SIMULATING THE REFORM OF MEANS-TESTED BENEFITS WITH ENDOGENOUS TAKE-UP AND CLAIM COSTS

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ISER Working Papers
Number 2004-04
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The support of both the Economic and Social Research Council (ESRC) and the University of Essex is gratefully acknowledged. The work reported in this paper is part of the scientific programme of the Institute for Social and Economic Research.
Acknowledgement: We are grateful to the Economic and Social Research Council for financial support of this research, under project grant R000239105. Material from the Family Resources Survey, made available by the Department for Work and Pensions via the UK Data Archive, has been used with permission. Geraldine Barker and Monica Hernandez provided valuable assistance. All responsibility for the analysis and interpretation of the data presented here lies with the authors. Participants in the NATSEM International Conference on Microsimulation, Canberra, December 2003 made valuable comments.

Readers wishing to cite this document are asked to use the following form of words:


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ABSTRACT

Microsimulation models are commonly used to examine the distributional impact of reforms of the means-tested benefit system. Take-up behaviour is related to the level of entitlement, so reform may induce changes in take-up. We develop a stochastic simulation method and apply it to a probit model of Income Support take-up by British pensioners. The method allows us to adjust net income for the welfare losses due to tangible or intangible claim costs. Endogenous take-up and claim costs both have an important impact on the simulated outcomes of the policy reform.
NON-TECHNICAL SUMMARY

In the UK, means-testing plays a large role in the targeting of welfare benefits on those in need. Examples of means-tested benefits include Income Support, Housing Benefit and Council Tax Benefit, which are only available to those with sufficiently low levels of income and savings. While means-testing is effective in controlling the cost of the benefit system, the necessity to claim one’s entitlement and then meet an income/assets test may deter some low-income households from taking up their entitlements.

Analysis of the impact of a proposed reform of the benefit system is usually done by means of microsimulation models, which examine the financial impact of the reform on a large sample of individual households. Such simulations are most commonly done under very strong assumptions about take-up behaviour (for example, 100% take-up) and they usually make no attempt to quantify the claim costs which prevent people claiming their entitlements.

In this paper, we do four things:

(1) We develop a statistical model of the take-up of Income Support (also known as the Minimum Income Guarantee) by pensioners, using data from the Family Resources Survey from the three tax years 1997-2000. We focus on the group of older pensioners (specifically 1- and 2-pensioner households, with members at least 5 years over state retirement age), who have a relatively high poverty rate. The take-up model demonstrates that the dominant influence on take-up behaviour is the size of the entitlement – people are more likely to claim large amounts than small ones – but it also identifies other important influences.

(2) We develop a method of taking take-up behaviour into account when simulating the impact of a benefit reform, together with a method of constructing confidence intervals to indicate the statistical reliability of the simulation results.

(3) We show how to quantify in cash-equivalent terms, the barriers to take-up (which might include social stigma, the “hassle” of claiming, the difficulty of finding out about the benefit system, etc.). It is then possible to adjust benefit income by subtracting these implicit claim costs to give a measure of income net of claim costs.

(4) We explore a hypothetical benefit reform that replaces the Housing Benefit and Council Tax Benefit systems with a housing allowance addition to Income Support. This new allowance would depend on regional average rents but not on the rent a claimant actually pays. Thus, unlike the present system, there would be no incentive for claimants to expand their housing expenditure at public expense. Using the simulation methods we have developed, we show that take-up behaviour makes a significant difference to the measured impact of the reform on poverty rates and thus to the policy conclusions that would be reached.
1 Introduction

Means-testing is an obvious way of focusing welfare spending on those most in need and therefore of controlling the burden on public finances. One of the drawbacks of means-testing is that people who are entitled to receive welfare benefits may not come forward to claim them and there is evidence that non-take-up of welfare benefits can be very widespread (Department for Work and Pensions, 2004). The take-up issue has been the subject of a great deal of applied research aimed at estimating the incidence and magnitude of claim costs, informational problems and attitudinal barriers to claiming entitlements. The studies by Ashenfelter (1983), Moffitt (1983), Blundell, Fry and Walker (1988), Duclos (1995), Blank and Ruggles (1996), Bollinger and David (1997), Kim and Mergoupis (1997) and Keane and Moffitt (1998) are examples of the development of this literature.

Take-up is not routinely accounted for in the simulation of policies or policy reforms. Frequently, simulations assume 100% take-up (Clark, 2002) and this tends to over-emphasise the efficiency of means-tested benefits in meeting the needs of the poor. In some countries the assumption of complete take-up gives rise to estimates of benefit entitlement that are considerably larger than the receipt that is known from administrative data (Sutherland, 2001). A simple solution is to tie entitlement to observed receipt on a case-by-case basis. This has the advantage of producing results that are easily reconciled with other statistics, but it severely limits the scope of policy changes that the model can simulate. An alternative simple approach is to assume a fixed probability of taking up which depends on personal characteristics but is not affected by changes in the benefit system (Hancock and Sutherland, 1997; Atkinson and Sutherland, 1998). This does capture the advantage of non-means-tested benefits to the extent that they are subject to fewer take-up problems. But it only provides a very approximate guide to the cost and distributional effects of reforms that extend means-testing to new groups or that change the design or level of generosity of the means-tested benefit.

In this paper, we demonstrate the importance of modelling take-up as an endogenous component of a policy simulation model. Take-up behaviour changes in response to changes in benefit entitlements and pre-benefit income. This affects the aggregate cost, the broad distributional effects and the impact of reforms on people in particular situations.
2 Take-up as a factor in policy reform

Our analysis is based on the UK, where there are three main types of state benefits for pensioners: the flat-rate basic state pension, an earnings-related state pension and means-tested benefits. There are also disability-related benefits which are not means-tested.

2.1 State pensions

Most pensioners are entitled to the basic state pension earned through paying National Insurance (NI) contributions during their working lives. At £77.45 a week, a full basic state pension is currently worth 17% of average gross earnings of full-time employees. Pensioners with partial NI contribution records are entitled to a basic state pension at less than this rate. The state earnings related pension scheme (SERPS) was introduced in 1978. Pensioners retiring in 1998/9 were the first cohort who could have earned maximum SERPS pensions, currently equivalent to about 30% of average earnings (Pensions Policy Institute, 2003). However, latest figures show that the average total state pension in payment is only marginally above the full basic state pension rate (Department for Work and Pensions, 2003). Entitlements to SERPS depend on NI contributions and past earnings. It is possible to opt out of SERPS and contribute to a private pension instead. SERPS was replaced with the State Second Pension in April 2002 but the incomes of pensioners who retired before then are not affected by this change.

2.2 Means-tested pensioner benefits

There are three main means-tested social security benefits for pensioners in the UK. During the period under the study they were: Income Support (IS) (subsequently renamed the Minimum Income Guarantee (MIG)) which provides general income maintenance; Housing Benefit (HB) which provides assistance with meeting rents; and Council Tax Benefit (CTB) which reduces recipients’ liabilities for the local Council Tax. In fiscal year 2001/2, 32% of all pensioners and 41% of single pensioners received some means-tested state benefit (Department for Work and Pensions, 2004). IS, CTB and HB suffer from varying degrees of non-take-up. Official estimates are that in 2001/2 33% of pensioners who appeared to be entitled to IS/MIG did not receive it.
Corresponding proportions for CTB and HB were 40% and 14% respectively (Department for Work and Pensions, 2004).

Although the state retirement pension is payable to individuals, means-tested benefits (IS, HB and CTB) are assessed and paid to pensioner units - single pensioners or couples where one or both is a pensioner. Entitlement to IS is zero if the pensioner unit’s capital holdings are above an upper threshold ($8,000 during the period in question). Otherwise it is the difference, if positive, between needs or ‘prescribed amounts’ (which depend on age, disability and whether single or living with a partner) and means or ‘assessable income’ (which is a function of the pensioner unit’s income and capital). Certain kinds of income, such as disability benefits, are excluded in part or in full from assessable income. Actual income from capital is also excluded. Instead a notional income from capital between a lower threshold ($3,000 during our data period) and the upper threshold is assumed at the rate of $1 a week for each $250 or part of $250 of capital between the two limits. For example, someone with capital of $6,000 is deemed to have an income from it of $12 a week (($6,000 - $3,000)/250).

HB and CTB also depend on prescribed amounts and assessable income. Prescribed amounts are calculated in the same way as for IS. However, the upper capital threshold is higher ($16,000) for HB and CTB than for IS. Assessable income therefore includes notional income, calculated as for IS, on capital between $3,000 and $16,000. Pensioners with assessable income at or below their needs are entitled to maximum HB, if they pay rent and/or to maximum CTB if they are liable for council tax. Pensioners entitled to IS are therefore automatically entitled to maximum HB and/or CTB. Subject to restrictions on what counts as eligible rent and council tax, maximum entitlements to HB and CTB cover 100% of these costs. Where assessable income exceeds the prescribed amount, entitlements to HB and CTB are reduced by 65% (HB) and 20% (CTB) of the excess of assessable income over prescribed amounts.

From October 2003 IS for pensioners has been subsumed within the more generous Pension Credit to which about half of all pensioners are expected to be entitled (Department for Work and Pensions, 2001).
2.3 A policy reform

HB is often criticised because it provides little incentive for claimants to move to cheaper housing (Kemp et. al., 2002). The ceilings on eligible rent are considerably above the rents paid by most pensioners. In comparison with the average regional reference rents calculated by Kemp et. al. (2002; table 3.1) for 1999, only 5% of pensioners in private rented accommodation in our 1999 sample have rents that exceed these limits. We investigate a policy reform which addresses this criticism by introducing a rent addition to IS. The rent addition varies by region of residence and household size (1, 2 or 3+ persons) but is not related to the claimant’s actual rent. The policy reform also involves a CTB addition to IS equal to the council tax payable by the claimant. We investigate two variants of the reform. Under variant 1, the existing system of HB and CTB remains available to pensioners who choose not to take-up their IS and to those whose entitlement to IS, under the reformed system, would be less than the sum of their HB and CTB entitlements. For variant 2, HB and CTB are no longer available.

3 Modelling take-up

3.1 Take-up behaviour

We begin with a static one period model of take-up behaviour, based on the following conventional latent regression model:

\[ y^* = z(x, \tau)\alpha + v \]  

where \( y^* \) is an unobservable measure of ‘willingness to claim’, \( z \) is a vector of explanatory variables, whose values depend on basic personal characteristics \( x \) and the rules of the tax-benefit system which are captured by a set of parameters, \( \tau \), of the tax-benefit system; \( \alpha \) is a vector of coefficients and \( v \) is a random disturbance term, normalised to have unit variance. Note that \( z \) will include variables like benefit entitlement, which is directly affected by policy-induced changes in \( \tau \). The vector \( \tau \) will contain things like tax and benefit rates, allowable capital limits, etc. We assume that actual take-up is indicated by the observable variable \( y \), generated as follows:
\[
y = \begin{cases} 
0 & \text{if } y^* \leq 0 \\
1 & \text{if } y^* > 0
\end{cases}
\]  

(2)

The conditional take-up probability is:

\[
\Pr(y = 1 | z) = \Pr(z\alpha + v > 0 | z) = F(z\alpha)
\]

(3)

where \(F(.)\) is the distribution function of the random variable \(-v\). If we use probit, then \(F(.)\) is the standard normal distribution function; if we use logit, then \(F(.)\) is the standard logistic distribution.

### 3.2 Evaluating the welfare costs of means-testing

Imperfect take-up is the consequence of some combination of factors acting as a barrier. There are several possibilities. Welfare dependency may have negative associations through social stigma or loss of self-esteem. There may be substantial costs in terms of the ‘hassle’ required to make and subsequently maintain a claim. Non-take-up may result from imperfect awareness of the existence of the benefit programme or of its provisions. There may be fear of incurring penalties through inadvertent error in completion of the claim form. Whatever the source of these barriers, they can be seen as tangible or intangible claim costs which, in principle, can be evaluated in cash-equivalent terms, using the compensating variation principle. The resulting cash sum can be subtracted from the net income of benefit recipients to give an improved welfare indicator that takes account of the fact that means-testing has its own overhead welfare cost. Pudney et. al., 2003 elaborate this idea further.

In the application reported below, the linear index \(z\alpha\) is specified to include (log) entitlement and a set of other covariates describing the characteristics and circumstances of the household. Write this specification as follows:

\[
y^* = \alpha_1 \ln b + z_2\alpha_2 + v
\]

(4)

where \(b = b(x, \tau)\) is the benefit entitlement under policy regime \(\tau\) and \(z_2\) is the vector containing all other covariates in the probit model; \(\alpha_1\) and
$\alpha_2$ are the corresponding coefficients. Under a rationality assumption, the entitlement will be claimed if it exceeds the implicit claim cost, $c$. In log terms $\ln b < \ln c$ defines take-up. The binary choice model defines the take-up event as $y^* > 0$, which is equivalent to $\ln b > -[z_2\alpha_2 + v]/\alpha_1$. The right hand side of this inequality must therefore be $\ln c$ and thus claim costs actually incurred are:

$$c = \begin{cases} 0 & \text{if } \ln b \leq -[z_2\alpha_2 + v]/\alpha_1 \\ \exp \{-[z_2\alpha_2 + v]/\alpha_1\} & \text{if } \ln b > -[z_2\alpha_2 + v]/\alpha_1 \end{cases} \quad (5)$$

If the random error $v$ could be observed or simulated, this quantity could be subtracted from the net income of benefit recipients to give a claim cost-adjusted welfare measure to use in summarising the effects of policy simulations. We look at ways of doing this in section 4 below.

### 3.3 The effect of a policy change on take-up

A policy change necessarily introduces the issue of dynamic adjustment to altered circumstances and this in turn introduces a distinction between sunk and non-sunk claim costs. In a stationary environment, this distinction is irrelevant: whatever the barriers to take-up, they can be expressed as an equivalent weekly amount using the revealed preference argument of the previous section. However, in a changing environment, it is possible that the sunk nature of claim costs act to reduce the potential claim costs associated with future take-up decisions. For example, suppose that the major barrier to claiming benefit is the onerous nature of the initial claim process but that, once this process is completed all relevant information is available to the programme administrators so that the process of re-assessing entitlement under the reformed programme imposes minimal costs on the claimant. In that case, potential claim costs in the pre-reform world might be high whereas, conditional on participation initially, the cost of maintaining participation post-reform would be small.

Superscripts 0 and 1 indicate the situations before and after a policy change occurs. Assume that the sunk element of claim costs is a fixed pro-
portion of the total. The behavioural structure is as follows:

\[
y^*0 = z^0 \alpha^0 + v^0 \\
y^*1 = z^1 \alpha^1 + \delta y^0 + v^1
\]  

(6)

where:

\[
y' = \begin{cases} 
0 & \text{if } y^*t \leq 0 \\
1 & \text{if } y^*t > 0 
\end{cases} \quad t = 0, 1
\]  

(7)

This implies that the sunk proportion of claim costs is equal to \(1 - e^{-\delta/\alpha_1}\), which varies between 0 for \(\delta = 0\) and 100% for \(\delta = +\infty\).

Without further assumptions, no \textit{ex ante} analysis can be made, since there is no way of knowing how the coefficients \(\alpha^t\) and random disturbances \(v^t\) might be affected by the policy change. To resolve this, make the following assumptions:

- **A1** The policy change is summarised in all relevant detail by the transition \(\tau^0 \rightarrow \tau^1\). Thus \(z^t = z(x, \tau^t)\) for \(t = 0, 1\)

- **A2** The way in which people respond to circumstances is not affected by the policy reform: thus \(\alpha^0 = \alpha^1\)

- **A3** The policy reform does not affect the degree of randomness in take-up behaviour. Thus \(v^1\) and \(v^0\) have the same marginal distributions

In addition we assume either:

- **A4a** The random factor \(v\) is completely unaffected by the policy change. Thus, \(v^0 = v^1\).

or:

- **A4b** The policy change may cause some change in the random disturbance \(v\). Thus \(v^0 \neq v^1\) and \(\text{corr}(v^0, v^1) = \rho\), \(|\rho| < 1\), where \(\rho\) is an assumed or estimated correlation coefficient.

\[\text{This can easily be generalised to allow } \delta \text{ to vary with characteristics } z \text{ but this is unnecessary for our purposes, since we only consider the two extreme cases } \delta = 0 \text{ or } +\infty.\]
Assumptions A4a and A4b are alternative assumptions about the way that random behavioural elements respond to the policy change. It is conceivable, for example, that a shift in policy could induce a change in basic attitudes that varies randomly across individuals. Note that A4a is equivalent to A4b with $\rho = 1$. In our view, the assumption $\rho = 1$ is very plausible, since the random term $v$ is likely to represent fundamental personal and contextual factors that would not be affected by a change to the financial rules of the benefit system. A low value of $\rho$ (such as $\rho = 0$, which we use to explore the robustness of our results), would imply a high degree of random ‘churning’ in the pattern of take-up at the time of a reform. Another possibility, which cannot realistically be assessed ex ante, is that there might be a systematic effect on the mean of $v$. For example, the publicity or confusion attending a benefit reform might cause a temporary rise or fall in take-up.

If the summary statistic to be computed can be expressed as the change in the value of a measure between the pre- and post-reform periods, then we do not have to specify the full joint distribution of $v^0$ and $v^1$: only the marginal distributions are needed and the correlation $\rho$ is irrelevant. However, if our summary statistic describes individual-level changes and cannot be expressed as the difference between a pre- and post-reform overall measure, then the correlation between $v^0$ and $v^1$ will have an effect on the conclusions. We now consider this in more detail.

4 Measuring the impact of policy reform

4.1 Definitions

There are two basic issues to decide at the outset: what variable will be used to indicate the welfare outcome for individual households? and what policy impact measures will be used to summarise the effect of policy on the distribution of welfare? For the former, we use net income, defined to include any receipt of means-tested benefit and exclude direct tax payments. This will clearly depend on take-up behaviour. For a household with characteristics $x$ under the tax-benefit system described by $\tau$, benefit entitlement is $b(x, \tau)$. Let original income excluding means-tested benefits be $m(x, \tau)$. Then actual net income is:

$$m(x, y|\tau) = yb(\tau, x) + m(x, \tau)$$  \hfill (8)
The definition (8) makes no adjustment for claim costs. An adjusted measure would be:

\[ m(x, y, c|\tau) = y [b(\tau, x) - c] + \overline{m}(x, \tau) \] (9)

where claim costs \( c \) are given by (5). Note that both \( y \) and \( c \) depend on the unobservable \( v \), so the measures (8)-(9) are not directly observable for a new policy regime. If we allow the possibility that \( v \) changes between the pre- and post-reform periods (\( \rho \neq 1 \)), then \( c \) will also be affected by the policy reform.

Define \( w \) to be the vector of all exogenous variables that are used to determine net income and to explain take-up behaviour. Consider as an example, the class of summary statistics expressible as the expectation of a known function \( \psi(.) \) of net incomes and exogenous characteristics:

\[ \mu = E \left[ \psi(m^0, m^1, w) \right] \] (10)

Using the law of iterated expectations:

\[ \mu = E \{ \mu(w) \} \] (11)

where \( \mu(w) \) is the conditional expectation \( E [\psi(m^0, m^1, w) \mid w] \). If we do not adjust for claim costs:

\[
\mu(w) = P^{00} \psi(m^0, m^1, w) + P^{01} \psi(m^0, m^1 + b^1, w) + P^{10} \psi(m^0 + b^0, m^1, w) + P^{11} \psi(m^0 + b^0, m^1 + b^1, w) \] (12)

where \( P^{jk} = Pr(y^0 = j, y^1 = k); j, k = 0, 1 \). If we allow for claim costs using (9) then:

\[
\mu(w) = \int \int \psi(m^0 + y^0[b^0 - c^0], m^1 + y^1[b^1 - c^1], w) dF(v^0, v^1) \] (13)

where \( F \) is the joint cdf of \( v^0, v^1 \) and where \( y^0, y^1, c^0, c^1 \) are treated as functions of \( v^0, v^1 \).

4.2 To condition on observed take-up or not?

In a typical microsimulation model, we have a set of survey data which includes an observation on the take-up indicator \( y \) for each household. This
reflects take-up under the conditions prevailing at the time of the survey, which may or may not coincide with the baseline pre-reform position in the policy analysis. With an estimated take-up model available, we have a choice of simulating hypothetical future take-up behaviour either conditional on the actual take-up behaviour observed in the survey, or independently of it. Consider again the problem of estimating the mean value of a function of net incomes, using a random sample of size $n$. We can estimate $\mu$ as:

$$\hat{\mu} = \frac{1}{n} \sum_{i=1}^{n} \mu(w_i) \quad (14)$$

where $\mu(w_i) = E[\psi(m_0, m_1, w_i) | w_i]$. The statistic $\hat{\mu}$ is unbiased and, with independence across sampled individuals, has variance:

$$\text{var}(\hat{\mu}) = \frac{E[\mu(w) - \mu]^2}{n} \quad (15)$$

Define $\xi$ as the survey observation on the take-up indicator $y$. Now compare the variance (15) across two alternatives: conditioning on personal characteristics and observed take-up, $w = (x, \xi)$; and conditioning only on personal characteristics, $w = x$.

$$\text{Var}(\hat{\mu}_{x,\xi}) - \text{Var}(\hat{\mu}_x)$$

$$= n^{-1} \left[ E \{\mu(x, \xi) - \mu\}^2 - E \{\mu(x) - \mu\}^2 \right]$$

$$= n^{-1} E \left[ -\{\mu(x, \xi) - \mu(x)\}^2 + 2\mu(x, \xi) \{\mu(x, \xi) - \mu(x)\} \right]$$

$$= -n^{-1} E \left[ \{\mu(x, \xi) - \mu(x)\}^2 \right] \leq 0 \quad (16)$$

Thus, conditioning on observed take-up behaviour in addition to personal characteristics inflates the variance of $\hat{\mu}$, for any function $\psi(.)$. Therefore it is generally more efficient to ignore observed take-up and use the take-up model instead. The efficiency gain comes from using the a priori knowledge of the structure of take-up probabilities.\(^2\)

\(^2\)The situation may not be quite so clear cut when the take-up model involves estimated parameters and the possibility of misspecification bias. It may be possible, in some cases, for the conditional simulator to be superior in mean squared error terms, despite its disadvantage in variance.
4.3 Analytical methods

There are two obvious approaches to take. One is to derive analytical expressions for the relevant summary measures and use sample data to estimate them directly. Assume we have a set of $n$ observations, collected by random sampling at a time when the policy described by $\tau_0$ was in force. For individual $i$ we observe actual take-up $y_i^0$, original income $m_i$, personal characteristics $x_i$ and the relevant poverty line $T_i$. Our aim is to estimate the impact of the policy shift from $\tau_0$ to $\tau_1$.

Assume that net income is not to be adjusted for claim costs and that the population characteristic we want to estimate is the expectation of a function $\psi$. Its conditional expectation is given by (12). Assume a probit model, so that the probabilities $P_{00}^0 \ldots P_{11}^0$ are of bivariate normal form:

\begin{align*}
P_{00} &= \Pr(y^0 \leq 0, y^1 \leq 0 \mid z^0, z^1) = \Phi(-z^0 \alpha, -z^1 \alpha; \rho) \\
P_{01} &= \Pr(y^0 \leq 0, y^1 > 0 \mid z^0, z^1) = \Phi(-z^0 \alpha, z^1 \alpha; -\rho) \\
P_{10} &= \Pr(y^0 > 0, y^1 \leq 0 \mid z^0, z^1) = \Phi(z^0 \alpha, -[z^1 \alpha + \delta]; -\rho) \\
P_{11} &= \Pr(y^0 > 0, y^1 > 0 \mid z^0, z^1) = \Phi(z^0 \alpha, [z^1 \alpha + \delta]; \rho)
\end{align*}

where $\Phi(.,.; \rho)$ is the cdf of the bivariate standard normal distribution with correlation $\rho$. In the special case where $\rho = 1$, these reduce to the following:

\begin{align*}
P_{00} &= 1 - \max \{\Phi(z^0 \alpha), \Phi(z^1 \alpha)\} \\
P_{01} &= \max \{0, \Phi(z^1 \alpha) - \Phi(z^0 \alpha)\} \\
P_{10} &= \max \{0, \Phi(z^0 \alpha) - \Phi(z^1 \alpha + \delta)\} \\
P_{11} &= \min \{\Phi(z^0 \alpha), \Phi(z^1 \alpha + \delta)\}
\end{align*}

where $\Phi(.)$ is the univariate standard normal cdf.

The probabilities $P_{00} \ldots P_{11}$ can be computed for each individual in the sample, using the estimated probit coefficients $\hat{\alpha}$, and can then be used to construct a weighted average of the values taken by $\psi$ in the four take-up regimes as in (12). The resulting estimate $\hat{\mu}_i$ would be averaged over individuals to give the estimated population characteristic $\hat{\mu}$.

This method can be extended to cover summary statistics which are functions of more than one expected value. An example is the mean gain of
gainers, defined as the following ratio of two means:

\[
\hat{\mu} = \frac{n^{-1} \sum_{i=1}^{n} \left[ \hat{P}_{i}^{00} \max \{0, m_i^1 - m_i^0\} + \ldots + \hat{P}_{i}^{11} \max \{0, m_i^1 + b_i^1 - m_i^0 - b_i^0\} \right]}{n^{-1} \sum_{i=1}^{n} \left[ \hat{P}_{i}^{00} \mathbb{1} \left( m_i^1 \geq m_i^0 \right) + \ldots + \hat{P}_{i}^{11} \mathbb{1} \left( m_i^1 + b_i^1 \geq m_i^0 + b_i^0 \right) \right]}
\]  

(25)

where \( \mathbb{1}(A) \) is the indicator function equal to 1 if the event \( A \) is true and 0 otherwise. Another class of summary measures involves quantiles such as the sample median of post-reform income, \( \hat{\mu} \), which can be estimated by solving the equation \( \hat{F}_{m,1}(\hat{\mu}) = 1/2 \) where \( \hat{F}_{m,1}(.) \) is a smoothed form of the mixed empirical cdf of \( m_i^1 \):

\[
\hat{F}_{m,1}(\hat{\mu}) = n^{-1} \sum_{i=1}^{n} \left[ \hat{P}_{i}^{00} \mathbb{1} \left( m_i^1 \leq \hat{\mu} \right) + \ldots + \hat{P}_{i}^{11} \mathbb{1} \left( m_i^1 + b_i^1 \leq \hat{\mu} \right) \right]
\]  

(26)

Smoothing can be done by replacing the indicator function \( \mathbb{1}(m_i^1 \leq \hat{\mu}) \) by a kernel function such as the Gaussian form \( \Phi \left( \frac{\hat{\mu} - m_i^1}{h} \right) \) where \( h \) is a small bandwidth parameter. This has the advantage of giving a unique solution for each quantile and of making the statistic a smooth function of the parameters \( \alpha \). Alternatively, we can use the standard non-smooth rule for defining sample quantiles. Other composite classes of statistic can be defined, for example the relative poverty headcount defined as the proportion of the sample falling below 60% of median income.

When net income is adjusted for claim costs, these expressions become much more complicated because the distribution of claim costs involves the process of self-selection into welfare participation. See Pudney et al. (2003) for an analysis of this case. The other main drawback of the analytical approach is that it is case-specific. A separate analytical expression is required for each summary measure to be estimated. In practice, this means that the analyst has to anticipate every type of summary measure that policy-makers might wish to use, then derive the relevant analytical expressions and implement them. In terms of practical convenience, a more promising approach is stochastic simulation.

### 4.4 Stochastic simulation methods

In very broad terms, the stochastic simulation approach uses the following algorithm:
Step 1 Specify a (large) number of replications, \( R \). For each sampled individual \( i \), simulate two sets of \( R \) hypothetical values, \( v_{1i}^{\prime}, \ldots, v_{Ri}^{\prime} \); \( t = 0, 1 \), for the random factor underlying each individual’s take-up behaviour.\(^3\)

Step 2 Think of these values as defining a set of \( R \) ‘shadow’ individuals, all identical except for their values of \( v_{ir}^{\prime} \). For each of them, determine whether or not take-up will occur in the pre- and post- policy settings by setting \( y_{ir} \) as 0 or 1, depending on the sign of \( z_{ir}^{\prime} + \alpha v_{ir}^{\prime} \).

Step 3 Calculate the pre-reform net incomes of each of the shadow individuals as

\[ m_{ir}^0 = m_i^0 \text{ if } z_{ir}^0 + v_{ir}^0 \leq 0 \text{ (non-take-up) or } m_{ir}^0 = m_i^0 + b_i^0 \text{ if } z_{ir}^0 + v_{ir}^0 > 0 \text{ (take-up).} \]

Construct \( m_{ir}^1 \) analogously using the latent indicator \( z_{ir}^1 + \delta y_{ir}^0 + v_{ir}^1 \). If net income is to be adjusted for claim costs, use \( m_{ir}^t = m_{ir}^t + b_i^t - \exp \{-[z_{ir}^t + \delta y_{ir}^0 + v_{ir}^t]/\alpha_1 \} \) as net income in take-up cases.

Step 4 This generates a complete set of \( N \times R \) pairs of net income figures. We then calculate all desired summary measures in the natural way from this expanded sample.

Provided the simulated values for \( v \) are generated appropriately and that a sufficiently large number of replications is used, this method will generally give good estimates of the required summary measures. For standard summary measures expressible as functions of moments and quantiles, stochastic simulation gives estimates with the same asymptotic properties as the analytical approach, except for an additional variance term of order \( 1/R \).

The method we use to generate pseudo-random values for \( v^0 \) is first to generate a uniform random variable, \( u^0 \), on the \((0, 1)\) interval, then to transform this to \( v^0 \) by using the inverse of the relevant distribution function. Thus, \( v_{ir}^0 \) is generated as follows:

\[ v_{ir}^0 = F^{-1}(u_{ir}^0) \tag{27} \]

If we use a probit model for take-up, we specify \( F \) as the standard normal distribution function \( \Phi(.) \). Its inverse \( \Phi^{-1}(.) \) is readily computable. If we use the logit model, then \( F(v) = (1 + \exp(-v))^{-1} \) and thus \( F^{-1}(u) = -\ln((1-u)/u) \). Once a random value for \( v^0 \) has been generated in this way, a correlated value for \( v^1 \) can be computed as follows. First generate a random value \( \varepsilon \) from the distribution \( F \), then calculate the variable

\[ v_{ir}^1 = \max\left(0, v_{ir}^0 + \delta y_{ir}^0 + \varepsilon \right) \text{ if take-up occurs.} \]

\(^3\)If we want to condition on observed take-up, these values should be consistent with the observed pre-reform take-up behaviour of individual \( i \) (i.e. \( v_{ir}^0 \leq -z_{ir}^0 \alpha \) for non-take-up and \( v_{ir}^0 > -z_{ir}^0 \alpha \) for take-up).
\( v^1 = \rho v^0 + \sqrt{1 - \rho^2} \varepsilon. \) This will have the same mean and variance as \( v^0, \) with a correlation of \( \rho. \) In the normal case, \( v^1 \) will have a normal distribution. 

**4.5 Confidence intervals**

We have argued previously (Pudney and Sutherland, 1994) that confidence intervals should be reported routinely in microsimulation studies, but this remains the exception rather than the rule. Confidence intervals are more troublesome when estimated behavioural parameters are involved, since they represent an additional source of error (Pudney and Sutherland, 1996).

All of the summary measures used in the application reported below are expressible as functions of one or more expected values. Write this class as follows:

\[
\Psi = \varphi (\mu_1(\alpha), ..., \mu_j(\alpha))
\]

(28)

where:

\[
\mu_j(\alpha) = E [\psi_j(m^0, m^1, w)]
\]

and \( \{\varphi, \psi_1...\psi_J\} \) are specified functions. We simplify the expression for \( \Psi \) by defining a conditional expectation \( \mu_j(w; \alpha) = E [\psi_j(m^0, m^1, w)|w] \) so that we can write:

\[
\Psi = \varphi (E \mu_1(w; \alpha), ..., E \mu_J(w; \alpha))
\]

(29)

where \( w \) is the vector of exogenous covariates. Note that an explicit form is available for \( \mu_j(w; \alpha), \) from knowledge of the take-up model and the function \( \psi_j(\cdot). \) The dependence of \( \mu_j(\alpha) \) on the take-up coefficients \( \alpha \) comes through expressions like (12) and (13). By analogy with (29), the estimate of \( \Psi \) is:

\[
\hat{\Psi} (\hat{\alpha}) = \varphi (\hat{\mu}_1(\hat{\alpha}), ..., \hat{\mu}_J(\hat{\alpha}))
\]

(30)

where \( \hat{\mu}_j(\hat{\alpha}) = n^{-1} \sum_{i=1}^n \mu_j(w_i; \hat{\alpha}). \) Under standard assumptions, these functions are differentiable with probability 1 in a neighbourhood of the true parameter \( \alpha. \) The usual asymptotic expansion gives the result:

\[
\sqrt{n} \left[ \hat{\Psi} (\hat{\alpha}) - \Psi \right] \overset{D}{\rightarrow} N(0, \varphi_\alpha \Omega_{\alpha} \varphi'_\alpha + \varphi_\mu \Sigma \varphi_\mu)
\]

(31)

\(^*\)Note that \( v^1 \) will have a non-logistic distribution in the logit case if constructed in this way. The bivariate logistic distribution does not permit an unrestricted range of values for the correlation coefficient, so it seems more important to have generality in the correlation structure than to insist on an identical distribution for \( v^0 \) and \( v^1. \)
where: $\varphi_\alpha(\alpha)$ and $\varphi_\mu(\mu)$ are respectively the row vectors of partial derivatives of $\varphi(\cdot)$ with respect to the vector $\alpha$ and the vector $\mu(\alpha) = [\mu_1(\alpha), ..., \mu_J(\alpha)];$

$\Omega$ is the asymptotic covariance matrix of $\sqrt{n}[\hat{\alpha} - \alpha]$; and $\Sigma$ has $j$, $k$th element $\text{cov}(\mu_j(w; \alpha), \mu_k(w; \alpha))$. For implementation, we would need a simple method of estimating the variance expression $n^{-1}[\varphi_\alpha \Omega \varphi_\alpha' + \varphi_\mu \Sigma \varphi_\mu]$. One approach would be to use the conventional estimated covariance matrix of the probit coefficients for $n^{-1}\Omega$ and $[n(n-1)]^{-1} \sum_{i=1}^n [\mu_j(w_i; \hat{\alpha}) - \hat{\mu}_j(\hat{\alpha})] [\mu_k(w_i; \hat{\alpha}) - \hat{\mu}_k(\hat{\alpha})]$ as an estimate of the $j$, $k$th element of $n^{-1}\Sigma$. The derivative vectors $\varphi_\alpha$ and $\varphi_\mu$ might be estimated by means of numerical difference approximations. With stochastic simulation, some smoothing method would be required to cope with the non-smooth nature of the simulation estimator for the $\mu_j$.

Asymptotic approximations like (31) have the drawback of being specific to a particular set of summary statistics and requiring reprogramming for each new application. A preferable approach is to bootstrap the whole estimation procedure by resampling from the dataset, re-estimating the probit model and the resulting summary statistics and then calculating an empirical confidence interval from the bootstrap replications. This may require very long computer run times if complicated models of take-up are used and particularly if simulation is used to generate the $\hat{\mu}_j$. In the next section we report the use of the bootstrap approach, using the Monte Carlo simulation procedure within each bootstrap replication. We use 400 Monte Carlo replications and 500 bootstrap replications, which was found in practice to give precision almost identical to the analytical approach for the cases we investigated, but avoided the need to write explicit code to handle each statistic separately.

5 Evidence from the Family Resources Survey

5.1 Simulating benefit entitlement and take-up using the Family Resources Survey

The FRS is a continuous cross-sectional survey of British households carried out on behalf of the Department for Work and Pensions. All adult respondents are asked whether they receive each of a comprehensive set of social
security benefits and if so, the amount they last received. Details of private sources of income, capital holdings, rent and council tax liabilities, personal and other characteristics relevant to calculating entitlement to means-tested benefits are also recorded. The survey can therefore be used to assess each pensioner unit’s entitlement to IS, CTB and HB, compare that with their recorded receipts of those benefits, and examine patterns of non-take-up. However, any errors in recorded income (including state benefits), capital, rent or council tax liabilities will lead to errors in assessed entitlement. The data used here have been subjected to an extensive error detection and correction procedure to minimise the potential for such errors (Hancock and Barker, 2004).

The analysis in this paper is based on data from three years of FRS spanning the period April 1997 to March 2000. The pensioner rates of IS, CTB and HB apply to single people aged 60 years or more or couples where either partner is aged at least 60. However, the sample used here was restricted to one- or two-pensioner units whose members are at least five years above state pension aged (men aged 70+ and women aged 65+). Those with income from employment or self-employment or still re-paying a mortgage were also excluded, resulting in an initial sample of 12,801. These restrictions mean that we concentrate on pensioners whose incomes are likely to be relatively stable and minimise the scope for measurement error which could lead us to assess benefit entitlement incorrectly. The focus on older pensioners is justified in terms of policy relevance since older pensioners are poorer than younger pensioners and more likely to be entitled to means-tested benefits (Curry and O’Connell, 2003). That is not to say that our sample is representative of all older pensioners. The main groups of older people who are excluded from the analysis are those living in institutions or in households containing other people besides their spouse. Further cases were excluded where, after detecting and correcting errors in recorded benefit receipt, their data were not sufficiently complete or reliable to make an assessment of their benefit entitlements. Additional details of how the sample was restricted are given in the appendix. The final sample used in the analysis consisted of 9,412 pensioner units, or 74% of the initial sample of 12,801.

Sutherland (2003) has used the 1999/0 FRS to investigate take-up amongst some of the groups of pensioners we have excluded.
5.2 A probit model of take-up

Table 1 presents the estimated probit model of IS take-up that we use to simulate take-up responses to a policy reform. The model was developed from earlier estimates of IS take-up (Hancock and Barker, 2003; Pudney, Hernandez and Hancock, 2004) with some modification to meet present needs. Selection of potential explanatory variables was guided by the assumption that pensioners will claim an entitlement to IS if they judge that the benefits of claiming outweigh the time, monetary and psychological costs of claiming and receiving benefits. Indirect measures of claim costs include: a) those which suggest physical barriers to claiming such as disability or sensory impairment; b) those which may indicate access, or lack of it, to potential sources of advice or information about benefit entitlement; and c) those which might be associated with the degree of psychological costs, or ‘stigma’ felt by the potential claimant. Variables which may capture these costs can fall into more than one of these categories. For example, the FRS records whether respondents are registered with their local authority as disabled, blind, partially-sighted or deaf. Such impairments may make claiming benefits more difficult but registration with a local authority implies contact with sources of welfare rights advice and possibly a predisposition to seek advice. Owning one’s home, rather than renting from the social sector, may mean that a high value is given to financial independence and signal high psychological costs associated with dependence on the state. Conversely, renting from a local authority or housing association may indicate access to information about benefit entitlements. Education may make claiming easier but more stigmatising.

The income variable we use is disposable (after meeting housing costs) income before claiming any entitlement to IS, divided by the number of people in the household (1 or 2). It consists of IS assessable income, estimated income generated from capital, income disregarded in assessing IS (but not disregarded disability benefits), HB and CTB less gross rent and council tax liabilities. Disregarded disability benefits are assumed to be matched by disability-related extra costs of living so it is not appropriate to treat them as additions to disposable income. This income construction is appropriate to the policy reform we model. It also has the incidental effect of reducing the correlation between income and capital on the one hand, and IS entitlement on the other, which would otherwise pose a difficulty in identifying the
separate effects of income, capital and entitlement on take-up.

Explanatory variables were retained if statistically significant at the 10% or higher significant level. The log of IS entitlement and per capita income were both highly significant. Personal characteristics retained in the model are age of the head of the benefit unit (entered as dummy variable indicating aged under 75), whether the unit is a single female as distinct from a couple or a single male, housing tenure (distinguishing local authority/housing association tenants and other tenants from owner-occupiers), whether living in Wales or Scotland rather than in England and whether the head was educated beyond age 14. Characteristics which were statistically insignificant and excluded from the model were: head or partner suffering from sensory impairments, or limiting long-standing illness, or registered with a Local Authority as disabled; ethnic origin; and a more detailed regional breakdown. A dummy variable for the whether the data relate to 1999/0, the last year of data, was just significant at the 10% significance level.

[***** Table 1 here *****]

5.3 Implementing the policy reform

The IS rent addition is set at the mean region and household size specific rent for all renters in the appropriate FRS year. In our sample of pensioners, this produces an average rent addition which is 6% higher than the average rent paid by renters. It is lower than actual rent for 36% of them but at least 50% higher for 12%. Among renters calculated to be entitled to HB under the pre-reform system, the rent addition is lower than rent paid for 38% and more than 50% higher for 10%. Corresponding proportions for renters entitled to IS are similar.

Under variant 1 of the policy reform, individuals may be better off financially by claiming HB/CTB instead of IS. In these cases we assume that HB/CTB rather than IS will be claimed, if HB/CTB is claimed under the

---

6However, note that there are few ethnic minority pensioners in the sample.
current system. In using the probit model to simulate pre- and post reform take-up of IS, base income (per capita after housing costs income before claiming any entitlement to IS) and entitlements are constructed as follows, where original income refers to all sources of non-means-tested income that are included in after housing costs per capita income:

(i) Pre-reform:

\[
\text{Base income} = \text{original income} \\
+ \text{HB entitlement, if HB received in FRS} \\
+ \text{CTB entitlement, if CTB received in FRS} \\
- \text{rent before HB} - \text{council tax before CTB}
\]

\[
\text{IS entitlement} = \text{pre-reform IS entitlement}
\]

(ii) Post-reform, variant 1 (new IS system with continued access to existing HB & CTB if no IS take-up or new entitlements < HB+CTB):

\[
\text{Base income} = \text{original income} \\
+ \text{HB entitlement, if HB received in FRS} \\
+ \text{CTB entitlement, if CTB received in FRS} \\
- \text{rent before HB} - \text{council tax before CTB}
\]

\[
\text{IS entitlement} = \text{post-reform IS entitlement} - \text{HB entitlement} \\
- \text{CTB entitlement (if positive)}
\]

(iii) Post-reform, variant 2 (new IS system with no access to existing HB & CTB for those entitled to IS):

\[
\text{Base income} = \text{original income} - \text{rent before HB} \\
- \text{Council Tax before CTB}
\]

\[
\text{IS entitlement} = \text{post-reform IS entitlement}
\]

Thus in each case, the IS entitlement variable used to predict take-up appropriately measures the marginal return to claiming. IS take-up under each regime is simulated stochastically with \( R = 400 \) replications, using the method set out in section 4.4 above. Initially, we set \( \rho = 1 \). Pensioners predicted to claim their pre-reform entitlements are therefore guaranteed to claim their post-reform entitlements as long as the latter are no smaller than 19
the former. All our summary measure have the mathematical form of a function of a set of expected values. Our main poverty indicator is the quadratic version of the Foster, Greer and Thorbecke (1984) index: $E(\psi(m, T))$ where $\psi(m, T) = ([T - m]/T)^2$ if $m < T$ and 0 otherwise and $T$ is a poverty threshold. This is estimated as:

$$F_{GT} = \frac{1}{n} \sum_{r=1}^{R} \sum_{i: m_{ir} < T_i} \left( \frac{T_i - m_{ir}}{T_i} \right)^2$$

(32)

where $i = 1...n$ indexes sample members and $m_{ir}$ is net income for household $i$ at replication $r$. We set the poverty threshold $T_i$ as a multiple ($\lambda$) of the sum of the relevant levels of pre-reform IS, mean rent (0 for non renters) and actual council tax paid by the household. This poverty line reflects the equivalence scale implicit in the design of the IS programme.

6 Results

6.1 Policy reform without adjustment for claim costs

Twenty-two per cent of the sample are calculated to be entitled to some IS under the pre-reform regime. This increases to 29% (variant 1) and 38% (variant 2) under the policy reform. All those entitled under variant 2 of the reform are also entitled in the pre-reform system. Eight per cent of those entitled to IS pre-reform are better off under variant 1 of the reform foregoing their IS entitlement and claiming HB/CTB and are thus excluded from the post reform, variant 1 entitled group.

Table 2 shows how the proportions entitled to IS vary across different pensioner types and also gives mean entitlements, mean income before IS and mean predicted take-up probabilities. At 43% pre-reform, entitlement to IS is particularly high among tenants in social housing and is made higher still by the reforms, increasing to 82% under variant 2. Couples and owner-occupiers have the lowest rates of entitlements - 7% and 10% respectively pre-reform, rising to 20% and 14% under variant 2 of the reform. Under the pre-reform system, overall take-up of IS is predicted to be 66%. Predicted take-up rates are highest for social tenants and pensioners aged under 75. The overall take-up rate is predicted to increase to 68% under variant 1 of the reform with the largest increases being for private tenants (from 64% to
67%) and couples (from 54% to 61%). Variant 2 is predicted to raise the overall take-up rate to 77% with substantial increases in take-up predicted for all groups except owner-occupiers. These changes reflect relatively large increases in mean entitlements to IS (from $19.60 to $47.10) and reductions in pre-IS income (from $105.20 to $84.30 on average) among those entitled to IS. The latter result from the removal of HB and CTB.

Stochastic simulation allows us to analyse post reform take-up according to pre-reform take-up and entitlement status. These results are highly sensitive to the assumption made about the relationship between $v^0$ and $v^1$. We would argue that the assumption $\rho = 1$ is much more plausible than $\rho = 0$. For example, under the former assumption there is a 9% simulated take-up rate post-reform (variant 1) among those who are entitled but not claiming IS re-reform. With $\rho = 0$, this rate rises to 62% as a consequence of the ‘churning’ implied by the zero correlation assumption. For variant 2 of the reform, the equivalent take-up rates are 32% and 75%. This degree of change at the individual level is completely implausible and renders the estimated numbers of gainers and losers unreliable. We therefore use the assumption $\rho = 1$ henceforth.

Table 3 shows the impact on calculated confidence intervals of making allowance for the fact that the parameters of the take-up model are estimated with error. The width of confidence intervals increases by up to 40% when this is done. This is not enough to make an important difference to our conclusions in the present application. Nevertheless, we report the full confidence intervals henceforth.

Table 4 examines the impact of alternative take-up assumptions. With complete take-up of HB, CTB and IS, pensioners in our sample gain overall
from variant 1 of the policy reform but lose marginally from variant 2 (first panel of Table 4). The reform delivers an average net weekly gain of $1.72 (variant 1) or a loss of $0.11 (variant 2). The same 17.5% of the sample gain under each variant because, under variant 1, those who are better off claiming HB/CTB instead of IS are still worse off than under the current regime, so they lose under both variants. Under variant 1, 5% of the sample lose, and 77% neither lose nor gain. 26% lose under variant 2, and 56% are unaffected. The mean gain amongst gainers is $11.91 under both variants. The mean losses among losers are $6.70 (variant 1) and $8.59 (variant 2).

[**** Table 4 here ****]

Allowing for non-take-up (with $\rho = 1$) paints a different picture. The second and third panels of Table 4 show the results under two extreme assumptions: 0% and 100% sunk costs. With no sunk costs, the proportions gaining and losing fall under both variants. The overall mean gain under variant 1 is $1.90 rather than $1.70 with perfect take-up. Under variant 2 our sample lose an average of $0.49 a week instead of $0.11. The proportion of owner-occupiers who lose falls from 19% to 12%, whilst social tenants are affected more: the proportion who gain falls from 49% to 38% (variant 1) or 45% (variant 2) but the mean gain rises from $9.14 to over $12 for both reforms. There is a modest reduction in the proportions losing: in variant 1 there is a fall from 15% to 11% and an increase in the mean loss from $5.60 to $6.10. Under variant 2, endogenising take-up has a marginal effect on the proportion of social tenants who lose but substantially increases their mean loss (from $10.84 to $18.08). Allowing for fully sunk costs changes things slightly, but not enough to alter the general conclusions about the two variants of the reform. The proportion of gainers and losers rise and fall respectively compared with the non-sunk costs case but mean gains and losses both fall. Overall the effect of fully sunk costs is to increase the average gain from each of the two reforms by a moderate amount.

In general, relative to these two variants of the endogenous take-up assumption, assuming perfect take-up tends to overestimate the proportions who gain and lose from the reforms and underestimates their mean gains.
and losses. This is mainly the consequence of a reform which replaces a benefit with relatively high take-up (HB) with a benefit with lower take-up (IS).

Figures 3 and 4 plot the FGT poverty index for different poverty thresholds, assuming complete take-up (Figure 3) and allowing for non-take-up (Figure 4). As we would expect, allowing for non-take-up increases poverty at all thresholds and under each policy regime. The assumption of complete take up suggests that both reforms reduce poverty. If non-take-up is allowed for, variant 1 reduces poverty but variant 2 increases it. Again this reflects the replacement of entitlements to a benefit with high take-up with entitlements to a benefit with low take-up.

[**** Figures 3 & 4 here ****]

6.2 The effect of claim costs

The existence of claim costs associated with means-tested sources of income implies that the welfare of those who are benefit-dependent is over-estimated by the analyses of actual cash income presented in the previous section. Table 5 summarises the mean levels of claim cost and entitlement by various groups of benefit recipients. Pre-reform, claim costs average $1.57 per week, or 7% of their mean entitlement. There is a slight rise to $1.85 under reform variant 1, although claim costs incurred by benefit recipients remain roughly constant as a proportion of entitlement. Under variant 2 of the reform, entitlements are much larger and the average claim cost increases accordingly to $2.47, since it now becomes worthwhile for those with relatively high claim costs to take up their entitlements. However, as a proportion of mean entitlement, average claim costs are now reduced to around 5%. Under both reforms, groups with relatively high entitlements (private tenants and older pensioners) incur high average levels of claim costs. Their welfare will therefore tend to be underestimated by conventional income analyses. These patterns have clear implications for the analyses of net income gains and losses in Table 6, where
both gains and losses are moderated, with a small reduction in the measured net income change.

[**** Tables 5 and 6 here ****]

Figure 5 reproduces the poverty analysis of Figure 3 (using $\rho = 1$) with net income adjusted for claim costs. Claim costs make an important difference to the character of the results. In addition to raising the level of measured poverty under all three policy regimes. Allowing for claim costs increases the extent to which poverty is higher under variant 2 of the reform relative to variant 1 or the pre-reform system. The reason for this is that variant 2 of the reform reduces income in the absence of a benefit claim, thus prompting higher take-up and an increased proportion of pensioners incurring claim costs.

[**** Figure 5 here ****]

7 Conclusions

In this paper we have considered analytical and stochastic simulation methods for using econometric models of benefit take-up in microsimulation models. We have demonstrated the use of a probit model of take-up in a microsimulation model of pensioner benefits, to allow for take-up behaviour to change in response to a policy reform. This involves stochastic simulation which also enables results to be adjusted for the implicit tangible and intangible costs incurred by benefit claimants as a result of claiming and receiving mean-tested benefits. The policy reform introduces rent and council tax additions to IS as an alternative (variant 1) or replacement (variant 2) for HB and CTB. This is an important case study, since it demonstrates the
potential impact of a reform that removes the incentive towards high rent expenditure inherent in the existing HB system.

As expected, our results show that measured poverty is greater when we allow for non-take-up, compared with an assumption of complete take-up. Poverty is greater still if we adjust for the claim costs borne by benefit recipients. More importantly, the simulated effect of reforms on measured poverty changes when we endogenise take-up. If 100% take-up is assumed, both of the two alternative variants of the reform reduce poverty. In contrast, when we allow for non-take-up, variant 2 of the reform uniformly increases poverty. This is essentially the result of replacing a benefit programme with relatively high take-up by one with lower take-up. This qualitative result is found whether or not we adjust income for estimated claim costs, but is particularly striking when income is measured net of claim costs.

Endogenous take-up and the associated implicit claim costs are clearly important aspects of the policy design problem. The way they are handled in the process of policy simulation is an important methodological issue that deserves more attention than it normally receives.

References


Table 1: Sample means of explanatory variables and probit coefficients

<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
<th>Sample mean (std. err.)</th>
<th>Probit coefficient (std. err)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ln (B)</td>
<td>log of simulated IS entitlement (£ per week)</td>
<td>2.372 (0.028)</td>
<td>0.170 (0.025)</td>
</tr>
<tr>
<td>Household head aged under 75 years</td>
<td>dummy variable =1 if household head under 75 years of age, 0 otherwise</td>
<td>0.299 (0.010)</td>
<td>0.245 (0.069)</td>
</tr>
<tr>
<td>Single female household</td>
<td>dummy variable =1 if female living alone, 0 otherwise</td>
<td>0.748 (0.010)</td>
<td>0.404 (0.068)</td>
</tr>
<tr>
<td>Local authority or housing association tenant</td>
<td>dummy variable=1 if renting from a local authority or housing association, 0 otherwise</td>
<td>0.606 (0.011)</td>
<td>0.633 (0.066)</td>
</tr>
<tr>
<td>Private tenant</td>
<td>dummy variable=1 if renting from a private landlord, 0 otherwise</td>
<td>0.095 (0.006)</td>
<td>0.371 (0.109)</td>
</tr>
<tr>
<td>Survey year is 1999/0</td>
<td>dummy variable=1 if survey in 1999/0, 0 if surveyed in 1997/8 or 1998/9</td>
<td>0.337 (0.010)</td>
<td>-0.083 (0.064)</td>
</tr>
<tr>
<td>Head educated beyond 14 years</td>
<td>dummy variable =1 if household head left full-time education after the age of 14, 0 otherwise</td>
<td>0.202 (0.009)</td>
<td>-0.293 (0.075)</td>
</tr>
<tr>
<td>Lives in Scotland or Wales</td>
<td>dummy variable =1 if household lives in Scotland or Wakes, 0 otherwise</td>
<td>0.171 (0.008)</td>
<td>-0.233 (0.079)</td>
</tr>
<tr>
<td>Per capita after housing costs income in absence of Income Support (‘base income’)</td>
<td>Net household income, excluding IS, less net housing costs, divided by number of people in household (1 or 2), £ per week</td>
<td>63.00 (0.413)</td>
<td>-0.008 (0.002)</td>
</tr>
<tr>
<td>Intercept</td>
<td></td>
<td></td>
<td>-0.134 (0.156)</td>
</tr>
</tbody>
</table>
Table 2: Proportions entitled to IS, mean entitlements and mean base incomes, pre and post reform (90% confidence intervals)

<table>
<thead>
<tr>
<th></th>
<th>Pre-reform</th>
<th>Post reform, variant 1</th>
<th>Post reform variant 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>For those entitled to IS</td>
<td>For those entitled to IS</td>
<td>For those entitled to IS</td>
</tr>
<tr>
<td></td>
<td>% entitled to IS</td>
<td>mean entitlement</td>
<td>% entitled to IS</td>
</tr>
<tr>
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<td>±0.75</td>
<td>±1.15</td>
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<td>±0.99</td>
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<tr>
<td>Owner-occupiers</td>
<td>±3.2</td>
<td>±2.76</td>
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</tr>
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<td>Head aged under 75</td>
<td>±1.0</td>
<td>±1.49</td>
<td>±2.10</td>
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<td>Head aged 75-89</td>
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<td>Head aged 90+</td>
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<td>±4.5</td>
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<tr>
<td>Single man</td>
<td>±1.7</td>
<td>±2.03</td>
<td>±2.72</td>
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<tr>
<td>Single woman</td>
<td>±1.1</td>
<td>±0.85</td>
<td>±1.22</td>
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<tr>
<td>Couple</td>
<td>±0.8</td>
<td>±2.53</td>
<td>±3.73</td>
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</table>

a. For comparability with mean entitlement base income is not per capita
Table 3: The impact of parameter estimation error on bootstrap confidence intervals 
(90% confidence intervals)

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<tr>
<th></th>
<th>Gainers</th>
<th>Losers</th>
<th>All</th>
<th>Gainers</th>
<th>Losers</th>
<th>All</th>
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<td>Post reform, variant 2</td>
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<td></td>
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<tr>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$a$</td>
<td>14.7</td>
<td>15.06</td>
<td>3.92</td>
<td>7.21</td>
<td>1.93</td>
<td>17.7</td>
</tr>
<tr>
<td>$b$</td>
<td>±0.4</td>
<td>±0.55</td>
<td>±0.18</td>
<td>±0.57</td>
<td>±0.09</td>
<td>±0.5</td>
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<tr>
<td>Tenants in social housing</td>
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<td>12.49</td>
<td>11.32</td>
<td>6.06</td>
<td>4.05</td>
<td>45.4</td>
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<td>±0.67</td>
<td>±0.41</td>
<td>±0.23</td>
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<td>Owner-occupiers</td>
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<td>Head aged under 75</td>
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<td>Head aged 75-89</td>
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<td>21.05</td>
<td>6.46</td>
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</tr>
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<td>19.3</td>
<td>14.03</td>
<td>6.35</td>
<td>7.01</td>
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<td>19.06</td>
<td>0.66</td>
<td>5.53</td>
<td>1.46</td>
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<td>±0.11</td>
<td>±1.67</td>
<td>±0.11</td>
<td>±0.5</td>
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</tbody>
</table>

*Confidence interval allowing for error in probit coefficients; b Confidence interval ignoring error in probit coefficients*
Table 4: Estimated proportions gaining and losing from the reforms and mean gains and losses: alternative treatments of take-up

<table>
<thead>
<tr>
<th></th>
<th>Post reform, variant 1</th>
<th></th>
<th>Post reform, variant 2</th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Gainers mean</td>
<td>Losers mean</td>
<td>All mean</td>
<td>Gainers mean</td>
</tr>
<tr>
<td></td>
<td>% gain, £pw</td>
<td>% loss, £pw</td>
<td></td>
<td>% gain, £pw</td>
</tr>
<tr>
<td>All pensioners in sample</td>
<td>17.5±0.6</td>
<td>11.91±0.50</td>
<td>5.4±0.50</td>
<td>6.70±0.64</td>
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<tr>
<td>Tenants in social housing</td>
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<td>5.61±0.46</td>
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<tr>
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<td>11.5±2.2</td>
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<td>0.0±0.0</td>
<td>0.0±0.0</td>
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</tr>
<tr>
<td>Head aged under 75</td>
<td>15.4±1.1</td>
<td>9.54±0.63</td>
<td>5.1±0.6</td>
<td>6.69±1.09</td>
</tr>
<tr>
<td>Head aged 75-89</td>
<td>18.8±0.9</td>
<td>13.07±0.70</td>
<td>5.5±0.5</td>
<td>6.64±0.81</td>
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<tr>
<td>Head aged 90+</td>
<td>24.9±4.9</td>
<td>16.98±3.35</td>
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<td>Single man</td>
<td>19.9±1.7</td>
<td>10.59±0.97</td>
<td>4.9±0.9</td>
<td>8.22±2.21</td>
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<tr>
<td>Single woman</td>
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<td>8.5±0.7</td>
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<td>1.1±0.3</td>
<td>4.87±1.70</td>
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<tr>
<td>All pensioners in sample</td>
<td>14.7±0.4</td>
<td>15.06±0.55</td>
<td>3.9±0.2</td>
<td>7.21±0.57</td>
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<td>Tenants in social housing</td>
<td>37.9±1.4</td>
<td>12.49±0.48</td>
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<td>6.06±0.41</td>
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<tr>
<td>Private tenants</td>
<td>28.8±2.5</td>
<td>35.74±1.88</td>
<td>7.0±1.1</td>
<td>16.39±3.53</td>
</tr>
<tr>
<td>Owner-occupiers</td>
<td>2.0±0.1</td>
<td>9.32±0.37</td>
<td>0.0±0.0</td>
<td>0.0±0.0</td>
</tr>
<tr>
<td>Head aged under 75</td>
<td>13.6±0.6</td>
<td>12.24±0.69</td>
<td>3.9±0.3</td>
<td>7.20±0.96</td>
</tr>
<tr>
<td>Head aged 75-89</td>
<td>15.2±0.5</td>
<td>16.53±0.73</td>
<td>3.8±0.3</td>
<td>7.17±0.69</td>
</tr>
<tr>
<td>Head aged 90+</td>
<td>23.6±2.9</td>
<td>21.05±2.92</td>
<td>6.5±1.6</td>
<td>7.95±2.48</td>
</tr>
<tr>
<td>Single man</td>
<td>14.4±1.0</td>
<td>14.91±1.13</td>
<td>2.9±0.4</td>
<td>9.50±2.37</td>
</tr>
<tr>
<td>Single woman</td>
<td>19.3±0.6</td>
<td>14.03±0.59</td>
<td>6.4±0.3</td>
<td>7.01±0.59</td>
</tr>
<tr>
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<td>19.06±1.42</td>
<td>0.7±0.1</td>
<td>5.53±1.67</td>
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</tbody>
</table>

Assuming complete take-up of IS, HB & CTB

Endogenous take-up, no sunk costs (δ = 0, ρ = 1)
Table 4 continued

<table>
<thead>
<tr>
<th>All pensioners in sample</th>
<th>Endogenous take-up with fully sunk costs ($\delta = \infty, \rho = 1$)</th>
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</thead>
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<td></td>
<td>$\frac{\beta}{\gamma}$</td>
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<tr>
<td></td>
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</tr>
<tr>
<td>Tenants in social housing</td>
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<tr>
<td></td>
<td>± 1.4</td>
</tr>
<tr>
<td>Private tenants</td>
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</tr>
<tr>
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<td>± 2.5</td>
</tr>
<tr>
<td>Owner-occupiers</td>
<td>2.7</td>
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<tr>
<td></td>
<td>± 0.2</td>
</tr>
<tr>
<td>Head aged under 75</td>
<td>16.3</td>
</tr>
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<td></td>
<td>± 0.6</td>
</tr>
<tr>
<td>Head aged 75-89</td>
<td>18.7</td>
</tr>
<tr>
<td></td>
<td>± 0.5</td>
</tr>
<tr>
<td>Head aged 90+</td>
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<td></td>
<td>± 3.2</td>
</tr>
<tr>
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<td>19.5</td>
</tr>
<tr>
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<td>± 1.1</td>
</tr>
<tr>
<td>Single woman</td>
<td>21.9</td>
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<td>± 0.6</td>
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<tr>
<td>Couple</td>
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<td>± 0.5</td>
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Table 5: Mean IS entitlement and claim costs of IS claimants allowing for non take-up
($\rho = 1, \delta = 0; 90\%$ confidence intervals)

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<th>Post reform, variant 2</th>
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<td>Mean</td>
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<td>claim costs, £pw</td>
<td>entitlement,</td>
</tr>
<tr>
<td></td>
<td>£pw</td>
<td></td>
<td>£pw</td>
</tr>
<tr>
<td>All pensioners in sample</td>
<td>21.87 ± 0.76</td>
<td>1.57 ± 0.39</td>
<td>25.71 ± 0.75</td>
</tr>
<tr>
<td>Tenants in social housing</td>
<td>21.90 ± 0.84</td>
<td>1.30 ± 0.33</td>
<td>24.07 ± 0.78</td>
</tr>
<tr>
<td>Private tenants</td>
<td>23.34 ± 2.56</td>
<td>1.80 ± 0.51</td>
<td>44.19 ± 2.57</td>
</tr>
<tr>
<td>Owner-occupiers</td>
<td>21.16 ± 1.36</td>
<td>2.30 ± 0.60</td>
<td>22.03 ± 1.27</td>
</tr>
<tr>
<td>Head aged under 75</td>
<td>21.45 ± 1.36</td>
<td>1.16 ± 0.32</td>
<td>21.98 ± 1.12</td>
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<tr>
<td>Head aged 75-89</td>
<td>21.36 ± 0.85</td>
<td>1.73 ± 0.43</td>
<td>27.04 ± 0.88</td>
</tr>
<tr>
<td>Head aged 90+</td>
<td>31.37 ± 2.94</td>
<td>2.48 ± 0.61</td>
<td>40.72 ± 3.70</td>
</tr>
<tr>
<td>Single man</td>
<td>24.68 ± 2.05</td>
<td>2.18 ± 0.55</td>
<td>26.37 ± 1.72</td>
</tr>
<tr>
<td>Single woman</td>
<td>21.68 ± 0.78</td>
<td>1.45 ± 0.37</td>
<td>25.82 ± 0.80</td>
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<td>Couple</td>
<td>19.74 ± 2.65</td>
<td>1.83 ± 0.50</td>
<td>24.62 ± 1.84</td>
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</tbody>
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33
Table 6: The impact of claim costs on measured income change
(90% confidence intervals)

<table>
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<tr>
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<th>Post reform, variant 1</th>
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<th></th>
<th>Post reform, variant 2</th>
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</thead>
<tbody>
<tr>
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<td>Gainers mean gain, £pw</td>
<td>%</td>
<td>losses £pw</td>
<td>mean gain</td>
<td>%</td>
<td>losses £pw</td>
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<tr>
<td>All pensioners in sample</td>
<td>14.7 ± 0.4</td>
<td>15.06 ± 0.55</td>
<td>3.92 ± 0.18</td>
<td>7.21 ± 0.57</td>
<td>1.93 ± 0.09</td>
<td>17.7 ± 0.5</td>
</tr>
<tr>
<td>Tenants in social housing</td>
<td>37.9 ± 1.4</td>
<td>12.49 ± 0.48</td>
<td>11.32 ± 0.67</td>
<td>6.06 ± 0.41</td>
<td>4.05 ± 0.23</td>
<td>45.4 ± 1.7</td>
</tr>
<tr>
<td>Private tenants</td>
<td>28.8 ± 2.5</td>
<td>35.74 ± 1.88</td>
<td>7.03 ± 1.06</td>
<td>16.39 ± 3.53</td>
<td>0.95 ± 0.01</td>
<td>31.6 ± 2.5</td>
</tr>
<tr>
<td>Owner-occupiers</td>
<td>2.0 ± 0.1</td>
<td>9.32 ± 0.37</td>
<td>0 ± 0.01</td>
<td>0 ± 0.01</td>
<td>0.18 ± 0.01</td>
<td>2.8 ± 0.2</td>
</tr>
<tr>
<td>Head aged under 75</td>
<td>13.6 ± 0.6</td>
<td>12.24 ± 0.69</td>
<td>3.95 ± 0.26</td>
<td>7.20 ± 0.96</td>
<td>1.38 ± 0.10</td>
<td>16.0 ± 0.6</td>
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<tr>
<td>Head aged 75-89</td>
<td>15.2 ± 0.5</td>
<td>16.53 ± 0.73</td>
<td>3.80 ± 0.25</td>
<td>7.17 ± 0.69</td>
<td>2.23 ± 0.12</td>
<td>18.6 ± 0.7</td>
</tr>
<tr>
<td>Head aged 90+</td>
<td>23.6 ± 2.9</td>
<td>21.05 ± 2.92</td>
<td>6.46 ± 1.59</td>
<td>7.95 ± 2.48</td>
<td>4.45 ± 0.85</td>
<td>27.7 ± 3.3</td>
</tr>
<tr>
<td>Single man</td>
<td>14.4 ± 1.0</td>
<td>14.91 ± 1.13</td>
<td>2.93 ± 0.37</td>
<td>9.50 ± 2.37</td>
<td>1.86 ± 0.19</td>
<td>18.1 ± 1.1</td>
</tr>
<tr>
<td>Single woman</td>
<td>19.3 ± 0.6</td>
<td>14.03 ± 0.59</td>
<td>6.35 ± 0.59</td>
<td>7.01 ± 0.59</td>
<td>2.26 ± 0.13</td>
<td>23.1 ± 0.8</td>
</tr>
<tr>
<td>Couple</td>
<td>7.8 ± 0.5</td>
<td>19.06 ± 1.42</td>
<td>0.66 ± 0.11</td>
<td>5.53 ± 1.67</td>
<td>1.46 ± 0.11</td>
<td>9.3 ± 0.5</td>
</tr>
<tr>
<td>All pensioners in sample</td>
<td>13.6 ± 0.6</td>
<td>11.50 ± 0.62</td>
<td>3.94 ± 0.26</td>
<td>6.82 ± 0.92</td>
<td>1.29 ± 0.09</td>
<td>16.3 ± 0.7</td>
</tr>
<tr>
<td>Tenants in social housing</td>
<td>37.9 ± 1.0</td>
<td>11.70 ± 0.63</td>
<td>11.29 ± 0.25</td>
<td>5.67 ± 0.65</td>
<td>3.79 ± 0.11</td>
<td>42.8 ± 0.8</td>
</tr>
<tr>
<td>Private tenants</td>
<td>28.6 ± 2.6</td>
<td>32.92 ± 1.64</td>
<td>7.02 ± 1.06</td>
<td>15.40 ± 3.39</td>
<td>8.35 ± 0.89</td>
<td>30.6 ± 2.5</td>
</tr>
<tr>
<td>Owner-occupiers</td>
<td>2.0 ± 0.1</td>
<td>8.22 ± 0.28</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>0.16 ± 0.01</td>
<td>5.9 ± 0.3</td>
</tr>
<tr>
<td>Head aged under 75</td>
<td>13.6 ± 0.6</td>
<td>11.50 ± 0.62</td>
<td>3.94 ± 0.26</td>
<td>6.82 ± 0.92</td>
<td>1.29 ± 0.09</td>
<td>16.3 ± 0.7</td>
</tr>
<tr>
<td>Head aged 75-89</td>
<td>15.2 ± 0.5</td>
<td>15.25 ± 0.63</td>
<td>3.79 ± 0.25</td>
<td>6.66 ± 0.65</td>
<td>2.06 ± 0.11</td>
<td>20.0 ± 0.8</td>
</tr>
<tr>
<td>Head aged 90+</td>
<td>23.3 ± 2.9</td>
<td>19.66 ± 1.59</td>
<td>6.42 ± 2.27</td>
<td>7.38 ± 2.82</td>
<td>4.10 ± 0.17</td>
<td>32.1 ± 3.5</td>
</tr>
<tr>
<td>Single man</td>
<td>14.3 ± 1.0</td>
<td>13.60 ± 1.01</td>
<td>2.93 ± 0.37</td>
<td>8.67 ± 0.22</td>
<td>1.69 ± 0.17</td>
<td>17.6 ± 1.1</td>
</tr>
<tr>
<td>Single woman</td>
<td>19.3 ± 0.6</td>
<td>13.15 ± 0.51</td>
<td>6.34 ± 0.34</td>
<td>6.59 ± 0.56</td>
<td>2.12 ± 0.12</td>
<td>25.4 ± 0.9</td>
</tr>
<tr>
<td>Couple</td>
<td>7.8 ± 0.5</td>
<td>17.41 ± 1.27</td>
<td>0.65 ± 0.11</td>
<td>5.12 ± 0.62</td>
<td>1.33 ± 0.10</td>
<td>9.1 ± 0.6</td>
</tr>
</tbody>
</table>
Figure 1: FGT poverty index pre- and post reform, assuming complete take-up

Figure 2: FGT poverty index pre- and post reform, allowing for non take-up
Figure 3: FGT poverty index pre- and post reform, allowing for non take-up and claim costs
Appendix: Derivation of the sample used in analysis

In the three years of FRS data used in this paper there were 26,229 pensioner units consisting of single people aged 60+ or couples where either partner was aged 60+, who would therefore be eligible for the pensioner rates of IS, CTB and HB. The scope of the analysis in this paper was restricted, as follows, to a sub-sample of 12,801 pensioner units:

- Only those at least five years above state pension age (i.e. men aged 70+ and women aged 65+) were used in the analysis. 10,339 younger pensioner units were excluded.
- Those who had any income from employment or self-employment were excluded, reducing the sample by a further 525.
- The sample was restricted to households consisting solely of a single pensioner aged 65/70+ or a couple where both partners were five or more years above state pension age were included. The presence of other household members considerably complicates the calculation of entitlements and increases the scope for measurement error. This restriction excluded another 2,140 pensioner units.
- Households who were still re-paying a mortgage were excluded, reducing the sample by a further 413. Mortgage repayments exist for only a small minority of the age group of interest but affect the calculation of IS entitlement and are a potential source of measurement error.
- Eleven cases who were in receipt of allowances from a spouse not in the household were also excluded.

A further 3,389 cases were not included in the analysis due to data deficiencies:

- 1,300 for whom details on capital holdings were missing and entitlement to benefits could not be assessed
- 1,608 for whom other missing/ inconsistent data prevented entitlements being calculated reliably
- 444 who were receiving one or more benefit to which they were calculated to be not entitled.
- 37 other cases where components of pre-IS income were missing.