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TAX AND BENEFIT REFORMS IN A MODEL OF LABOUR MARKET TRANSITIONS

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Abstract

We present a method for taking advantage of labour market transitions to identify the effects of financial incentives on employment decisions. The framework we use is very flexible and by imposing few theoretical assumptions it allows us to extend the modelled sample relative to structural models. We take advantage of this flexibility to include disabled persons in the model and to jointly analyse the behaviour of disabled and non-disabled persons. A great deal of attention is paid to the appropriate modelling of financial incentives in the labour market. In the case of disabled persons, taking account of financial incentives turns out to be an extremely complex process but one that in the end turns out to be well worth the effort. The model is used to compare reactions in the labour market to marginal changes in financial incentives and also to model one of the most important reforms of the UK Labour government – the introduction of the Working Families' Tax Credit. The methodology relies on matching the transition and income data derived from cross-sectional and panel surveys, and could be used in other countries for which detailed, reliable income data are not collected in a panel format.

* Michal Myck is with the German Institute for Economic Research (DIW), Berlin (e-mail: mmyck@diw.de) and Howard Reed is with the Institute for Public Policy Research (IPPR) (e-mail: h.reed@ippr.org). This paper is based on the methodology and results developed under two research projects carried out for several UK government departments while both authors were employed at the Institute for Fiscal Studies (IFS). The methodology was initially developed under the project called "Fiscal policy and labour supply" conducted for the HM Treasury, the Inland Revenue (currently HMRC) and the Department for Work and Pensions, while its extensions and further results were developed under the project called "Including disabled persons and their partners in a dynamic model of labour supply" carried out for the Department for Work and Pensions. We would like to acknowledge the financial support of all three departments that contributed to this research. We would also like to thank the civil servants involved in these projects for their advice and extremely useful comments at various stages.

Both authors have since moved from the IFS; Michal Myck is a Senior Economist at DIW, while Howard Reed is the Research Director at the IPPR. Michal Myck would like to express appreciation for the financial support provided by the REVISER project, which enabled the completion of this final paper. Data from the Family Resources Survey and the Labour Force Survey used in this paper were supplied by the UK Data Archive, who bear no responsibility for its analysis or interpretation. Microsimulations for the UK were conducted using the tax and benefit model TAXBEN of the IFS, to whom we are grateful for making it available to us. We are also grateful to our colleagues from the IFS for their suggestions and comments during the development of the projects. The usual disclaimer applies.

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1. Introduction

Since first being elected in 1997, the Labour government in the UK has introduced a number of reforms to the country's tax and benefit system. Starting in 1999, the system of in-work support for low-earning families with children and for disabled persons in work (with or without children) was reformed in a way that made it significantly more generous than the previous system. Table 1 below gives details of the main types of benefits and tax credits in the UK and shows the principal reforms between 1997 and 2003. This paper focuses on the effect of what broadly might be called the 'first round' of reforms, occurring between 1999 and 2002 (the 'second round' of reforms in 2003 focused more on changes to the administration and labelling of benefits and tax credits rather than their financial value).[1] More detailed information on these reforms can be found in Dickens, Gregg & Wadsworth (2003), Balls, Grice & O'Donnell (2004) and Shaw & Sibieta (2005).

The methodology presented in this paper originates from the work done by Gregg, Johnson & Reed (1999), who developed a model of labour market entry for the UK labour force. The analysis accounts for labour market dynamics to a greater extent as we model both employment entry *and exit*. Perhaps more importantly, the methodology offers an original treatment of individuals in couples in the labour market. The other key features of the model are:

- It relies on estimating the probability of transition between different labour market states, conditional on being in a certain state a year earlier (this is implemented using information from the Labour Force Survey (LFS), which follows families for five quarterly interviews).
- In addition to controlling for characteristics such as age and family status, the model conditions these transition probabilities on the financial incentives individuals encounter in the labour market. Financial incentives are estimated using the Family Resources Survey (FRS) and the tax and benefit microsimulation model of the Institute for Fiscal Studies (IFS), TAXBEN. The calculation of financial incentives accounts for the partial take-up of some benefits and treats childcare costs as fixed costs of working. Information on financial incentives from the LFS and FRS is matched.
- The model includes disabled persons and we present a detailed framework for modelling financial incentives for this group of the working-age population. Individuals are treated as 'disabled' for the purposes of the estimation if they report 'work-limiting disability' or claim disability benefits (or both).

[1] In addition, there were reforms to the direct tax system over the period – for example, a 10% starting rate of income tax was introduced over a narrow band of income in 1999, and basic-rate income tax was reduced in 2000. Payroll taxes were also reformed: the structure of National Insurance contributions was changed slightly to make it more consistent with income tax and the rates were raised in 2003.

- Single persons and those who live in couples are treated separately for the purpose of the estimation (as is the case with most structural models).

Table 1. Main benefits and tax credits in the UK system and reforms between 1997 and 2003

Benefit/tax credit	Situation in 1997	Reforms 1997-2003
In-work support for families with children in which in-work earnings are low	Family Credit available for those working 16 hours or more per week; limited additional childcare support through income disregard; a full-time bonus available for working 30 hours or more per week; means-tested – withdrawn at 70% when net income is above a specified threshold	1999: Working Families' Tax Credit (WFTC) replaces Family Credit; it is similar in structure but more generous, with a lower taper (55%) and more support for childcare through a childcare credit 2000-02: Generosity of WFTC gradually extended 2003: WFTC replaced by two tax credits – Child Tax Credit (CTC) and Working Tax Credit (WTC); generosity is similar but the assessment period for means test and structure of benefits are different
Support for disabled persons when out of work: contributory benefit	Incapacity Benefit (IB) available for individuals who are incapable of work (and satisfy a personal capability assessment from a doctor); paid to those with sufficient previous payroll (National Insurance) contributions, although this requirement is waived in some cases; it has a range of rates according to how long a claimant has been on the benefit (the rate rises over time)	Claim conditions tightened at various points over this period 2001: IB made partly means-tested on private or occupational pension income
Support for disabled persons when out of work: non-contributory benefit	Income Support, the main benefit for persons not in work who are not expected by the government to seek work owing to sickness or disability, includes Disability Premia (ISDP); a range of different levels of the benefit are payable depending on the severity of disability; the benefit is means-tested with withdrawal at 100% once gross income is above a certain threshold; many IB claimants are also eligible for ISDP as IB by itself is insufficient to float individuals off the means test	Slight changes to eligibility rules; increases in child additions for Income Support, but little change in the generosity of Disability Premia in real terms
Help with mobility and care costs for disabled persons	Disability Living Allowance (DLA), payable at a range of rates for persons who require significant amounts of help in connection with their bodily functions or with making outside journeys	No major changes over this period
In-work support for disabled persons with low earnings	Disability Working Allowance (DWA), with a structure similar to that of Family Credit	1999: Disabled Persons Tax Credit (DPTC) replaces DWA; rates and structure similar to WFTC for the most part 2003: In-work support for disabled persons combined with support for families with children in the Working Tax Credit (WTC) scheme; additional premia available for disabled persons

Source: Authors' data.

Explicit treatment of disability in labour market models is rare, and to our knowledge none of the models applied to UK data has attempted to link disability to choices of labour market participation. Early US studies of the relationship between disability and labour market participation (e.g. Parsons, 1982 and Slade, 1984) suggested a very strong relationship between the value of out-of-work disability benefits and employment. Bound (1989) argued, however, that these studies exaggerated the effect of disability benefits. He showed that a large proportion of the fall in employment among disabled persons recorded in the US would have occurred with or without the disability benefit scheme.

Most of the recent studies analysing the relationship between disability and labour market participation use semi- or non-structural approaches. In some cases, so-called 'natural experiments' enable the identification of labour supply elasticities and responsiveness for disabled persons (Gruber, 2000 and Campolieti, 2003). In others, as for example in Harkness (1993), although the authors develop a structural model, the estimation is then conducted in a non-structural fashion. Nevertheless, a distinctive feature of these models is that the estimations are conducted solely on disabled persons and are therefore not directly comparable with the non-disabled population. Compared with estimates derived from natural experiments, the model presented here is more general and not specific to a given policy or area of the country.

This paper is organised as follows. Section 2 presents the structure of the labour supply models that we estimate. Section 3 explains specifically how the model uses information on the changes in financial incentives that individuals and families face as a result of the benefit reforms to estimate the models. Section 4 briefly explains how the model is used to simulate the labour supply effects of changes to benefit policies. Section 5 details the data we use and in particular how 'disability' is defined in the data. Section 6 presents the results of the labour supply model. Section 7 concludes.

2. The modelling structure

In this section we present an overview of the whole modelling process. In the estimation we rely on matching information derived from two different datasets (the LFS and FRS). This process is described in detail in section 3.4. While financial incentives are calculated using the FRS, employment transitions can only be observed in the LFS, which is a five-quarter, rolling panel dataset. The estimation of financial incentives takes into account the partial take-up of several benefits, along with modelling the benefits for disabled persons and giving consideration to the cost of childcare for those with young children. These features of the modelling process make the calculation of financial incentives much more accurate but at the same time imply a greater complexity of the whole modelling process. The overall process can be divided into four stages:

i) computation of expected values for inputs into the tax and benefit simulation (done using the FRS and LFS);

ii) computation of incomes in different employment states and under different take-up scenarios (done using the FRS);

iii) calculation of the financial incentives in different employment states including the partial take-up of benefits and childcare use (done using the FRS for non-disabled persons and the LFS for disabled persons); and

iv) estimation of labour-market transition models.

We begin the description of the methodology with details of the estimation procedures for single persons and couples. In each case we estimate the probability of changing the labour market state between waves 1 and 5 of the LFS, i.e. in two periods separated by a year. The estimated probability is thus the probability of being in a state of employment at time (t) conditional on the employment state a year earlier (at time (t-1)).

2.1 Modelling the transitions of single persons

Two separate equations are estimated for single persons:

1) an *entry equation* for the sub-sample of persons who were not employed in period (*t-1*); and

2) an *exit equation* for those who were employed at (*t-1*).

Let $work_{i,t}$ be an indicator variable describing whether person *'i'* is employed at time (*t*). The probability that someone not working enters work – or the 'entry model' – can be represented as:

$$\Pr(work_{i,t} = 1 \mid work_{i,t-1} = 0) = \Phi(\beta_1^{'} X_{i,t}^{entry}) \qquad (1)$$

and the probability that someone working stops work – or the 'exit model' – can be represented as:

$$\Pr(work_{j,t} = 0 \mid work_{j,t-1} = 1) = \Phi(\beta_2^{'} X_{j,t}^{exit}) \qquad (2)$$

In practice, each individual in the data can contribute to only one of these two equations, depending on their employment status at time (*t-1*). Function $\Phi(.)$ is the normal cumulative distribution function, and $X^{entry}{}_{it}$ and $X^{exit}{}_{jt}$ are vectors of regressors including individual characteristics. In our approach, the regressors include the characteristics of age, family structure, disability status, region, etc., plus the financial incentives encountered by individuals in the labour market, i.e. incomes in and out of work.

2.2 Modelling the transitions of individuals in couples

In the model we use for couples, we identify initial employment states at the level of the couple and not the individual, and then model couples' behaviour as a bivariate choice made by partners individually but allowing for correlation between partners' decisions.[2]

The semi-structural approach makes no assumptions concerning the process that determines the observed distributions of hours of work. The method is consistent with the view that the decisions of one member of the couple affect and are affected by the choices of the other, and represents a natural extension of the methodology used to model single individuals.

Our modelling of couples distinguishes among four states a couple can be in:

1) a man working and a woman working (which we refer to as a (1,1) couple, to which we assign the parameter value $D_{i,t}$=1);

2) a man working and a woman not working (a (1,0) couple, $D_{i,t}$=2);

3) a man not working and a woman working (a (0,1) couple, $D_{i,t}$=3); and

4) a man not working and a woman not working (a (0,0) couple, $D_{i,t}$=4).

[2] The initial methodology was based on modelling the couples' choice with the multinomial logit model. The need to include a large set of regressors makes the bivariate probit model a more natural choice and we would like to thank Alan Duncan for suggesting this approach. As Myck (2005) demonstrates, for the same set of regressors the performance of these two models in terms of generated response to changes in financial incentives is very similar.

The aim of our labour supply model is to model the transitions of individuals in couples between these states conditional on the state at time (*t-1*). The sample is therefore divided into four sub-samples: (1,1), (1,0), (0,1) and (0,0), and then we model the transitions as a choice made by each of the partners allowing for correlation between their decisions. This means that we estimate four separate sets of equations for couples in the sample.

In the case of analysing partners' choices at their individual level the transition probability for the two partners is described by the *bivariate normal cumulative distribution function*. For example, the probability of choosing state (*'q'*) in the case of couples that are in employment state (1,0) at time (*t-1*) is:

$$\Pr(D_{i,t} = q \mid D_{i,t} = 2) = \Phi_2(\pi^m * X_i^m \beta_m, \pi^w * X_i^w \beta_w, \pi^m * \pi^w * \rho), \quad \textit{for } q = 1,2,3,4 \quad (3)$$

where π^m is 1 if the man exits and –1 if he does not, while π^w is 1 if the woman enters and –1 if she does not. Vectors X_i^m and X_i^w include net income variables. $\Phi_2(.)$ is the bivariate normal CDF, and ρ is the correlation parameter denoting the extent of correlation between the two transition equations for men and for women. Corresponding expressions for transition probabilities can be written for the other three initial employment states.

3. Modelling financial incentives

The first stage of the modelling process consists of estimating gross wages for labour market entrants (i.e. those who are not employed). Because the model only distinguishes between employment and non-employment we also estimate a measure of the expected number of hours worked if employed. For persons with children we also estimate the cost of childcare under different employment scenarios (for example, if both parents are working or if either of them is working).

Below we discuss how financial incentives are calculated for non-disabled persons (section 3.1) and disabled persons (section 3.2). We must remember here that financial incentives in the transitions model (estimated on the LFS) are imputed from the FRS by matching group-average values of financial incentives for individuals or couples with the same characteristics. Section 3.4 gives brief details of this matching procedure. Section 3.1 also explains how the intermediate equations for wages, hours of work and childcare costs are estimated.[3]

3.1 Financial incentives for persons without disabilities

For individuals with disabilities, the modelling of financial incentives is conducted almost entirely using the FRS. The only exception is made for the estimation of entry wages. This is estimated using the LFS data, in which we can identify persons who enter employment between time (*t-1*) and (*t*). The computation of financial incentives, both in and out of work, is most straightforward in the case of non-disabled persons without children. To calculate financial incentives for this group the FRS information on demographics, assets, area of residence, etc., and require a measure we use of gross wage and of hours of work when employed. Hours of work are estimated on the FRS sample of working persons using OLS regression on the sample of those employed, with regressors as shown in Table 2. The wages for the non-employed sample are imputed using an entry-wage equation run on the LFS entry sample. The entry-wage equations are estimated for men and women separately using OLS on the log hourly wage measure, and the regressors comprise: year dummies, a cubic in age, age at which the person left full-time education, a regional dummy for London and the South East (which are

[3] Detailed results of the intermediate models are available from the authors on request.

particularly high wage areas in the UK), marital status and a disability dummy. The precise treatment of wages in the model is a little more complex; we return to this issue in section 3.3. For the moment let us just assume that for all individuals in our sample we have a measure of expected hours of work when employed and a measure of gross hourly wage.

Table 2. Regressors used for hours equations

Regressor	**Single men no children**	**Single women no children**	**Single parents**	**Married men**	**Married women**
Year dummies	●	●	●	●	●
Cubic in age	●	●	●	●	●
Age left full-time education	●	●	●	●	●
Regional dummies	●	●	●	●	●
Number of children	–	–	●	●	●
Age of youngest child	–	–	●	●	●
Disability dummy	●	●	●	●	●
Number of obs	9,962	8,004	3,895	29,940	25,293

Note: ● indicates use in sub-sample regression on employed persons in the FRS
Source: Authors' data.

Using these measures of hours of work and gross hourly wage we can compute income in and out of work for individual *'i'* (who does not have children) in the LFS sample as:

$$Y_{ig}^{E} = \frac{1}{Jg} \sum_{jg=1}^{Jg} f(\hat{h}_{E,jg}, w_{jg}*, \varsigma_0) \qquad (4)$$

while for a couple *'i'* (also without children) as:

$$Y_{ig}^{E} = \frac{1}{Jg} \sum_{jg=1}^{Jg} f(\hat{h}_{E,jg}^{m}, w_{jg}^{m}*, \hat{h}_{E,jg}^{w}, w_{jg}^{w}*, \varsigma_0) \qquad (5)$$

where

- *'i'* and *'j'* index individuals in the LFS and FRS samples respectively, *'g'* indexes a specific group and *'E'* is a specified employment state.[4] For couples indices 'm' and 'w' identify the man and the woman respectively;
- *'Jg'* is the number of individuals (or couples) *'j'* in group *'g'* in the FRS;

[4] *'E'* takes values 0 (non-employed) and 1 (employed) for single persons and 1 (state (1,1)), 2 (state (1,0)), 3 (state (0,1)) and 4 (state (0,0)) for couples.

- $\hat{h}_{E,jg}$ is a measure of hours worked in employment state *'E'*, which for non-employment takes value 0 and for employment is a measure of expected hours worked based on the linear hours equation;
- $w_{jg}*$ is a gross wage measure;
- ς_0 stands for the tax and benefit system in place at the time the data was collected; and
- the net income of individuals in the FRS is a function $f(.)$ of hours of work, gross hourly wages and the tax and benefit system.

The calculation is more complex for those with children because it accounts for take-up of the Working Families' Tax Credit (WFTC), the probability of childcare use and the use of childcare subsidies in scenarios where at least one person in the family is employed.[5] Let us define three variations of the tax and benefit system:

- 'ς_1' is a system with WFTC childcare subsidies in which everyone takes up 100% of their modelled WFTC entitlement;
- 'ς_2'is a system without WFTC childcare subsidies in which everyone takes up 100% of their modelled WFTC entitlement; and
- 'ς_3' is a system in which no one takes up the WFTC.

Defining *'M'* as a vector of hours of work and gross hourly wages and $\hat{C}$ as the predicted childcare cost in the employment state *'E'*, we can define three measures of net income for family *'j'* in the FRS:

$$Y^1_{E,j} = q(M_{E,j}, \varsigma_1, \hat{C}_{E,j})$$

$$Y^2_{E,j} = q(M_{E,j}, \varsigma_2)$$

$$Y^3_{E,j} = q(M_{E,j}, \varsigma_3) \qquad (6)$$

Let $\hat{P}^{WFTC}$ be the expected measure of WFTC take-up, i.e. a measure of probability that the family claims the WFTC, conditional on being eligible for it. Also let $\hat{P}^C$ be a predicted measure of childcare use, i.e. a measure of probability that the family will use childcare in a given employment scenario. Then function $f(.)$ from equations (4) and (5) takes the following form:

$$f(M_{E,j}, \hat{C}_{E,j}) = [Y^3_{E,j}] + [(Y^2_{E,j} + (Y^1_{E,j} - Y^2_{E,j}) * \hat{P}^C_{E,j} - Y^3_{E,j}) * \hat{P}^{WFTC}_{E,j}] - [\hat{C}_{E,j} * \hat{P}^C_{E,j}] \qquad (7)$$

The first term in square brackets on the right-hand side is value of net family income in employment state *'E'* in the scenario where they do not claim the WFTC. The second term in square brackets is the expected value of the WFTC, taking into account the value of childcare subsidies (multiplied by the probability of childcare use) and the probability of WFTC take-up.

[5] The take-up rate for Income Support/Jobseekers Allowance, Housing Benefit and Council Tax Benefit is assumed to be 100% for all individuals in the sample. In the case of these benefits this assumption seems acceptable given that take-up rates for these benefits are in the range of 80-95% (see for example Department of Social Security, 1999).

The third term is the expected childcare cost, given the calculated value of childcare weighted by the expected probability of using it.[6]

The final measure of net income for family *'i'* in the LFS is an average for the corresponding group in the FRS in the same way as for those without children.

Table 3 gives a list of the regressors used in the different childcare equations – the childcare cost equation, the equation to determine the hours of paid childcare among families that use paid childcare, the equation to determine the use of childcare and the equation for the take-up of Family Credit/WFTC.

Table 3. Regressors used for childcare hours, cost and take-up equations

Regressor	**Hourly childcare cost**	**Hours of paid childcare among those who use it**	**Use of paid childcare**	**Take-up of Family Credit/WFTC**
Year dummies	●	●	●	●
Cubic in age	–	●	●	–
Male dummy	–	●	●	●
Age left full-time education	–	●	●	–
Regional dummies	●	●	●	●
More than two children		●	●	●
Age of youngest child	●	●	●	●
Hourly childcare cost	–	●	–	–
Non-employed household member	–	–	●	–
Value of WFTC eligibility	–	–	–	●
Works less than 30 hrs per week	–	●	●	●
Number of obs	3,666	815	3,373	1,764

Note: ● indicates use in sub-sample regression on employed persons in FRS

Source: Authors' data.

3.2 Financial incentives for disabled persons

For those with disabilities we add another stage that allows a more precise allocation of the major disability benefits – Incapacity Benefit (IB), the Disability Living Allowance (DLA) and the Disabled Persons Tax Credit (DPTC). The reason for doing so, rather than following the

[6]Detailed results of the childcare cost and childcare hours equations, Family Credit/WFTC take-up modelling and childcare-use probability models are available from the authors on request.

methodology used for modelling the WFTC (for example), is that on the basis of the data alone it is difficult to determine eligibility for disability benefits. Therefore, standard take-up modelling methods cannot be easily applied. As we show below, in cases where take-up modelling is necessary, the LFS contains more information than the FRS. This extra information can be used in a disability-benefit eligibility/take-up model. Given the computational intensity of this method we apply it only to the most commonly claimed disability benefits: the IB, DLA and DPTC. In addition, our methodology also indirectly models the Income Support Disability Premiums (ISDP).[7]

For disabled individuals and for couples with a disabled person, we compute net incomes in different employment states in a greater number of scenarios than for those without disabilities.[8] The scenarios are determined by 'imposed' benefit eligibility. For example, we calculate net incomes in work and out of work assuming that the person receives the DLA and assuming that s/he does not. As a consequence each disabled person in the LFS sample is assigned several in- and out-of-work measures of income. To use the DLA example, for a single disabled individual without children we therefore have:

$$Y_{ig}^{E,DLA} = \frac{1}{Jg}\sum_{jg=1}^{Jg} f(\hat{h}_{E,jg}, w_{jg}*, \varsigma_0^{DLA}) \tag{8}$$

$$Y_{ig}^{E,NoDLA} = \frac{1}{Jg}\sum_{jg=1}^{Jg} f(\hat{h}_{E,jg}, w_{jg}*, \varsigma_0^{NoDLA}) \tag{9}$$

In the case of the DLA, whether income is assigned including or excluding the DLA is determined by recorded benefit receipt by person *'i'* in the LFS data. Since the DLA is independent of employment status, if a person declares receipt of the DLA in the data, s/he is assigned an income with the benefit both in and out of work.

[7] The Income Support Disability Premium (ISDP) is an addition to Income Support, which is the main means-tested income replacement benefit in the UK. As disabled persons tend to be poorer than the rest of the UK population on average, the ISDP is a very commonly claimed, means-tested disability-related benefit. Unfortunately, neither of the datasets we use contains explicit information on whether a family receives the ISDP as a specific component of its Income Support or not. We only have information on whether individuals receive Income Support and (in the case of the FRS) the total Income Support amount. Since Income Support is means-tested, knowing the amount of the benefit received does not allow the identification of whether or not someone receives the disability premium. The only way of imputing the receipt of the premium is through the identification of another disability-related benefit on which the ISDP is made conditional (the so-called 'qualifying benefit').

As a consequence, the ISDP is automatically added in the TAXBEN model for all those who are eligible to receive Income Support and receive a qualifying benefit. Since the model assumes a 100% take-up of Income Support, in calculating the net incomes in different scenarios the model extends this assumption to disability premiums for those who claim a qualifying benefit. Both the DLA and IB are qualifying benefits. Therefore in our procedure of computing incomes for disabled persons as described above, the net incomes out of work that are calculated for disabled persons under the assumption of receiving the DLA or IB also include the ISDP.

[8] For details on the employment/benefit claim scenarios in which net income are calculated, see the appendix.

The allocation of the benefit is slightly different in the case of IB because eligibility for IB is dependent, among other things, on being out of work. For individuals who are observed in the LFS as being out of work (*'E'* = 0) at time (*t*) we use the same method as for the DLA. We compute:

$$Y_{ig}^{E=0,IB} = \frac{1}{Jg}\sum_{jg=1}^{Jg} f(\hat{h}_{E,jg}, w_{jg}*, \varsigma_0^{IB}) \tag{10}$$

$$Y_{ig}^{E=0,NoIB} = \frac{1}{Jg}\sum_{jg=1}^{Jg} f(\hat{h}_{E,jg}, w_{jg}*, \varsigma_0^{NoIB}) \tag{11}$$

and allocate the income that corresponds to the recorded IB claim. Yet, since we also need a measure of financial incentives out of work for those who are employed at time (*t*) (and who therefore cannot have a recorded IB claim), we estimate an IB take-up/eligibility equation on the basis of information from the LFS at time (*t-1*) and (*t*).[9] A predicted take-up/eligibility probability measure ($\hat{P}_i^{IB}$) is then derived for all those who are disabled and in work at time (*t*) and a measure of income out of work is calculated using the predicted IB take-up probability, as follows (note that *'i'* identifies a person in the LFS):

$$Y_{i,g}^{E=0} = Y_{i,g}^{E=0,NoIB} + (Y_{i,g}^{E=0,IB} - Y_{i,g}^{E=0,NoIB}) * \hat{P}_i^{IB} \tag{12}$$

Our calculations of income out of work also account for the possibility of joint receipt of the IB and DLA. For those who are out of work with recorded IB and DLA receipt we allocate:

$$Y_{ig}^{E=0} = \frac{1}{Jg}\sum_{jg=1}^{Jg} f(\hat{h}_{E,jg}, w_{jg}*, \varsigma_0^{DLA+IB}) = Y_{ig}^{E=0,DLA+IB} \tag{13}$$

while for those in work at time (*t*) with a recorded receipt of the DLA we calculate income out of work as:

$$Y_i^{E=0} = Y_i^{E=0,DLA,NoIB} + (Y_i^{E=0,DLA+IB} - Y_i^{E=0,DLA,NoIB}) * \hat{P}_i^{IB} \tag{14}$$

Because the DPTC is an in-work benefit it is only allocated to incomes in the in-work scenarios (*'E'*=1). Group level income with the DPTC is calculated as:

$$Y_{ig}^{E=1,DPTC} = \frac{1}{Jg}\sum_{jg=1}^{Jg} f(\hat{h}_{E,jg}, w_{jg}*, \varsigma_0^{DPTC}) \tag{15}$$

This measure of income is allocated to persons who work at time (*t*) and are recorded as claiming the DPTC in the LFS. We also allocate this measure of income for the in-work scenario to individuals who are out of work at time (*t*) and who are recorded as receiving the IB. Those who either work and receive both the DLA and the DPTC or are not working and receive the IB and the DLA are assigned income with the DPTC and the DLA as income for their in-work scenario.

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[9] Details of the estimation are presented in the appendix.

A similar methodology is used when calculating the financial incentives for couples, but it recognises that there are more possibilities with regard to who receives particular benefits.[10]

For disabled persons with children the same methodology is applied but in line with the calculation for non-disabled persons we calculate incomes under the three variations of the tax and benefit system $(\varsigma_1, \varsigma_2, \varsigma_3)$ defined in section 3.1, making different DLA, IB and DPTC claim assumptions.[11]

3.3 Treatment of wages

One of the key determinants of financial incentives to work is the gross hourly wage. The model requires us to calculate financial incentives to work for those who are observed in work (and therefore for whom we know the actual hourly wage) and for those who are not. In the latter case, a wage prediction is needed.

The approach we use to model wages is to use actual wages for persons with observed wages, and for those without to integrate net incomes in work over the distribution of the residual. This treatment ensures that wages for those with and without observed wages are drawn from the same conditional distributions. It leads to estimating transition models for non-workers (and for couples with at least one non-working partner) using simulated maximum likelihood estimation methods.

Simulating the likelihood function

In the case of the entry probit model the simulated likelihood function we estimate is:

$$\ln L = \sum_{i=1}^{I} \ln\left[\frac{1}{K}\sum_{k=1}^{K}\Phi(q_i * X_{i,\varpi k}\beta)\right] \tag{16}$$

where *'i'* indexes individuals in the LFS entry sample and $X_{i,\varpi k}$ is a vector of individual characteristics and includes a measure of income in work based on the wage measure ϖk using the k[th] draw from the wage distribution. Here *'q'* takes value 1 if the person enters and (–1) if the person does not enter.

Similarly we can derive a simulated likelihood function for the bivariate probit estimation for couples. Using the example from equation (3) in the bivariate probit specification we estimate the following log likelihood function:

$$\ln L_{(1,0)} = \sum_{j=1}^{n} \ln\left[\frac{1}{K}\sum_{k=1}^{K}\Phi_2(\pi^m * X^m_{j,\varpi k}\beta_{1m}, \pi^w * X^w_{j,\varpi k}\beta_{1w}, \pi^m * \pi^w * \rho)\right] \tag{17}$$

where π^m is 1 if the man exits and –1 if he does not, while π^w is 1 if the woman enters and –1 if she does not. Vectors $X^m_{j,\varpi k}$ and $X^w_{j,\varpi k}$ include net income variables and ϖk indicates the k[th] draw from the entry wage distribution.

Similar simulated likelihood functions can be derived for (0,1) and (0,0) couples. For the exit model and for (1,1) couples we do not need to use the simulated likelihood estimation since we use observed wages to calculate incomes in work.

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[10] See the appendix for details.

[11] Again, for details see the appendix.

In the example where only the man is working at time (*t-1*) net incomes calculated for the (0,1) and (1,1) scenario are based on the actual wages of the man and on the woman's wages drawn from the conditional wage distribution. Net incomes are calculated *k* times on the basis of *k* independent draws from the wage distribution. For couples (0,0), i.e. those in which neither of the partners are employed at time (*t-1*), we draw independently from the distribution of men's and women's wages *k* times and calculate net incomes at the couple level for different scenarios for *k* pairs of wages.[12]

3.4 Matching the data of the LFS and FRS

In matching the income information from the FRS with that in the LFS we have followed the method applied in the original labour-market transitions project (Gregg, Johnson & Reed, 1999). This relies on averaging incomes in groups defined by certain observable characteristics in the FRS and allocating these averages to corresponding groups in the LFS. The group-defining characteristics have been adjusted to take account of different age criteria and of disability status. Grouping is done exclusively within different employment status groups (i.e. employed and non-employed for singles and the four employment states for couples defined by the employment status of the partners). Single persons are grouped by the following characteristics:

- *data year*, by four years (1999-00 to 2002-03)
- *gender*, by two groups
- *age*, by five age groups – 20-24, 25-36, 37-50, 51-54 and 55-59 (women)/64(men)
- *education*, by three groups – left school aged <17, left school at 17-18, left school at 19+
- *residence*, by two groups – either living in London/South East or not
- *children*, by three groups – no children, one or two children, three children or more
- *age of the youngest child*, by two groups – have a child aged 0-4 or not
- *disability*, by two groups – disabled or not disabled.

For couples the following characteristics have been used to group the data:

- *data year*, by four years (1999-00 to 2002-03)
- *age of the man*, by five age groups – 20-24, 25-30, 30-36, 37-44, 45-54 and 55-65
- *age of the woman*, by four age groups for (1,1) couples – 20-32, 33-44, 45-54 and 55-60; by three age groups for other couple types – 20-32, 32-54 and 55-60
- *education level*, by five groups for (1,1) couples: 1) both partners left school aged 19+; 2) the man left school aged 19+ and the woman aged <19; 3) the woman left school aged 19+ and the man aged <19; 4) the man left school aged 17 or 18 and the woman aged <19; and 5) the man left school aged <17 and the woman aged <19; by four groups for other couple types: 1) both partners left school aged 19+; 2) either of the partners left school aged 19+; 3) either of the partners left school aged 17 or 18 but no one left school aged 19+; 4) both left school aged <17
- *residence*, by two groups – either living in London/South East or not

[12] Note that in this case we would ideally want to use a double-integral over wage distributions of the man and the woman. This is done for example in van Soest's (1995) structural model. Such an approach would, however, require k^2 number of final net incomes for (0,0) couples. Given the already high computational intensity of the model we decided to draw pairs of wages only *k* times.

- *children*, by three groups – no children, one or two children, three children or more
- *age of youngest child*, by two groups – have a child aged 0-4 or not
- *disability*, by two groups – either of the partners is disabled or none of the partners disabled.

4. Simulating a policy change

The methodology developed in this paper is intended as a tool for policy analysis in which the key area of interest is the simulation of the employment effects of changes to taxes and benefits. In section 6 we present the results of simulating the effects of the introduction of the WFTC in 1999, holding all other aspects of the tax and benefit system constant. The policy simulation involves the following stages:

i) calculating expected transition probabilities (for example from non-employment to employment) using the original financial incentive variables on which the model is estimated (i.e. using the 'base' tax and benefit system);

ii) replacing the financial incentive variables with incentives calculated using a 'reformed' tax and benefit regime (i.e. incentives after the introduction of a reform, such as the WFTC) and calculating the expected transition probabilities using the new financial incentive variables; and

iii) with the two sets of expected transition probabilities, calculating the expected number of individuals in various employment states under the two regimes. The difference between these is the employment effect of the simulated reform.

Using the estimated model coefficients from the transition equations we produce a vector of predicted probabilities corresponding to potential employment states for each benefit unit:

$$\hat{\Pi}_{iB}^{E}(X_i, Y_{iB}^{E}(\varsigma_B, w_i^*, \hat{h}_i)) \tag{18}$$

where X_i is a vector of individual characteristics included in the model and Y_{iB}^{E} is a vector of incomes in *'E'* employment states for individual/couple *'i'* (for whom we predicted employment hours $\hat{h}_i$ and wages w_i^* (two of these in the case of couples)) using the base tax system ς_B. Such a vector of probabilities can also be calculated using financial incentives from the reformed tax and benefit system, ς_R:

$$\hat{\Pi}_{iR}^{E}(X_i, Y_{iR}^{E}(\varsigma_R, w_i^*, \hat{h}_i)) \tag{19}$$

The difference in these predicted probabilities between the base and reform tax and benefit systems represents the effect of the reform on this particular individual/couple. The effect of the reform on transition probabilities can be represented as:

$$\begin{pmatrix} \hat{\Pi}_{iB}^{E=j} \\ . \\ . \\ \hat{\Pi}_{iB}^{E=J} \end{pmatrix} - \begin{pmatrix} \hat{\Pi}_{iR}^{E=j} \\ . \\ . \\ \hat{\Pi}_{iR}^{E=J} \end{pmatrix} = \begin{pmatrix} \Delta\hat{\Pi}_{i}^{E=j} \\ . \\ . \\ \Delta\hat{\Pi}_{i}^{E=J} \end{pmatrix} \tag{20}$$

where $\sum_j \Delta\hat{\Pi}_i^{E=j}$ is zero.

These sample-level estimates are then grossed up to the population level using FRS grossing factors, which are matched to the LFS in the same way as financial incentives. This procedure compensates for any attrition in the LFS sample.

4.1 Short- and long-term effects of labour market reforms

The initial results from the policy simulation give the predicted changes in transition rates between labour market states over the same period that the data is taken from, i.e. over one year, from the 1st to the 5th quarter of the LFS. These results are unlikely to be comparable with simulations from structural models since unlike the latter they are unlikely to correspond to long-run equilibrium effects of policies. The most natural notion of equilibrium in our transitions approach is that of a state in which the number of persons entering and exiting employment is the same. Using this definition we can derive such labour market equilibriums under base and reform financial incentive levels and the difference in employment levels between these could be treated as the full equilibrium policy effect.

This approach relies on two assumptions:

1) that equilibrium can be generated as a result of a Markov transition process, i.e. that the observed transition rates between employment states in the most recent period of the initial data are 'equilibrium' rates, such that in the absence of changes to financial incentives, they would persist indefinitely into the future (and are not affected by moves of individuals in and out of employment); and

2) that changes in financial incentives induced by policy changes will produce a *permanent* change in transition rates.

The Markov transition-process assumption is rather strong, as it implies that compositional changes do not affect the transition rates. Nevertheless, as can be seen in the policy simulation presented in section 6.4 (and as other simulations using the model confirm), the equilibrium is reached very quickly (after only about 5-6 iterations), which in our view makes the assumption weaker and justifies our approach.

The remainder of this section shows how these assumptions can be used to derive long-run equilibrium stocks of persons in different labour market states, and the effects of changes in financial incentives on those long-run stocks.

4.1.1 Calculations for single persons

Denoting the (grossed up) stock of working single persons at time t as W_t^s, the stock of non-working persons as U_t^s and the total stock of (working age) single persons as N_t^s, changes in the stocks of the employed and non-employed over each time period are captured by the formulae:

$$W_{t+1}^s = (W_t^s \times (1 - \Pr(exit_{t+1}))) + (U_t^s \times \Pr(enter_{t+1})) \tag{21}$$

$$U_{t+1}^s = (U_t^s \times (1 - \Pr(entry_{t+1}))) + (W_t^s \times \Pr(exit_{t+1})) \tag{22}$$

where $\Pr(exit_{t+1})$ is the probability that a person who is single leaves work by time (*t+1*) conditional on their being in work at time (*t*), and $\Pr(entry_{t+1})$ is the probability that a single person enters work by time (*t+1*) conditional on their not being in work at time (*t*). If we assume that the total working age population of singles, N_t^s, is stable over time, we can define long-run equilibrium employment as $W_t^s = W_{t+k}^s = W_*^s$, for all k, and likewise for U_*^s and N_*^s. The probabilities of entry and exit, $\Pr(entry_*)$ and $\Pr(exit_*)$, are also constant over time in this equilibrium. The long-run stocks can be calculated according to the formula:

$$W_*^s = (W_*^s \times (1 - \Pr(exit_*))) + ((N_*^s - W_*^s) \times \Pr(entry_*)) \tag{23}$$

which rearranges to:

$$W_*^s = \frac{N_*^s \times \Pr(entry_*)}{\Pr(exit_*) \times \Pr(entry_*)}, \tag{24}$$

with $U_*^s = N_*^s - W_*^s$.

In the policy simulation, a tax and benefit reform R produces a new set of entry and exit predictions (call them $\Pr(entry_*^R)$ and $\Pr(exit_*^R)$). These are plugged into equation (25) to produce new long-run employment predictions.

4.1.2 Calculations for couples

For couples, the formulae are more complicated owing to the fact that we are analysing transitions to and from four labour market states rather than two, but the basic principle is the same. Denoting the stocks at time (t) as

WW_t^c = stock of couples with both partners working;

WU_t^c = stock of couples with a man working and woman not working;

UW_t^c = stock of couples with a man not working and woman working;

UU_t^c = stock of couples with both partners not working; and

the total couples population as $N_t^c = WW_t^c + WU_t^c + UW_t^c + UU_t^c$, we have four transition probabilities from each original employment state E_t^c:[13]

$$\Pr(WU_{t+1}^c \mid E_t^c)$$
$$\Pr(UW_{t+1}^c \mid E_t^c)$$
$$\Pr(UU_{t+1}^c \mid E_t^c)$$
$$\Pr(WW_{t+1}^c \mid E_t^c) \tag{25}$$

[13] In the bivariate probit each of these probabilities is derived from the individual transition probabilities of the two partners.

Using this notation, the number of two-earner couples at time (*t+1*) can therefore be calculated as in the equation:

$$\begin{aligned} WW_{t+1}^{c} &= (WW_{t}^{c} \times (\Pr(WW_{t+1}^{c} \mid WW_{t}^{c})) + (WU_{t}^{c} \times \Pr(WW_{t+1}^{c} \mid WU_{t}^{c}) + \\ &+ (UW_{t}^{c} \times \Pr(WW_{t+1}^{c} \mid UW_{t}^{c}) + (UU_{t}^{c} \times \Pr(WW_{t+1}^{c} \mid UU_{t}^{c}) \end{aligned} \tag{26}$$

where the first term on the right-hand side is the number of couples who remain two-earner couples at time (*t*), the second and third terms are the number of couples moving from one earner to two-earner couples, and the third term represents the number of couples moving from no-earner to two-earner couples. In a similar way we can calculate the number of couples at time (*t+1*) in each of the four employment states.

For the long-run changes, the notational conventions for the stocks are as for single persons, e.g. $WW_{t}^{c} = WW_{t+k}^{c} = WW_{*}^{c}$. The equilibrium transition probabilities are denoted as $\Pr^{*}(WW \mid UU) = \Pr(WW_{t+k+1}^{c} \mid UU_{t+k}^{c})$ for all *k*, and likewise for all 16 transition probabilities. The equations for the long-run stocks for the example of two-earner couples are:

$$\begin{aligned} WW_{*}^{c} &= (WW_{*}^{c} \times \Pr^{*}(WW \mid WW)) + (WU_{*}^{c} \times \Pr^{*}(WW \mid WU)) + \\ &+ (UW_{*}^{c} \times \Pr^{*}(WW \mid UW)) + (UU_{*}^{c} \times \Pr^{*}(WW \mid UU)) \end{aligned} \tag{27}$$

and similarly we can derive the long-run equilibrium stocks for the other employment states. The fact that there are four labour market states involved for couples instead of the two that we have for singles means that the long-run stocks of couples in each labour market state cannot be directly computed analytically; however, it is easy to calculate the long-run equilibrium stocks iteratively.

4.1.3 Estimating the significance of the employment effects using a bootstrap procedure

From the point of view of the policy-maker it is important to know whether the simulated employment effects are statistically significant once we account for the precision of estimation. We do this by bootstrapping the simulated employment response. Each estimation results in a vector of coefficients $\hat{\beta}$ and an estimate of the variance-covariance matrix $\hat{\Omega}$. To account for the precision of estimation, the simulations need to use not only the mean values of $\hat{\beta}$, but also the information contained in $\hat{\Omega}$. Simulation bootstrapping relies on repeating the reform simulation K number of times (where K is at least several hundred), each time with a different set of coefficients $\hat{\beta}^{k}$, where

$$\hat{\beta}^{k} = \hat{\beta} + \varepsilon_{k}^{\hat{\Omega}} \tag{28}$$

Each $\hat{\beta}^{k}$ is a sum of the estimated vector of coefficients and a vector of estimation errors drawn with replacement from the estimation error distribution with mean zero and variance-covariance matrix $\hat{\Omega}$. With a large number of draws from this distribution and a corresponding number of simulations, the distribution of simulated employment response will allow the determination of confidence intervals on the simulations and identify the statistically significant effects.

5. Data for estimation

The modelling process relies on the use of two datasets: the LFS the FRS. This section presents some information on the datasets and the basic descriptive statistics. We begin with the description of the definition of 'disability' used in this study and the comparison of disability information as reported in the two data sources.

5.1 Definition of disability

We rely on two sources of data on disability to identify disabled persons. These are:

1) data on self-reported work-limiting disability status; and

2) data on the receipt of any disability-related benefits.

Defining disability in this way ensures that:

- The definition is consistent across the two datasets – both datasets include questions on work-limiting disability and on benefit claim.
- Information on which the disability definition is based does not directly relate to employment status, so the definition covers those in and out of work.
- The 'disabled' defined in this way include all claimants of disability benefits; this is important from the perspective of reform simulations and ensures that any modelled reform to disability benefits will only affect individuals who are defined as 'disabled' in the model.

Table 4 presents some basic information on the proportion of disabled persons in the FRS and the LFS. Depending on the dataset and the precise definition, this proportion varies between about 16% and 18%.

Table 4. Disabled persons in the LFS and FRS samples (%)

Data year	Share of persons who report limitations concerning the amount or type of work they do		...and/or claim disability benefits	
	FRS sample	**LFS sample**	**FRS sample**	**LFS sample**
1999-00	15.5	16.7	17.0	17.9
2000-01	16.5	16.7	18.0	17.8
2001-02	15.1	16.5	16.6	17.7
2002-03	15.7	18.4	17.3	19.5
Total	15.7	17.1	17.2	18.2

Sources: Authors' calculations on the basis of the FRS 1999-00 to 2002-03 and the LFS Spring 1999 to Winter 2002 (only the final wave from each survey); complete samples; fiscal (FRS) years correspond to waves: spring-winter in the LFS.

Turning to the data on benefit receipt, we would expect that since the eligibility criteria for all disability benefits include a form of disability test, most individuals claiming disability benefits would have limitations in terms of the type or amount of work they can do. This is not always the case, however. Having a disability benefit claim does not always correspond to an affirmative answer to questions concerning work limitations. To ensure the consistency of the study's definition of disability we thus extend our definition of disability to also include the benefit claimants who say they are not limited in the amount or type of work they can (could) do. The difference between columns 2 and 4 (for the FRS) and columns 3 and 5 (for the LFS) in

Table 4 is the proportion of persons who claim a disability benefit and yet do not declare work-limiting disability in the FRS and LFS samples respectively.

Self-reported disability may be problematic owing to the endogeneity of the response to this question with respect to labour market status, as documented in earlier work on this issue (e.g. Parsons, 1982 and Bound, 1991). From a purely analytical point of view, it would have been better to use an objective measure of disability, based for example on a medical test, but such information does not exist in the data available to us. Nevertheless, the questions on which we base the disability definition are asked of all surveyed individuals and are not directly linked to work status. Moreover, as we saw above, the modelling of disability-related financial incentives is largely based on the disability-benefit claim information actually reported in the data, which should ensure that the financial incentives arising through disability-related benefits and tax credits are handled correctly in the modelling process.

5.2 Sample selection

The following selection criteria have been applied to the LFS and FRS samples. In the LFS and the FRS we exclude:

- full-time students;
- observations with key information missing or inconsistent;
- the self-employed;
- individuals aged less than 20 and more than 55;[14] and
- individuals who change their marital/co-habiting status between times (*t-1*) and (*t*) in the LFS panel.

The FRS data covers the years 1999-2000 to 2002-03. Corresponding to this is an LFS dataset from spring 1998 to winter 2002. In the LFS we only use the observations for which we have information from wave 1 (corresponding to (*t-1*) in the model) and wave 5 (corresponding to (*t*) in the model).

5.3 Employment transitions in the LFS

One of the key issues addressed in this paper is the examination of employment transitions by disability status. Here we present entry and exit rates from the LFS for those who are and who are not disabled at time (*t-1*) by marital status, gender, age and whether or not they have children. Note that at this stage this is purely descriptive.

The LFS data presented in Table 5 confirm that individuals who are disabled are less likely to enter the labour market if they are not employed and are more likely to exit a year after being observed as an employee. The entry rate among disabled women is four times lower than among non-disabled women, and disabled men are eight times less likely to enter work than non-disabled men. Exit rates are about three times higher for disabled persons than for non-disabled persons. Exit rates of men are lower for those living in couples, while entry rates are slightly higher for single men than for those living in couples. Entry rates are higher for single women than for women in couples. Having a child reduces entry and increases labour market exit. As

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[14] Age restrictions are slightly different for the intermediate models, which also include individuals over the age of 55 and still of working age (i.e. younger than 64 for men and 60 for women). This improves the identification of the models. Including individuals close to retirement age makes the identification of the effect of financial incentives on transitions very difficult, given that the FRS does not allow us to model the financial incentives individuals encounter to retire early (because, for example, it contains little information on the prospective pension arrangements of those who are not retired).

far as age effects are concerned, it is generally the case that labour market mobility reduces with age – individuals in higher age groups have a lower probability of entering and lower probability exiting.

Table 5. Entry and exit rates by gender, age, family characteristics and disability status (%)

	Total	Men	Women
Exit			
Overall exit rate	3.44	4.03	2.70
Age group 20-30	4.05	4.77	3.14
Age group 31-42	3.27	4.07	2.32
Age group 53-54	3.09	3.32	2.79
Disabled	8.83	9.85	7.65
Non-disabled	3.11	3.69	2.39
Single individuals	4.12	4.18	4.05
Individuals in couples	3.05	3.94	1.97
Have children	4.02	4.90	3.07
Entry			
Overall entry rate	18.93	21.89	17.22
Age group 20-30	29.26	38.07	24.22
Age group 31-42	17.39	18.78	16.79
Age group 53-54	11.66	12.74	10.79
Disabled	5.67	5.37	5.95
Non-disabled	28.92	43.56	23.29
Single individuals	19.42	22.61	16.75
Individuals in couples	18.36	20.45	17.62
Have children	16.78	19.62	16.27

Source: Authors' calculations on the basis of the LFS Spring 1999 to Winter 2002 (panels starting from spring 1998 to spring 1999 and ending at winter 2001 to winter 2002).

6. Results

In this section we present details of the estimation and simulation results from what we judge to be the best specification of the model. The results include both the singles and the couples models and simulations are conducted separately for singles and couples and then jointly for the whole sample (see section 4.2). As above we conduct a simulation bootstrap to check the statistical significance of the predicted employment effects. To account for the disability status of individuals in the sample the models include a set of disability controls. This is important to better understand how disability affects employment but also to minimise the effect of endogeneity of disability status with respect to employment. We allow for different responses to financial incentives by non-disabled persons without children, non-disabled persons with children and the disabled.

Given better identification and higher precision of the estimated coefficients and of the simulated employment effects we impose *a priori* restrictions in terms of which financial incentive variables enter the model. Each partner's entry and exit can be directly influenced solely by income in the *(t-1)* employment state and in the state in which s/he can move, assuming the other partner remains in the original state. Indirectly, however, the move is also determined by the financial incentives the other partner faces in the alternative to which s/he can move between *(t-1)* and *(t)*.

In section 6.1 we present a list of variables included in the regressions for single persons and couples. A summary of the results is presented in section 6.2, while the appendix contains details of the estimations. Finally, in section 6.3 we present the results of policy simulations using the model. The simulations include an exercise whereby we simulate the employment response to a small net income change (the same for all individuals and couples). This facilitates greater understanding of the sensitivity of various groups of individuals to changes in financial incentives that are implied by the model. Given the nonlinear nature of the models, the degree of this sensitivity is difficult to judge purely on the basis of estimated coefficients or marginal effects. As noted in the introduction, the policy reform we choose to simulate using our model is the introduction of the WFTC.

6.1 Regressors in the transition models

For single persons we include financial incentive variables in the form of logarithms of predicted income in work and out of work. Income measures are split into separate regressor variables in order to allow differential effects of financial incentives by three categories of individuals:

- disabled persons (denoted as D in the results presented in Tables 7-10);
- non-disabled persons with children (denoted as C, ND); and
- non-disabled persons without children (denoted as NC, ND).

Apart from the financial incentive variables, the preferred specification for single individuals uses the regressor variables listed in Table 6. It is important to stress here that, following Gregg, Johnson & Reed (1999), we exclude education controls from the transition models. This decision follows from difficulties involved with identifying the model when education information enters transition equations, which most probably derives from a very high correlation of net incomes and education level. This in a sense implies an exclusion restriction. Education in the model determines the financial incentive variables, but is then assumed not to affect transitions. The same assumption was made in the original Gregg, Johnson & Reed (1999) model.

The models for couples include essentially the same control variables as those listed in Table 6, but in the case of each partner's equation in the bivariate probit we include controls for the characteristics of the other partner. For example, in each of the equations we control for the age and the disability status of both the man and the woman. In each equation we have a variable for the net income in the employment state at time (*t-1*) and then net income in the employment state that results from the entry or exit of the respective partner. Because we allow for differentiated responses to financial incentives (as in the singles' model), each equation contains six financial incentive variables.

Table 6. Regressors in the transition models

Age	Linear, squared and cubic terms
Disability status	Because disability status can change across LFS waves, we include indicator variables for each combination of individual disability at LFS wave 1 (t-1) and at LFS wave 5 (t). That is, taking non-disability at (t-1) and (t) as the base category, we have dummies for: ▪ not disabled at (t-1), disabled at (t); ▪ disabled at (t-1), not disabled at (t); and ▪ disabled at (t-1) and at (t).
Disability type	We control for the type of disability by including two dummies for the health problem that affects the individual most: ▪ mental disability; and ▪ sight/hearing/speech impediment. We also include a dummy for receipt of the DLA at time (t-1) as a proxy control for severity of disability.
Number and ages of children	We include indicator variables for: ▪ having a child at all or not; ▪ having two or more children; ▪ presence of a child aged less than 5; and ▪ presence of a newborn baby.
Other dummy variables	We include indicator variables for: ▪ data years; ▪ being a woman; ▪ being a woman and having a child; ▪ living in London/South East; ▪ being unemployed as defined by the International Labour Organisation (ILO) at (t-1) (entry model only); and ▪ being ILO long-term unemployed at (t-1) (entry model only).

Source: Authors' data.

6.2 Major findings in the final specification of the transition models for singles

This section discusses the main findings from the estimations of the transition models for single persons. The results are summarised in Table 7 below.

6.2.1 The singles' entry model

The left-hand column of Table 7 shows the results from estimating the model on a sample of single persons who were unemployed or inactive in the labour market at LFS wave 1, where the dependent variable is entry into work by LFS wave 5 – the 'entry model'.

Table 7. Main model results: Single persons

Regressors	Entry equation (dependent variable: work entry)			Exit equation (dependent variable: work exit)		
	Coeff.	**s.e.**		**Coeff.**	**s.e.**	
Year 2000	-0.0131	(0.0516)		-0.1103	(0.0426)	**
Year 2001	0.0079	(0.0533)		-0.1048	(0.0432)	**
Year 2002	0.0584	(0.0534)		-0.0480	(0.0419)	
Age	-0.2500	(0.0921)	***	-0.1232	(0.0782)	
Age squared	0.0063	(0.0026)	**	0.0022	(0.0022)	
Age cubed	-0.0001	(0.0000)	**	0.0000	(0.0000)	
Has a child	0.1537	(0.1740)		-0.4618	(0.1670)	***
Has 2+ children	-0.1026	(0.0834)		0.0853	(0.1040)	
Has child aged <5	-0.2653	(0.0644)	***	0.2317	(0.0799)	***
Newborn	-0.2180	(0.1456)		0.6095	(0.1531)	***
Woman with a child	0.2869	(0.1357)	**	-0.0835	(0.1121)	
Woman without a child	0.1770	(0.0585)	***	-0.2458	(0.0413)	***
Lives in London/SE	0.0591	(0.0438)		0.0330	(0.0377)	
Disabled (t-1, t)	2.0264	(1.1562)	*	-2.1688	(0.8990)	**
Disabled (t) only	1.9628	(1.1559)	*	-1.8977	(0.8935)	**
Disabled (t-1) only	0.2862	(0.0836)	***	0.0194	(0.0906)	
Mental dis. (t-1)	-0.2324	(0.0863)	***	0.3725	(0.1270)	***
Sight/hearing/speech dis. (t-1)	-0.0150	(0.1594)		-0.2419	(0.1419)	*
DLA receipt (t-1)	-0.3323	(0.1016)	***	-0.0547	(0.1433)	
ILO unemployed (t-1)	0.7960	(0.0469)	***	–	–	
LTU (t-1)	-0.6670	(0.0645)	***	–	–	
Ln (inc 0) NC, ND	-0.3780	(0.1336)	***	0.0535	(0.1460)	
Ln (inc 1) NC, ND	0.6287	(0.1577)	***	-0.1833	(0.1164)	
Ln (inc 0) C, ND	-1.0526	(0.3751)	***	0.7864	(0.2025)	***
Ln (inc 1) C, ND	1.1940	(0.3649)	***	-0.7150	(0.1885)	***
Ln (inc 0) D	-0.3907	(0.1905)	**	0.8275	(0.1355)	***
Ln (inc 1) D	0.1219	(0.2490)		-0.2943	(0.1459)	**
Constant	0.8359	(1.1326)		0.9898	(0.8620)	
No. observations	8878			23108		
Log likelihood	-2955.74			-3887.15		

*** significant at 1%; ** significant at 5%, * significant at 10%

Notes: Ln (inc 0) – log income out of work; LN (inc 1) – log income at work; NC – does not have children, ND – not disabled (at t), D – disabled (at t); LTU – long-term unemployed; FI – financial incentives

Mental disability (at (t-1)) is either depression/bad nerves/anxiety or mental illness/phobia/panics/nervous disorders

Sight/hearing/speech disability (at (t-1)) is either difficulty with sight, hearing or speech impediment

Source: Authors' calculations.

If movements into work are more likely among individuals with larger gains to work (other things being equal), then we would expect to find the coefficients on the income out-of-work (inc 0) variables to be negative (because higher out-of-work income is likely to be negatively correlated with the propensity to enter work), and that the coefficient on income in-work (inc 1) variables should be positive (individuals are more likely to enter work if their income in work is higher). In Table 7, this pattern exists for all three groups (disabled, non-disabled parents and non-disabled non-parents), although the coefficient on financial incentives in work is not statistically significant for disabled persons. The age coefficients imply that there is a negative relationship between age and the propensity to enter work, but the relationship is non-linear. Single persons aged below 30 are notably more likely to enter work, other things being equal, than those aged over 30. Between the ages of 30 and 50 the probability of entering work is roughly constant, but above 50 it falls quite sharply. The variables of having a child and having more than two children are not statistically significant, which suggests that most of the effects of children on work entry are captured by the different financial incentives encountered by parents, and the fact that parents respond differently to financial incentives than non-parents. Having a child *aged under five* is, however, significantly negatively related to work entry even after controlling for financial incentives. The indicator for being a woman shows that, other things being equal, single women are more likely to enter work than single men, particularly if they have children. This may reflect the fact that the employment rate of lone mothers was increasing relative to other groups in the labour market over this period.

The indicators for disability indicate, perhaps surprisingly, that disabled single persons are *more* likely to enter work than non-disabled single persons controlling for other factors (including the impact of financial incentives in the out-of-work state, which is more negative for the disabled than the non-disabled. Still, these dummies are only marginally statistically significant with the exception of disability at (*t-1*). In this case, however, it is plausible that someone who was disabled at (*t-1*) and is not at time (*t*) may be more likely to enter than someone who is not disabled at both the periods.[15] The dummy variable for mental disability suggests that individuals with mental disabilities are less likely to enter work. Similarly, those who receive the DLA at (*t-1*) are also less likely to be in work at (*t*). The unemployed as defined by the International Labour Organisation (ILO) are, unsurprisingly, more likely to enter employment, although the effect is smaller for those who have been jobless for more than a year at (*t-1*).

6.2.2 The singles' exit model

The most right-hand column of Table 7 gives the results from a probit equation estimated on the sample of single persons in work at LFS wave 1, where the dependent variable is leaving work by LFS wave 5 – the 'exit model'.

In the exit equation, we would expect the financial incentive variables to have the opposite sign to what we would expect in the entry equation. That is, we would expect the coefficients on the inc 1 (income in work) variables to be negative and the coefficients on inc 0 to be positive. As with the entry model, this is what we do find, but the effects are only statistically significant for disabled persons and non-disabled persons with children.

The relation between age and exit probability, conditional on other factors, is much weaker than it was for the entry model. The linear age term is significant (and negative) only at the 10% level, and the quadratic and cubic terms not at all. Having a child is negatively associated with leaving work conditional on other factors, but having a child aged 5 or under is *positively* associated with leaving work, as is having a baby born between wave 1 and wave 5 of the LFS. Women without children are significantly less likely to leave work than men without children, conditional on other factors.

In terms of the impact of disability variables, the disability dummies themselves are positive and statistically significant. Yet individuals who declared mental disability as their main health problem at (*t-1*) are more likely to exit work between (*t-1*) and (*t*), while those who have problems with sight, hearing or speech problems are less likely to exit than other disabled persons. This is an interesting and important finding. It may reflect the fact that persons who

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[15] This type of relationship would of course be observed if disability was endogenous to work status (which we suspect is the case).

have such problems enjoy some special employment protection or when they do find work they put extra effort towards maintaining it. At the same time, the interaction between financial incentives and disability acts to reinforce the effects of financial incentives.

6.3 Major findings in the final specification of the transition models for couples

The discussion of results in this section refers to estimations presented in Tables 8 to 11 below. The couples regressions are estimated by bivariate probit. This means that there are two sets of coefficients in every regression – one for the male partner and one for the female partner. The model also estimates the degree of correlation between the decisions of partners (the statistical significance of this correlation is measured by the statistical significance of either 'rho' or 'arthrho', the latter being a transformation of rho used in the estimation).

6.3.1 Transitions of individuals in (0,0) couples

Table 8 shows the results for the model for couples wherein neither partner is in work in LFS wave 1 (time (*t-1*)). We now have six sets of coefficients on the financial incentive variable: disabled, non-disabled parents and non-disabled non-parents, for men and women separately.

If individuals are more likely to enter work when the financial reward is greater, then we would intuitively expect a negative coefficient on the (0,0) incomes, and positive coefficients on the (1,0) or (0,1) incomes. In fact, we find this pattern only for disabled men, disabled women and non-disabled mothers, and the coefficients on financial incentive variables are only statistically significant for disabled men.

Men who are disabled in both LFS waves or only in the later LFS wave are less likely to enter work than other groups. On top of this, men with partners who are disabled in both LFS waves are less likely to enter work. This may be because of caring responsibilities for the partner, for example. Women who are disabled in both waves are less likely to move into work than other women, but the man's disability does not affect the woman's work entry to any measurable extent. The severity of disability as measured by the DLA-receipt indicator variable is negatively related to men's entry.

Having a child aged less than five and a newborn baby is associated with being less likely to move into work for women. The other children variables are not significant for either men or women once financial incentives are taken into account. Interestingly, women in couples in this starting state are less likely to move into work by wave 5 if they live in London or the South East, conditional on other factors.

The model confirms an intuitive association of unemployment with the probability to enter. Being ILO unemployed (i.e. looking for work and being prepared to take a job) is positively correlated with entry for both men and women. Remaining unemployed for over a year, however, reduces the probability of entering relative to the other unemployed. Finally, we find a positive and statistically significant correlation between the labour market decisions of partners. A positive correlation in this model indicates that there is a tendency for both partners to want to choose the same labour market status.

6.3.2 Transitions of individuals in (0,1) couples

Table 9 shows the results of the couples model for the group in which the man was not working in LFS wave 1, but the woman was – i.e. starting state (0,1). This is the least common of the four starting states for a couple, so sample sizes are small and the coefficients are not precisely estimated. We also suspect that this group contains a number of cases whereby the man in the couple has been temporarily displaced from work, which should be borne in mind when analysing the results.

Table 8. Results for couples – Neither working at wave 1 (0,0)

	Men entry			Women entry		
Year 2000	0.1816	(0.1415)		0.0738	(0.1603)	
Year 2001	0.4613	(0.1443)	***	0.1729	(0.1654)	
Year 2002	-0.0108	(0.1572)		0.3267	(0.1607)	**
Age, M	-0.2514	(0.3574)		0.4195	(0.4416)	
Age squared, M	0.0067	(0.0096)		-0.0095	(0.0116)	
Age cubed, M	-0.0001	(0.0001)		0.0001	(0.0001)	
Age, W	-0.2622	(0.3128)		-0.1131	(0.3431)	
Age squared, W	0.0071	(0.0087)		0.0020	(0.0095)	
Age cubed, W	-0.0001	(0.0001)		0.0000	(0.0001)	
Disabled, M (t-1, t)	-0.6370	(0.1730)	***	-0.1866	(0.2664)	
Disabled, M (t only)	-0.6859	(0.2375)	***	0.1061	(0.3113)	
Disabled, M (t-1 only)	0.2607	(0.2335)		-0.2742	(0.3416)	
Disabled, W (t-1, t)	-0.4222	(0.1810)	**	-0.7862	(0.2032)	***
Disabled, W (t-1 only)	-0.5137	(0.2800)	*	0.2192	(0.2383)	
Disabled, W (t only)	-0.2540	(0.2195)		-0.3473	(0.2302)	
Mental dis. M (t-1)	-0.3977	(0.3078)		0.0370	(0.2439)	
Mental dis. W (t-1)	-0.0148	(0.2415)		0.0536	(0.3061)	
Sight/hearing/speech dis. M (t-1)	0.2619	(0.4078)		0.0199	(0.4789)	
Sight/hearing/speech dis. W (t-1)	–	–		0.4992	(0.6308)	
DLA receipt M (t-1)	-0.9763	(0.3939)	**	0.1192	(0.1841)	
DLA receipt W (t-1)	0.1429	(0.1976)		-0.1734	(0.2958)	
Children (one or two)	-0.0395	(0.1801)		-0.3062	(0.2166)	
Children three+	0.0911	(0.2329)		-0.4782	(0.2887)	*
Have child aged <5	0.1163	(0.1652)		-0.2003	(0.1941)	
Newborn	-0.0891	(0.2245)		-0.9897	(0.4608)	**
Live in London/SE	0.0739	(0.1406)		-0.3145	(0.1757)	*
ILO unemployed M (t-1)	1.0170	(0.1324)	***	0.2743	(0.1711)	
LTU, M (t-1)	-0.8157	(0.1439)	***	-0.2895	(0.1825)	
ILO unemployed W (t-1)	0.1767	(0.1844)		0.7400	(0.1796)	***
LTU, W (t-1)	-0.0762	(0.3888)		-0.5148	(0.3709)	
Ln(inc 0,0) ND, NC	-0.2285	(0.4762)		0.0893	(0.7605)	
Ln(inc 0,1) ND, NC	–	–		-0.1672	(0.7801)	
Ln(inc 1,0) ND, NC	-0.0841	(0.4694)		–	–	
Ln(inc 1,1) ND, NC	–	–		–	–	
Ln(inc 0,0) D	-1.1987	(0.3829)	***	-0.2796	(0.6777)	
Ln(inc 0,1) D	–	–		0.1271	(0.7008)	
Ln(inc 1,0) D	0.7902	(0.3865)	**	–	–	
Ln(inc 1,1) D	–	–		–	–	
Ln(inc 0,0) ND, C	-0.1878	(0.2948)		-0.3753	(0.3928)	
Ln(inc 0,1) ND, C	–	–		0.2998	(0.4853)	
Ln(inc 1,0) ND, C	-0.1421	(0.3157)		–	–	
Ln(inc 1,1) ND, C	–	–		–	–	
Constant	7.0525	(4.5473)		-4.2530	(5.7147)	
Athrho	0.4296	(0.0949)	***	–	–	
Rho	0.4050	–		–	–	
No. observations	1502			–	–	
Log likelihood	-681.04			–	–	

Notes for Tables 8-11: *** significant at 1%; ** significant at 5%; * significant at 10%; Ln (inc 0,0) – log income when both partners are out of work; Ln (inc 0,1) – log income when only women are working; Ln (inc 1,0) – log income when only men are working; Ln (inc 1,1) – log income when both partners work;

NC – no children, ND – not disabled (at t); D – disabled (at t) is disability defined on the level of the couple (i.e. disabled if at least one partner disabled);

Disability type defined using information on the health problem that affects the person most: mental disability (at (t-1)) is either depression/bad nerves/anxiety or mental illness/phobia/panics/nervous disorders; sight/hearing/speech disability (at (t-1)) is either difficulty with sight, hearing or speech impediments;

LTU – long-term unemployed; M – man; W – woman; Rho – measure of correlation between the men's and the women's equations; Athrho – a transformation of rho, which is used in the estimation of bivariate probit

Source: Authors' calculations.

Table 9. Results for couples – Woman only working at wave 1 (0,1)

	Specification 2					
	Men entry			Women exit		
Year 2000	-0.0221	(0.1426)		0.2160	(0.2020)	
Year 2001	-0.0298	(0.1559)		0.3681	(0.2042)	*
Year 2002	-0.0612	(0.1578)		0.3258	(0.2115)	
Age, M	-0.7146	(0.6349)		0.4189	(0.7547)	
Age squared, M	0.0157	(0.0157)		-0.0084	(0.0190)	
Age cubed, M	-0.0001	(0.0001)		0.0001	(0.0002)	
Age, W	0.3147	(0.4724)		-0.6102	(0.5898)	
Age squared, W	-0.0074	(0.0124)		0.0142	(0.0156)	
Age cubed, W	0.0001	(0.0001)		-0.0001	(0.0001)	
Disabled, M (t-1, t)	-0.3995	(0.2870)		0.0079	(0.3185)	
Disabled, M (t only)	-0.5653	(0.3843)		0.7414	(0.4019)	*
Disabled, M (t-1 only)	0.0277	(0.2436)		-0.6203	(0.5239)	
Disabled, W (t-1, t)	0.2210	(0.2459)		1.0863	(0.2403)	***
Disabled, W (t-1 only)	0.0159	(0.2815)		0.4041	(0.3109)	
Disabled, W (t only)	0.2897	(0.2705)		0.9327	(0.2637)	***
Mental dis. M (t-1)	-0.4832	(0.3286)		-0.1187	(0.3467)	
Mental dis. W (t-1)	0.1611	(0.5350)		0.4626	(0.5393)	
Sight/hearing/speech dis. M (t-1)	-0.7610	(0.4494)	*	–	–	
Sight/hearing/speech dis. W (t-1)	0.2227	(0.5408)		-0.4536	(0.6689)	
DLA receipt M (t-1)	-0.5129	(0.2430)	**	0.0008	(0.2241)	
DLA receipt W (t-1)	0.1076	(0.5380)		0.5044	(0.4756)	
Children (one or two)	0.0470	(0.1732)		-0.5422	(0.2335)	**
Children three+	0.1615	(0.2800)		-0.5648	(0.3621)	
Have child aged <5	-0.6367	(0.2234)	***	0.0089	(0.2864)	
Newborn	0.7412	(0.3890)	*	0.2535	(0.4376)	
Live in London/SE	0.1305	(0.1394)		-0.0278	(0.1884)	
ILO unemployed M (t-1)	1.1174	(0.1265)	***	0.2498	(0.1976)	
LTU, M (t-1)	-0.7283	(0.1810)	***	0.4056	(0.2390)	*
Ln(inc 0,0) ND, NC	–	–		0.5188	(0.5099)	
Ln(inc 0,1) ND, NC	-0.8731	(0.5073)	*	0.1931	(0.4999)	
Ln(inc 1,0) ND, NC	–	–		–	–	
Ln(inc 1,1) ND, NC	0.8615	(0.5385)		–	–	
Ln(inc 0,0) D	–	–		0.3652	(0.3719)	
Ln(inc 0,1) D	-1.1339	(0.4484)	**	0.3555	(0.3983)	
Ln(inc 1,0) D	–	–		–	–	
Ln(inc 1,1) D	0.9771	(0.4708)	**	–	–	
Ln(inc 0,0) ND, C	–	–		1.4183	(0.5474)	**
Ln(inc 0,1) ND, C	0.6046	(0.4335)		-0.5539	(0.4737)	
Ln(inc 1,0) ND, C	–	–		–	–	
Ln(inc 1,1) ND, C	-0.5415	(0.4786)		–	–	
Constant	6.1298	(8.0064)		-3.3222	(9.7262)	
Athrho	-0.1337	(0.1116)		–	–	
Rho	-0.1329	–		–	–	
No. observations	1014			–	–	
Log likelihood	-594.04			–	–	

Notes: See notes for Table 8.

Source: Authors' calculations.

If individuals are more likely to enter work and less likely to leave work, the larger is the pay-off from working; thus we would expect the coefficients on the financial incentive variables to be positive on the income (1,1) state for men and on the income (0,0) state for women, and to be negative on the income (0,1) state for men and on the income (0,1) state for women. We find this pattern for three of the six groups: disabled men, non-disabled mothers and non-disabled non-parent men; the financial incentive variables are only statistically significant for disabled men and non-disabled mothers.

Analysis of the age variables shows that they are not a significant determinant of either men's entry into work or women's work exit. Neither partner's labour market transitions are affected by the woman's age.

The disability of women is positively related to their exit, and partners of disabled men only in period (*t*) are also more likely to exit work. Men with sight, speech or hearing problems and those receiving the DLA are less likely to enter employment, as are those with a child aged less than 5 (though men with a newborn baby are in fact more likely to enter employment). Conditional on other factors, women's exit probability is lower for those with children.

The correlation between the labour market decisions of partners is negative, but not statistically significant. A negative correlation in this model indicates that there is a tendency for both partners to want to choose the same labour market status.

6.3.3 Transitions of individuals in (1,0) couples

Table 10 gives results for the case in which the couples' starting state is (1,0) – i.e. the man in the couple is in work but the woman is not at LFS wave 1. This is far more common in the data than the starting state (0,1).

If individuals are more likely to enter work, and less likely to leave work, the larger is the pay-off from working; thus in this model we would expect the coefficients on the financial incentive variables to be positive on the income (1,1) state for women and on the income (0,0) state for men, and to be negative on the income (0,1) state for women and on the income (0,1) state for men. This pattern can be found for disabled men and women, non-disabled fathers and women who are neither disabled nor parents; the financial incentive variables are significantly different from zero, although only for the disabled men and women.

It is only for men that the disability dummies for disability at both (*t-1*) and (*t*) and disability at (*t*) are statistically significant and have the expected signs. For women, disability at both periods (*t-1*) and (*t*) and at period (*t*) is negatively correlated with entry while disability at period (*t-1*) is only positively correlated with entry. Women's severe disability, as measured by the receipt of DLA at (*t-1*) is negatively correlated with entry. Having small children is also negatively correlated with women's propensity to enter employment.

The correlation between partners' decisions is negative but not statistically significant. Thus again the correlation between partners' decisions indicates that there is a tendency for both partners to want to choose the same labour market status.

6.3.4 Transitions of individuals in (1,1) couples

Finally, Table 11 gives the results for the case in which the couples' starting state is (1,1) – i.e. both the man and woman are working in LFS wave 1. If couples are less likely to leave work because they receive a large financial reward for working, then the coefficients on (1,1) income should be negative and the coefficients on the other income states should be positive. We observe this pattern for disabled men and women, mothers and non-disabled women without children, and they are significantly different from zero for disabled men and women and non-disabled women without children.

Table 10. Results for couples – Man only working at wave 1 (1,0)

	Specification 2					
	Men exit			**Women entry**		
Year 2000	-0.0586	(0.0874)		-0.0152	(0.0532)	
Year 2001	-0.0346	(0.0900)		-0.0534	(0.0566)	
Year 2002	0.0338	(0.0866)		-0.0943	(0.0565)	*
Age, M	-0.3274	(0.2751)		0.0935	(0.1946)	
Age squared, M	0.0081	(0.0072)		-0.0025	(0.0050)	
Age cubed, M	-0.0001	(0.0001)		0.0000	(0.0000)	
Age, W	-0.3616	(0.2372)		0.1219	(0.1617)	
Age squared, W	0.0083	(0.0064)		-0.0030	(0.0044)	
Age cubed, W	-0.0001	(0.0001)		0.0000	(0.0000)	
Disabled, M (t-1, t)	0.6341	(0.1395)	***	-0.2830	(0.1612)	*
Disabled, M (t only)	0.7600	(0.1415)	***	-0.1233	(0.1559)	
Disabled, M (t-1 only)	0.2572	(0.1666)		0.0315	(0.1217)	
Disabled, W (t-1, t)	0.0317	(0.1539)		-0.7750	(0.1621)	***
Disabled, W (t-1 only)	0.2522	(0.1635)		0.1881	(0.1051)	*
Disabled, W (t only)	0.2218	(0.1745)		-0.6804	(0.1764)	***
Mental dis. M (t-1)	-0.0972	(0.3887)		0.1504	(0.3421)	
Mental dis. W (t-1)	0.1358	(0.1729)		-0.1567	(0.1591)	
Sight/hearing/speech dis. M (t-1)	-0.4223	(0.3370)		0.1468	(0.1897)	
Sight/hearing/speech dis. W (t-1)	–	–		-0.2535	(0.2375)	
DLA receipt M (t-1)	0.3954	(0.3442)		0.4473	(0.3812)	
DLA receipt W (t-1)	-0.1249	(0.1478)		-0.2748	(0.1369)	**
Children (one or two)	-0.0176	(0.1351)		0.0243	(0.1059)	
Children three+	0.1246	(0.1687)		-0.0343	(0.1170)	
Have child aged <5	0.0259	(0.0962)		-0.3734	(0.0556)	***
Newborn	-0.0663	(0.1532)		-0.4888	(0.1046)	***
Live in London/SE	-0.0369	(0.0776)		-0.0165	(0.0471)	
ILO unemployed W (t-1)	0.0956	(0.1078)		1.0854	(0.0598)	***
LTU, W (t-1)	-0.3428	(0.3462)		-0.4660	(0.1601)	***
Ln(inc 0,0) ND, NC	-0.3126	(0.2427)		–	–	
Ln(inc 0,1) ND, NC	–	–		–	–	
Ln(inc 1,0) ND, NC	0.2116	(0.2167)		-0.8268	(0.5906)	
Ln(inc 1,1) ND, NC	–	–		0.8968	(0.5919)	
Ln(inc 0,0) D	0.4051	(0.1894)	**	–	–	
Ln(inc 0,1) D	–	–		–	–	
Ln(inc 1,0) D	-0.3319	(0.1782)	*	-0.8100	(0.4713)	*
Ln(inc 1,1) D	–	–		0.9225	(0.4820)	*
Ln(inc 0,0) ND, C	0.2489	(0.1642)		–	–	
Ln(inc 0,1) ND, C	–	–		–	–	
Ln(inc 1,0) ND, C	-0.2025	(0.1332)		0.1447	(0.4148)	
Ln(inc 1,1) ND, C	–	–		-0.0334	(0.4565)	
Constant	7.1186	(3.0618)	**	-3.6480	(2.2202)	
Athrho	-0.0290	(0.0499)		–	–	
Rho	-0.0290	–		–	–	
No. observations	6069			–	–	
Log likelihood	-3539.65			–	–	

Notes: See notes for Table 8.

Source: Authors' calculations.

Table 11. Results for couples – Both working at wave 1 (1,1)

	Men exit			Women exit		
Year 2000	-0.0259	(0.0537)		-0.0141	(0.0409)	
Year 2001	-0.1122	(0.0571)	**	0.0330	(0.0416)	
Year 2002	0.0114	(0.0548)		0.0195	(0.0422)	
Age, M	-0.3024	(0.1933)		0.1431	(0.1514)	
Age squared, M	0.0079	(0.0050)		-0.0035	(0.0039)	
Age cubed, M	-0.0001	(0.0000)		0.0000	(0.0000)	
Age, W	-0.0642	(0.1629)		-0.0194	(0.1247)	
Age squared, W	0.0005	(0.0043)		-0.0005	(0.0034)	
Age cubed, W	0.0000	(0.0000)		0.0000	(0.0000)	
Disabled, M (t-1, t)	0.7309	(0.1457)	***	0.1653	(0.1120)	
Disabled, M (t only)	0.6724	(0.1490)	***	0.2259	(0.1171)	*
Disabled, M (t-1 only)	0.1312	(0.1051)		0.0600	(0.0816)	
Disabled, W (t-1, t)	-0.0839	(0.1420)		0.7823	(0.1178)	***
Disabled, W (t-1 only)	-0.1244	(0.1328)		0.1509	(0.0886)	*
Disabled, W (t only)	0.1780	(0.1395)		0.7105	(0.1212)	***
Mental dis. M (t-1)	0.5738	(0.2138)	***	0.0100	(0.2668)	
Mental dis. W (t-1)	0.0376	(0.2762)		0.4792	(0.1500)	***
Sight/hearing/speech dis. M (t-1)	-0.2147	(0.1785)		0.0383	(0.1317)	
Sight/hearing/speech dis. W (t-1)	–	–		-0.1572	(0.1910)	
DLA receipt M (t-1)	0.3868	(0.2484)		0.3954	(0.2529)	
DLA receipt W (t-1)	0.2044	(0.2532)		-0.0915	(0.1731)	
Children (one or two)	0.0551	(0.0892)		-0.2094	(0.0856)	**
Children three+	0.0835	(0.1187)		-0.0651	(0.1014)	
Have child aged <5	0.1277	(0.0687)	*	0.4058	(0.0446)	***
Newborn	0.0380	(0.1085)		0.4911	(0.0536)	***
Live in London/SE	-0.0708	(0.0492)		0.0915	(0.0353)	**
Ln(inc 0,0) ND, NC	–	–		–	–	
Ln(inc 0,1) ND, NC	-0.0360	(0.3050)		–	–	
Ln(inc 1,0) ND, NC	–	–		0.9749	(0.4280)	**
Ln(inc 1,1) ND, NC	0.0470	(0.3097)		-0.9623	(0.3990)	**
Ln(inc 0,0) D	–	–		–	–	
Ln(inc 0,1) D	0.8358	(0.2320)	***	–	–	
Ln(inc 1,0) D	–	–		0.9253	(0.3160)	***
Ln(inc 1,1) D	-0.7334	(0.2312)	***	-0.9123	(0.3040)	***
Ln(inc 0,0) ND, C	–	–		–	–	
Ln(inc 0,1) ND, C	-0.0407	(0.2456)		–	–	
Ln(inc 1,0) ND, C	–	–		0.3020	(0.2970)	
Ln(inc 1,1) ND, C	0.0331	(0.2191)		-0.2829	(0.2914)	
Constant	2.5656	(2.1636)		-2.7938	(1.7068)	
Athrho	0.1644	(0.0390)	***	–	–	
Rho	0.1629	–		–	–	
No. observations	25121			–	–	
Log likelihood	-6285.30			–	–	

Notes: See notes for Table 8.

Source: Authors' calculations.

Disability is positively correlated with exit for both men and women. Those who have a mental disability are also more likely to exit than other disabled persons. The presence of children primarily affects women's propensity to leave work; yet while having a small child or a newborn baby increases the probability of exit, having children seems to reduce the probability of exit conditional on other characteristics. Women living in London or the South East are more likely to leave employment.

The correlation between the labour market decisions of partners is positive and statistically significant. A positive correlation in this model indicates that there is a tendency for both partners to want to choose the same labour market status.

6.4 Simulating a policy change using the final version of the model

The model specifications presented above are employed below to simulate the effects of introducing the WFTC as it was implemented in October 1999. The WFTC increased the generosity of in-work support for families with children in the UK by increasing the maximum values of support individuals could apply for and reducing the withdrawal taper of the transfer. As with its predecessor, the Family Credit, the WFTC was conditional on at least 16 hours of paid employment per week worked by at least one adult in the family and on net family income.[16] The reform also included changes to the generosity of childcare support and increases in in-work support for disabled persons (the Disabled Persons' Tax Credit), which are modelled in our approach.

We begin this section with a simulation exercise aimed at a better understanding of the degree of responsiveness to financial incentives by different groups of individuals and couples. This is done by comparing entry and exit rates in response to £1 changes in incomes in and out of work. Such an exercise can be useful for understanding how the model operates, since all individuals and all couples are treated in the same way (regardless of whether they have children or are disabled, and regardless of their net income) and therefore compositional effects are not so important for changes by group. We thus simulate changes in transition probabilities when weekly income in and out of work changes by £1 (approximately €1.47).[17]

The results of these simulations, conducted on the 2001 FRS/LFS data, are presented in Table 12. The table shows several important conclusions that can be drawn on the basis of the model. First, the overall effect of changes in financial incentives out of work is much stronger for single persons than for those in couples. This also applies to changes in income in work with the exception of its effect on the exit rate of men in couples. In the last case the effect is about twice the size of the effect on single men. As far as responsiveness to changes in income by age group is concerned, this generally seems to be strongest for younger individuals.

The difference in responsiveness between disabled and non-disabled persons is greatest for the effect of changes in out-of-work income on the exit rate. A £1 change in net income out of work changes the exit rate of disabled persons by 0.084 of a percentage point (about 1% of the

[16] For details of the reform see Blundell et al. (2000), Myck (2000) or Myck et al. (2006).

[17] In the case of couples this is slightly more complex and changes in income depend on the original employment state the couple is in at (*t-1*), and on the restrictions imposed in the estimation. For couples (0,0) the change in income in work implies a £1 change in both (1,0) and (0,1) incomes and the change in income out of work implies a £2 change (£1 per person) in (0,0) income. For couples (0,1) the change in income in work implies a £2 change in (1,1) income and a £1 change in (0,1) income, and the change in income out of work implies a £2 change in (0,0) income and £1 change in (0,1) income. Similarly for couples (1,0) the change in income in work implies a £2 change in (1,1) income and a £1 change in (1,0) income, and the change in income out of work implies a £2 change in (0,0) income and £1 change in (1,0) income. For couples (1,1) the change in income in work implies a £2 change in incomes in both (1,1) and the change in income out of work implies a £1 change in (1,0) and (0,1) incomes.

baseline exit rate), while it changes the exit rate of non-disabled persons by 0.011 of a percentage point (0.4% of the baseline exit rate). Interestingly, although the effect of a change in income in work on exit rates in terms of percentage point changes is also greater for the disabled as a percentage of the baseline exit rates it is the same for the disabled and non-disabled.

Table 12. Transition responsiveness – Effect of increasing income in and out of work by £1

	Total	**Men**	**Women**
Grossed-up population	20,991,000	10,743,000	10,248,000
Exit sample	16,387,000	9,072,000	7,315,000
Entry sample	4,604,000	1,671,000	2,933,000
Disabled in exit sample	835,000	454,000	381,000
Disabled in entry sample	1,991,000	965,000	1,026,000
Singles in exit sample	6,015,000	3,354,000	2,662,000
Singles in entry sample	2,510,000	1,156,000	1,354,000
EXIT (in %)			
Overall exit rate	3.25	3.89	2.45
Age group 20-30	3.74	4.42	2.88
Age group 30-42	3.15	4.07	2.05
Age group 43-54	2.94	3.22	2.57
Disabled	8.45	9.09	7.70
Non-disabled	2.97	3.62	2.16
Single individuals	3.74	3.72	3.77
Individuals in couples	2.96	4.00	1.70
£1 out-of-work effect on exit rates			
Overall exit rate	0.015	0.016	0.014
Age group 20-30	0.016	0.017	0.016
Age group 30-42	0.015	0.017	0.012
Age group 43-54	0.014	0.014	0.013
Disabled	0.094	0.103	0.083
Non-disabled	0.011	0.011	0.010
Single individuals	0.021	0.017	0.027
Individuals in couples	0.011	0.015	0.006
£1 in-work effect on exit rates			
Overall exit rate	-0.008	-0.010	-0.005
Age group 20-30	-0.009	-0.010	-0.007
Age group 30-42	-0.008	-0.010	-0.005
Age group 43-54	-0.008	-0.011	-0.004
Disabled	-0.022	-0.028	-0.015
Non-disabled	-0.007	-0.009	-0.005
Single individuals	-0.009	-0.006	-0.013
Individuals in couples	-0.008	-0.013	-0.001
ENTRY (in %)			
Overall entry rate	18.94	22.61	16.85
Age group 20-30	29.02	38.67	23.23
Age group 30-42	17.48	18.86	16.89
Age group 43-54	12.04	13.70	10.76
Disabled	5.74	5.38	6.09
Non-disabled	29.01	46.17	22.65
Single individuals	18.98	22.51	15.97
Individuals in couples	18.89	22.82	17.61

Table 12. Continued

£1 out-of-work effect on entry rates			
Overall entry rate	-0.064	-0.097	-0.045
Age group 20-30	-0.108	-0.148	-0.084
Age group 30-42	-0.045	-0.085	-0.027
Age group 43-54	-0.050	-0.069	-0.035
Disabled	-0.041	-0.053	-0.029
Non-disabled	-0.086	-0.158	-0.057
Single individuals	-0.096	-0.099	-0.094
Individuals in couples	-0.027	-0.093	-0.004
£1 in-work effect on entry rates			
Overall entry rate	0.036	0.035	0.037
Age group 20-30	0.063	0.064	0.063
Age group 30-42	0.032	0.033	0.032
Age group 43-54	0.018	0.016	0.021
Disabled	0.010	0.009	0.010
Non-disabled	0.057	0.071	0.052
Single individuals	0.057	0.044	0.067
Individuals in couples	0.012	0.015	0.011

Note: Effects on entry and exit rates are presented as percentage point changes relative to the baseline rates.

Source: Authors' calculations.

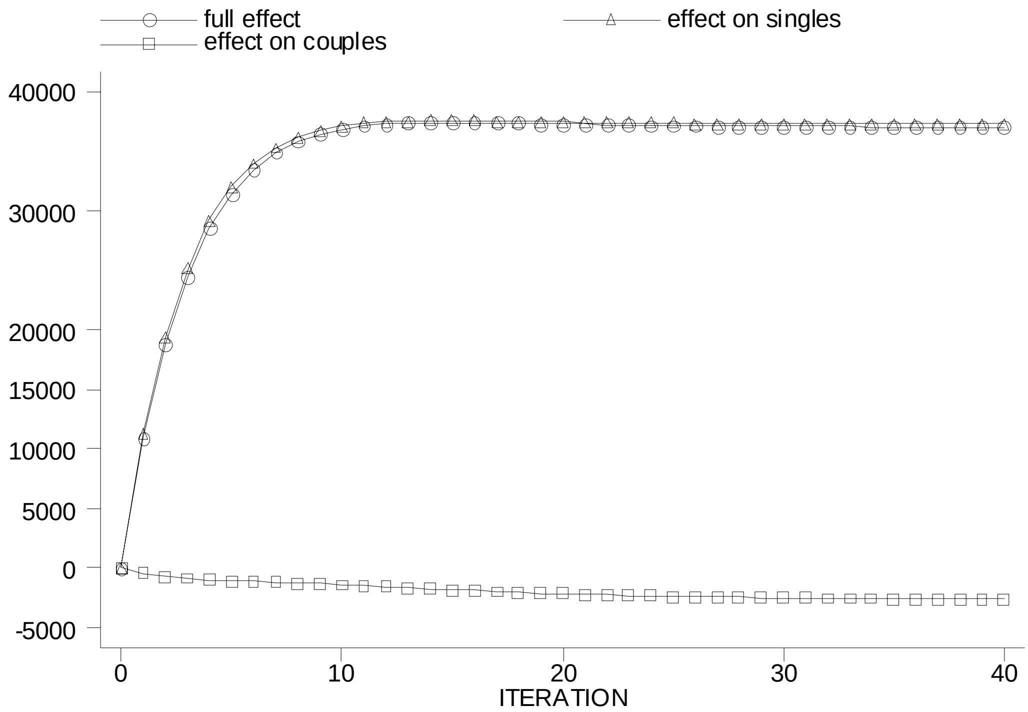
As far as the effect of changes in income out of work on work entry is concerned, the percentage point changes suggest that non-disabled persons are more responsive than disabled persons. A £1 change in net income out of work reduces the entry rate by 0.041 of a percentage point for disabled persons and by 0.086 for the non-disabled. On the other hand a £1 change in income in work increases the entry probability for disabled persons by 0.010 and of non-disabled persons by 0.057 of a percentage point. Yet if we take the effect on entry rates relative to the baseline entry rates, we find that out-of-work income has a greater negative effect on the entry rate of disabled persons, and the effect of a £1 change in in-work income is almost the same for the disabled and non-disabled population.

The above results suggest that fiscal policy targeted at the disabled should be conducted with great care if it is to provide the correct set of incentives for disabled persons. It seems that changes in out-of-work income may have very strong negative effects on the employment of disabled persons, while changes in in-work income may not be sufficient to induce a significant employment response among individuals with disabilities.

Employment effects of introducing the WFTC

The estimated long-run change in the employment effect from introducing the WFTC is an increase of around 37,000 and this figure is statistically and significantly different from zero. On average, employment falls for couples, but rises for single persons (i.e. lone parents): when equilibrium effects are calculated separately for singles and couples (see section 4.2), we find that the WFTC increases employment among lone parents by about 37,000, while reducing employment among couples by about 3,000. The latter figure comes from a rise in employment among married/cohabiting men (+600) and a fall among married/cohabiting women (-3,300), although neither of these figures are statistically and significantly different from zero. To put this into perspective, in 1999 when the WFTC was introduced there were about 1.6 million lone parents in the UK (of whom around 50% were working) and about 5.3 million couples with dependent children (of whom around 95% had at least one earner in work.). In Figure 1 we show the path of the long-run equilibrium employment effect of the reform. The convergence path is presented separately for single persons and couples and also for the entire sample.[18] We can see that the long-run equilibrium effect is reached quickly, after about ten iterations.

Figure 1. Employment effect of the WFTC reform



Source: Authors' calculations.

In Table 13 we present some more detailed breakdowns of the simulated short-run effects. The top part of the table presents the grossed-up 1999-00 sample on which the simulation is run. The table then shows exit rates, the effect of the WFTC reform on exit rates, entry rates and the effect of the reform on the probability to enter. All the results are shown separately for men and women and together for the whole sample, and are split by age group and disability status. The WFTC reduces exits among lone parents, but increases exits among parents in couples. Overall, the exit rate among parents falls by about 0.024 of a percentage point, and the fall is concentrated among the younger part of the population. Exit rates rise among disabled persons, probably because working disabled parents are most likely to be living in couples.

Nevertheless, the WFTC increases the probability of entry for almost all groups of parents we consider. It is negative only for disabled mothers in couples. The overall entry rate increases by 0.4 of a percentage point and the increase is much higher for women. This is to a large extent determined by the fact that the probability of entry among single mothers increases by 1 percentage point from 12.6% to 13.5%. Among individuals in couples the increase in the probability of entry is higher for fathers.

[18] The two separate convergence paths do not have to sum to the path generated for the full sample (see section 4.4.2 for details).

Table 13. Effect of the introduction of the WFTC on entry and exit rates of individuals with children

	Total	**Men**	**Women**
Grossed-up population	9,054,000	3,838,000	5,216,000
Exit sample	6,536,000	3,433,000	3,103,000
Entry sample	2,517,000	405,000	2,113,000
Disabled in exit sample	353,000	179,000	174,000
Disabled in entry sample	745,000	238,000	506,000
Lone parents in exit sample	667,000	55,000	612,000
Lone parents in entry sample	892,000	36,000	857,000
EXIT (in %)			
Overall exit rate	4.12	4.99	3.16
Age group 20-30	6.89	8.41	5.55
Age group 30-42	3.94	5.15	2.71
Age group 43-54	3.27	3.52	2.90
Disabled	8.85	9.62	8.06
Non-disabled	3.85	4.73	2.87
Single parents	8.31	6.89	8.44
Couples	3.64	4.96	1.86
Effect of WFTC reform on exit rates			
Overall exit rate	-0.024	0.018	-0.071
Age group 20-30	-0.105	-0.002	-0.195
Age group 30-42	-0.013	0.030	-0.057
Age group 43-54	-0.012	0.006	-0.037
Disabled	0.044	0.047	0.040
Non-disabled	-0.028	0.017	-0.078
Single parents	-0.419	-0.292	-0.431
Couples	0.021	0.024	0.017
ENTRY (in %)			
Overall entry rate	16.66	18.31	16.35
Age group 20-30	17.17	23.43	16.62
Age group 30-42	17.51	20.21	17.05
Age group 43-54	13.44	13.87	13.22
Disabled	6.39	6.49	6.34
Non-disabled	20.98	35.23	19.50
Single parents	12.40	6.77	12.64
Couples	19.00	19.42	18.88
Effect of WFTC reform on entry rates			
Overall entry rate	0.361	0.124	0.407
Age group 20-30	0.585	0.229	0.616
Age group 30-42	0.303	0.133	0.333
Age group 43-54	0.146	0.071	0.183
Disabled	0.024	0.093	-0.008
Non-disabled	0.503	0.169	0.537
Single parents	0.936	0.486	0.955
Couples	0.046	0.089	0.033

Notes: Only individuals with children; reform effects presented as percentage point changes in probability to enter or exit.

Source: Authors' calculations.

7. Conclusions

A change of government in the UK in 1997 led to a series of reforms to the system of in-work and out-of-work transfer payments for individuals on low incomes with children or disabilities (or both). The consequent introduction of the Working Families' Tax Credit and the Disabled Persons Tax Credit in 1999 provides an ideal changed policy environment for using microeconometric modelling to estimate labour supply responses to changes in the financial incentives encountered by individuals and couples. In this paper we have developed a semi-structural model of labour supply and demonstrated its usefulness with regard to simulating tax and benefit reforms, using data from a period in the UK in which the system of support for disabled and non-disabled persons underwent considerable change as a result of reforms introduced by the Labour government. We have addressed the question of how one can include disabled persons in a labour supply model and explicitly account for differences in financial incentives between the disabled and non-disabled populations. The methodology we present considers important features of the labour market, such as the fixed cost of work and the take-up of benefits, and takes advantage of observed labour market dynamics to identify the factors determining labour market behaviour. We have also presented methodologies for assigning financial incentives to individuals with disabilities and we hope these can be applied in other labour market studies. Although the methods are computationally intensive, it seems that the gain in terms of precision from calculating financial incentives for disabled persons justifies their use.

Our estimations suggest that financial incentives are important determinants of labour market transitions, for both single persons and those living in couples. The effect of financial incentives could be more precisely estimated for single persons than for couples, which could stem from the more complex nature of labour market decisions among the latter. The models also suggest that financial incentives play a greater role among individuals with children and among the disabled than for non-disabled persons without children. We find that in several models the coefficients on financial incentives for non-disabled persons without children are not statistically significant. The estimated correlations among partners in couples suggest that partners tend to choose the same employment states. From the point of view of policy-making it is important to stress the difference in responsiveness to changes in the out-of-work income between disabled and non-disabled persons. The first group are much more likely to react to changes in out-of-work income (in terms of both increases in the exit probability and reductions in the entry probability). On the other hand, the responsiveness to changes in income in work is (proportionally) almost the same for disabled and non-disabled individuals.

This paper has also presented the results of a simulation on tax and benefit reform using the model. The simulated results of the WFTC reform are broadly in line with other results from the labour supply literature (Blundell et al., 2000, Blundell & Reed, 2000 and Brewer et al., 2003). The introduction of the WFTC increases employment by 37,000. In a simulation exercise in which we changed net incomes by £1 per week for all individuals and couples we found an important difference in the responsiveness to changes in income in and out of work between disabled and non-disabled persons. The results suggest that policies other than increasing financial incentives in work should be considered if the government wants to increase the participation of disabled persons in the labour market.

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Appendix

Modelling financial incentives – Benefit claim scenarios in TAXBEN

This appendix outlines the methodology for computing financial incentives. Because disability benefits in the model are allocated on the basis of the actual benefit receipt reported in the LFS, the number of scenarios under which we calculate incomes in the FRS needs to correspond to different observed combinations of benefit claim in the LFS.

The need to distinguish between incomes with and without certain disability benefits in the LFS implies that for each disabled person and each scenario we have to calculate incomes under two assumptions: assuming that the person receives the benefit and assuming that s/he does not receive it. Moreover, since some benefits can be and are claimed jointly we also need to consider the possibility of the joint claiming of benefits.

To explain how the methodology works let us consider an example. Let us say that we want to assign financial incentives to a person who is disabled and is recorded in the LFS as claiming DLA in both periods (*t-1*) and (*t*). Since incomes are calculated in the FRS and then transferred to the LFS as group averages to represent the financial incentives of this person correctly we need the average for this group to include the DLA. This can be achieved by calculating incomes for all individuals in the group and making them all eligible for the DLA. Of course if it is the case that in the LFS we also have a person who does not claim the DLA and belongs to the same 'income' group, then for all individuals in the group we also need to calculate incomes assuming that none of the group members claims the DLA.

Tables A1 and A2 show the number of options for which we calculate incomes for single persons and couples respectively. For persons with children we calculate incomes in 51 scenarios for couples and 16 scenarios for singles. Some necessary simplifications had to be made to limit the computational intensity. For example, for couples we calculate the DLA in scenarios in which only the man receives it (although incomes with the DLA are then allocated taking into account the actual claim of both partners). In order to be able to implement the full extended model with take-up equations for the WFTC (in line with the methodology presented in section 2) for families with children we also calculate incomes assuming zero take-up of the WFTC. These incomes are then used to calculate the expected value of the WFTC given the WFTC take-up equations.

Incomes in 16 scenarios for singles and 51 scenarios for couples are calculated for all benefit units in the FRS samples. We then calculate group averages for all these incomes and move them across to the LFS. Depending on reported benefit-claim data in the LFS, individuals in the LFS (and thus in the final transitions model) are assigned income with the disability benefits they are recorded as receiving. Because we calculate net incomes with and without disability benefits for all persons in the FRS 'disabled' groups, the group average should accurately reflect the difference between net income with and without the modelled disability benefits. The method also includes WFTC take-up modelling, which is done separately for each of the scenarios in which single individuals or couples can claim the WFTC (with or without other benefits). As in the original model the WFTC take-up modelling stage takes place before matching incomes with the LFS, but this time it is done several times for each potential employment state (in different disability-benefit claim scenarios).

With all this computational intensity on the FRS/TAXBEN side, it is really important to allocate the appropriate income to the individuals and couples in the LFS to correctly reflect the financial incentives the individuals encounter. As outlined in the paper, the allocation of incomes in the LFS is made conditional on:

- receipt of disability benefits in period (*t*);
- employment state at period (*t-1*); and
- employment state at period (*t*).

Table A1. Modelling incomes with disability benefits – Singles

Scenario	Working/not working	DLA	IB	DPTC
1	No	No	No	No
2	Yes, no childcare subs.	No	No	No
3*	Yes, with childcare subs.	No	No	No
4	Yes, no childcare subs.	No	No	Yes
5*	Yes, with childcare subs.	No	No	Yes
6	No	Yes	No	No
7	Yes, no childcare subs.	Yes	No	No
8*	Yes, with childcare subs.	Yes	No	No
9	Yes, no childcare subs.	Yes	No	Yes
10*	Yes, with childcare subs.	Yes	No	Yes
11	No	No	Yes	No
12	No	Yes	Yes	No

Notes: For families with children in scenarios marked with * we calculate incomes also under the assumption of 0% take-up of WFTC. The incomes with and without WFTC are then used to calculate the expected value of the WFTC in the WFTC take-up equation. This gives the total of 10 TAXBEN runs for each single individual in the FRS.

Source: Authors' data.

Table A2. Modelling incomes with disability benefits – Couples

Scenario	(Man, woman)			
	Employment status	DLA claim	IB claim	DPTC
1	(0,0)	(0/0)	(0/0)	(0/0)
2*	(0,1)	(0/0)	(0/0)	(0/0)
3*	(1,0)	(0/0)	(0/0)	(0/0)
4	(1,1) (without childcare)	(0/0)	(0/0)	(0/0)
5*	(1,1) (with childcare)	(0/0)	(0/0)	(0/0)
6*	(0,1)	(0/0)	(0/0)	(0/1)
7*	(1,0)	(0/0)	(0/0)	(1/0)
8	(1,1) (without childcare)	(0/0)	(0/0)	(1/0)
9*	(1,1) (with childcare)	(0/0)	(0/0)	(1/0)
10	(0,0)	(1/0)	(0/0)	(0/0)
11*	(0,1)	(1/0)	(0/0)	(0/0)
12*	(1,0)	(1/0)	(0/0)	(0/0)
13	(1,1) (without childcare)	(1/0)	(0/0)	(0/0)
14*	(1,1) (with childcare)	(1/0)	(0/0)	(0/0)
15*	(0,1)	(1/0)	(0/0)	(0/1)
16*	(1,0)	(1/0)	(0/0)	(1/0)
17	(1,1) (without childcare)	(1/0)	(0/0)	(1/0)
18*	(1,1) (with childcare)	(1/0)	(0/0)	(1/0)
19	(0,0)	(1/0)	(1/0)	(0/0)
20*	(0,1)	(1/0)	(1/0)	(0/0)
21*	(0,1)	(1/0)	(1/0)	(0/1)
22*	(1,0)	(1/0)	(0/1)	(0/0)
23*	(1,0)	(1/0)	(0/1)	(1/0)
24	(0,0)	(0/0)	(0/1)	(0/0)
25*	(0,1)	(0/0)	(1/0)	(0/0)
26*	(0,1)	(0/0)	(1/0)	(0/1)
27*	(1,0)	(0/0)	(0/1)	(0/0)
28	(0,0)	(0,0)	(1,0)	(0,0)
29*	(1,0)	(0/0)	(0/1)	(1/0)
30	(0,0)	(1/0)	(1/1)	(0,0)
31	(0,0)	(0/0)	(1/1)	(0,0)

Notes: For employment states, 1 = working and 0 = not working, which are presented above as (head, spouse); for benefit claims, 1 = claims benefit and 0 = does not claim, which are presented as (head/spouse)

For families with children for scenarios marked with * we calculate incomes also under an assumption of 0% take-up of WFTC. The incomes with and without the WFTC are then used to calculate the expected value of the WFTC in the WFTC take-up equation. This gives the total of 28 TAXBEN runs for each couple in the FRS.

Source: Authors' calculations.

A take-up model for the Incapacity Benefit

In assigning financial incentives to disabled persons who are in work at time *t*, incentives in the out-of-work scenario (which may include the IB) cannot be based on reported benefit claims, since the IB is a benefit that is only paid conditional on the claimant being out of work. Although some of the working disabled may be eligible to claim IB when out of work, we cannot observe this potential eligibility in the LFS. To model financial incentives as accurately as possible we propose to calculate incentives in the out-of-work scenario by assuming partial take-up estimated on the basis of an IB take-up model.

For several reasons the standard approach to estimating take-up equations seems unsuitable for the estimation of the IB take-up model. First of all, unlike in the case of the WFTC, in the IB case we do not know if a person is eligible for the IB if he or she were to be out of work. In estimating the WFTC take-up equation the data contains all the characteristics that condition eligibility (number of children, hours worked, savings and income) and the only final condition is income at a certain number of hours worked, which can be estimated. As far as IB eligibility is concerned, self-reported disability status, which is recorded in the data, is *not* a sufficient condition for IB eligibility. IB eligibility requires (for example) being assessed as incapable of work and having paid sufficient NI contributions. For this reason IB eligibility can change even if all of the reported characteristics of a disabled person remain the same. In such circumstances any model of the 'take-up' of Incapacity Benefit will in fact be a joint model of eligibility and take-up.

While for persons observed in the LFS who are out of work we have a record of their IB claim, for those in work we will not have this information. On the basis of observed characteristics alone there is no way of determining the IB eligibility of a person who is currently working if this person were to leave work. We therefore have to infer the joint probability of eligibility and claim from the information available. One way of determining IB eligibility/take-up of a person who is currently working if this person were to leave work would be to look at the probabilities of IB receipt among those out of work conditional on observed characteristics and apply them to the sample of employees. Such an approach would rely on the assumption that there are no systematic differences between those in work and those out of work conditional on observed characteristics. It is highly likely, however, that there are systematic differences between those in and out of work as far as IB eligibility is concerned. This means that a simple probit estimation of IB receipt conditional on observed characteristics will be biased. We therefore propose to use a Heckman corrected-probability model with which we should be able to correct for a potential selection bias if suitable instruments are available.

We use two models of selection-corrected probability of the IB receipt among the disabled population. One estimates the probability of claiming the IB (at time *t*) among those who were out of work at time (*t-1*) and are still out of work at time *t*, and another among those who were working at time (*t-1*) and are out of work at time (*t*). The selection process we wish to control for is therefore leaving the sample of those out of work in the first case, and entering the sample of persons out of work in the second case.

Let us define the dependent variable '*ib*' as 1 if a disabled person receives the IB and 0 if s/he does not:

$$P(ib_{t,i} = 1 \mid disabled_{t,i} = 1, work_{t-1,i} = h, work_{t,i} = 0) = \alpha + \beta X_i + \varepsilon_i \quad \text{for } h\text{=1 or } h\text{=0} \quad \text{(A1)}$$

The variable *ib* is only observed if the person is out of work and we therefore have to define a selection equation:

$$P(work_{t,i} = 0 \mid disabled_{t,i} = 1, work_{t-1,i} = h) = \delta + \lambda Z_i + \nu_i \quad \text{for } h\text{=1 or } h\text{=0} \quad \text{(A2)}$$

If the residuals ε_i and v_i from these two equations are correlated, then the simple probit equation of *ib* on X_i will be biased.

Our *a priori* hypothesis is that disabled persons who enter work are less likely to receive the IB in the out-of-work state, and that disabled persons who leave work are more likely to receive the IB than those who stay employed. We use demographic characteristics, information on home ownership and whether the job at time (*t-1*) was permanent to identify the selection equation.[†]

Table A3 presents results from the two estimations. In both equations selection into the sample (i.e. not being employed and thus potentially eligible for IB) is statistically significant, and those in the sample are more likely to claim the IB than those who are out of the sample at time (*t*), i.e. those who are in work.

Table A3. Results of the IB receipt equation

	If worked at (t-1)			**If did not work at (t-1)**		
	Coeff.	**s.e.**		**Coeff.**	**s.e.**	
IB receipt equation						
Year 2000	-0.0304	(0.0960)		-0.0141	(0.0406)	
Year 2001	0.0944	(0.0971)		0.0903	(0.0405)	**
Year 2002	0.0124	(0.0958)		0.0355	(0.0403)	
Male dummy	0.2919	(0.0760)	***	0.3652	(0.0301)	***
Left school aged 17-18	-0.1558	(0.1030)		0.0275	(0.0466)	
Left school aged 19+	-0.1542	(0.1309)		-0.1397	(0.0555)	**
Age – 16	0.0206	(0.0032)	***	0.0127	(0.0015)	***
Lives in London/SE	-0.3971	(0.0841)	***	-0.0026	(0.0353)	
Married/cohabiting	-0.1340	(0.0772)	*	0.0361	(0.0297)	
Received IB at (t-1)	–	–		2.4890	(0.0345)	***
Constant	-1.4502	(0.2252)	***	-1.8180	(0.0574)	***
Selection equation						
Year 2000	-0.0255	(0.0463)		-0.0176	(0.0528)	
Year 2001	0.0166	(0.0475)		0.0147	(0.0544)	
Year 2002	-0.0746	(0.0458)		-0.0400	(0.0529)	
Male dummy	-0.1677	(0.0339)	***	-0.1258	(0.0403)	***
Left school aged 17-18	-0.1503	(0.0467)	***	-0.0931	(0.0548)	*
Left school aged 19+	-0.2988	(0.0548)	***	-0.0604	(0.0644)	
Age – 16	-0.0491	(0.0076)	***	0.0107	(0.0086)	
Age – 16 squared	0.0012	(0.0001)	***	0.0003	(0.0002)	*
Lives in London/SE	-0.1441	(0.0383)	***	-0.1106	(0.0440)	**
Married/cohabiting	-0.1091	(0.0391)	***	-0.1922	(0.0432)	***
Received IB at (t-1)	–	–		0.5744	(0.0495)	***
Has child aged <5	0.2337	(0.0593)	***	-0.2545	(0.0409)	***
Has three+ children	0.1597	(0.0710)	**	0.0852	(0.0672)	
House owner	0.3546	(0.0616)	***	0.0575	(0.0634)	
Job at (t-1) was temporary	-0.3692	(0.0398)	***	–	–	
Constant	-0.3449	(0.1051)	***	1.2737	(0.1147)	***
Athrho	0.4443	(0.1834)	**	0.5256	(0.2619)	**
Rho	0.4172	(0.1515)		0.4820	(0.2011)	
No. observations	9593			14800		
Uncensored observations	1275			14118		
Log likelihood	-4371.35			-7074.82		

*** significant at 1%; ** significant at 5%; * significant at 10%

Notes: Rho – measure of correlation between the men's and the women's equations; Athrho – a transformation of Rho that is used in the estimation of bivariate probit

Source: Authors' calculations.

[†] The last instrument can only be used for the case in which we estimate the probability of IB receipt among those who were employed at (*t-1*).

REVISER – Research Training Network on Health, Ageing and Retirement

REVISER was launched by several members of the ENEPRI network in August 2003. The project was financed under the programme on Improving the Human Research Potential & the Socio-Economic Knowledge Base of the 5th EU Research Framework Programme.

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- **DIW** (Deutsches Institut für Wirtschaftsforschung), Berlin
- **ETLA** (the Research Institute of the Finnish Economy), Helsinki
- **FEDEA** (Fundación de Estudios de Economía Aplicada), Madrid
- **LEGOS** (Laboratoire d'Economie et de Gestion des Organisations de Santé, Université de Paris-Dauphine), Paris

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This project is coordinated by Jorgen Mortensen, Associate Senior Research Fellow at CEPS. For further information, contact him at: jorgen.mortensen@ceps.be.

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PRAXIS	Center for Policy Studies, Tallinn, Estonia
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