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**The Labor Supply Effect of  
In-Kind Transfers\***

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## **Abstract**

We estimate a model of labor supply and participation in multiple programs for UK lone mothers which exploits a reform of in-work transfers. Cash entitlements increased but eligibility to in-kind child nutrition programs was lost. We find that in-work cash and in-work in-kind transfers both have large positive labor supply effects. There is, however, a utility loss from program participation which is estimated to be larger for cash than for child nutrition. This implies that the partial cash out of the in-kind benefits reduced labor supply.

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## 1. Introduction

In-kind transfers are widespread and extensive. A recent survey (Currie and Gahvari (2008)) shows that the proportion of US welfare that is in-kind, as opposed to cash, has increased over time. Indeed, even abstracting from the rise in in-kind medical programs, the share of in-kind support has tended to increase. In 2002 Food Stamps, the School Lunch and Breakfast programs, and WIC (Supplemental Nutrition Program for Women, Infants and Children) alone accounted for over 0.33% of GDP.

Health, housing, childcare, education, and nutrition are commonly the subject of in-kind transfers. In some cases such transfers are targeted on low income and/or high need households; either directly through means-testing or, indirectly, through ensuring that self-selection occurs. In the UK, the most important means-tested in-kind transfer programs are housing subsidies for the poor, costing around 1.5% of GNP, and the two principal food transfer programs for low income households with children, costing a further 0.6%<sup>1</sup>. The self-targeting property of in-kind transfers, such that only the poor participate, has been one popular argument made in their support but this does not carry much weight in developed countries where income is relatively easy to observe. Indeed, there are few examples of in-kind transfers in developed economies that rely entirely on self-selection – most impose eligibility conditions, often related to income and/or needs. There is extensive evidence on the labor supply effects of cash transfer programs<sup>2</sup> but very little that addresses the effects of in-kind transfers.

Cash transfer programs are often supplemented by in-kind transfers. The expansion of the principal US in-work transfer program, Earned Income Tax Credit

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<sup>1</sup> Very recently the UK has seen the introduction of some universal free childcare provision, and some means-tested support for childcare expenditures. Neither program has had its labor supply effects analyzed.

<sup>2</sup> See Brewer *et al* (2008) for a recent overview for the UK, and Moffitt (1992) provides an extensive review of US research which is updated in Meyer and Rosenbaum (2001). Scholz (1996), for example, discusses the EITC expansion and implications for incentives.

(EITC), has been accompanied by the growth of in-kind transfers such as food stamps and medical cover for both the working and non-working poor. The UK has similar in-work, out-of-work, and in-kind transfer programs to the US and has experienced similar expansions of its principal in-work cash transfer program (now known as Working Tax Credit in the UK) but the expansion of this UK program was, in part, financed from removing in-kind entitlements. In contrast to the tendency for the US to expand in-kind provision, a UK reform in 1988 implied that low income *working* households with children experienced a rise in cash transfer entitlement but a loss of eligibility to in-kind transfers<sup>3</sup>. There was effectively a partial cash-out of in-kind transfers in 1998 for low income families with a working parent. However, in-kind transfers are again on the UK policy agenda and the welfare milk program that we analyze here has recently been expanded to include fruit and vegetables.

The objective of the paper is to measure the effect of in-kind transfers relative to cash by exploiting the observed variation in labor supply of lone mothers in pooled cross-section survey data. This paper exploits the 1988 reform to estimate a structural labor supply model which allows for endogenous multiple welfare program participation and we focus on the relative labor supply responses to cash and in-kind transfers. The model considers the effect on the labor supplies of a sample of lone mothers of the UK's Family Credit in-work cash transfer program (the precursor to Working Tax Credit), the out-of-work transfer program known as Income Support (roughly corresponding to the US TANF program), as well as the three principal in-kind programs for low income

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<sup>3</sup> Slesnick (1996) shows that the US the expansion of in-kind transfers for those out of work has been a major factor in protecting the living standards of the poor despite a fall in real cash incomes. The labor supply effect of the expansion of the UK in-work welfare program has been analyzed in Blundell (2006) and references therein.

households: Housing Benefit<sup>4</sup> for those with high housing costs, Welfare Milk Tokens for families with pre-school age children, and Free School Lunches for children of school age.

## 2. Existing Literature

There are at least three difficulties in estimating the impact of transfer programs on labor supply behavior. First, labor supply and program participation decisions may be determined simultaneously. For example, if labor supply depends on the net marginal wage and the net marginal wage depends on whether one participates in a transfer program. Moreover, the unobservable determinants of labor supply may also affect program participation giving rise to endogeneity. Secondly, in the context of multiple transfers, simultaneity arises because participation in any one program depends upon the level of entitlement, which is itself a function of receipt of other transfers. Thirdly, in the context of in-kind transfer programs, it may be difficult to place a value on them.

The existing literature on the effects of in-kind transfers on labor supply is sparse, despite the heavy expenditures that are made on such transfers. Three of the four published papers that are directly concerned with this issue take a structural approach to estimation: Fraker and Moffitt (1988) and Keane and Moffitt (1998) investigate single mothers, while Hagstrom (1996) considers the effects on the labor supplies of married couples<sup>5</sup>. They each adopt discrete choice approaches to labor supply modeling and assume that in-kind transfers are equivalent to cash. This implicitly assumes that preferences are separable in labor supply so that the only effect that such transfers have is

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<sup>4</sup> Housing Benefit is effectively an in-kind benefit in the UK since it is hypothecated to pay rent and in many cases it pays the rent directly.

<sup>5</sup> There are a few UK studies of program participation but these invariably assume that labor supply is exogenous: an example is Blundell, Fry and Walker (1988). Similarly, existing UK labor supply research on in-work transfer programs assume that program participation is exogenous to labor supply: an example is Brewer *et al* (2008).

through the income and substitution effects associated with their cash value<sup>6</sup>. In such a separable model, food stamps reduce labor supplies through both their income and substitution effects.

However, each of these studies allows for non-participation in welfare programs, including in-kind transfers, in a way which permits the cash value of an in-kind transfer to have a different effect on labor supply from an equivalent cash transfer. Such structural modeling makes explicit assumptions about the nature of preferences and identifies preference parameters from variations in budget constraints across households. Fraker and Moffitt (1988) use SIPP data to estimate a trivariate ordered probit model for discrete (ordered 3-state) labor supply, AFDC and Food Stamp program participation. Labor supply is estimated conditional on program participation and, although endogeneity is allowed for, separability between program participation and labor supply is assumed. In Keane and Moffitt (1998) AFDC, Food Stamps and housing subsidies are modeled as a trivariate probit simultaneously with a discrete choice (ordered 3-state probit) for labor supply.

One drawback of these papers is that they assume that if part-time work is preferred to non-participation, then so too is full-time work and therefore utility comparisons are not made between all alternatives. The validity of this depends upon the budget constraint being convex, which is invariably not the case for US (or UK) lone mothers. Hagstrom (1996) also uses SIPP data and consider a nested multinomial logit discrete model of labor supply with wives' discrete choices (unordered 3-state) conditional on husbands' (unordered 3-state) choices, and participation in food stamps

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<sup>6</sup> There are very few studies that investigate the extent to which preferences between labor supply and consumption goods are separable. Blundell and Walker (1982) decisively reject the assumption of weak separability in their work on married couples drawn from earlier cross-sections of the same data source that is used here. Currie and Gahvari (2008) emphasise the possibility that in-kind transfers could increase labor supply to the extent that they are complementary – for example, childcare subsidies.

conditional on both labor supplies<sup>7</sup>. Separability is still assumed and the unpalatable assumption with standard multinomial logit models of the independence of irrelevant alternatives is circumvented by allowing nesting. However, the ordering of the nesting is not innocent in this context, since food stamps are conditioned on wife labor supply which is, in turn, conditioned on husband labor supply. While this frees up the correlation structure somewhat, the assumed ordering of the nesting is arbitrary and implies that the correlations are not entirely unrestricted<sup>8</sup>.

All three of these structural papers<sup>9</sup> conclude that food stamps have small and insignificant negative effects on labor supplies<sup>10</sup>. In contrast, a recent fourth paper, by Hoynes and Schnanzenbach (2007), exploits the staggered introduction of the US food stamp program across counties and uses the PSID and pooled Census data to estimate its effect using a difference in differences methodology<sup>11</sup>. The paper is careful to consider the possibilities that the food stamp roll-out interacted with an earlier program. The PSID allows the effects on hours of work and participation to be estimated and they find economically large, but statistically insignificant, negative effects. A limitation of the Census data is that it only permits the analysis of the probabilities of labor force participation and family income exceeding \$10,000, and they find economically small, but statistically significant, negative effects..

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<sup>7</sup> Married couples are assumed not to be entitled to AFDC. In contrast, Hoynes (1996) focuses on the AFDC Unemployed Parents program.

<sup>8</sup> Train (2003) provides extensive details of the implications of IIA and tests for it.

<sup>9</sup> A further example is Brewer *et al* (2007) who estimate a structural model of labor supply together with program participation, but they ignore in-kind transfers. For identification, they rely on a 1999 change of Family Credit, whereas our paper exploits the 1988 reform. In 1999 FC was expanded considerably and its administration was changed. Importantly, they show that the stigma associated with FC fell and, together with higher entitlements, this generated a large increase in labor force participation.

<sup>10</sup> Along with almost all of the labour supply literature we assume that fertility and marital status are exogenous. Evidence on how responsive these are to welfare is mixed. See, for example, Joyce *et al* (2002) on fertility and Bitler *et al* (2004) on marital status.

<sup>11</sup> Fischer (2000) is an additional labor supply study which is concerned with US housing subsidies. He shows that they have large negative effects.

Our paper lies somewhere between the difference in differences and purely structural approaches. We adopt structural assumptions on preferences to allow us to simulate the effects of a complex reform and to break down its effects into those due to changes in cash program entitlements and changes to in-kind program eligibility rules. The benefit of adopting a structural approach is that we can learn more – once we have estimated preference parameters we can use those parameters to simulate the effect of other changes that may be of interest. Of course, the cost is that we adopt possibly restrictive assumptions<sup>12</sup>.

### 3. Transfer Programs in the UK

The nature of the UK welfare system relevant to the labor supply of lone mothers is well documented elsewhere<sup>13</sup> so only a brief review that highlights the main features is presented here. An important reform to the structure of UK transfer programs occurred in 1988. Income Support (IS, known as Supplementary Benefit before the 1988 reform) is cash and is the UK equivalent to the US TANF. This is intended to ensure that household incomes do not fall below some minimum. For lone parents eligibility to IS does not require them to be available or searching for work. Entitlement depends on the number and ages of children and it imposes a 100% implicit tax rate on all sources of household income above some minimal level. Housing Benefit (HB) covers a proportion of the rent and rates (a local property tax) for households not in receipt of IS where the proportion

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<sup>12</sup> One of the in-kind transfers (free school lunches) that we analyze has a seasonal element to it (it is only available during school terms) and the seasonal pattern has a regional dimension to it (school terms are different in Scotland relative to England and Wales). However, it seems unlikely that labor supply would vary in response to the short-run variations in the availability of free school lunches arising from school holiday periods. Thus, we do not feel that it is sensible to try to exploit this source of variation within a difference-in-differences framework.

<sup>13</sup> See for example Duncan and Giles (1996) and references therein. In our analysis we incorporate all welfare program entitlements (as well as income tax and social security contributions) into the budget constraints. Indeed all combinations of program participation are considered, and we shall describe only those in detail that are of direct interest for the current application.



depends on income - making it effectively a means-tested in-work transfer<sup>14</sup>. Family Credit<sup>15</sup> (FC) is payable to low income families but only if hours of work exceed some level - it is means-tested and is explicitly an in-work cash benefit. The main means-tested *in-kind* transfers are to low income households with children. Free School Lunches are an in-kind transfer equivalent of US National School Lunch Program. Welfare Milk Tokens are an in-kind transfer to households with pre-school children and are similar to the US Food Stamp program<sup>16</sup>. Hereafter the Free School Lunch and Welfare Milk Token programs are together denoted in-kind transfers to households with children (CH).

Welfare Milk Tokens were available for each child under age 5, and could be exchanged for 7 pints<sup>17</sup> of liquid milk per week. Free School Lunches were available for each school-aged child during school days.

While Income Support has an unambiguously negative effect on work incentives, FC exhibits a notch in the budget constraint which increases the probability of working (although, because FC is means tested, it may act as a disincentive to working long hours). Prior to the 1988 reform both IS and FC recipients were eligible for CH, but since 1988 only IS participants have been entitled: FC participants receive cash but no CH. Prior to 1988 those on FC were also eligible for the CH. The 1988 reform also involved an expansion of FC so that entitlement levels were higher. In effect, in 1988 there was a partial cash-out of CH for those with low incomes in work. This makes participation in

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<sup>14</sup> Income Support contains an element to cover housing costs which is as least as generous as the provisions of Housing Benefit. For example Income Support will cover certain mortgage interest payments while HB does not.

<sup>15</sup> FC was originally referred to as Family Income Supplement from 1973-1988, from 1988-1999 it was reformed and called Family Credit. It was expanded in 1999 and re-named Working Families' Tax Credit until 2003 when it was split into Working Tax Credit and Child Tax Credit. We are only concerned with the period around the 1988 reform and will use the term Family Credit throughout.

<sup>16</sup> See Currie (1996) for an exhaustive review of US in-kind transfers. Moffitt (1989) uses the Puerto Rico Food Stamp cash-out as a natural experiment to estimate the value of an in-kind transfer directly.

<sup>17</sup> Imperial pints contain 20 fluid ounces (568ml), compared to 16 for US pints (473 ml).

the CH programs important to the work participation decision post-reform, whereas pre-reform CH was *also* important for the hours of work choice conditional upon participation. Essentially a budget constraint notch (a discontinuity equal to the value of the CH) has moved back from the point where FC exhaustion occurred to the point where IS runs out.

To clarify the way in which IS, FC, and CH might affect labor supply, Figure 1 shows a characterization of a possible budget constraint. We assume, for simplicity of illustration, that there is no HB entitlement (i.e. this individual lives rent free or in owner occupied accommodation) and we ignore income taxation and social security contributions. The dashed line from the origin represents the budget constraint in the absence of the welfare programs, with slope equal to the wage rate. The black bold line A-B-C-D-E-F is the budget constraint with cash transfers pre-reform. A-B is the level of Income Support entitlement at zero hours of work. B-C is flat because Income Support is means-tested with a withdrawal rate of 100%. When hours reach 24, Family Credit becomes payable with an entitlement given by the vertical distance C-D. As hours and earnings increase, Family Credit is withdrawn at 70% along D-E. Entitlement is exhausted at point E. E-F is beyond the welfare system. Free School Lunches and Milk Tokens are associated with both Income Support and Family Credit and the monetary value of these are denoted by dashed-dotted lines.

The reform affects both cash and in-kind transfers from 24 hours of work. The cash transfer budget line is denoted A-B-C-D'-E'-F. Changes to the cash budget line are colored green. Family Credit became somewhat more generous as denoted by C-D', and was withdrawn at 50% along D'-E'<sup>18</sup>. Crucially, in-kind transfers were lost for those on

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<sup>18</sup> The 70% taper under the pre-reform FC system was based on gross income, while the 50% taper under the post-reform system was based on income net of tax and social security.

Family Credit. The monetary of this loss is denoted by the red colored dashed-dotted line. In-kind transfers are now only associated with Income Support and monetary value of this is unchanged and denoted by the black dashed-dotted lines. Of course, in practice, Housing Benefit, income tax and social security contribution systems overlay this figure which causes additional complexities that we ignore in this stylized diagram. However the figure conveys the essential two elements of the in-work reform: an increase in cash generosity and the loss of in-kind transfers.

There are no official figures for CH program participation. Official figures based on FES data (see Department of Social Security (1991)) for lone parent FC program participation in 1987 are not available although the total figure for couples and lone parents was 51% of eligible cases (so-called, caseload take-up). Earlier unofficial figures in Fry and Stark (1993) are similar. Subsequent official statistics were based on the FES data pooled over successive years and the figure for 1990/91 (1991/1992) is 62% (66%).. Comparable 1987 figures for HB and IS are 69% and 95% respectively. Clearly HB and FC have a more serious "take-up" problem than IS, and this motivates our approach of modeling FC and HB take-up but assuming IS entitlements are received..

Family Credit was a welfare program and not part of the income tax system<sup>19</sup>. Claiming FC involved completing a (long and detailed) form every 6 months and verifying earnings by producing three consecutive monthly (or seven weekly) pay slips. Employers were contacted to verify that applicants met the minimum hours condition if that was not apparent from the pay slips<sup>20</sup>. Asset information was also required but, at least for lone parents, this usually involved no more than stating that one did not have

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<sup>19</sup> Family Credit was subsequently replaced by Working Families' Tax Credit (WFTC) in October 1999. One way in which WFTC differed from FC was that, in most cases, it was to be delivered via employers in the pay cheque. A second difference was that WFTC was administered by the tax, not the welfare, authorities.

<sup>20</sup> Our sample period pre-dates the 1999 introduction of the UK national minimum wage.

assets which exceeded a large value. Housing Benefit was complicated because it was administered by local government offices rather than the welfare authorities, each with slightly different claim procedures and forms. Invariably the level of rent had to be verified but tenants usually had “rent books” or tenancy agreements that would serve this purpose. New applications had to be made whenever circumstances changed. Income Support usually involved an interview at a local office of the Social Security Department, where applicants were asked about their detailed circumstances and expected to produce substantiating documentation.

In contrast, in-kind transfers required that applicants only complete a short form detailing the number and ages of their children and verify that they were in receipt of Income Support (or also Family Credit prior to the 1988 reform). Income Support for lone mothers did not require that they were “available for work” so, unlike the case of long term unemployed, there was no requirement to “sign-on” (periodically declare that one was available for work) at the local office of the government Department for Employment. Income Support, Family Credit and Housing Benefit, at the time, was paid directly into a bank account or, for those without an account, by mailing a “giro cheque” that could be cashed at Post Offices<sup>21</sup>

Welfare Milk Tokens were small colored plastic disks which could be exchanged in shops, or with doorstep delivery services, and sellers were then reimbursed by the Department of Health. They were eventually replaced by books of vouchers. Over this

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<sup>21</sup> In the case of those living in social housing, which was still common in the early 1990’s, HB may have been paid directly to the local government since they also acted as the landlord.

period, schools maintained a list of Free School Lunch eligible children, and would issue them with tickets each week. Ineligible children had to buy their tickets weekly<sup>22</sup>.

The major distinguishing feature of claiming cash program entitlements is the high costs of claiming, compared to the low marginal costs of claiming an associated in-kind transfer. Moreover, it seems likely that in the majority of cases the only agents who knew that individuals were receiving cash transfers were the recipients themselves and government officials, while knowledge of in-kind transfer receipt was potentially shared with local shop assistants and peers at school. It seems likely that non-participation in the cash programs by those who were eligible was largely driven by imperfect information and the transaction costs of claiming, while it seems likely that in-kind transfers may have low value for the user to exchange, perhaps because of stigma, but have relatively low information/transaction costs for the claimant. Of course, in the absence of identifying information on factors that might affect take-up but not labor supply, such as experimental, or at least local, variation in claiming costs, identifying the causes of non-participation is problematic.

#### 4. Family Expenditure Survey Data

Our data consist of 15 pooled cross-sections of Family Expenditure Surveys from April 1978 to March 1992<sup>23</sup>. In order to abstract from intra-household distributional issues we select a sample of lone mothers who are householders which yields 4527

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<sup>22</sup> Storey and Chamberlin (2001) provide details of qualitative research that is directed towards improving take-up of Free School Lunches, such as ensuring that the free and paid-for tickets are indistinguishable and that a separate queue for lunch is not imposed on the recipients of free tickets.

<sup>23</sup> It is difficult to use data prior to 1978 because of the absence of schooling information, used in the estimation of wage equations, and data beyond 1992 does not contain appropriate information about housing costs to deal with changes in the local tax system that occurred at this time. Moreover, from April 1992 the minimum hours requirement for FC was reduced to 16. We restrict our attention to the period before April 1992 to avoid this complication.

observations<sup>24</sup>. We compute eligibility and the level of entitlement from a very detailed routine that acknowledges all relevant features of the tax, welfare and social security contribution systems including in-kind transfers<sup>25</sup>. The labor supply data is usual weekly hours and relates to the survey week. We divide the observed data into groups according to weekly hours of work as: unemployed (UE), defined as usual hours are zero and economic position is coded as "searching for work"; non-participants (NP), defined as having hours less than 10 and not searching for work; lower part time (LPT) defined, as hours ranging from 10 to 19; higher part time (HPT), with hours from 20 to 29, and full time (FT), defined as hours 30+. Table 1 shows some summary statistics broken down by labor supply status and pre/post reform. Figure 2 shows the usual weekly hours of work distributions (in 4-hour bin widths) both before and after the 1988 reform. There is an increase in zero hours, largely at the expense of full time work. Hourly data (not shown) exhibits reporting modes at multiples of 10 and 5 hours, and there is a pronounced spike at 24 which is the minimum hours of work requirement for receiving FC<sup>2627</sup>.

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<sup>24</sup> We exclude households containing multiple "benefit units" in order to focus on a more homogeneous sample of lone mothers making independent labour supply and program participation decisions.

<sup>25</sup> The routine is based on the Institute for Fiscal Studies' TAXBEN computer program but deals with all of the changes that have taken place between 1978 and 1992. See Johnson, Stark and Webb (1990) for details of TAXBEN. Moreover, we allow for wages to be determined differently across employment states because of the large differential between part-time and full-time wages rates that is a feature of the UK labor market (see Ermisch and Wright (1991)).

<sup>26</sup> Saez (1999) shows that bunching at kinks in the budget constraint can easily become less apparent with even modest amounts of measurement error.

<sup>27</sup> Subsequent to our data, the minimum hours level for entitlement to FC fell from 24 to 16 (from April 1992), and from July 1995 a further notch in the budget constraint was introduced when a £10 addition to FC entitlement was added for those working 30 hours or more, but these are outside the period of our data. In principle, we could treat the April-December 1992 data as a hold-out sample and use our estimates to compare the predicted consequences of the reduction in the hours requirement with actual behavior. However, the reform was implemented when cases renewed so it would not be until October 1992 that all cases would face the new hours minimum and this would leave us with 90 observations.

Program participation is summarized in Table 2 where the data is divided according to our definition of labor force status<sup>28</sup>. The table uses actual observed weekly income and hours worked data to compute eligibility. The participation rates ("take-up" rate of entitlements) are computed to be 45.4% for FC, 58.4% for Housing Benefit and 85.6% for CH. These figures are somewhat lower than official rates because the official methodology includes "pipeline" cases, estimated from administrative data, in the numerator.

As is to be expected there are significant numbers of participants who are apparently ineligible. In the case of FC these arise because there is no requirement to report changes in circumstances once eligibility is established (on the basis of 3 months or 7 weeks worth of documented income and hours), and eligibility lasts for 6 months before it needs to be re-assessed<sup>29</sup>. For CH there is some local authority discretion in the provision of nutrition transfers to children at school and disabled children may be eligible but we cannot observe this in our data<sup>30</sup>. HB has the largest proportion of ineligible participants. Fry and Stark (1993) point out that this is largely because of payments of arrears for those who may not be entitled on the basis of current circumstances.

The importance of observed multiple transfer receipt (ignoring calculated entitlement) is shown in Table 3. The sample proportions receiving 3, 2, 1 and 0 transfers are respectively 1.6, 6.3, 66.7 and 25.4%. While the data appears to be dominated by individuals receiving just a single transfer this is because of the low level of labor market

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<sup>28</sup> The sensitivity of the labor supply model estimates to the hours grouping was tested. Parameters were not significantly affected by altering the LPT and HPT criteria, until HPT reaches 35 hours, which brings the FT hours peak into HPT

<sup>29</sup> This property generates incentives for inter-temporal substitution that can cause ineligible participation. Moreover, there is no requirement to report changes in circumstances that affect eligibility.

<sup>30</sup> We allow for non-receipt of CH associated with school summer vacations. Other vacations are difficult to time. However, observations report receipt of CH over two consecutive weeks and it is extremely unlikely that this survey period would exactly coincide with a two week school vacation break. We count a household as a participating in CH if there are *any* free school meals reported in a two week period.

participation (we would expect to find multiple transfer receipt for those in-work). Sample proportions entitled to multiple transfers are much higher<sup>31</sup>. The 40 cells in Table 3 each correspond to a term in the likelihood in our econometric analysis in Section 5

## 5. Econometric Framework

The budget constraints faced by UK lone mothers are likely to take complicated piecewise-linear forms with several important non-convexities, as illustrated in Figure 1 in the previous section<sup>32</sup>. We follow much of the literature on modeling the labor supply of low income households and approximate continuous hours by a choice among discrete alternatives<sup>33</sup>. Recent labor supply work, for example by Keane and Moffitt (1998), Hoynes (1996), and Brewer *et al* (2007) takes the discrete choice approach. The first uses an ordered probit Random Utility Model. The drawback of this approach is that scaling it up to handle a large number of choices requires moving to simulation based estimation methods because of the complexity of the integration involved. In contrast, the second and third papers treat choices as a multinomial logit where the number of choices is effectively irrelevant to the computational complexity. The drawback here is that the multinomial logit imposes the restriction that preferences must satisfy the independence of irrelevant alternatives property. However, Hoynes (1996) and later work relax this restriction by allowing for an additive stochastic term to the utility associated with each

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<sup>31</sup> IS receipt is not included in Table 3. Consequently multiple receipts are understated, for example, 80% of CH recipients also receive IS.

<sup>32</sup> One non-convexity is due to the FC notch at 24 hours interacting with the 100% tax faced by those on IS. More non-convexities arise from FC and HB eligibility ceasing as earnings rise. Withdrawal of CH creates a notch where IS ends post 1988, and where FC ended prior to 1988. A notch exists at the lower earnings limit for social security contributions.

<sup>33</sup> The use of discrete choice modeling for labor supply problems has a long history. Zabalza, Pissarides and Barton (1980) characterize the choice over retirement, part-time or full-time work as an ordered probit with random parameters for a sample of older people. They can do this because their sample exhibit kinked but *convex* budget sets. Moffitt (1984) estimates a discrete choice model where there is gross wage endogeneity which is modeled as a quadratic relationship between wages and hours. Fraker and Moffitt (1988) is an example that includes in-kind transfers (Food Stamps).



choice. Hoynes (1996) considers participation in a single program (AFDC-UP) together with husband and wife discrete choice labor supply. This is a model of labor supply and cash program participation, and still represents the state-of-the art in the literature. The econometric framework is a multinomial logit with hours approximation error which is integrated out together with finite mixing. This is an unordered choice framework which does not impose independence of irrelevant alternatives (IIA). Furthermore there is no need to assume separability between labor supply and program participation. Brewer *et al* (2006) also follows the multinomial logit approach and also avoids the independence of irrelevant alternatives by allowing unobserved heterogeneity to enter in a number of ways – through program participation costs, and unobservable costs of labor market participation as well as random parameters.

Like Hoynes and Brewer *et al*, we allow for unordered labor supply choices, but we do not adopt the logit with mixing to avoid IIA but rather use a multinomial probit. That is, like Keane and Moffitt (1998), we adopt a probit specification but we do not restrict it to be ordered.. Like Hoynes and Brewer *et al*, we also allow for unobserved heterogeneity through random parameters. While our approach would not scale up to a larger choice set with the same ease as those based on a multinomial logit framework, it has the same degree of flexibility.

It is useful to summarize the restrictions we have put on the labor supply and program participation model so as to place these in the context of the literature. We assume that program participation is a function of demographics and income from the program. This function does not vary across labor market states, demographics do not vary across state, only program income varies. Hence we obtain a program participation index which varies across labor market state according to this function of entitlement. Exploiting the nature of the choice set and restricting program participation functions

makes the problem a much more tractable without imposing further restrictions on preferences or functional form. For example, FC eligibility is restricted to those in work and CH is restricted to Income Support recipients and only to FC recipients pre-reform.

McFadden (1984) surveys the discrete response literature and motivates a choice of modeling framework appropriate to the present context following Hausman and Wise (1978). That is, we estimate an unordered Probit Random Utility Model over labor supply states and participation in transfer programs. Furthermore, we control for the fact that some of those not working would rather be employed – i.e. are involuntarily unemployed<sup>34</sup>. These choices are determined by, among other things, the income levels associated with each state. Since we only observe the one alternative that is chosen, we need to predict incomes for each state from the income in the observed state. However, it would be computationally demanding to estimate the wages associated with each labor market alternative jointly with the choice among alternatives<sup>35</sup>. But since we only require consistent predictions of wages in order to estimate the determinants of each state, we adopt a two-step procedure. In the first step we estimate full-time and part-time wage equations which use a reduced form for labor market status to control for the endogeneity of hours and use these estimates to predict incomes in the part-time and full-time positions<sup>36</sup>. Income for non-participants is computed from the welfare system and

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<sup>34</sup> This seems particularly important since our data covers a period when there was widespread unemployment.

<sup>35</sup> Modelling wages and choices jointly is impractical since each evaluation of the likelihood would require a pass through the tax-benefit code. Our budget constraint is highly non-convex and this would be computationally demanding.

<sup>36</sup> MaCurdy, Green and Paarsch (1990) show that inconsistent estimates may result from using predicted gross wages in a non-linear second stage labor supply equation. One solution is to integrate out the prediction error in the wage equations, at the cost of increasing the dimensionality of the estimation problem. Van Soest (1995) does this for the Netherlands, on top of a simpler logit structure, and finds labor supply elasticities to be unchanged. However, in view of the complex, highly non-linear nature of the UK tax-benefit system we regard the errors in predicting wages to be of second order importance.

observed unearned (non-transfer) income. In the second step, we estimate the random utility model using the predicted incomes in each state<sup>37</sup>.

The budget constraint is approximated by just four discrete labor supply alternatives: non-participation (NP), low hours part-time (LPT), high hours part-time (HPT) and full-time (FT)<sup>38</sup>; in combination with three transfer programs: Family Credit (FC), Housing Benefit (HB) and in-kind transfers to children (CH). So individuals face at most (5\*8=) 40 possible alternatives (4 labor supply states plus unemployment and 3 binary transfer program combinations). The choices between these alternatives are driven by differences in the utilities attached to them. To be consistent with choice theory implies determining all 31 utility differences (8 alternatives involve unemployment which we do not regard as a distinct choice).

We are able to reduce the dimension of the problem by taking advantage of some of the restrictions inherent in the structure of the model. Let  $p$  index each program in the set of programs  $P=\{HB, FC, CH\}$ . Participation in each separate program is indicated  $T^p$ , which together compose the complete program participation vector  $\mathbf{T}_s^p = (T^{HB}, T^{FC}, T^{IK})'$ . Hence participation in programs  $\mathbf{T}_s^p$  and labor supply  $h_s$  completely characterize a state,  $s$ . Let the utility associated with choosing state  $s$  be  $U^*(y_{is}^0, h_{is}, \mathbf{y}_{is}^p, \mathbf{T}_{is}^p; \mathbf{X})$  where  $\mathbf{y}_{is}^p$  is the income associated with the programs  $P$ ,  $y_{is}^0$  is other (i.e. non-transfer) income,  $h_s$  is hours,  $\mathbf{T}_s^p$  is the program participation vector associated with this alternative, and  $\mathbf{X}$  is a vector of individual characteristics.

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<sup>37</sup> In common with the program participation literature, we do not take into account errors in classification which may arise through miss-measurement of transfer receipt or errors in calculating eligibility. We appeal to our good match with aggregate data and our adoption of best practice entitlement calculations to support this omission. See Poterba and Summers (1995) for a treatment of errors in classification in the context of unemployment transitions.

<sup>38</sup> We compute their incomes at 6, 16, 26, and 36 hours.

Now consider a statistical specification which allows for random variation in behavior due to an additive disturbance and variation in tastes,  $U^*(y_{is}^0, h_{is}, \mathbf{y}_{is}^p, \mathbf{T}_{is}^p; \mathbf{X}, \varepsilon_{is})$ , where  $U_{is}^*$  is unobservable utility of state  $s$  for individual  $i$ ,  $\varepsilon_{is}$  is an alternative specific random error term. Thus, the utility gain of moving from alternative  $s$  to  $t$  is:

$$(1) \quad U_{is}^* - U_{it}^* \equiv U^*(y_{is}^0, h_{is}, \mathbf{y}_{is}^p, \mathbf{T}_{is}^p; \mathbf{X}, \varepsilon_{is}) - U^*(y_{it}^0, h_{it}, \mathbf{y}_{it}^p, \mathbf{T}_{it}^p; \mathbf{X}, \varepsilon_{it})$$

In a discrete choice model the set of alternatives is assumed to be common across individuals. We assume that labor supply is a function (which is allowed to vary across hours) of individual characteristics (which are fixed irrespective of hours), and a function (which is fixed across hours, but varies across programs) of characteristics of alternative combinations of programs and hours (which vary across hours and programs). In other words, labor supply is a function of individual-specific characteristics and alternative-specific characteristics. In particular, hours comparisons are a function of demographics and incomes. The utility difference between labor supply states can be expressed as

$$(2) \quad U_{is}^* - U_{it}^* \equiv \mathbf{g}(y_{is} - y_{it}) \boldsymbol{\psi}_i + X_i \boldsymbol{\omega}_{st} + (\varepsilon_{is} - \varepsilon_{it})$$

where  $\boldsymbol{\psi} = (\psi^{HB}, \psi^{FC}, \psi^{IK}, \psi^0)'$ , with  $\psi_i = \bar{\psi} + \tilde{\psi}_i$ ,  $\mathbf{g}(y_{is} - y_{it})$  is assumed to be linear, and  $\boldsymbol{\psi} = (\psi^{HB}, \psi^{FC}, \psi^{IK}, \psi^0)'$  with  $\psi_i^p = \bar{\psi}^p + \tilde{\psi}_i^p$  is a matrix of functions of differences in net incomes (from transfer programs  $\mathbf{y}_{is}^p$  and non-program sources  $y_{is}^0$ ). The choice of  $\mathbf{g}(\cdot)$  is arbitrary. Brewer *et al* (2006) use a quadratic utility function in their analysis of the successor program to Family Credit, but here we find that a linear local approximation can be accepted.  $\bar{\psi}$  reflects the mean tastes of the sample while  $\tilde{\psi}_i$  is a coefficient which shows how  $i$  differs from the mean individual, and  $(\varepsilon_{is} - \varepsilon_{it})$  is an additive disturbance

assumed to be iid across  $i$  but not necessarily across  $s$ <sup>39</sup>.  $\varepsilon_{is}$  could represent unobserved attributes of alternatives or individuals which affect choices but, by assumption, are uncorrelated with  $\tilde{\psi}_i$ . The  $\varepsilon_{is}$  does not in itself capture variation in tastes. The appropriate way to model differing tastes among individuals with identical observables is to estimate a taste variance parameter,  $\tilde{\psi}_i$ <sup>40</sup>.

As usual in this class of model, only the utility differences between the number of alternatives minus one can be identified. It is possible to interpret the parameters  $\omega_{st}$  as a gain (or a loss) in utility from having the characteristics  $\mathbf{X}$  when one compares the alternative  $s$  to the alternative  $t$ , where the latter choice is the reference.

To summarize, from equation (2), the probability of observing  $i$  in labor market state  $s$  is given by

$$(3) \quad \Pr[U_{is}^* > U_{it}^*] = \Pr[\mathbf{g}(y_{is} - y_{it})\boldsymbol{\psi}_i + X_i\boldsymbol{\omega}_{st} > (\varepsilon_{is} - \varepsilon_{it})] \quad \forall s \neq t$$

Program participation is assumed to be a function (which does not vary across hours) of individual and program characteristics: specifically, demographic variables and the levels of entitlement. Consequently program participation can vary with labor market state, as does entitlement and eligibility. In particular, an individual  $i$ , in labor market state  $s$  will take-up transfer  $p$  if it offers a utility gain. This is assumed to be determined by the following latent and observed program participation (take-up) equations:

$$(4) \quad T_{is}^p = \begin{cases} 1 & \text{if } T_{is}^{p*} \equiv \mathbf{V}_i^p \boldsymbol{\beta}^p + Y_{is}^p \boldsymbol{\gamma}^p + \eta_{is}^p > 0 \text{ and } E_{is}^p > 0 \\ 0 & \text{otherwise} \end{cases} \quad \forall p = HB, FC, IK$$

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<sup>39</sup> Hausman and Wise (1978) assume  $(\varepsilon_{is} - \varepsilon_{it})$  to be iid across alternatives too.

<sup>40</sup> Fischer and Nagin (1981) show that failure to incorporate this taste variation induces a downward bias to estimates of taste parameters. Demographics could also be included in the variance term, but in the absence of strong priors guiding what ought to be included, this is not pursued.

where  $T_{is}^{p*}$  is the latent variable corresponding to observed take-up  $T_{is}^p$  of a transfer program  $p$ , which we define to be unity if  $i$  is observed to be participating in the program and zero otherwise;  $\mathbf{V}_i^p$  is a vector of individual characteristics which do not vary across labor market states;  $\beta^p$  is a corresponding vector of parameters;  $Y_{is}^p$  is transfer entitlement which may vary across labor market states;  $\gamma^p$  is an associated coefficient and  $\eta_{is}^p$  is a random error. Observed program participation is zero if entitlement,  $E_{is}^p=0$ .

The relationship between labor supply and program participation is established through the income function  $\mathbf{g}(.,.)$ . Hours comparisons are made on the basis of income differences, amongst other things. These differences are decomposed into HB, FC, CH and other income differences separately. Other income is differenced directly, whereas the differences in program incomes are the differences in the program participation indices, which are, in turn, a function of entitlement levels. It is straightforward to show that when comparing labor market states  $s$  and  $t$ , the difference in program participation indices between states turns out to be a function of entitlement differences only. That is,

$$(5) \quad T_{is}^{p*} - T_{it}^{p*} \equiv (Y_{is}^p - Y_{it}^p) \gamma^p + (\eta_{is}^p - \eta_{it}^p)$$

It is evident from equation (5) that  $T_{is}^{p*}$  has the dimension of income, and can be interpreted accordingly. Restricting program participation to be a function of size of benefits allows only for “variable cost stigma” in the terminology of Moffitt (1983). This is relaxed by allowing take-up to also be a function of individual demographic characteristics, thus further incorporating “fixed cost stigma”.

Our model does not require that we impose additive separability between labor supply and program participation<sup>41</sup>. Indeed, imposing the restriction  $\psi^p = 0$  allows a direct test of separability between labor supply and participation in each program  $p$ . Furthermore,  $\tilde{\psi}_i^p$  allows taste heterogeneity to vary across types of income.

It is useful to summarize the restrictions we have put on the labor supply and program participation model so as to place these in the context of the literature. We assume that program participation is a function of demographics and income from the program. This function does not vary across labor market states, demographics do not vary across state, only program income varies. Hence we obtain a program participation index which varies across labor market state according to this function of entitlement. Exploiting the nature of the choice set and restricting program participation functions makes the problem a much more tractable (4 labor market alternatives, unemployment and 3 programs) 7-equation system<sup>42</sup>.

The relationship between labor supply and program participation comes through differences in incomes and functions of entitlements. We assume multivariate normality of error terms and allow additional flexibility by estimating random coefficients on income differences. Hoynes (1996) imposes an even more restrictive logit error structure, but frees this up by adding heterogeneity terms following Heckman and Singer (1984). A novelty of our approach is that: we allow taste heterogeneity through random coefficients; we nest additive separability of labor supply and program participation; but impose only a

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<sup>41</sup> Non-separability means that program participation directly affects labor market status in addition to its effect through income levels at each state. Note from Equation (5) that although the terms in individual characteristics cancel out, the error terms do not. These terms carry through into the variance of the labor supply function (see the Appendix).

<sup>42</sup> A similar functional restriction is imposed by Keane and Moffitt (1998).

minimal economic structure on the data. Details concerning stochastic specification, likelihood contributions and implementation are relegated to the Appendix.

The importance of allowing for involuntary unemployment in a labor supply model is quite well established in the literature and this seems particularly appropriate for the period covered by this data. Falsely assuming everyone to be on their labor supply curve may exaggerate the estimated disincentive effects of the welfare system. The Family Expenditure Survey data we use asks those with zero hours work in the labor market whether they are actively looking for a job and we follow Blundell, Ham and Meghir (1987) and others who use this information to discriminate between voluntary non-participation and involuntary unemployment<sup>43</sup>. This is important because women who are involuntarily unemployed are not observed to be in their most preferred state, and must be classified appropriately in a choice model. For the purposes of labor supply modeling this group is assumed to reveal that some positive hours state is preferred to zero. Furthermore, individuals observed in any positive hours labor market state are assumed to prefer their observed state to all alternatives and are not rationed in exercising this preference. They are distinguished by the following reduced form latent and observed unemployment rationing equations

$$(6) \quad R_i = \begin{cases} 1 & \text{if } R_i^* \equiv \mathbf{Z}_i \boldsymbol{\tau} + v_i > 0 \\ 0 & \text{otherwise} \end{cases}$$

where  $R^*$  is the latent variable describing the rationing process, and  $R_i$  is the observed outcome, which we define to be unity if  $i$  is observed to be not working and searching for work and zero otherwise.  $\mathbf{Z}$  is a vector of demand side variables,  $\boldsymbol{\tau}$  is a corresponding vector of parameters, and  $v_i$  is a random error. While this is an extension that has not

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<sup>43</sup> Allowing labor market rationing does not mean that we rule out fixed costs in the participation decision. Indeed, Blundell, Ham and Meghir (1998) apply a search theoretic framework to a labor supply model with job seekers, allowing for fixed costs of work. We do not develop this interpretation here, and assume these unobserved costs to be part of the choice-specific and ration error terms.



previously been considered in the labor supply and program participation literature, we consider it important because we would otherwise understate the extent of program non-participation. That is, we would assume that non-workers prefer that state to, say, part-time work with program participation when in fact they simply cannot find a job<sup>44,45</sup>. Our objective is simply to control for potential misclassification with an auxiliary reduced form rationing function.

The labor supply equations are identified because there are households without eligibility to transfers at any employment status: largely because they have high wages and/or unearned (non-transfer) incomes. Labor supply choice itself is distinguished from unemployment rationing by the exclusion of regional unemployment rate from labor supply functions. Identification of the determinants of participation in the various programs is achieved through exogenous variation in eligibilities and entitlements. Time series variation in real housing costs are extremely important in affecting HB entitlement, and the variation in real school lunch and milk prices determine the value of CH entitlements<sup>46</sup>. For both FC and CH we rely on the fact that the data spans the reform in 1988: FC entitlements were increased and associated in-kind transfers lost. Thus, our method relies on both step change associated with the policy reform and the time series variation in entitlements that using 15 years of data allows.

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<sup>44</sup> The specification for the determination of wages is  $\log w_i^h = Z_i^h \gamma^h + e_i^h$  for  $h=PT, FT$  and where  $PT(=LPT+HPT)$  and  $FT$  indicate part-time and full-time labor force status. We estimate the wage equations by including the Mills Ratios from a Bivariate Probit model of participation *vs.* non-participation and full-time *vs.* part-time work conditional on participation. We include the level of unearned income in the reduced form labor force status equations but not in the wage equations to achieve identification. Details are available on request.

<sup>45</sup> To reduce the dimensionality of our model we appeal to the results in Blundell, Ham and Meghir (1987) which tests for the exogeneity of rationing in their double hurdle model of labor supply and finds that their FES data supports this.

<sup>46</sup> We assume, like virtually all of the labor supply literature, that labor supply depends only on prices through the real wage: milk and food prices do not directly affect labor supply.

## 6. Estimates

The model estimates are presented in Table 4. The labor supply and rationing equations (upper pane) and program participation (lower pane) equations are all estimated simultaneously. It is convenient to discuss each pane in turn as the nature of the two sets of dependent variables is different, and consequently the interpretation differs accordingly.

In the top pane, the labor supply model has two types of explanatory variable: alternative-specific (income differences) and alternative invariant (demographics). For income differences we estimate a coefficient mean and variance (indicated in the table by *Random*) and for demographics we estimate a coefficient mean (indicated by *Fixed*) only.

Consider the fixed parameters in the labor supply model. A negative sign implies that a variable is associated with decreasing the probability of moving to the destination state. For example, a negative coefficient on *Widow* in the  $LPT \rightarrow NP$  equation means that being a widow makes one less likely to prefer *NP* than *LPT*. A number of coefficients are worth remarking on at face value. The presence of young children reduces the *FT* probability, and pre-school aged children reduce the probability of working any positive hours. The coefficients in the  $HPT \rightarrow NP$  equation are not well determined, though they are significantly different from the corresponding coefficients in the other comparisons with *NP*. This suggests that a specification which allows for region and time effects everywhere may be asking too much of our relatively small part-time sample, though *HPT* ought still to be considered a distinct alternative in its own right.

Interpretation of the *random* parameters on alternative-specific variables is more direct. This tells us of the impact of the difference in the variable between states on the probability of being in any state. A positive sign implies that states with larger values of

the variable are preferred to those with smaller values. The positive coefficient,  $\bar{\psi}$ , on an income difference implies that more of that income is preferred to less. As well as estimating the mean of the income difference coefficients, the variance of  $\tilde{\psi}_i$  is estimated to allow for taste heterogeneity.

Income difference coefficients are estimated according to program. Program income differences arise through differences in  $Y_i^p$  across different states, where  $p$  is FC, CH or HB. For CH we use market value of the transfer. Since the level of demographic variables is alternative-invariant, what remains is a function of transfer entitlement only. These functions are comparable across programs, and our estimates imply that FC entitlement has less of a labor supply effect than does CH entitlement, and HB does not have a significant effect at all on labor supply.

Other (that is Income Support and earned) income enters into the labor supply function directly. We can put the  $Y^{other}$  coefficient into some perspective by calculating the implied utility gain associated with an additional pound of other income at 0.0447 (4.474/100). Furthermore, the utility loss associated with working LPT, HPT, FT is 0.92, 1.06, 1.27, which is valued at £20.56 (sd 5.14), £23.69 (sd 1.56), £28.38 (sd 4.47) respectively on average for the sample<sup>47</sup>. This compares with the utility gain from an extra £1.00 of FC and CH of 0.0222 (= 0.0690 x 0.3223) and 0.0362 (= 0.0748 x 0.4843) respectively – which, in money terms, is approximately £0.49 and £0.81. We are able to treat the difference between regular and transfer income as a measure of stigma. Hence the variable cost stigma of FC participation at mean positive entitlement of £25.10 is £12.58. Similarly for a mean positive CH entitlement of £7.33, the variable cost stigma is £1.39.

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<sup>47</sup> These numbers are calculated from the mean of the levels of the indices, and their differences.

These results suggest the economic model is supported by the data: there is a utility gain from income, a loss from working and a significant variable cost stigma to program participation. Further support for the choice of modeling framework is given by the significant correlations between the unobservables in the choice equations. Significant random parameters on the income functions support the random utility approach which accommodates taste heterogeneity.

In the lower pane of Table 4 the program participation results are presented. Participation in each transfer program is a positive and significant function of entitlement level. The unrestricted correlation structure which we allow across take-up unobservables appears to be appropriate. HB unobservables are positively correlated with both FC and CH. FC and CH are themselves uncorrelated. This is surprising since the former gives rise to eligibility for the latter in 20% of cases. A possible explanation is that those with IS, who are mainly out of work, have different unobservable characteristics. This result suggests that the nature of CH transfers and their take-up is distinctive: perhaps, not surprising, since the stigma, at least in the case of free school lunches, is directly borne by the children.

A direct test of separability between program participation and labor supply is a test of the significance of the program participation indices in the labor supply functions. These tests indicate that labor supply and program participation *per se* are non-separable<sup>48</sup>. Non-separability is a feature of FC and CH but not of HB<sup>49</sup>.

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<sup>48</sup> A Lagrange Multiplier test statistic for separability has the following form:

$$\lambda = \left( \frac{\partial \ln L(\hat{\theta}_{T^{p^*}=0})}{\partial (\hat{\theta}_{T^{p^*}=0})} \right)' I(\hat{\theta}_{T^{p^*}=0})^{-1} \left( \frac{\partial \ln L(\hat{\theta}_{T^{p^*}=0})}{\partial (\hat{\theta}_{T^{p^*}=0})} \right) \square \chi_{131-6}^2$$

where is the estimated unrestricted parameter vector on which the restriction  $T^{p^*}=0$  is imposed. This has a value of 188, compared with a 5% critical value of 152, and the associated probability is 0.00023. Hence we reject separability of programs from labor supply.

Ideally one would like to be able to evaluate the model by seeing how well it simulates actual events in the data, such as welfare reforms. Unfortunately, although we have a reasonably large sample we still rely on post-reform cell sizes that are sometimes quite small. Thus, there is little prospect for being able to estimate over sub-samples of the data<sup>50</sup>. However, we can see how well the estimates enable us to track the data over time. Figure 3 illustrates the performance of the model over time. The main feature of the data is the trend from FT to NP (the omitted category) and the model picks this up quite well.

A more transparent way to examine the implications of the estimated parameters is to define a representative individual and simulate the effects of changing some of her characteristics. Our representative woman has median or modal values for all characteristics. She has weekly regular income (in 1992 prices) of £105, £115, £130, £145 at NP, LPT, HPT, FT respectively; has zero eligibility for FC, HB or CH; lives in rented accommodation; has a youngest child at secondary school (aged 11-18); faces a local unemployment rate of 5%; and lives in the South East in 1992. The simulation exercise performed in Table 5 is for program participation response. HB and CH participation respond most to increasing level of entitlement. FC is only one third as responsive as HB, despite the same low reference levels.

In a similar way, we simulate labor supply responses in Table 6 for the same representative individual. That stigma costs have important consequences for labor supply incentives is clear from comparing the responses to transfer incomes with the response to other income. That is, comparing the effect of different kinds of incomes on labor market

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<sup>49</sup> These test statistics have a similar form with (131-2) degrees of freedom. FC, CH and Housing Benefit have values of 160, 181 and 101. Hence we reject separability for FC and CH only.

<sup>50</sup> For example, when we drop the last third of the data and re-estimate only using the pre-reform period, coefficients on income differences become imprecise. Pre-reform we are relying on real price differences for housing, food and milk, together with year-to-year entitlement changes. This exercise of splitting the sample illustrates the importance of the 1988 reform for identification of our model.

status reveals the relative effects of the stigma or information/transaction costs associated with different benefits. Other (Income Support and non-transfer) income has the largest effects: £10 added to income at NP increases the NP probability by almost 6% from 31%, while £10 of FC income would increase the probability by 2.4%, while the same amount spent on CH at NP would increase the probability by 4%. CH transfers appear to be much less stigmatized than FC. This may be a reflection of it being borne by the children rather than the parent in many cases; or perhaps that it is establishing eligibility for the initial cash transfer that is stigmatizing and subsequent in-kind transfer participation is less so<sup>51</sup>. Furthermore, most CH recipients (80%) also receive Income Support, and have lower incomes than FC recipients. Indeed Table 5 shows that CH is more than twice as responsive as FC participation to level of entitlement.

Labor supply simulations in Table 6 indicate low responsiveness to relative income differences at both LPT and HPT. Transfers for HPT generally do not reduce FT. However, extending in-work transfers down to LPT is mainly at the expense of FT. The last column of Table 6 shows that the unemployment rationing function appears to be working well. As more women are encouraged to participate, a larger proportion of individuals are unable to find jobs and become involuntarily unemployed. Misclassifying this group as voluntary non-participants would bias downwards the labor supply incentive effects.

Table 7 shows simulations of the labor supply effects of fixed and variable cost stigma from FC and CH. Essentially the same simulation exercise as in Table 6 is performed, and the differential incentive effects of FC and CH program income relative to other income are decomposed. Accounting for variable cost stigma, we simulate 100%

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<sup>51</sup> Keane and Moffitt (1998) find there are economies to program participation and stigma does not increase proportionately with the number of programs.

transfer participation, but allow transfer income to have different utility to other income. Accounting for fixed cost stigma, we simulate transfer income giving the same utility as other income, but allow for program non-participation. With both fixed and variable cost stigma together, the full effect of transfer income is as in Table 6. Without fixed or variable cost stigma, CH and FC has the same effect as other income on labor supply.

Fixed and variable cost stigma are of about equal importance in explaining the somewhat weaker incentive effects on labor supply of CH relative to other income. Whereas for FC, fixed cost stigma explains most of the associated weaker labor supply incentive effects.

## 7. Summary and Conclusion

In 1988 UK in-work transfer programs for low income households with children were reformed: cash transfer entitlements were increased but eligibility to nutrition programs was removed. This was a partial cash-out of the in-work in-kind transfers while out-of-work transfers were unchanged.

Here we estimate a model of labor supply and participation in multiple programs using a sample of lone mothers drawn from repeated cross-section surveys that bridge the reform. We find that in-work cash and in-work in-kind transfers both have large positive labor supply effects. There is, however, some utility loss from program participation and this is larger for cash than for nutrition programs. This implies that the partial cash out of the in-kind benefits effectively reduced labor supply.

Our findings have several implications for public policy. First, we show that an increase in transfer entitlements available for part-time work has only a modest impact on the probability of working part-time, and some impact on wanting (but not being able) to participate (i.e. unemployment), but such an increase has essentially no adverse effect on

the probability of full-time work. Expanding transfer entitlements to full-time work has stronger participation effects. However, increasing the availability of in-work transfers to those lower down the hours distribution does cause moderate reductions in full-time.

Secondly, we find that nutrition transfers are more important for labor supply relative to equivalent cash transfers, because of their differential value to recipients since our estimates imply that nutrition programs suffer from only mild stigma/transaction/information costs. This is a feature which has not been incorporated in previous empirical UK labor supply applications and our results suggest that nutrition transfers may have a useful role to play in promoting work incentives<sup>52</sup>. The 1988 partial cash-out of nutrition transfers in-work is thus shown to have *reduced* labor supply. Third, however, we find evidence of statistically significant, and not inconsiderable, stigma/transaction/information costs which implies that in-work transfers are not as effective at countering the disincentive effect of out-of-work transfers, or at countering poverty amongst the working poor, as they might otherwise be. If it were possible to reduce these costs associated with transfer programs, this would have an important impact on the labor force non-participation rate for lone mothers, it would imply large savings in government expenditure on Income Support payments for those not working, and it would increase the welfare of those in receipt of transfers.

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<sup>52</sup> There is currently some debate in the UK (particularly, Scotland under their devolved powers) about reintroducing nutrition program entitlement to families receiving in-work transfers.



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## Appendix Likelihood and implementation

It is convenient in random utility models to parameterize state-dependent variables with random coefficients in order to capture individual taste heterogeneity. However, for the purposes of exposition, first we shall ignore the random parameterization and the existence of state-specific characteristics. This digression to a simpler structure allows us to write the likelihood as a product of the take-up, rationing and labor supply likelihood contributions. Essentially this amounts to considering a simpler variance-covariance matrix<sup>53</sup> and omitting income functions and associated mean parameters from the likelihood. So the likelihoods presented are first that of a tetranomial probit with full correlation structure but without random coefficients, and second that of a trivariate probit.

The full likelihood (with our temporary simplifying assumptions) can be obtained by combining our latent and observed models with the stochastic assumptions so that  $L=L_{MNP} \cdot L_{MVP}$  where

$$L_{MNP} = \begin{cases} \prod_{i \in 1} \Phi_3 \left( X \omega_{12}, \frac{X \omega_{12}}{\sigma_{13}}, \frac{X \omega_{14}}{\sigma_{14}} \right) \\ \prod_{i \in 2} \Phi_3 \left( -X \omega_{12}, \frac{X (\omega_{13} - \omega_{12})}{\sqrt{1 + \sigma_{13}^2 - 2\rho_{23}\sigma_{13}}}, \frac{X (\omega_{14} - \omega_{12})}{\sqrt{1 + \sigma_{14}^2 - 2\rho_{24}\sigma_{11}}} \right) \Phi_1(Z\tau) \\ \prod_{i \in 3} \Phi_3 \left( \frac{X (\omega_{12} - \omega_{13})}{\sqrt{1 + \sigma_{13}^2 - 2\rho_{23}\sigma_{13}}}, \frac{-X \omega_{13}}{\sigma_{13}}, \frac{X (\omega_{14} - \omega_{13})}{\sqrt{\sigma_{13}^2 + \sigma_{14}^2 - 2\rho_{34}\sigma_{13}\sigma_{11}}} \right) \Phi_1(Z\tau) \\ \prod_{i \in 4} \Phi_3 \left( \frac{X (\omega_{12} - \omega_{14})}{\sqrt{1 + \sigma_{14}^2 - 2\rho_{24}\sigma_{11}}}, \frac{X (\omega_{13} - \omega_{14})}{\sqrt{\sigma_{13}^2 + \sigma_{14}^2 - 2\rho_{34}\sigma_{13}\sigma_{14}}}, \frac{-X \omega_{14}}{\sigma_{14}} \right) \Phi_1(Z\tau) \\ \prod_{i \in 1} \Phi_3 \left( -X \omega_{12}, -\frac{X \omega_{13}}{\sigma_{13}}, -\frac{X \omega_{14}}{\sigma_{14}} \right) \Phi_1(-Z\tau) \end{cases}$$

<sup>53</sup> Without additive terms for the covariance of functions of individual income.

and where the states 1 through 4 are respectively unrationed: NP, LPT, HPT, FT. State 5 is involuntary unemployment.  $\Phi_1$  and  $\Phi_3$  are univariate and trivariate normal cumulative distribution functions. Similarly

$$L_{MVP} = \prod \int_{HB-}^{HB+} \int_{FC-}^{FC+} \int_{IK-}^{IK+} \phi_3(s^{HB}, s^{FC}, s^{IK}) ds^{HB} ds^{FC} ds^{IK}$$

$$p^+ = +\infty, p^- = V^P \beta^P \quad \text{if } E^P = 1, T^P = 1$$

$$p^+ = V^P \beta^P, p^- = -\infty \quad \text{if } E^P = 1, T^P = 0$$

$$p^+ = +\infty, p^- = -\infty \quad \text{else}$$

where  $P$  indicates  $HB$ ,  $FC$  and  $CH$ . This general notation allows uni-, bi- and trivariate combinations,  $\phi_3$  is the trivariate normal probability density function.

Our stochastic specification in the fixed parameter case, in particular the assumption of no correlation between error terms in take-up and labor supply is quite restrictive. In the more general case where explanatory functions of income are free to vary between states, the simultaneous nature of the decision process becomes apparent. The choice among labor market states is a function of the earned income and transfer income received in the observed state relative to all others. A program participation index is estimated from a take-up equation, which depends, among other things, on the value of the transfer. The difference between this index (a function of size of entitlement and individual characteristics) in alternative labor market states, is an appropriate way to incorporate transfer income when program participation is endogenous. To make the link explicit it is instructive to consider an example of a single likelihood contribution in full, including random parameters. Let us pick the hypothetical case of a non-participant who is eligible for all transfers but does not take-up in-kind benefits.

$$\begin{aligned}
L &= L_{MVP}^{HB+,FC+,IK-} \cdot L_{MNP}^{NP} \\
L_{MVP}^{HB+,FC+,IK-} &= \Phi_2 \left( V_{NP}^{HB} \beta^{HB}, V_{NP}^{FC} \beta^{FC}, \mu_{HB,FC} \right) \\
&\quad - \Phi_3 \left( V_{NP}^{HB} \beta^{HB}, V_{NP}^{FC} \beta^{FC}, V_{NP}^{IK} \beta^{IK}, \mu_{HB,FC}, \mu_{HB,IK}, \mu_{HB,IK} \right) \\
L_{MNP}^{NP} &= \Phi_3 \left( \frac{X \omega_{12} + (G_1 - G_2) \bar{\psi}}{\sqrt{(G_1 - G_2)^2 \tilde{\psi} + 1}}, \frac{X \omega_{13} + (G_1 - G_3) \bar{\psi}}{\sqrt{(G_1 - G_3)^2 \tilde{\psi} + \sigma_{13}^2}}, \frac{X \omega_{14} + (G_1 - G_4) \bar{\psi}}{\sqrt{(G_1 - G_4)^2 \tilde{\psi} + \sigma_{14}^2}}, \right. \\
&\quad \frac{(G_1 - G_2)(G_1 - G_3) \tilde{\psi} + \rho_{23} \sigma_{13}}{\sqrt{(G_1 - G_4)^2 \tilde{\psi} + 1} \sqrt{(G_1 - G_4)^2 \tilde{\psi} + \sigma_{13}^2}}, \\
&\quad \frac{(G_1 - G_3)(G_1 - G_4) \tilde{\psi} + \rho_{24} \sigma_{14}}{\sqrt{(G_1 - G_4)^2 \tilde{\psi} + \sigma_{14}^2} \sqrt{(G_1 - G_4)^2 \tilde{\psi} + \sigma_{13}^2}}, \\
&\quad \left. \frac{(G_1 - G_2)(G_1 - G_4) \tilde{\psi} + \rho_{34} \sigma_{13} \sigma_{14}}{\sqrt{(G_1 - G_2)^2 \tilde{\psi} + 1} \sqrt{(G_1 - G_4)^2 \tilde{\psi} + \sigma_{14}^2}} \right)
\end{aligned}$$

where  $G = (Y_j, V_j^{HB} \beta^{HB}, V_j^{FC} \beta^{FC}, V_j^{IK} \beta^{IK})'$ . Since demographics are alternative-invariant, these program participation index comparisons come down to differences in functions of level of entitlement.

Multivariate normal integrals were evaluated numerically using Gaussian quadrature following Butler and Moffitt (1982). Estimation was in several stages, each producing starting values for the next. The labor supply and program participation models were estimated separately without correlation; followed by the simultaneous model without random parameters; then with random parameters; and then correlations were introduced. This procedure was robust to different sets of random starting values for the correlation and variance terms.

Table 1 Sample Means (Standard Deviations)

	Pre April 1988	Post March 1988	All
Own age	35.5 (9.1)	33.1 (8.4)	34.6 (8.9)
# Children aged 0-4	0.37 (0.62)	0.53 (0.69)	0.43 (0.65)
# Children aged 5-10	0.57 (0.73)	0.62 (0.77)	0.59 (0.75)
Prob h=0	0.508	0.573	0.531
H h>0	26.4 (12.5)	25.3 (13.7)	26.0 (13.0)
# Observations	2906	1621	4527

Table 2 Labor Supply, Transfer Program Eligibility and Participation

Program	Transfer program status		Labor market status					All
	Receiving	Entitled	UE	NP	LPT	HPT	FT	
FC	N	N	234	2527	317	228	670	3976
	N	Y	32	0	0	75	136	243
	Y	N	4	25	25	16	36	106
	Y	Y	5	0	0	77	120	202
CH	N	N	79	539	172	261	769	1820
	N	Y	35	241	18	25	36	355
	Y	N	9	114	23	27	79	252
	Y	Y	152	1658	129	83	78	2100
HB	N	N	233	2349	260	215	246	3303
	N	Y	17	87	34	54	175	367
	Y	N	11	52	21	39	217	340
	Y	Y	14	64	27	88	324	517
Total			275	2552	342	396	962	4527

Table 3 Labor Supply and Multiple Transfer Receipt

CH	Program participation		Labor market status					All
	HB	FC	UE	NP	LPT	HPT	FT	
N	N	N	75	566	93	120	299	1153
N	N	Y	1	3	4	18	38	64
N	Y	N	36	207	79	113	402	837
Y	N	N	154	1717	134	59	54	2118
N	Y	Y	2	4	14	35	66	121
Y	N	Y	6	7	2	18	19	52
Y	Y	N	1	37	11	11	51	111
Y	Y	Y	0	11	5	22	33	71
			275	2552	342	396	962	4527



Table 4 *Estimates of Labor Supply, Unemployment and Program Participation*

Labor supply	LPT->NP		HPT->NP		FT->NP		Unemployment	
<i>Fixed</i>								
intercept	0.961	<i>0.188</i>	0.893	<i>0.521</i>	1.085	<i>0.661</i>	-1.040	<i>0.228</i>
renter	0.187	<i>0.028</i>	0.009	<i>0.035</i>	0.046	<i>0.019</i>	0.261	<i>0.039</i>
age	-0.043	<i>0.894</i>	-0.269	<i>0.717</i>	-0.963	<i>0.448</i>	-1.805	<i>1.107</i>
age <sup>2</sup>	-0.126	<i>1.168</i>	0.261	<i>0.897</i>	1.425	<i>0.662</i>	-0.203	<i>1.468</i>
child 0-4	0.235	<i>0.087</i>	0.487	<i>0.241</i>	0.155	<i>0.067</i>	0.230	<i>0.045</i>
child 5-10	-0.075	<i>0.037</i>	0.046	<i>0.034</i>	0.077	<i>0.036</i>	0.087	<i>0.030</i>
widow	-0.147	<i>0.035</i>	0.027	<i>0.040</i>	0.060	<i>0.030</i>	-0.146	<i>0.052</i>
unemp. rate							0.009	<i>0.092</i>
<i>Random</i>								
		<i>Ψ-bar</i>		<i>Ψ-tilde</i>				
Y <sub>other</sub>		4.474	<i>0.211</i>	1.049	<i>0.049</i>			
Y <sup>FC</sup>		0.322	<i>0.154</i>	0.980	<i>0.399</i>			
Y <sup>HB</sup>		0.008	<i>0.025</i>	0.598	<i>0.400</i>			
Y <sup>CH</sup>		0.484	<i>0.219</i>	1.000	<i>0.550</i>			
<i>Covariance</i>								
ρ <sub>LPT-&gt;NP</sub>			0.091	<i>0.090</i>	0.445	<i>0.060</i>		
ρ <sub>HPT-&gt;NP</sub>					-0.699	<i>0.092</i>		
σ	1.000	-	0.560	<i>0.560</i>	0.232	<i>0.196</i>		
<hr/>								
Program participation	FC		HB		CH			
intercept	-1.055	<i>1.205</i>	-0.469	<i>0.908</i>	0.102	<i>0.572</i>		
renter	0.448	<i>0.231</i>			0.626	<i>0.115</i>		
age	-0.048	<i>0.588</i>	-0.317	<i>0.439</i>	0.019	<i>0.297</i>		
age <sup>2</sup>	-0.042	<i>0.777</i>	-0.359	<i>0.547</i>	-0.347	<i>0.414</i>		
child 0-4	-0.123	<i>0.229</i>	0.232	<i>0.190</i>	0.369	<i>0.125</i>		
child 5-10	-0.082	<i>0.156</i>	0.092	<i>0.117</i>	0.089	<i>0.105</i>		
widow	-1.451	<i>0.664</i>	0.252	<i>0.135</i>	-0.258	<i>0.201</i>		
unemp. rate	0.565	<i>0.181</i>	0.459	<i>0.131</i>	-0.008	<i>0.085</i>		
Y <sup>P</sup>	0.069	<i>0.036</i>	0.279	<i>0.090</i>	0.074	<i>0.005</i>		
<i>Covariance</i>								
ρ <sub>CH</sub>		-0.220	<i>0.154</i>	0.211	<i>0.114</i>			
ρ <sub>FC</sub>				0.435	<i>0.123</i>			

Note: Standard errors *in italics*. Log likelihood -6825. Number of observations 4527. The labor supply and unemployment equations also include 8 region dummies and 7 dummies for consecutive pairs of years.

Table 5 *Program Participation Simulations for a Representative Individual*  
*% expected and expected change by state*

Variable	Program		
	CH	HB	FC
Reference	84.42	40.89	41.61
CH + £10	<b>8.76</b>	0.00	-0.01
HB + £10	0.01	<b>10.75</b>	0.01
FC + £10	0.01	0.01	<b>3.16</b>
owner	-19.80	0.00	-13.87
age + 10	-0.35	-1.77	-1.45
unemp. + 1%	-0.22	1.85	2.05
child 0-4	7.39	10.12	-5.02
child 5-10	2.19	3.81	-3.14
widow	-10.23	-9.48	-25.42

Note: The representative individual has a weekly income (in 1992 prices) of £105, £115, £130, £145 at NP, LPT, HPT, FT respectively; has zero eligibility for FC, HB or CH; lives in rented accommodation; has a youngest child at secondary school (aged 11-18); faces a local unemployment rate of 5%; and lives in the South East in 1992

Table 6 *Labor Supply Simulations for a Representative Individual*  
*% expected and expected change by state*

Variable	Labor supply				Ration UE
	NP	LPT	HPT	FT	
Reference	30.68	8.95	10.82	43.01	6.53
Y <sub>NP</sub> + £10	<b>5.72</b>	-0.01	-0.48	-4.68	-0.54
Y <sub>LPT</sub> + £10	0.04	<b>0.38</b>	-0.05	-0.37	0.00
Y <sub>HPT</sub> + £10	-0.56	-0.05	<b>0.63</b>	-0.07	0.05
Y <sub>FT</sub> + £10	-3.40	-0.35	-0.15	<b>3.57</b>	0.32
CH <sub>NP</sub> + £10	<b>4.05</b>	-0.04	-0.34	-3.28	-0.38
CH <sub>LPT</sub> + £10	-0.04	<b>0.27</b>	-0.03	-0.20	0.00
CH <sub>HPT</sub> + £10	-0.39	-0.03	<b>0.39</b>	-0.01	0.04
CH <sub>FT</sub> + £10	-3.56	-0.20	-0.01	<b>3.44</b>	0.34
FC <sub>NP</sub> + £10	<b>2.43</b>	-0.02	-0.21	-1.97	-0.23
FC <sub>LPT</sub> + £10	-0.02	<b>0.16</b>	-0.02	-0.12	0.00
FC <sub>HPT</sub> + £10	-0.23	-0.02	<b>0.23</b>	0.00	0.02
FC <sub>FT</sub> + £10	-2.15	-0.12	0.00	<b>2.08</b>	0.20
owner	-10.30	3.22	0.20	8.83	-1.96
age + 10	-0.13	0.49	0.54	1.07	-1.98
unemp. + 1%	0.00	0.00	0.00	-0.01	0.01
child 0-4	41.40	-2.08	-7.75	-28.62	-2.60
child 5-10	17.54	2.16	-1.36	-17.48	-0.85
widow	13.19	3.87	-0.71	-13.85	-2.50

Note: Representative individual same as for Table 5.

Table 7 Labor Supply Effects of Stigma and Non-take-up for a representative individual (% expected by state)

Variable	Stigma cost		Labor supply				Ration
	variable	fixed	NP	LPT	HPT	FT	UE
Reference			30.68	8.95	10.82	43.01	6.54
CH <sub>NP</sub> + £10	Y	Y	<b>4.05</b>	-0.04	-0.34	-3.28	-0.39
CH <sub>LPT</sub> + £10	Y	Y	-0.04	<b>0.27</b>	-0.03	-0.20	0.00
CH <sub>HPT</sub> + £10	Y	Y	-0.39	-0.03	<b>0.39</b>	-0.01	0.04
CH <sub>FT</sub> + £10	Y	Y	-3.56	-0.20	-0.01	<b>3.44</b>	0.33
CH <sub>NP</sub> + £10	Y	N	<b>5.83</b>	-0.03	-0.50	-4.75	-0.55
CH <sub>LPT</sub> + £10	Y	N	-0.27	0.40	-0.04	-0.12	0.03
CH <sub>HPT</sub> + £10	Y	N	-0.91	-0.08	0.71	0.19	0.09
CH <sub>FT</sub> + £10	Y	N	-3.72	-0.39	-0.17	3.93	0.35
CH <sub>NP</sub> + £10	N	Y	<b>5.47</b>	-0.06	-0.46	-4.44	-0.51
CH <sub>LPT</sub> + £10	N	Y	-0.05	<b>0.36</b>	-0.04	-0.28	0.01
CH <sub>HPT</sub> + £10	N	Y	-0.53	-0.04	<b>0.53</b>	-0.01	0.05
CH <sub>FT</sub> + £10	N	Y	-3.62	-0.28	-0.01	<b>3.46</b>	0.45
FC <sub>NP</sub> + £10	Y	Y	<b>2.43</b>	-0.02	-0.21	-1.97	-0.23
FC <sub>LPT</sub> + £10	Y	Y	-0.02	<b>0.16</b>	-0.02	-0.12	0.00
FC <sub>HPT</sub> + £10	Y	Y	-0.23	-0.02	<b>0.23</b>	0.00	0.02
FC <sub>FT</sub> + £10	Y	Y	-2.15	-0.12	0.00	<b>2.08</b>	0.19
FC <sub>NP</sub> + £10	Y	N	<b>5.41</b>	0.03	-0.43	-4.50	-0.51
FC <sub>LPT</sub> + £10	Y	N	0.92	<b>0.35</b>	-0.10	-1.08	-0.09
FC <sub>HPT</sub> + £10	Y	N	0.44	0.01	<b>0.42</b>	-0.83	-0.04
FC <sub>FT</sub> + £10	Y	N	-2.30	-0.22	-0.12	<b>2.42</b>	0.22
FC <sub>NP</sub> + £10	N	Y	<b>3.52</b>	-0.03	-0.30	-2.86	-0.33
FC <sub>LPT</sub> + £10	N	Y	-0.03	<b>0.23</b>	-0.03	-0.18	0.01
FC <sub>HPT</sub> + £10	N	Y	-0.34	-0.03	<b>0.34</b>	-0.01	0.04
FC <sub>FT</sub> + £10	N	Y	-3.11	-0.18	-0.01	<b>3.00</b>	0.30
Y <sub>NP</sub> + £10	N	N	<b>5.72</b>	-0.01	-0.48	-4.68	-0.55
Y <sub>LPT</sub> + £10	N	N	0.04	<b>0.38</b>	-0.05	-0.37	0.00
Y <sub>HPT</sub> + £10	N	N	-0.56	-0.05	<b>0.63</b>	-0.07	0.05
Y <sub>FT</sub> + £10	N	N	-3.40	-0.35	-0.15	<b>3.57</b>	0.33

Note: Representative individual same as for table 5.

Figure 1 Stylized Budget Constraint

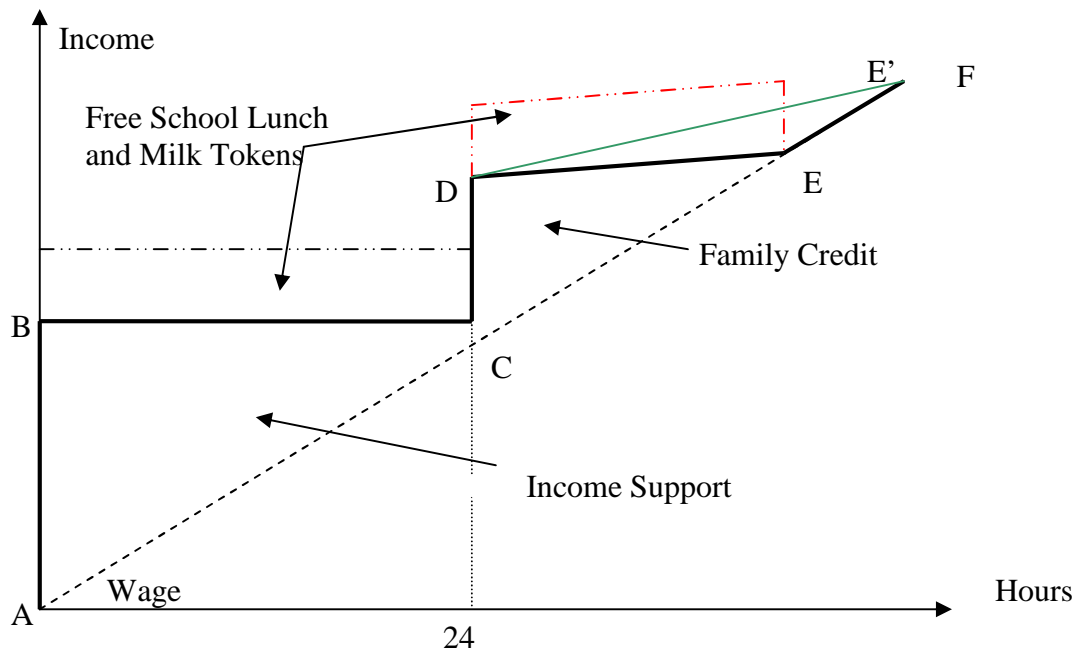
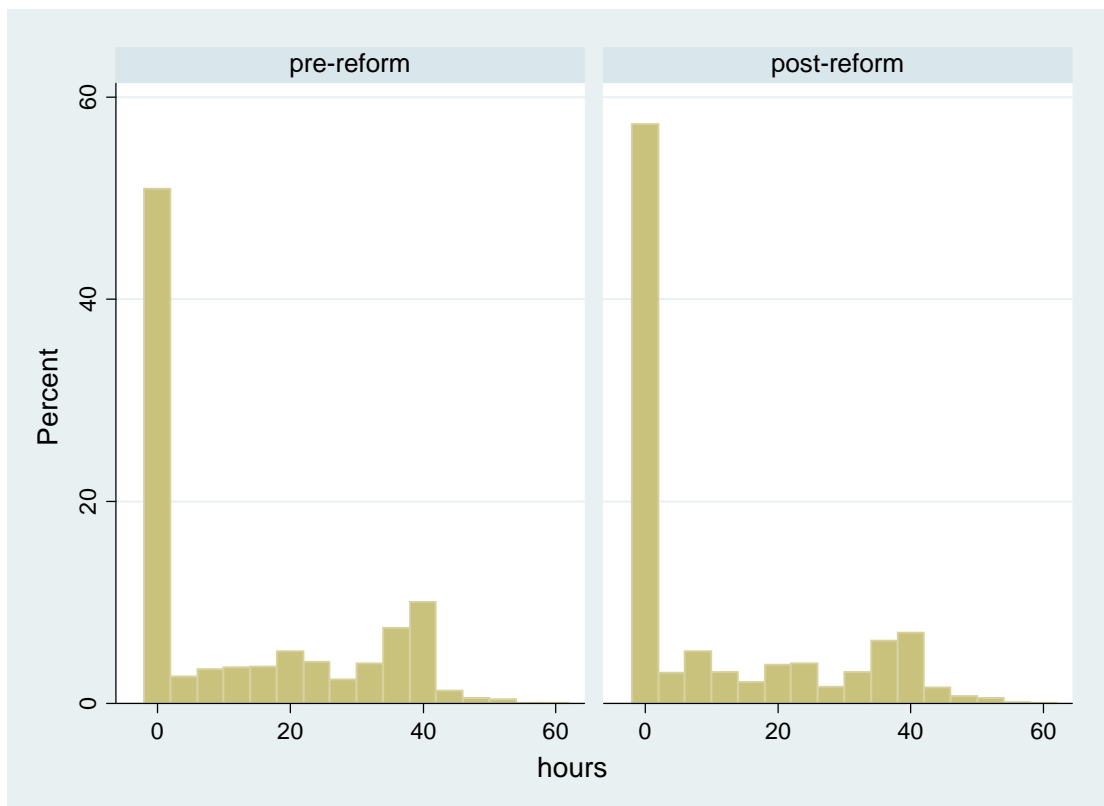


Figure 2 Usual weekly hours distribution



Note: 4-hour bins, 0.1% have hours > 60.

Figure 3 Actual and Predicted Labor Supply

