and out of work requires us to observe wages for the entire sample. Moreover, we wish to allow for the possibility that pre-tax wages are correlated with (unobserved) preferences for work (endogenous pre-tax wages). This is addressed by using *predicted* rather than actual wages for both workers and non-workers.

We specify a wage equation of the form

$$\ln w_{it} = d_t^{ed} + \beta_t^{ed\prime} A_{it} + \gamma^{ed} Region + u_{it} \tag{1}$$

where A_{it} age effects and *Region* is a set of region dummies and the superscript *ed* signifies a parameter which varies according to which education group a person belongs to. Thus the wage equation is specific to each education group and all coefficients vary with time. The main conceptual difficulty with estimating this equation here is the fact that wages are observed for workers only. To correct for selection we use the well known Heckman (1979) two step estimator. The key assumption that allows us to do this is is that the income that one would gain when out of work can be taken as random once we take as given family composition, housing tenure and region. The randomness comes partly from government policy changes and the way that changes in the housing market conditions affects the level of benefits to be received. More formally the *instrument* for correcting for this selectivity bias is defined by

$$Z_{it} = Y^{NP} - G_{it}'\gamma$$

where we have defined $E(Y^{NP}|Family\ composition, tenure,\ region,\ time) = G_{it}'\gamma$, with G_{it} representing the variables in brackets and where the time dummies enter additively with no interactions with the other variables. By taking the residual rather than the level of non-work income we avoid the endogeneity problem arising from the potential correlation of family composition and region with wages. Thus we start by estimating a reduced form probit equation for participation including time effects interacted with region and education and the instrument Z_{it} defined above. Based on this reduced form probit we construct the inverse Mills ratio, which we then include in the wage equation. Using the estimated wage equation 1 we predict wages for all individuals, whether they work or not.

Box 3.

Estimating a model of male employment (continued)

We will use these wages to construct in work income for each individual. Each person is assigned a predicted wage. Then for each person we evaluate income, whether working or not, allowing for all benefits and taxes (depending on personal circumstances) and based on this predicted wage for hours 0,23,37,41,46,51,63. Note that actual income earned based on actual hours for workers is disregarded, making the measure comparable for workers and non-workers.

Following the computation of the two measures of income, in work and out of work we can estimate the participation probability using a probit model. However there is still one important difficulty here. We cannot take these measures as exogenous for the participation equation, even if they are based on predicted wages: higher preferences for work due to unobservables will tend to be related to higher marginal tax rates; this is but one example of reverse causality. We thus use a "two stage least squares" approach, where the two measures of income are predicted using appropriate instruments. To motivate the instruments we need to explain the policy context and the reforms of the 1980s that subsequently affected the evolution of transfer income right through the period of our investigation (1994 to 2004).

3.1.1 Where does the variability of income come from?

To credibly estimate the effects of taxes and benefits we need to argue that these incomes vary across time and individuals for reasons that are unrelated to work preferences. Over the sample period of our data numerous reforms took place changing the levels of benefits and taxes at various points in time. In itself this is not sufficient because the effects of the policy reforms could be confounded with aggregate shifts in hours of work. However these reforms have affected different groups of individuals differently as argued in Blundell, Duncan and Meghir (1998). One such reform is crucial to identification and has been used in particular by Blundell, Reed and Stoker (2003). In the 1980s the public housing rents started growing at the market rate following a reform of the then government. The implication is that housing benefit, which compensates one for rents started rising in line with these increases. As the housing market moved in different ways across different parts of the country this meant that out of work income would change in differential ways across the country too. Once we control for aggregate time effects and region we rely on this residual variation (i.e. region-time interactions) to identify the impact of out-of-work income on labour supply. The same set of reforms will also help identify the effect of in-work income, which also depends on housing benefit. However, further reforms, including tax credits and changes in the tax rates will induce further variability in this measure, which will affect individuals in different cohorts differently.

Given the above discussion, there will be substantial *differential* effects on benefit entitlement due to the reforms in different parts of the country. Thus instead of using the actual in-work and out of work income

measures, which depend on actual housing costs which may be endogenous (in the sense that they relate to household preferences and past choices), we predict these and thus average them over different types of households; we only use the variation over time different regions and education groups. Moreover, we never use actual in-work income; rather we use in-work income derived by using predicted wages and taking averages over all possible hours intervals, with weights the observed distribution of hours. The participation equation excludes time-region and time-education interactions, allowing only for constant region and education effects in labour supply as well as additive time effects. This assumes that preferences for work do not exhibit different trends across groups.

3.1.2 The data

Our data source is the Family Resources Survey (FRS). This is an annual cross sectional survey of approximately 23,000 households in Great Britain and has been designed specifically for socio-economic research with a focus on income, expenditures and employment. We use 11 annual waves of the FRS from 1994 to 2004 and choose a sample of men, either single or living with partners and aged between 22-59 inclusive. We exclude the self-employed, those in full-time education and those entitled to disability benefits as well as those living in Northern Ireland. This leaves us with a sample of 31,461 single males (with an average age of 35), and a sample of 91,372 men with partners (with an average age of 41).

The in-work and out-of-work net incomes are calculated using the IFS tax and benefit model (TAXBEN) and are derived using the full set of determinants of taxes and benefits as observed in the FRS. This model combined with the FRS is remarkably accurate at predicting tax revenues and benefit expenditures.

3.1.3 Results

In Table 1 we present the "marginal effects" of increasing the two income measures on the probability of participation by education group and marital status of the man.[34] Thus each number represents the increase (or decrease for negative numbers) of the probability of work as a result of a percentage increase in out-of-work or in-work income respectively. First note that dealing with endogeneity of in-work income in particular is very important and indeed the bias is the direction one would expect: the positive correlation between the tax rate faced and the propensity to work means that everything else equal, those most favourable to

[34] These are changes in probability of work corresponding to unit increase in the income measure. Each person has two income measures: one is the predicted income were he to work (in-work income) and one is the predicted income were he not to work (out-of work income). The combination of these two measures together with their coefficients reflects the return to work for each individual. The participation probability does not depend on the difference in incomes, but on the income measures individually with separate weights: each income measure has a different weight because income is valued differently when in work than when out of work.

	Income Exogenous		Income Endogenous	
	Log out-of-work income	**Log in-work income**	**Log out-of-work income**	**Log in-work income**
			Single Men	
Low Education	-0.1837	-0.0243	-0.2517	0.1683
	(0.0079)	(0.0302)	(0.0509)	(0.0936)
Medium Education	-0.0583	-0.1359	-0.1411	0.3081
	(0.0086)	(0.0325)	(0.0418)	(0.0770)
High Education	-0.0300	-0.1402	-0.0061	0.0732
	(0.0061)	(0.0276)	(0.0304)	(0.0469)
			Married or Cohabiting Men	
Low Education	-0.2220	0.3636	-0.1698	0.3182
	(0.0041)	(0.0066)	(0.0348)	(0.0644)
Medium Education	-0.1039	0.1526	-0.1246	0.1267
	(0.0052)	(0.0092)	(0.0274)	(0.0480)
High Education	-0.0608	0.1152	-0.0515	0.0341
	(0.0039)	(0.0081)	(0.0292)	(0.0413)
Standard errors in parentheses.				

Table 1: Wage and Income paticipation elasticities for Men (UK).

working for reasons of preference also end up with lower after tax in-work income (because of taxation), causing a negative bias. This is clearly the case for single men where the results in the first two columns, that do not allow for endogeneity, give negative incentive effects. Once we deal with this issue the incentive effects of higher in-work income become apparent (last column).

The results in the last two columns are sensible. First, income incentives matter most for the lower educated individuals. The participation probability of higher educated persons responds less to both changes in out of work and in in-work income. Indeed for those with College education the effects are not significant at conventional levels and the point estimates are very small. However, for those with statutory education the marginal effects are large. At a participation rate of 60%, which is about the number for the unskilled, the elasticity of participation with respect to in-work income is 0.27 for single men and about 0.53 for married men. The out of work income elasticities for the two groups are 0.42 and 0.60 respectively. These are quite high numbers and imply that welfare benefits can have substantial effects on the work behaviour of unskilled and even for men with high school education. However as we argued earlier simple elasticities like that can be quite misleading as far as evaluating specific reforms. Moreover, reforms we are likely to consider in practice, may affect incomes at many parts of the budget constraint and there may be interactions ith other welfare benefits . In the next section we undertake a simple illustrative exercise and we use our model to predict the impact of a couple of simple reforms to give an idea of what these results imply.

3.1.4 Simulating Reforms

The model we have estimated ignores the hours dimension, taking hours to be drawn randomly from the observed distribution. In other ways however, the model is more sophisticated than many in the literature in that it allows for the complete structure of the tax and welfare-benefit system at the same time allowing for the endogeneity of both hourly wages and post tax incomes. It achieves this by using the information from a number of tax reforms over time and the different way they have affected different types of individual, living in different parts of the country.

Within the context of this model simulating a tax reform implies changing the required parameters of the tax and welfare-system and then computing how this will change the out-of-work and expected in-work income of each individual and the resulting work probability. The purpose of this section is to illustrate what a model such as this has to say about tax reform. It also emphasizes the fact that knowing the elasticity alone is not sufficient to predict what the effects will be. If anything, the reform will typically change the in-work and out-of-work incomes of different types of individuals in different ways: making tax credits more generous will affect low wage individuals but not higher wage ones for instance.

The baseline British tax system which we will "reform" can be described as follows: there is a non-taxable earnings allowance (£4745 at the time) beyond this (in 2004) there is a 10% a 22% and a 40% tax bracket. In addition to these taxes individuals contribute to National Insurance, a tax which is justified as funding pensions. The employees' NI rate is 11% and declines to 1% beyond a particular level of earnings called the Upper Earnings Limit (UEL). This means that effectively the marginal tax rates were 21%, 33% and 41%, abstracting from employers national insurance. Both NI and income tax payments are assessed on individual income and there are no deductions allowed for consumption or mortgages. In addition there are a number of welfare benefits, including housing benefit and working tax credits which are assessed on the basis of family income. In particular the Working Tax Credit (WTC) is a means-tested tax credit for those working a qualifying number of hours per week, whilst the Child Tax Credit (CTC) provides means tested support to families with incomes up to approximately £57,000. For more information on the UK tax and benefit system see Adam and Browne (2006), O'Dea, Phillips and Vink (2007), and the relevant chapter of this publications.

To illustrate the implications of the estimates we will carry out a relatively sweeping reform where the system described above will be replaced by a flat tax. We consider two sets of tax parameters: one is

Flat Tax Reform: Integrated Income Tax NI and Tax Credits	
Flat-rate income tax of 31% (36.65% for married men) on all income exceeding increased personal allowance. Removal of UEL on National Insurance Contributions. Tax Credit not tapered away at additional rate.	
Single Men	Cohabiting Men
Overall **42%** marginal tax rate	Overall **47.65**% marginal tax rate

Table 2: Probit Results for male participation - marginal effects.

revenue neutral for single men and the other for married/cohabiting men. The employment behaviour of the female partner is taken as fixed here. Table 2 provides the details of the reform, while figures 7 and 8 show graphically how the reform affects single and married men.[35]

The flat tax has distinctly different impacts upon the net-income of the single man and the cohabiting man (with one child); this is because of the differing entitlements to tax credits which are fully integrated and tapered away as part of standard income tax payments in this reformed system. The single man, eligible only for working tax credit (when working at least 30 hours per week) faces a higher tax rate implying lower net income at hours less than 30 as well as above 55 when the working tax credit has been 'tapered away'.

For the married man, on the other hand, the new system involves higher transfer income in the form of the more generous working tax credit for couples and the child tax credit. Below 35 hours, the marginal tax rate is lower because tax credits are no longer being tapered away at their pre-reform 37% rate. Despite a 47.65% marginal tax rate, 'universal tax credits' ensure that with a £10 hourly wage, income is considerably higher in the reform system even at 70 hours per week. The reform is financed by individuals with higher wages. Figures 7 and 8 illustrate the impact of the reform on the budget constraint of a single and a cohabiting man with one child respectively.

Overall the reform reduces the income of those not entitled to tax credits and increases the incomes of those eligible, particularly those in couples with children. Table 3 shows the estimated effect of the reform, separately for single and cohabiting men. This uses the actual FRS data and consequently the results are representative of the population and include all observed demographic groups with their frequencies as found in the data. The results are broken down by quartile of wages.

The reform has a modest positive impact on the employment probability, with this being more notable for men with partners. For single men the small positive employment effects are observed for those with wages

[35] In these figures the man is assumed to earn £10 per hour the spouse (if there is one) works 20 hours at £6 per hour; their child is aged 10.

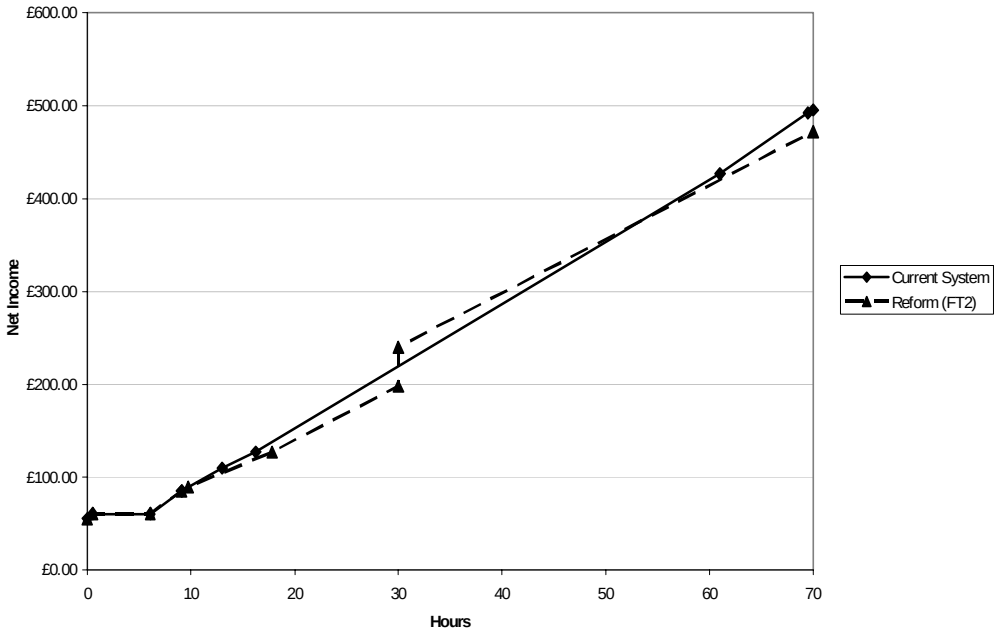

Figure 7:

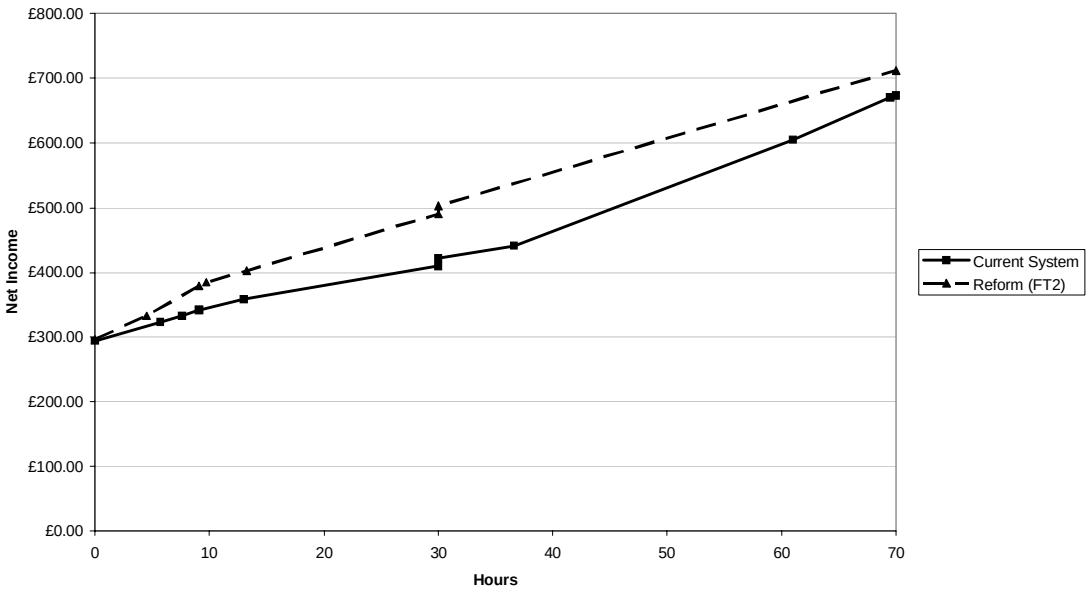

Figure 8:

Group	Estimated Overall Impact
Single Men	
Lowest Quartile	-0.20%
Quartile 2	0.65%
Quartile 3	0.66%
Highest Quartile	0.08%
Overall	0.31%
Married Men	
Lowest Quartile	2.02%
Quartile 2	0.68%
Quartile 3	-0.02%
Highest Quartile	-0.25%
	0.61%

Table 3: Probit Results for male participation - marginal effects.

in the 2nd and third quartile. However, the reform predicts a substantial positive employment effect for low wage cohabiting men, with some small negative employment effects for higher wage individuals. The reform does not discourage participation for those paying for the reform basically because their work probability is so high. So it looks as if this reform has the important advantage of encouraging work for the lowest wage individuals but has little cost in terms of lost employment by those who pay for it. The conclusion however may be misleading because our model is incomplete in at least two important dimensions. First, we do not allow hours to change. Second, we do not allow non-hours|effort to change. Finally, a reform such as this is likely to have longer term effects on investment in human capital as well as possible General Equilibrium effects. These would need to be evaluated carefully if such a reform is to be considered seriously. Nevertheless, our aim was not so much to discuss the merits of such a reform, but to illustrate the implications of our estimates for the sensitivity of participation to a major reform and to show what the magnitude of the parameters would mean for a major change to the tax system.

4 Conclusions

The study of labour supply is key to understanding the welfare and revenue effects of taxation. However, there are many dimensions to labour supply and each seems to be most relevant for a different group of persons. We have thus considered hours of work per week and per year, labour force participation and total taxable income. The picture that emerges is very interesting. Incentives matter and taxation can generate important distortions.

Male hours of work are almost completely irresponsive to changes in work incentives; however male

participation, particularly for those with low or medium levels of education can be very responsive: the number of people working among the low skill can be very sensitive to the design of welfare benefits and tax credits as operated in the UK with an hours condition, for instance. Hours of work and labour force participation for women with young children and particularly for lone mothers are also quite sensitive to tax and benefit incentives. Participation elasticities (work/non work) are positive and demonstrate quite a lot of sensitivity to incentives for the decision to work or not. For highly educated individuals the sensitivity of both hours of work and participation to work incentives are almost zero. However, for higher income and higher skill individuals the total income elasticity is substantial, but probably less than one. Thus for low skill men the structure of the benefit system is likely to affect their work probability. For high skill men higher rates of taxes are likely to discourage effort and creativity quite substantially to imply important efficiency effects of taxation.

In our chapter we have also tried to give a flavour of the complexity of estimating the effects of tax and benefit reforms, particularly when the system has elements of regressivity. The size of the elasticity is not sufficient to give us a complete view of the labour supply effects of tax and benefit reforms. The magnitude of the responses will also depend on the whole structure of the budget constraint. Non-convexities, such as those induced by the tax credit system can induce large behavioural responses, even if the elasticities are quite small. So a complete analysis of the effort/hours responses of reforms requires simulation taking into account the whole structure of the tax and transfer system.

Finally, it is important to remember that taxes and welfare benefits affect more than just work effort. They can change other decisions, including most importantly the decision to accumulate human capital. We have presented some evidence that such a margin of adjustment may be important. However, this adjustment is "hidden" because its impact is much longer term which likewise makes it more difficult to estimate due to the difficulties in disentangling the impact of tax reforms from secular trends. Genuine policy analysis has to address the longer term issues, which could prove to be the most important for behavioural and welfare effects. A well designed tax and benefit system will need to recognise that all groups in the population can be quite sensitive to taxes and benefits in many different dimensions.

Table A1: Married Female Labour Supply (Continuous Hours Elasticities)

Study	Data / Sample	Variables Used	Labour Supply Model	Uncomp. Wage Elasticity	Income Elasticity
Arellano & Meghir (1992)	UK Family Expenditure Survey and Labour Force Survey 1983 Age 20-59 **married**, 11535 employed, 13200 non-employed.	H: Weekly Hours Y: Consumption based other income measure W: marginal wage rate	Semi-log labour supply with fixed costs and job search costs; Budget set assumed convex and piecewise linear; allows endogenous wages and unearned income using IV approach.	0.29 to 0.71 Depending on age of children and woman. At sample means: 0.37	-0.13 to -0.40 -0.13
Blomquist & Hansson-Brusewitz (1990)	Swedish Level of Living Survey 1981: sample size 795, 640 employed Age 25-55 **married**	H: Annual Hours W: Wage, SS Y: Spouse's net income plus benefits and capital income.	Linear & Quadratic labour supply; Convex and Non-Convex piece-wise linear budgets; some specifications control for taxes and benefits, others do not; predicted wages ,both Heckman corrected and full information maximum likelihood (FIML); fixed and random preferences.	Evaluated at Means Heckman Fixed: 0.386 FIML Fixed: 0.79 Heckman, quadratic, Fixed: 0.58 Heckman, Random: 0.77	 -0.03 -0.243 -0.05 -0.06
Blundell, Duncan & Meghir (1998)	UK Family Expenditure Survey 1978 – 1992: sample size 16781 employed 7845 non-employed, aged 20-50 **married or cohabiting**	H: Usual Weekly Hours & Overtime W: after tax Usual Pay and overtime over H Y: non-durable weekly consumption minus earnings	Semi-log linear labour supply; includes controls for children, education and cohort; accounts for taxes and benefits; grouping estimator (based on education and cohort) to overcome simultaneity.	No children: 0.14 Youngest child 0-2: 0.21 Youngest child 2-5: 0.37 Youngest child 5-10: 0.13 Youngest child 11+: 0.13	0 -0.19 -0.17 -0.10 -0.06
Bourgiugnon & Magnac (1990)	French Labour Force Survey 1985: sample size 1175 employed, 817 non-employed aged 18-60 **married**	H: Normal Weekly Hours W: Hourly Net Wage & SS Y: Spouses net income & benefits.	Linear labour supply; convex piecewise linear budget constraint; accounts for taxation but ignores non-convexities induced by benefits; random preferences; can include fixed costs; exogenous wage.	Tobit: 0.3 Hausman-style: 1 Fixed Costs: 0.05	-0.2 -0.3 -0.2

Table A1: Married Female Labour Supply (Continuous Hours Elasticities)

Cogan (1981)	US National Longitudinal Study of Mature Women 1967: **Married women** aged 30-35. 898 workers and 939 non.	H: Annual Hours of work W: hourly wage Y: Husband's Earnings.	Semi-log Labour supply (linear in hours); wages predicted using selection correction; and labour supply subject to reservation hours to account for fixed costs; does not account for taxes or benefit payments.	Elasticity at mean 1400 hours per year 0.864 No Fixed Costs 2.4	At $10,000 0.16 0.66
Hausman (1981)	US Panel of Income Dynamics 1975: sample size 575 participants, 510 non-participants **married**	H: Annual Hours of Work W: hourly wage, SS Y: Transfer and asset income evaluated at 8% return	Linear Labour Supply. Convex (piece-wise linear) and Non-Convex (fixed-costs) budget set	0.995 0.906	-0.121 -0.13
Heckman (1974)	US National Longitudinal Study of Mature Women 1966. **Married Women** aged 30 – 44 with child<10.	H: Annual Hours W: hourly wage (linear) Y: Husbands Earnings and non-labour income.	Direct estimation of indifference curves.	N/A Provides estimates of effect of variables on 'marginal' reservation wage: $10,000 'exogenous' income increases by 22%. N/A	
Ashenfelter & Heckman (1974)	US 1960 Census of Population. **Married Women** aged 25 – 54.	H: Participations W: hourly wage Y: Unearned Income.	Labour supply linear in differentials, proxying differentials by differences from mean values; exogenous wages; does not account for taxes or benefits; unitary family framework.	Evaluated at Means: 0.912 (-0.075 cross elasticity) Imposing Unitary assumptions 1.15 (0.12 cross elasticity)	N/A N/A
Kaiser et al (1992)	German SocioEconomic Panel 1983: sample size 1076 employed, 2284 non-employed, non-retired **married**	H: Yearly Hours W: hourly wage, SS Y: income from rents, benefits and capital.	Linear Labour Supply Convex piecewise linear budget set	1.04	-0.18

Table A1: Married Female Labour Supply (Continuous Hours Elasticities)

Triest (1990)	US Panel Study of Income Dynamics 1983 sample size: 715 employed, 263 non-employed aged 25 – 55 **married**	H: Yearly Hours, all jobs W: average hourly wage, SS Y: Income from rents, dividends etc	Linear Labour supply; Convex and piecewise linear budget set; accounts for taxes and benefits; uses actual wages and imputed wages separately; other income exogenous.	IV: 0.03 ML 0.26 to 0.28 (Depends on error terms)	-0.19 - 0.15to -0.17
H: Hours/Work Measure used, W: Wage Measure used, Y: Income measure used. SS Net wage includes social security deductions.					

Table A2: Female Labour Supply - Participation Elasticities

Study	Data / Sample	Variables Used	Labour Supply Model	Uncomp. Wage Elasticity	Income Elasticity
Aaberge et al (1999)	Italian Survey of Household Income and Wealth 1987. Families aged 20 – 70, self employment income < 20%	H: not given W: net wages Y: other income	Family Labour supply, not subject to unitary restrictions; Non linear labour supply; non-convex budget constraint; accounts for taxes and benefits; hours and supply constraints (demand /institutions); exogenous wages and unearned income.	Mean of sample: 0.654 10th income percentile 2.837 11th – 89th percentiles 0.742 90th income percentile 0.031	 -0.014 -7.00 0.096 -0.051
Arrufat & Zabalza (1986)	UK: 1974 General Household Survey. 3495 married women aged less than 60 with husbands less than 65	H: weekly Hours / Participation W: gross wages Y: adjusted unearned income plus husband.	CES utility function convex budget constraint; optimisation errors and preference heterogeneity; accounts for taxes but not benefits.	Mean of sample: 1.41	-0.14
Blundell, Ham & Meghir (1987)	UK FES Survey 1981. 2011 married women. 1076 employed, 935 zero hours. Aged 16 – 60 married to men 16 – 65	H: participation W: marginal net wages Y: Consumption-based other income	Non-linear labour supply model with unemployment (relaxation of Tobit); accounts for both taxes and benefits; predicted wages for non participants.	Tobit: 0.04 Double Hurdle 0.08	
Pencavel (1998)	US March CPS 1975-94 Sample selection: women aged 25 – 60	H: Participation W: hourly wage Y: Non labour income.	Log-linear labour supply; controls for age and cohort (each cohort has own wage profile); education allowed to vary and indirect wage effect via education; does not account for taxes or benefits; wages treated as both exogenous and endogenous; not selection-corrected.	WLS, corrected for selection 0.77 – 0.839 IV – US trade balance and education, corrected for selection. 0.791 – 0.892 IV – as above with control for education 1.826	
H: Hours/Work Measure used, W: Wage Measure used, Y: Income measure used. FES: UK Family Expenditure Survey. CPS: US Current Population Survey CES: Constant Elasticity of Substitution					

Table A3: Lone Mothers' Labour Supply

Study	Data / Sample	Variables Used	Labour Supply Model	Uncompensated. Wage Elasticity
Blundell, Duncan & Meghir (1992)	UK: Family Expenditure Survey 1981 – 1986: sample size 1654. Lone mothers no self-employed	H: Usual Weekly Hours W: Hourly Wage Y: Consumption Based	Mmarginal rate of substitution function; accounts for taxation but not benefits; wages and income endogenous, and wages selection-corrected.	Basic rate taxpayers: 0.16 All lone mothers: 0.34 Excluding hours 'bunches' 0.14
Brewer, Duncan, Shephard & Suarez (2005)	UK: Family Resources Survey 1995 – 2002. 13,458 lone mothers aged<60, not self employed and not disabled.	H: Usual Weekly Hours W: Hourly Wage Y: Net income evaluated at discrete hours.	Discrete choice over 5 positive hours; fixed costs, heterogeneous tastes and joint choice over programme participation; accounts for taxes and benefits; endogenous childcare use.	Net income Participation Elasticity: 1.02
Dickert, Houser and Scholz (1995)	USA SIPP 1990. Single women with children. Exclude those with high assets	H: Participation W: Gross Hourly Wage Y: Net income evaluated at discrete hours	Discrete choice over non-participation and 2 positive hours points; taxes and benefits accounted for; IV – return to work instrumented by whether state has high or low benefits.	Participation Elasticity from EITC: 0.85 From returns to work: 0.35
Eissa & Liebman (1996)	USA CPS 1985-87 and 1989-91. Single women with children	H: Participation W: Hourly Wage Y: Net income evaluated at discrete hour	No explicit structural labour supply model. Difference in difference estimator comparing those with children and those without following US TRA86 reform	Participation Elasticity: 1.16
Ermisch & Wright (1991)	UK: 1973 – 1982 General Household survey. 2062 lone mothers with 966 employed.	H: Work or Not. W: Net Hourly Wage Y: Net income evaluated at different points	Discrete choice of work and not-work; accounts for taxes and benefits in a simplified manner; includes fixed costs of work; predicted wages, Heckman selection-corrected; includes demand-side controls (regional unemployment).	Participation Elasticity: 1.7 Eligible for FIS: 1.8 Ineligible for FIS: 1.2 (Both net wages)
Jenkins (1992)	UK: 1989 Lone Parents Survey. 1235 lone mothers, with 519 in employment.	H: Full or Part time W: Gross Hourly Wage Y: Net income evaluated in and out of work.	Discrete choice over two positive hours points; double hurdle model (participation and employment); includes fixed costs; accounts for benefits but not taxes; predicted wages for non-participants, selection-corrected.	Participation Elasticity: 1.80 Full-time work Elasticity: 1.44 (Both gross wages)
Keane and Moffitt (1998)	USA: 1994 SIPP. Single women with children. Exclude those with high assets	H: Full or Part time W: Gross Hourly Wage Y: Net income evaluated in and out of work.	Discrete choice over two positive hours points; Jointly model decision of labour supply and welfare programme participation; accounts for benefits but not taxes; predicted wages for non-workers; identification off cross-state variation in programme generosity.	Participation Elasticity: 0.96 Total Elasticities: 1.82 1.47 – 1.97
Walker (1990)	UK: 1979 – 1984 Family	H: Work or Not	Discrete choice of work and not-work; accounts	Participation Elasticity:

Table A3: Lone Mothers' Labour Supply

	Expenditure Survey with 1729 lone mothers.	W: Gross Hourly Wage Y: Net income evaluated in and out of work.	for benefits; predicted wages used, not selection corrected.	0.7 (net income)
FIS: Family Income Supplement, an early name for the UK in work benefit System EITC: the US Earned Income Tax Credit. H: Hours/Work Measure used, W: Wage Measure used, Y: Income measure used. SIPP: US Survey of Income and Programme Participation, FES: UK Family Expenditure Survey, GHS: UK General Household Survey, PSID: US Panel Study of Income Dynamics. TRA86 the US tax reform of 1986				

Table A4: Male Labour Supply (Continuous Hours Elasticities)

Study	Data / Sample	Variables Used	Labour Supply Model	Uncomp. Wage Elasticity	Income Elasticity
Ashenfelter &Heckman (1974)	US 1960 Census of Population; **married** men aged 25 – 54.	H: Annual Hours W: hourly wage Y: Unearned Income	Labour supply linear in differentials, proxying differentials by differences from mean values; exogenous wages; does not account for taxes or benefits; unitary family framework.	Evaluated at means: 0.06	-0.11
Blomquist & Newey (2002)	Swedish Level of Living Survey 1973, 1980, 1990; **married** aged 20 – 60; 2321 across 3 waves	H: Annual Hours of Work Y: Other Income W: Calculated Hourly Wage	Non-parametric labour supply; convex budget constraint with allowance for "small" non-convexities; estimated non-parametrically over the budget set; actual wages used.	0.06-0.08	(parametric model) -0.02
Bourgiugnon and Magnac (1990)	French Labour Force Survey 1985; all employed **married** aged 18-60; sample size is 1992.	H: Normal Weekly Hours Y: Family Allowances W: hourly net wage	Linear Labour Supply; Convex (Piecewise Linear) Budget Constraint; accounts for taxation but ignores non-convexities induced by benefits; random preferences; can include fixed costs; exogenous wage.	Evaluated at means: 0.1	-0.07
Flood & MaCurdy (1992)	Swedish Household Market and Non-Market Survey 1984 all employed, **married** men 25 – 65; sample of 492	H: Annual hours of work Y: Asset income & Benefit Income W: Calculated Hourly Wage	Linear and semi logarithmic Convex (piecewise linear and differentiable); allows for benefits and taxation; uses calculated (actual) wage with no selection-correction.	-0.25 to 0.21	0.04 to -0.1
Kaiser et al. (1992)	German Socioeconomic Panel 1983, **married**, non-retired; sample of 2382 employed, 939 not.	H: Annual hours of work Y: rents, capital income and transfer payments W: Calculated Hourly Wage	Convex and non-convex (piecewise linear)	Evaluated at means: - 0.04	-0.28
MaCurdy, Green & Paarsch (1990)	USA Panel Study of Income Dynamics 1975: sample size 1017, all employed, **married** aged 25-55.	H Annual hours of work Y: rent, interest, dividends, spouses income etc. W: Calculated Hourly Wage	Linear labour supply; piecewise linear and differentiable budget set; non-convex portions 'convexified'; accounts for taxes and tax credits	Evaluated at means: -0.24 – 0.032	-0.01

Table A4: Male Labour Supply (Continuous Hours Elasticities)

Pencavel (2002)	USA Current Population Survey 1968-1999. **All** employed Males. Sample size not given.	H: Annual hours of work Y: Current Non-Wage Income (for standard uncomp. wage elasticity). W: Calculated Hourly Wage	Log-linear labour supply; linear budget constraint; no explicit treatment of tax and benefit system; actual wages; includes controls for demographic characteristics; same IV approach as Pencavel (1998), table A1.	Labour Supply Function (A) White: -0.14 Black: -0.12 (B) White: 0.25 Black: 0.12 First Differenced (A) White: -0.02 Black: -0.17 (B) White: -0.18 Black: 0.10	
H: Hours/Work Measure used, W: Wage Measure used, Y: Income measure used.					

Table A5: Male Labour Supply (Participation Elasticities)

Study	Data / Sample	Variables Used	Labour Supply Model	Uncomp. Wage Elasticity	Income Elasticity
Aaberge et al (1999)	Italian Survey of Household Income and Wealth 1987. Families aged 20 – 70, self employment income < 20%	H: not given W: net wages Y: other income	Family Labour supply, not subject to unitary restrictions; Non linear labour supply; non-convex budget constraint; accounts for taxes and benefits; hours and supply constraints (demand /institutions); exogenous wages and unearned income.	Mean: 0.046 10^{th} income percentile 0.053 11^{th} – 89^{th} percentiles 0.051 90^{th} income percentile -0.01	 - 0.003 -0.01 -0.04 0.014
H: Hours/Work Measure used, W: Wage Measure used, Y: Income measure used.					

Table A6: Intertemporal Labour Supply Elasticities (Male and Female)

Study	Data / Sample	Variables Used	Labour Supply Model	Inter-temp (Frisch) Wage Elasticity
Ackum-Agell & Meghir (1995)	Swedish Engineering Employers Confederation Survey of Employment. 1970 – 1987. **All men**	W: Calculated Hourly Wage H: Quarterly Hours of Work (including over-time) Y: Not observed	Log linear labour supply with first difference specification; life-cycle labour supply & within period; does not account for taxes or benefits;	Evaluated at means: 0.14
Altonji (1986)	USA PSID 1968 – 1981. **Married Men** aged no less than 25 in 1968 or older than 60 in 1979.	W: Hourly wage profile H: Annual Hours of work Y: assets instrumented by consumption.	Double log Frisch labour supply function	Varies by estimation approach 0.00 - 0.35
Blundell, Meghir & Neves (1993)	Pseudo-panel constructed from UK FES 1970-1984. **Married women**	W: Hourly Wage H: Weekly Hours	Flexible specification of preferences allowing for corner solutions and uncertainty; fixed costs. Marginal after tax wages	No Children 0.58 With Children 0.80 – 1.22
Domeij & Floden (2006)	USA PSID **male household heads** with sample based on 1984 1989 & 1994.	W: Hourly wage (calculated for salaried workers) H: Annual Hours Y: Asset Stocks (focus on total but suggests liquid may be more appropriate)	Borrowing Constraints; Log-linearization of the Euler Equation; includes specifications with separable and non-separable utility; does not account for taxes.	Full Sample 0.16 Liquid Assets > X 0.33 – 0.49 Total Assets > X 0.19 – 0.49 Exclude Borrowing Constrained 0.55
French (2004)	USA PSID & Validation data. **Males, head of households.** 1980 – 86.	W: Hourly Wage (as reported) and employer provided 'true hours' H: Annual Hours – same as above.	Log linear Frisch labour supply; does not account for taxes or benefits; wages exogenous; IV approach that controls for non-classical measurement error	Controlling for measurement error -0.03 - 0.16 (insignificant)
French (2005)	USA PSID between 1968 and 1997	W: Hourly Wage H: Annual Hours and Participation Y: Asset Profile	Accounts for key aspects of the US tax code and for private and state pension entitlements; wages selection corrected; Considers tied wage hours packages	Age 40: Standard model: 0.37 Wage/hours packages: 0.19 Age 60: Standard Model: 1.33

Table A6: Intertemporal Labour Supply Elasticities (Male and Female)

				Wage/hours packages: 1.04
Heckman & MaCurdy (1980,83)	USA PSID 1968-1975 Continuously **married women** aged 30-65. White. 672	W: Hourly wage profile H: Annual Hours and Participation Y: asset profile	Log-linear Frisch labour supply model allowing for corner solutions; Linear budget constraint; does not account for taxes or benefits;	Evaluated at means: 1.8
Imai & Keane (2004)	USA NLSLME 1979 – 95. **White Men** aged 20+ with 6 yrs of continuous data, no periods of unemployment.	W: Hourly wage H: Annual Hours Y: asset stock	Dynamic structural model with past hours of work affecting current wages through human capital accumulation. All persistence is attributed to state dependence.	Evaluated at means: 3.82 Allowing for incentives through human capital accumulation Age range 20-60 0.8-3
Lee (2001)	USA PSID 1967-76 balanced **All men** 5787 1967-90 unbalanced **All men** 29405	W: Hourly Wage (calculated for salaried workers) H: Annual Hours	Log-linear labour supply, first differenced; correction for finite sample bias; actual wages; does not account for taxes or benefits.	Evaluated at means: 0.50
MaCurdy (1981)	PSID prime age, white, **married men** 1967-76. Age 25-46 years in 1967	W: average annual earnings H: Annual Hours	Double log Frisch labour supply (CES utility function). IV on wage using family background, education, age and time dummies.	0.10-0.23
Pistaferri (2003)	panel section of the Bank of Italy SHIW 1989–93 **Married men**, age 26-59	W: Hourly wage H: Weekly hours	Log-linearised Euler equation Uses after tax marginal wages Decomposes changes in wages to anticipated and unanticipated components based on subjective expectations.	Intertemporal Frisch elasticity 0.70 Unanticipated wage change 0.51
H: Hours/Work Measure used, W: Wage Measure used, Y: Income measure used. FES: UK Family Expenditure Survey, PSID: US Panel Study of Income Dynamics. NLSLME: US National Longitudinal Study of Labor Market Experience				

Table A7: Taxable and Total Income Elasticities

Author (Date)	Data (Years)	Tax Change	Sample	Controls for Income Distribution and Mean Reversion	Definition of Income	Elasticity Results
Lindsey (1987)	Repeated Tax Cross-Sections 1980 – 1984	ERTA 81	AGI> $5k	None	Taxable Income	1.05 – 2.75 Central: 1.6
Feldstein (1995)	NBER Tax Panel 1985 & 1988	TRA 86	Married, non-aged non-S corp Income > $30k	None	AGI Taxable Income	0.75 – 1.3 1.1 ('lower income') to 3.05 ('higher income')
Navratil (1995)	NBER Tax Panel 1980 & 1983	ERTA 81	Married Income > $25k	Average Income	Taxable Income	0.8
Feldstein & Feenberg (1996)	IRS published data 1992 & 1993	OBRA 93	High Income	None	Taxable Income	1
Auten-Caroll (1997)	Treasury Tax Panel 1985 & 1989	TRA 86	Age 25-55, non-S corp. Income> $15k	Include log income in base year	Gross Income Taxable Income	0.57 0.57
Sammartino and Weiner (1997)	Treasury Tax Panel 1985 to 1994	OBRA 93	Age < 62	None	AGI	Zero long-run response
Goolsbee (1998)	Panel of Corp. Exec 1991 to 1994	OBRA 93	Corporate Execs 95% Income> $150k	Average Income	Wages, Bonuses & Stock Options	Short Run: 1 Long Run: 0.1 – 0.33
Caroll (1998)	Treasury Tax Panel 1985 & 1989	OBRA 93	Married aged 25-55 Income > $50k	Average Income	Taxable Income	0.5
Goolsbee et al (1999)	Tax Statistics (agg) 1922 – 1989	Various Reforms	Income > $30k	None	Taxable Income	-1.3 to 2 depending on the reform
Saez (1999)	NBER Tax Panel 1985 & 1988	Fiscal Drag	Married & Singles	Include Log Income and Polynomials of Income	AGI Taxable Income	0.25 0.4

Table A7: Taxable and Total Income Elasticities

Moffitt & Wilhelm (2000)	SCF Panel 1983 & 1989	TRA 86	Oversampling of High Incomes	Use Various Sets of Instruments	AGI	2 Hours worked 0.2
Gruber & Saez (2000)	NBER Tax Panel 1979 to 1990	ERTA 81 & TRA 86	Same marital status in paired-years	Include Log Income, trend effects and a 10 piece spline.	'Broad Income' Taxable Income	0.12 0.4 0.57 (high income) 0.18 (low income)
Sillamaa & Veall (2000)	Canadian Longitudinal Admin Survey. 1986 to 1989	Canadian TRA 88	Federal Tax paid > $625 (Can) Aged 25 – 64 65+	Include log income in base year. Instrumental Variables approach	Gross Income Taxable Income Employment Income S/E Income High-Income GI	0.25 0.14 0.22 1.12 1.30
Saez (2003)	NBER Tax Panel 1978 to 1983	Fiscal Drag	Married & Singles	Include Log Income and Polynomials of Income	AGI Taxable Income Wage Income	0.4 0.4 0
Kopczuk (2005)	University of Michigan Tax Panel 1979 to 1990	ERTA 81 & TRA 86	Same marital status in paid-years. Other criteria	Include current income, non-linear controls for income	Taxable Income	0.2 – 0.57
Eissa & Giertz (2006)	Treasury Tax Panel 1992 – 2003 & Execucomp 1992 – 2004	OBRA 93, TRA 97, EGTRRA	Executives of S&P 500 companies and top 1% of Tax Panel.	Includes current and future after-tax rates. No controls for mean reversion etc.	Earned Income AGI 1993: Long Run (SR) 2001: Long Run (SR)	 0.19 (0.82) -0.7 (0.00)
ERTA 81: Economic Recovery Tax Act (1981), TRA 86: Tax Reform Act (1986), OBRA 93 Omnibus Reconciliation Act (1993), TRA 97: Taxpayer Relief Act (1997), EGTRRA: Economic Growth and Tax Relief Reconciliation Act (2001). (A)GI: (Adjusted) Gross Income. NBER: National Bureau of Economic Research. IRS: Internal Revenue Service.						

5 Appendix 1: Some technical terms explained

- Budget set: in this context, a relationship between hours worked and the amount of income this provides.

- Utility function: a utility function is the economists' way of representing individual preferences over different goods; for given quantities of each good a utility function implies a rate that the individual is willing to trade one good for another (consumption for leisure in our case) – the marginal rate of substitution. Individuals choose a point on their budget set so as to maximise their utility. The size of the marginal rate of substitution is directly related to the impact of incentives on the supply of effort,

- Marginal tax rate: the tax rate that would be paid on a small additional amount of income (i.e. at the margin). This may be higher or lower than the average tax rate which is the amount of tax paid at a given income divided by that income.

- Income and substitution effects: suppose the tax rate is increased. The income effect is the effect of the reduction in net income implied by higher taxes. It implies one would work more because one is poorer. The substitution effect, on the other hand, causes one to work less because the trade of between work and leisure (i.e. the net wage) has been made less favourable. In this case, the two effects work in opposite directions but this is not always so.

- Elasticity: this is the "proportional change in X, given a '1 unit' change in Y". In this context, the labour supply elasticity with respect to the wage is the "proportional change in labour supply, given a '1 unit' increase in the (net hourly) wage rate". An elasticity of 1 means labour supply increases by 1% for a 1% rise in the net wage; an elasticity of 0.1 means a 0.1% rise for a 1% increase in the net wage. The size of the elasticity is determined by the income and substitution effects detailed above.

Further concepts and terms will be defined in the relevant sections of the chapter.

6 Appendix 2: The Difference in Differences Estimator and the taxable income elasticity

In this appendix we look in some detail at the difference in differences estimator that has been used to estimate the impact of reducing higher marginal tax rates. When we refer to the treatment group we refer to individuals who benefit from a tax reduction (or more generally change). The control group is the group to whom these are compared. Specifically what is frequently estimated is some version of the following double

log specification

$$\log E_{is} = \alpha_0 + \beta \log p_s + \beta \log(1 - t_{is}) + u_{is}$$

where E_{is} stands for earnings for individual i in period s, p_t is the unit price of effort in period s, and t_{is} is the tax rate faced by the individual. [36] The last term u_{is} is unobserved and constitutes the *random income shock*. The nature of this shock plays an important role in our attempts to understand incentive effects. In this simplified framework, the effect we wish to estimate is β,namely the proportionate effect on earnings (or taxable income in other contexts) of a percentage change in the proportion of earnings retained after tax.[37] The approach to estimating β followed in the literature[38], is to compare the growth of earnings for a group that was subject to a tax reform (say the very high earners) to a group with earnings just below the level at which the tax cut took effect. This approach ignores the fact we do not observe the price of effort p and treats it as a common factor affecting every group in the same way; hence it drops out when we compare across groups of individuals.

To see how this works, suppose we have two populations operating in the same labour market, but one consisting of individuals who earn less initially so that they face lower tax rates than the members of the other group. Suppose a policy reform is introduced whereby the tax rate of the higher earners is reduced. The lower-earnings group with incomes not targeted by the reform will constitute the *control* group. It is assumed that we observe the same set of individuals before and after the reform; the classification in treatment (those affected by the reform) and control group (those not affected) is based on their original income. We ignore observed unearned income, which in practice we can control for. The difference in these two groups will be reflected in differences in the mean of u in the pre-reform period (i.e. the mean of u_{i0}); the method indeed needs to assume that this mean affects outcomes in both periods in exactly the same way. In technical jargon this means that any changes in income are permanent. The *difference-in-differences* estimator for the effect of the tax reduction is based upon the *difference* in the change (Δ) in log earnings in the treatment group ($\log E_1$) from that of the control group i.e. $\Delta \log E_1 - \Delta \log E_0$. This is then scaled by the percentage change in the proportion of earnings taken home $(1-t)$, or more accurately the change in $\log(1-t)$. This calculation aims at obtaining an estimate of β. However there are three important difficulties with the interpretation of the results: a. income shocks are unlikely to be permanent; b. the price of effort may change differently for each of the groups and c. aggregate economic trends may differ across lower and

[36] Notice that by the properties of logs the log of the after tax price of effort is $\log((1-t)p) = \log p + \log(1-t)$.
[37] Note that this is not the same as (minus) the elasticity of earnings with respect to the tax rate. The latter is -$\beta \frac{t}{1-t}$.
[38] see Feldstein (1995, 1999) for example.

higher earning individuals. The approach described has to assume all these issues away. The expression below summarises the problems by including three different confounding components. To do this in a simple way we have expressed the way the income shocks persist from one period to the next as $u_{i1} = \rho u_{i0} + \varepsilon_{i1}$. This means that in period 1 (after the reform) a proportion ρ of the income shock that occurred in period 0 continues to affect the observed level of income. The approach assumes that this proportion is 1, i.e. that the shock is permanent. Suppose there is a tax reform and call D the percentage change in the proportion of earnings that the person in the $High$ group can keep minus the same for the Low income group.[39] Formally, $D = \Delta \log(1-t)^H - \Delta \log(1-t)^L$.Thus what the method really estimates is

$$\frac{\Delta \log E^H - \Delta \log E^L}{D} = \beta + (\rho - 1)\frac{(u_0^H - u_0^L)}{D} + \frac{(g^H - g^L)}{D} + \frac{\Delta \log(p^H/p^L)}{D} \tag{2}$$

where a superscript H denotes those with a higher income in the first period and L those with a lower one. u_0^H is the average first period random income "shock" for those classified as high income in the first period (the treatment group) and similarly u_0^H for the low income individuals. So for example $\Delta \log E^H$ is the earnings growth of those classified as "high income" in the pre-reform period. In what follows we will suppose that the reform reduced the tax rate faced by the higher income individuals relative to the low income individuals; thus $D > 0$.

The first term in 2 reflects mean reversion of incomes. Unless all shocks are permanent ($\rho = 1$) we expect this term to be negative and will bias downward the effect β we are seeking to estimate. This is the bias caused by mean reversion and is discussed at length by Gruber and Saez (2000).[40] The second term reflects the aggregate growth rate of individuals in different parts of the initial income distribution. So during periods of increasing inequality, such as the 80s in the US and the UK this term will be positive; this means that the incomes of those higher up in the distribution are growing faster than those lower down for reasons that may not be related to the tax reform directly and this will bias upwards the effect we wish to estimate. The final term has to do with whether individuals at a lower part of the income distribution offer a different type of skill to those at a higher part. In the extreme, all these individuals just offer the same type of skill, more or less effectively, and then the adjustment $\Delta \log \frac{p_1}{p_0}$ will be zero because the price for a unit of effort across the two groups grows in the same way. However, under reasonable assumptions $\Delta \log \frac{p_1}{p_0}$ will be negative when the tax rate relating to the higher earning individuals is cut[41] This can occur

[39] The $High$ and Low categories are defined by the income position before the reform took place.

[40] Note that Feldstein categorises people on the basis of the pre-reform marginal tx rate. This is a function of the pre-reform income. Hence although more complicated this is in effect a categorisation by initial income and the same arguments apply.

[41] To show this we have taken a CES production function with two types of labour. The labour supply elasticities of the two

because the decrease in tax for the higher income group will increase their supply of labour and will lead to a shift in the demand for labour from the lower skill to the higher skill group. In equilibrium one can show that $\Delta \log \frac{p_1}{p_0}$ is then negative. The result is a downward bias for the estimated earnings elasticity. Thus accounting for such *general equilibrium* effects would lead to larger elasticities (β) than those implied by the *difference-in-differences* framework. The approach we described above is thus fraught with problems: mean reversion in income and general equilibrium effects bias downward the elasticity, while aggregate trends can go either way. For the specific case of the reforms analysed in the US (the 1986 reform in particular) the increase in inequality would bias the elasticity upwards.

7 References

Aaberge, R., Colombino, U. & Strom, S. (1999), "Labour Supply in Italy: An Empirical Analysis of Joint Household Decisions, with Taxes and Quantity Constraints", Journal of Applied Econometrics, Vol. 14, No. 4, pp. 403 – 422

Adam, S. & Browne, J. "A Survey of the UK Tax System", Institute for Fiscal Studies (2006)

Ackum-Agell, S. & Meghir , C. (1995), "Male Labour Supply in Sweden: Are Incentives Important", Swedish Economic Policy Review

Adda, J., Dustmann, C., Meghir, C & Robin, J-M. (2006), "Career Progression and Formal versus On-the-Job Training", IZA working Paper.

Altonji, J. G. (1986), "Intertemporal Substitution in Labour Supply: Evidence from Micro Data", The Journal of Political Economy, Vol. 94, No. 3, Part 2, pp. S176 – S215

Arellano, M. & Meghir, C. (1992), "Female Labour Supply and On-the-Job Search: An Empirical Model Estimated Using Complimentary Datasets", The Review of Economic Studies, Vol. 59, No. 3, pp. 537 – 559

Arrufat, J. L. & Zabalza, A. (1986), "Female Labour Supply with Taxation, Random Preferences and Optimization Errors", Econometrica, Vol. 54, No. 1, pp. 47 – 63

Ashenfelter, O. & Heckman (1974), "The Estimation of Income and Substitution Effects in a model of Family Labor Supply", Econometrica, Vol. 42, No. 1, pp 73 - 85

Auten, G. & Carroll, R. (1999), "The Effect of Taxes on Household Income", The Review of Economics and Statistics", Vol. 81, No. 5, pp. 681 – 693

Blomquist, S. & Hansson-Brusewitz, U. (1990), "The Effect of Taxes and Male And Female Labor Supply

groups can differ.

in Sweden", The Journal of Human Resources, Vol. 25, No. 3, pp. 317 - 357

Blomquist, S. & Newey, W. (2002), "Nonparametric Estimation with Nonlinear Budget Constraints", Econometrica, Vol. 70, No. 6, pp. 2455 - 2480

Blow, L. and I. Preston (2002) "Deadweight Loss and Taxation of Earned Income: Evidence from Tax Records of the UK Self Employed" Institute for Fiscal Studies Working Paper WP02/15

Blundell, R., Chiappori, P., Magnac, T. & Meghir, C. (2007), "Collective Labour Supply: Heterogeneity and Nonparticipation", Review of Economic Studies (2007) 74, 417–445

Blundell, R., Chiappori, P. & Meghir, C. (2004), "Collective Labour Supply with Children", IFS Working Paper, WP02/08

Blundell, R., Duncan, A. & Meghir, C. (1992), "Taxation in Empirical Labour Supply Models: Lone Mothers in the UK", The Economic Journal, Vol. 102, No. 411, pp. 265 - 278

Blundell, R., Duncan, A. & Meghir, C. (1998), "Estimating Labor Supply Responses Using Tax Reforms", Econometrica, Vol. 66, No. 4, pp. 827 - 861

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

Blundell, R., MaCurdy, T. (1999), "Labor Supply: A Review of Alternative Approaches," in Handbook of Labor Economics, Vol. 3A. Ashenfelter and Card eds.

Blundell, R., MaCurdy, T. & Meghir, C. (2007), "Labor Supply Models: Unobserved Heterogeneity, Nonparticipation and Dynamics", forthcoming *Handbook of Econometrics*, Heckman and Leamer eds.

Blundell, R., Meghir, C. & Neves, P. (1993), "Labour Supply and Intertemporal Substitution", Journal of Econometrics, Vol. 53, No. 1, pp. 137 - 160

Blundell, R., Meghir, C., Symons, E. & Walker, I. (1998), "Labour supply specification and the evaluation of tax reforms", Journal of Public Economics, Vol. 36 (1) pp. 23 - 52.

Blundell, R., Reed, H. & Stoker, T. (2003), "Interpreting Aggregate Wage Growth: The Role of Labor Market Participation", The American Economic Review, Vol. 93, No. 4, pp. 1114 – 1131

Blundell, R. & Walker, I. (1986), "A Life Cycle Consistent Empirical Model of Family Labour Supply Using Cross Section Data", The Review of Economic Studies, Vol. 53, No. 4, pp. 539 – 558.

Bourguignon, F. & Magnac, T. (1990), "Labor Supply and Taxation in France", The Journal of Human Resources, Vol. 25, No. 3, pp. 358 - 389

Brewer, M. & Browne, J. (2006), "The Effect of the Working Families' Tax Credit on Labour Market

Participation", IFS Briefing Notes, No. 69

Brewer, M., Duncan, A., Shephard, A. & Suarez, M. (2005) "Did Working Families' Tax Credit work? The final evaluation of the impact of in-work support on parents' labour supply and take-up behaviour in the UK", IFS report for HMRC.

Browning, M., Bourguignon, F., Chiappori, P.-A. and Lechene, V. (1996), "Incomes and Outcomes: AStructural Model and Some Evidence from French Data", Journal of Political Economy, 102, 1067–1096.

Burtless, G. & Hausman, J. (1978), "The Effect of Taxation on Labor Supply: Evaluating the Gary Negative Income Tax Experiment", The Journal of Political Economy, Vol. 86, No. 6, pp. 1103 – 1130

Chiappori, P.-A. (1988), "Rational Household Labor Supply", Econometrica, 56, 63–89.

Chiappori, P.-A. (1992), "Collective Labor Supply and Welfare", Journal of Political Economy, 100, 437–467.

Cogan, J. (1981), "Fixed Costs and Labor Supply", Econometrica, Vol. 49, No. 4, pp. 945 – 963

Devereux, J. (2004), "Changes in Relative Wages and Family Labor Supply", Journal of Human Resources, Vol. 39, No. 3, pp. 696 – 722

Dickert, S., Houser, S. & Scholz, J. (1995) "The earned income tax credit and transfer programs: a study of labor market and program participation", in Tax Policy and the Economy, NBER and MIT Press, Poterba, J (ed)

Domeij, D. & Floden, M. (2006), "The labor-supply elasticity and borrowing constraints: Why estimates are biased", The Review of Economic Dynamic, Vol. 9, pp 242 - 262

Donni, O. (2003), "Collective household labor supply: nonparticipation and income taxation", Journal of Public Economics, Vol. 87 (5), pp. 1179 - 1198

Donni, O. (2007), "Collective female labour supply: theory and application", The Economic Journal, Vol.117, pp 94 - 119.

Eckstein, Z. & Wolpin, K. (1989), "Dynamic Labour Force Participation of Married Women and Endogenous Work Experience", The Review of Economic Studies, Vol. 56, No. 3

Eissa, N. & Giertz, S. (2006), "Trends in High Incomes and Behavioural Responses to Taxation: Evidence from Executive Compensation and Statistics of Income Data", Congressional Budget Office Working Papers, No. 2006-14

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

Ermisch, J & Wright, R. (1991), "Welfare Benefits and Lone Parents' Employment in Great Britain", The Journal of Human Resources, Vol. 26 (3) pp 424 - 456.

Feldstein, M. (1995), "The Effects of Marginal Tax Rates on Taxable Income: A Panel Study of the 1986 Tax Reform Act", *Journal of Political Economy*, Vol. 103, No. 3, pp. 551 – 572

Feldstein, M. & Feenberg, D. (1995), "The Effects of Increased Tax Rates on Taxable Income and Economic Efficiency: A Preliminary Analysis of the 1993 Tax Rate Increases", NBER Working Paper Series, No. W5370

Flood, L. & MaCurdy, T (1992), "Work disincentive effects of taxes: an empirical study of Swedish men", Carnegie-Rochester Conference Series on Public Policy

French, E. (2004), "The Labor Supply Response to (Mismeasured but) Predictable Wage Changes", The *Review of Economics and Statistics*, Vol. 86, No. 2, pp. 602 - 613

French, E. (2005), "The Effects of Health, Wealth, and Wages on Labour Supply and Retirement Behaviour", *Review of Economic Studies* (2005) 72, 395–427

Goolsbee, Austan (1999) "Evidence on the High-Income Laffer Curve from Six Decades of Tax Reform" *Brookings Papers on Economic Activity* Vol. 1999, No. 2 (1999), pp. 1-64

Goolsbee, A. (2000), "What Happens when you Tax the Rich? Evidence from Executive Compensation", *Journal of Political Economy*, Vol. 108, No. 2, pp. 352 – 378

Gorman, W. (1959), "Separable Utility and Aggregation", Econometrica, Vol. 27, No. 3, pp. 469 - 481

Gruber, J. & Saez, E. (2000), "The Elasticity of Taxable Income: Evidence and Implications", NBER Working Paper Series, No. 7512

Hausman , J. (1981), "Labour Supply: How Taxes affect Economic Behaviour", Tax and the Economy, *The Brookings. Institution.*

Hausman Jerry A. (1985) "The Econometrics of Nonlinear Budget Sets" *Econometrica* Vol. 53, No. 6 (Nov., 1985), pp. 1255-1282

Heckman, J. (1974), "Effects of Childcare Programs on Women's Work Effort", The Journal of Political Economy, Vol. 82, No. 2, Part 2, pp. S136 – S163

Heckman, J. (1974a), "Shadow Prices, Market Wages and Labor Supply", Econometrica, Vol. 42, No. 4, pp. 679 - 694

Heckman, J. & MaCurdy, T. (1980), "A Lifecycle Model of Female Labor Supply", The Review of Economic Studies, Vol. 47, No. 1, pp. 47 – 74

Heckman, J. & MaCurdy, T. (1983) "Corrigendum on A Life Cycle Model of Female Labour Supply" *The Review of Economic Studies* Vol. 49, No. 4 (Oct., 1982), pp. 659-660

Hill, S. (1982), "Estimating the Relationship Between Unemployment Compensation and Duration of Unemployment: The problem of Non-Filers", The Journal of Human Resources, Vol. 17, No. 3, pp. 460 – 470

Hotz V. Joseph, Finn E. Kydland; Guilherme L. Sedlacek (1988) "Intertemporal Preferences and Labor Supply" Econometrica Vol. 56, No. 2 (Mar., 1988), pp. 335-360

Imai, S. & Keane, M. (2004), "Intertemporal Labor Supply and Human Capital Accumulation", International Economic Review, Vol. 45, No. 2, pp. 601 - 641

Jenkins, S. (1992), "Lone Mothers' Employment and Full Time Work Probabilities", The Economic Journal, Vol. 102, No. 411, pp. 310 - 320.

Kaiser, H,.Spahn, P. & van Essen U. (1992), "Income taxation and the supply of labour in West Germany", Jahrbücher für Nationalökonomie und Statistik

Keane, M. & Moffitt, R. (1998), "A Structural Model Multiple Welfare Participation and Labor Supply", International Economic Review, Vol. 39, No. 3, pp. 553 – 589

Keane, M, Wolpin, K. (1997), "The Career Decisions of Young Men", Journal of Political Economy, Vol. 105, No. 3, pp. 473 - 522

Kopczuk, W. (2005), "Tax Bases, Tax Rates and the Elasticity of Taxable Income", The Journal of Public Economics, Vol. 89, No, 11-12, pp. pp 2093 - 2119

Lee Chul-in (2001), "Finite Sample Bias in IV Estimation of Intertemporal Labor Supply Models: Is the Intertemporal Substitution Elasticity Really Small?", The Review of Economics and Statistics, Vol. 83, No. 4, pp. 638 – 646

Lise, J. & Seitz, S. (2007), "Consumption Inequality and Intra-household Allocations", IFS Working Papers, W09/07, Institute for Fiscal Studies

Lindsey, L. (1987), "Individual Taxpayer Response to Tax Cuts: 1982-1984, with Implications for the Revenue Maximizing Tax Rate", Journal of Public Economics, Vol. 33, pp. 173 - 206

MaCurdy, T. (1981), "An Empirical Model of Labor Supply in a Life-Cycle Setting", The Journal of Political Economy, Vol. 89, No. 6, pp. 1059 – 1085

MaCurdy, T. (1983), "A Simple Scheme for Estimating an Intertemporal Model of Labor Supply and Consumption in the Presence of Taxes and Uncertainty", International Economic Review, Vol. 24, No. 2,

pp. 265 – 289

MaCurdy, T., Green, D. & Paarsch, H. (1990), "Assessing Empirical Approaches for Analyzing Taxes and Labor Supply", The Journal of Human Resources, Vol. 25, No. 3, pp 415 – 490

Meade, James (1978) *The structure and reform of direct taxation.* Report of a committee chaired by Professor J.E. Meade, ISBN: 978-0-04-336064-4 January 1978 (Allen and Unwin)

Meyer, Bruce and D. Dan T. Rosenbaum (2001) "Welfare, the Earned Income Tax Credit, and the Labor Supply of Single Mothers" *The Quarterly Journal of Economics*, Vol. 116, No. 3. (Aug., 2001), pp. 1063-1114.

Moffit, R. (1984), "The Estimation of a Joint Wage-Hours Labor Supply Model", Journal of Labor Economics, Vol. 2, No. 4, pp. 550 – 566

Moffitt, R. (1984), "Profiles of Fertility, Labor Supply and Wages of Married Women: A Complete Life Cycle Model", The Review of Economic Studies, Vol. 51, No. 2, pp. 263 – 278

Moffitt, R. & Wilhelm, M. (2000), "Taxation and the Labor Supply Decisions of the Affluent" in Does Atlas Shrug? The Economic Consequences of Taxing the Rich, ed. J. Slemrod, Cambridge University Press

Mroz, T. (1987), "The Sensitivity of an Empirical Model of Married Women's Hours of Work to Economic and Statistical Assumptions", Econometrica, Vol. 55, No. 4, pp. 765 – 799

Navratil, J. (1995), "The Economic Recovery Tax Act of 1981: Evidence on Individual Taxpayer Behavior from Panel Tax Return Data", Unpublished Harvard Thesis (see Gruber & Saez)

Nickell, S. (1979), "The Effect of Unemployment and Related Benefits on the Duration of Unemployment", The Economic Journal, Vol. 89, No. 353, pp. 34 – 49

O'Dea, C., Phillips, D. & Vink, A. (2007), "A Survey of the UK Benefit System", Institute for Fiscal Studies

Pencavel, J. (1998), "The Market Work Behaviour and Wages of Women: 1975-94", The Journal of Human Resources, Vol. 33. No. 4, pp. 771 – 804

Pencavel, J. (2002), "A Cohort Analysis of the Association between Work Hours and Wages among Men", The Journal of Human Resources, Vol. 37, No. 2, pp 251 – 274

Pistaferri, Luigi (2003) "Anticipated and Unanticipated Wage Changes, Wage Risk, and Intertemporal Labor Supply", Journal of Labor Economics, 2003, vol. 21, no. 3

Sammartino, F. & Weiner, D. (1997), "Recent Evidence on Taxpayers' Response to the Rate Increases in the 1990's", National Tax Journal, Vol. 50, No. 3, pp. 683-705

Saez, E. (1999), "The Effect of Marginal Tax Rates on Income: A Panel Study of 'Bracket Creep'", NBER Working Paper 7367

Saez, E. (2003), "The effect of marginal tax rates on income: a panel study of 'bracket creep'", Journal of Public Economics, Vol. 85, pp. 1231 - 1258

Silaama, M. & Veall, M. (2000), "The Effect of Marginal Tax Rates on Taxable Income: A Panel Study of the 1988 Tax Flattening in Canada", QSEP Research Report, No. 354

Thomas, D. (1990), "Intra-Household Resource Allocation: An Inferential Approach", Journal of Human Resources, 25, 635–664.

Triest, R. (1990), "The Effect of Income Taxation on Labor Supply in the United States", The Journal of Human Resources, Vol. 25, No. 3 (Special Issue), pp. 491 - 516

Walker, I. (1990), "The Effect of Income Support Measures on the Labour Market Behaviour of Lone Mothers", Fiscal Studies, Vol. 11, No. 2, pp. 55 - 74

Ziliak, J. & Kniesner, T. (1999), "Estimating Life Cycle Labor Supply Tax Effects", The Journal of Political Economy, Vol. 107, No. 2, pp. 326 – 359