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Household Unemployment and the Labour Supply of Married Women

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A recent reform to the UK unemployment insurance (UI) system has reduced the duration of entitlement from 12 to six months. The UI and welfare systems interact in the UK in such a way that exhaustion of UI for married individuals has potentially large disincentive effects on the labour supply of spouses. A model of labour supply is estimated for married women allowing for endogenous unemployment durations of husbands and wives. We distinguish between transfer programme induced incentive effects; correlation between labour supply and wages within couples; complementarity between the leisure times of spouses; and a discouraged worker effect.

INTRODUCTION

The adverse work incentive effects of transfer programmes for those with low incomes are well known.[1] UK and US welfare policy has emphasized reducing the out-of-work transfer programme caseload by promoting supply-side policies to expand employment. In addition, the expansion of in-work transfer programmes (Working Families' Tax Credit (WFTC) in the UK and Earned Income Tax Credit (EITC) in the USA) have been important elements of recent reforms. The reduction in programme participants *per se* has been pursued by reducing real net entitlements, tightening eligibility restrictions and imposing time limitations.[2] Indeed, several of the US states have used their waivers to impose time limits on AFDC (see Hoynes, 1996b). In the United Kingdom, Unemployment Insurance (UI) entitlement duration has recently been reduced from 12 to six months, renamed the Job Seeker's Allowance (JSA), and now has the shortest duration among OECD countries (together with the United States and Italy—see OECD, 1996).

This UK reform continues the trend away from insurance-related benefits[3] towards reliance on income-tested assistance for the unemployed (Atkinson and Micklewright, 1989), since once UI entitlement is exhausted unemployed individuals may be entitled, subject to a family means test, to claim Income Support. Thus, the reform is also a shift away from transfers for the unemployed made on an individual basis towards transfers based on family income, and this has implications for the labour supply decisions of all family members. The policy was introduced in the UK to promote the incentive for the unemployed to shorten their duration of unemployment, and the potential impact that the change would have on the incentives for wives of unemployed men to work has not hitherto been considered.

The estimation of family labour supply models has been developed in Ashenfelter and Heckman (1974), Heckman and MaCurdy (1980), Hausman and Ruud (1984) and Blundell and Walker (1986). A reduction in family

income arising from the unemployment of the husband will lead to an increase in the probability that the wife will enter the labour force, and to an increase in the wife's hours conditional upon participation, if leisure is a normal good and leisures are separable in the utility function.[4] This phenomenon has sometimes been termed the Added Worker Effect (AWE).

Heckman and MaCurdy (1980) show that the AWE should be small in a life-cycle context with intertemporal separability and perfect credit markets. The argument is that the income reduction from a temporary spell of a husband's unemployment is small relative to lifetime income. The wives of men who face a higher unemployment risk should have permanently higher hours and earnings, not just when the husband is actually unemployed. That is, if the unemployment shock is transitory, it should not distort the intertemporal allocation of the wife's labour.

Thus, in practice, the magnitude of the AWE depends, among other factors, on the relative ease with which households can adjust to income loss in other ways beside changes in wife's hours, for example through a more intensive job search by the husband, or through borrowing. Liquidity constraints mean that families may have inadequate access to resources for consumption smoothing, so the wife's hours may well need to increase during the spell of her husband's unemployment. Dynarski and Sheffrin (1987) show that, even in a life-cycle model with perfect capital markets, consumption may respond to job loss if that loss conveys new information about lifetime prospects. So a life-cycle response to perceived greater unemployment risk may be an increase in labour supply during the spell of unemployment. However, the extent to which spousal labour supply adjustments can maintain family income when another household member is unemployed is limited by married women's relatively low earnings potential.[5]

UI and UA (unemployment assistance) transfer programmes provide a state-contingent income stream which in part counteracts the negative income shock from the husband's unemployment. Such programmes may reduce a wife's employment response to her husband's unemployment.[6] If transfers are made wholly on an individual basis, as is the case in most UI systems, then there is only an income effect on the decisions of other family members.[7] However, UA, with its associated family means-testing, will typically impose a high marginal effective tax rate on the earnings of the spouse[8] (and perhaps other family members too).

The estimation of the impact of household unemployment on spousal labour supply faces several difficulties. Assortive mating may confound empirical estimates of labour supply response since it may imply that skills and wage offers may in any case be correlated within families. There may be differences in tastes for work by women married to unemployed men relative to women married to employed men. Furthermore, local labour market conditions may reflect employment opportunities facing the whole family. More generally, there may be a Discouraged Worker Effect (DWE), whereby wives are less likely to search for work when there is a general economic downturn since the returns to search fall.[9]

Thus, in our estimates of a labour supply model for married women here, we allow for endogenous unemployment duration of husbands in order to address the problem of correlation between unobservables across spouses. We

also allow for the unemployment duration of wives so as to distinguish between labour market non-participation and an inability to obtain work, since treating all non-workers as being on their labour supply curve may exaggerate welfare system disincentives. This is applied to the UK UI and UA programmes for a sample of married couples. The estimates show that women married to men who have been unemployed for more than six months are quite different from other married women in both observable and unobservable ways. The presence of young children has a much stronger influence, and the welfare system (together with low shadow wages) accounts for about half the difference in labour supply behaviour. Our simulations suggest that the success of the Job Seeker's Allowance programme depends crucially on its effectiveness in getting husbands back to work. The results suggest that the labour supply disincentives from the welfare system facing women married to men who remain unemployed are made significantly worse by the reform.

I. LITERATURE

Most studies of the impact of a husband's unemployment on his wife's working pattern focus on the participation margin. Garcia (1991) estimates a participation probit for 946 wives taken from a 1978 UK Cohort Study of the Unemployed and concludes that extending UI to UA men (i.e. extending the duration of UI entitlements) would increase participation of wives of unemployed men by 8%. Giannelli and Micklewright (1995) use monthly data for 1983–87 on 2000 married couples from the German Socio-Economic Panel (GSOEP) to estimate a fixed effect logit for the wife's labour market participation. They find that having a husband who is unemployed short-term is only weakly associated with the wife being a non-participant.

Lundberg (1985) focuses explicitly on this issue.[10] She estimates a multinomial logit on monthly US data for transitions between non-participation, employment and unemployment as a function of husbands' employment status, which is assumed to be exogenous. She finds a small AWE for white wives; that is, when the husband becomes unemployed, the probability of a non-participating wife entering the labour force increases, but the probability of the wife moving from unemployment to employment falls.[11]

The only cross-country comparative work is that of Dex *et al*. (1995). They estimate wives' employment probits given exogenous husband employment status, and find no effect on wife's participation in Denmark and the United States, but a negative effect in the United Kingdom. They attribute this effect to the UK UI programme where UI entitlements are a function of the wife's earnings.

A number of studies address wives' hours of work response to husbands' unemployment. For the United States, Heckman and MaCurdy (1982) estimate a fixed effect hours tobit on 672 married women from the 1968–75 Panel Study of Income Dynamics (PSID) and find a significant positive effect of husbands' unemployment on wives' hours of work, which is consistent with an AWE. Gruber and Cullen (1996) use both Tobit and Heckman selection models for wives' hours on a sample of women with unemployed husbands from the Survey of Income and Program Participation (SIPP) 1984–92 and find only a small effect on wives' labour supply.

In the United Kingdom, Layard *et al.* (1980) estimate a Tobit model for married women's participation and hours using 2200 married couples from the 1974 General Household Survey and find that the wives of unemployed men have lower expected hours conditional upon employment. Kell and Wright (1990) estimate a bivariate probit for wives' participation and full-time work, conditional on participation, using 2051 married couples from the 1983 Family Expenditure Survey. Their results are consistent with the incentives implied by the structure of the tax and benefit system as discussed in Dilnot and Kell (1990): women are less likely to work when families receive UA, but hours of work conditional upon participation are greater than the average for the population because the incentive to work part-time is undermined by the UI system because UI entitlements are a function of the wife's earnings.

Our approach is distinctive from previous work in several ways. First, we allow for the labour supplies for husbands and wives to be correlated for unobservable reasons[12] as well as through any interactions via the household budget constraint. That is, we explicitly model the interactions through the budget constraint at the same time as we allow for a correlation via the unobservables. In particular, we analyse the effect of the husband's unemployment *duration* on the wife's labour supply since, in our UK data, it is duration of unemployment that is important in determining how the interactions of the budget constraint occur and it appears to be the dimension over which married women's labour supply behaviour differs most according to the husband's unemployment status.[13] Third, we consider married women's labour supply together with the possibility that both husband and wife suffer from involuntary unemployment.

We implement a choice-based unordered response model which is appropriate for dealing with both the non-convex budget constraints facing women married to unemployed men, and the wives of the employed. The methodology used enables us to evaluate incentive effects of recent reforms to transfer programmes for the unemployed, while dealing with many of the empirical problems that have dogged previous estimates of the effect of the husband's employment status on the wife's labour supply.

II. Transfer Programmes for the Unemployed

The latest UI reforms reduced the maximum duration of transfer receipt from 12 to six months, and the programme changed name from Unemployment Benefit to Job Seeker's Allowance (JSA).[14] A number of UK studies show that there is a lower probability of leaving unemployment the higher is the level of benefits received.[15] However, the evidence also suggests that the effect of unemployment income on the conditional probability of leaving unemployment[16] declines with duration, and there appears to be no effect after the fifth (Narendranathan and Stewart 1993) or sixth month (Narendranathan *et al.* 1985).[17] If, in the light of this, the *direct* effect of JSA on re-employment is small, then it may be the case that any direct beneficial effects on work incentives will be outweighed by the deterioration in incentives facing spouses in married couples. The important point is whether husband's unemployment-related benefits are linked to wife's earnings. The most common transfer programme for the unemployed is a UI transfer based on purely individual

contributions, supplemented by UA (for those with inadequate UI) which is means-tested on the basis of family income. This is the pattern for the United Kingdom with the exception that there is a wife's earning allowance, which is completely withdrawn if the earnings of the wife exceed it. The introduction of the JSA means that those who are unemployed for 6–12 months can no longer receive UI but may become entitled to UA.

Recent changes should be placed in the context of the broader reforms to the tax and benefit system that have occurred during the last twenty years. There has been increasing emphasis on the importance of incentive issues, and this motivates our evaluation of JSA based of identifying incentive effects from changes in welfare entitlements which occurred during the sample period 1978–92. During the 1980s all transfers to the unemployed have increased in stringency[18] and have been made taxable (from 1982). The introduction of Job Seeker's Allowance continues the trend from insurance-related benefits towards family-income-tested assistance for the unemployed that was highlighted in Atkinson and Micklewright (1989). Indeed, an increasingly large proportion of the unemployed fail to qualify for UI on grounds of insufficient contributions.[19]

UA entitlements have also deteriorated. From 1980 UA entitlements for married couples were removed if either partner worked over 24 hours in a week. Prior to this, entitlement had been *reduced* on account of partner's earnings but was not entirely precluded. This particularly affected couples without children who were not entitled to Family Credit. Recent UK reforms have had the effect of discouraging single-household formation and increasing dependence between family members. Non-householder's entitlement to UA has been removed, and the rate for those under 25 has fallen in order to encourage people not to leave the parental home until they are financially independent. The US welfare system also generates adverse incentives for the formation of two-parent families.[20]

It is evident that the recent UK JSA reform is consistent with the direction of earlier welfare policy changes since 1978: towards family-based means-tested transfers for the unemployed. This is important, since it suggests that it is not unreasonable to exploit the time series changes that have occurred in the past to assist in the identification of the effect of current reforms.

III. Data

Our data consist of 15 pooled cross-sections of Family Expenditure Surveys (FES)[21] from 1978 to 1992 which yields a sample of 43,531 married couples who are householders. We compute eligibility and the level of entitlement from a very detailed routine[22] that acknowledges all of the features of the tax, welfare[23] and social security contribution systems (except for in-kind transfers), basing our calculations on estimated wage equations. In this section we use the FES data to motivate our study and our chosen approach. We describe the changes of household employment status that have recently occurred, and show that husband's unemployment duration is the appropriate dimension over which to analyse married women's labour supply.

Jenkins (1995) shows that UK income inequality has increased since the 1970s. This is explained by growing earnings dispersion (Gosling *et al.* 1994),

wage dispersion (Meghir and Whitehouse 1996), increasing polarization between dual- and no-earner households (Machin and Waldfogel 1994) and the increase in benefit-dependent families (Gregg and Wadsworth 1996).[24] Figure 1 shows the evolution of employment status of married couples over time in the FES data. We see an increase in the proportion of married couples with an unemployed husband. The trend is for an increasing proportion of couples who are both not working at the expense of couples where only the husband works.[25]

Figure 2 examines unemployment duration for this growing proportion of married men who are out of work. There are reporting modes at multiples of six months, but otherwise no obvious bunching of durations to motivate a particular grouping of the data. Thus, we group unemployment durations into classes corresponding to the time limits on the different transfer programmes that may be available to those out of work. These groups are those unemployed

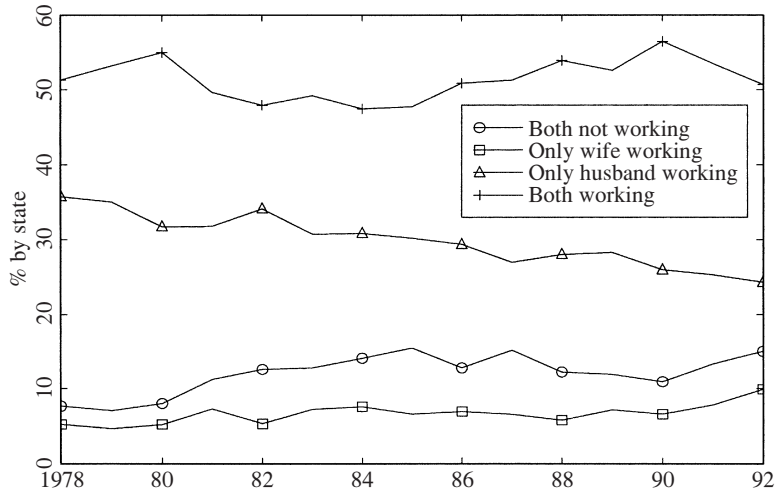

FIGURE 1. Married couple employment status, 1978–92.

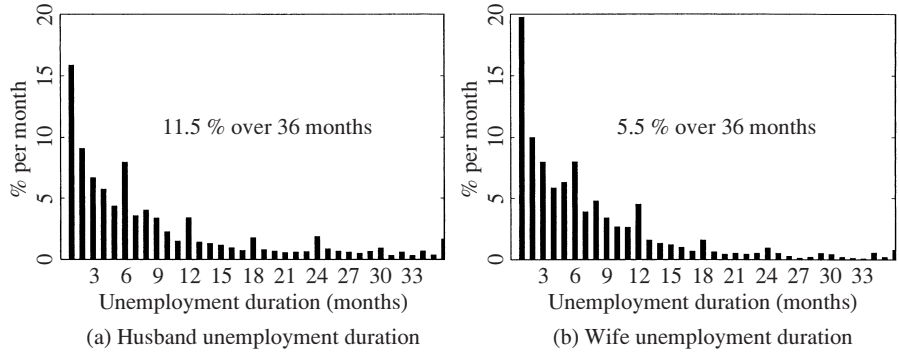

FIGURE 2. Unemployment duration of married couples, 1978–92.

short-term (ST) for less than 7 months, medium-term (MT) from 7 to 12 months, and long-term (LT) for over 12 months.[26] Figure 3 shows the evolution of the male unemployment duration groupings over time. While there is some cyclicality, the principal secular changes are the decrease in the proportion of ST by about a third, which is largely reflected in an increase in LT. The proportion unemployed longer than six months (MT + LT) has doubled over the period.

Our focus is on wives' response to husbands' unemployment rather than the other way around. We follow the existing literature in analysing wives who are treated as secondary earners because, throughout the sample period, wives earned about 25% of married couples earnings. The hours distribution for working married women is shown in Figure 4. There exists a distinct bunching at high hours and a less clear bunching at lower hours centred around 20. Our analysis is based on discrete choice modelling, and we define three groups of usual weekly hours: zero, part-time (PT) from 1 to 30 hours, and full-time (FT) over 30. Among those not working, we make the further distinction of those involuntarily unemployed (UE) and true non-participants (NP).[27].

The full decomposition of household employment status is given in Table 1. Of all married women, 15.5% have an unemployed husband. Of women with an employed husband (row 1), 65.4% (= 29.2 + 36.2) are themselves employed, 31.4% are non-participants and 3.1% (= 1.3 + 0.7 + 1.1) are unemployed. In contrast, women with an unemployed husband (row 5) are composed of: 48.3% (= 22.3 + 26.0) employed, 45.3% non-participants, and 6.5% (= 2.0 + 1.5 + 3.0) unemployed.

There appears to be no difference between the labour supply of women with employed husbands and those with short-term unemployed husbands. However, there are large differences compared with those married to husbands with longer-term unemployment. Wives' non-participation rates (column 3) are 31.4%, 35.0%, 52.0% and 69.6% for those with, respectively, employed, ST, MT and LT unemployed husbands.

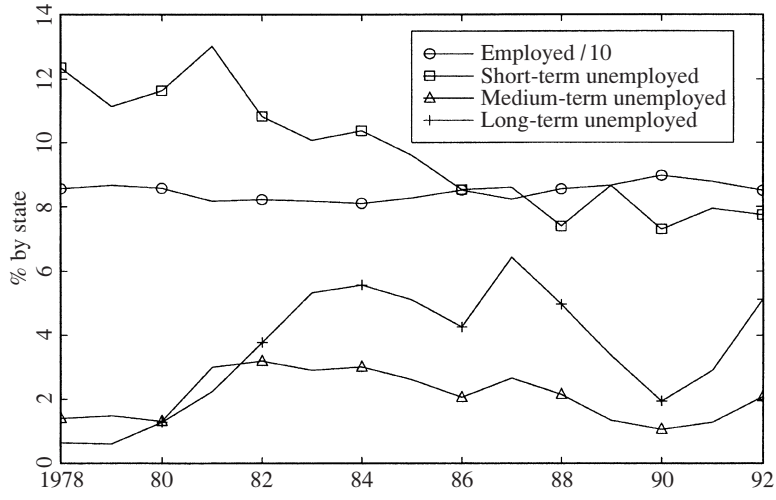

FIGURE 3. Unemployment duration of married men over time, 1978–92.

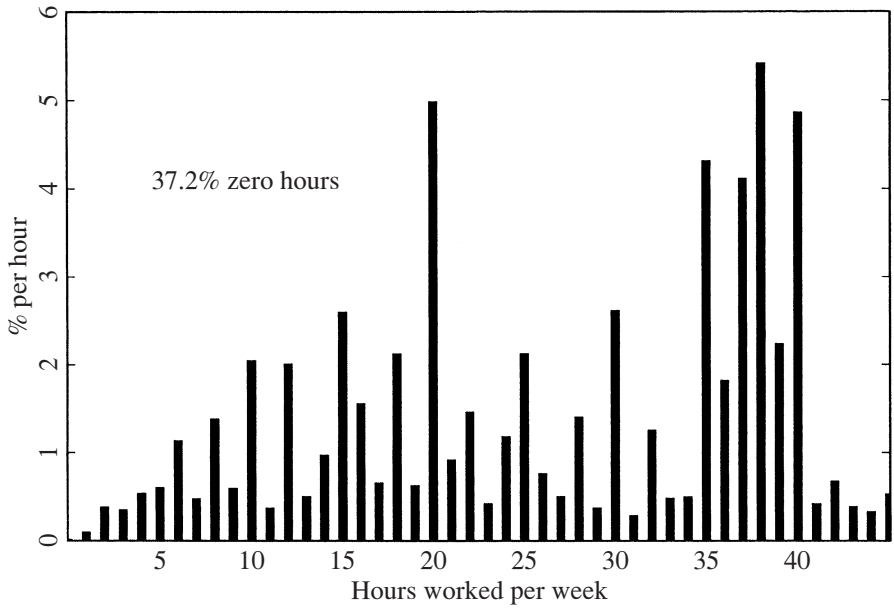

FIGURE 4. Married women hours distribution, 1978–92

TABLE 1
HOUSEHOLD LABOUR FORCE STATUS

Husband's employment status	Wife's labour supply decision			Wife's Unemployment status			All
	Full-time	Part-time	Non-part	Short	Medium	Long	
Employed	10733	13326	11535	496	270	407	36767
	(29.2)	(36.2)	(31.4)	(1.3)	(0.7)	(1.1)	(100.0)
	[87.7]	[88.3]	[79.0]	[78.2]	[73.2]	[67.1]	[84.5]
Short-term unemployed	1189	1370	1500	100	48	78	4285
	(27.7)	(32.0)	(35.0)	(2.3)	(1.1)	(1.8)	(100.0)
	[9.7]	[9.1]	[10.3]	[15.8]	[13.0]	[12.9]	[9.8]
Medium-term unemployed	180	199	486	22	29	19	935
	(19.3)	(21.3)	(52.0)	(2.4)	(3.1)	(2.0)	(100.0)
	[1.5]	[1.3]	[3.3]	[3.5]	[7.9]	[3.1]	[2.1]
Long-term unemployed	139	189	1075	16	22	103	1544
	(9.0)	(12.2)	(69.6)	(1.0)	(1.4)	(6.7)	(100.0)
	[1.1]	[1.3]	[7.4]	[2.5]	[6.0]	[17.0]	[3.5]
All unemployed	1508	1758	3061	138	99	200	6764
	(22.3)	(26.0)	(45.3)	(2.0)	(1.5)	(3.0)	(100.0)
	[12.3]	[11.7]	[21.0]	[21.8]	[26.8]	[32.9]	[15.5]
All	12241	15084	14596	634	369	607	43531
	(28.1)	(34.7)	(33.5)	(1.5)	(0.8)	(1.4)	(100.0)
	[100.0]	[100.0]	[100.0]	[100.0]	[100.0]	[100.0]	[100.0]

Note: The figures indicate number of observations (row percentages) and [column percentages].

IV. Econometric Framework

The budget constraints faced by UK women married to unemployed men are likely to take a complicated piecewise-linear form with several important non-convexities.[28] Moreover, we find strong evidence that there is non-convexity in the *gross* budget constraint induced by a marked differential between the wages of full-time workers and part-time workers (which may be due to the incidence of the payroll tax system, or because of fixed costs in the production process). There are severe difficulties associated with estimating a labour supply model that allows for the possibility of continuous-hours substitution[29] in the face of such complex budget constraints. Our approach follows much of the literature on modelling the labour supply of low-income households and approximates the continuous choice with a choice among discrete alternatives.[30] Each regime is characterized by some specific hours level. Individuals choose between these alternatives, and no hours substitution is allowed within regimes.[31]

McFadden (1984) surveys the discrete response literature and motivates a multinomial probit modelling framework appropriate to the present context following Hausman and Wise (1978). More recently, Hoynes (1996a) and McFadden and Train (1998) have suggested tackling multinomial choice problems using generalizations of the multinomial logit to incorporate (respectively, discrete and normal) distribution mixing. The attraction of these approaches is that the restrictiveness of a conventional logit is relaxed but the computational simplicity is retained as the number of alternative choices increases. However, the benefits of an extended multinomial logit approach are limited in the context of the small number of alternatives that we shall consider.

We estimate an unordered probit random utility model over three states (full-time work, part-time work and non-participation), and further control for the fact that some of those working zero hours would rather be working. Since these choices are determined by the income levels associated with each state, and we observe only one of these, we need to predict incomes for each state from the income in the observed state. As it would be computationally burdensome to estimate the wages associated with each state jointly with the choice of state, and since we require only the consistent prediction 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 labour market status to control for the endogeneity of labour market status, and use these estimates to predict incomes in the part-time and full-time positions.[32] Income for non-participants is computed from a knowledge of the welfare system and observed unearned (non-transfer) income. In the second step, we estimate the random utility model using the predicted income in each state.

A measure of goodness-of-fit for the wage equations is obtained by regressing observed on fitted values. The R^2 values for part-time and full-time wages are 0.27 and 0.34, respectively. A measure of the precision of our net income calculations can be obtained by passing predicted wages, at the observed hours of work, though the tax and benefit programme and comparing computed entitlements and liabilities with observed transfers. For Income Tax, NI, Family Credit, Income Support and Housing Benefit, the respective correlations are 0.60, 0.75, 0.53, 0.21, 0.80 and the R^2 values are 0.36, 0.56,

0.28, 0.45, 0.64. Non-takeup and non-compliance contribute somewhat to the mismatch. However, we would argue that our calculations follow best UK practice, and that the added complexity of dealing with prediction errors by incorporating the tax and benefit calculations into the estimation method is beyond the scope of the present paper.

The identification of the first-step reduced-form bivariate probit for labour force status is through functional form alone. As is quite standard in labour supply modelling, in the first-stage labour supply model we include unearned income, which is excluded from the wage equation, and schooling, which is included in the wage equation but not in the labour supply model. Moreover, the labour supply model includes year dummies, so identification relies heavily on the wide variation in real welfare entitlements over time, partly driven by real variations in housing costs. Identification of the labour supply and unemployment model could be achieved by relying solely on an assumption of joint normality of the error terms. Further exclusion restrictions imposed are that net income differences affect labour supply but not unemployment duration, and that education affects labour supply decisions only indirectly through the wage.

We approximate the budget constraint by just three discrete points: NP, PT, FT.[33] The choices between the three alternatives are assumed to be driven by differences in the utility attached to them. Let the utility associated with choosing state k be $U_i(y_k, h_k; X)$ where y_k is the income and h_k the hours associated with this choice and X is a vector of individual characteristics.

Now consider a statistical specification[34] which allows for random variation in behaviour that is due to an additive disturbance and variation in tastes,[35] $U_i^*(y_k, h_k;\ X, \varepsilon_k)$, where U_{ik}^* is unobservable utility of state k for individual i. Thus, the utility gain of moving from alternative k to j is

$$(1) \qquad U_i^*(y_j, h_j;\ X, \varepsilon_j) - U_i^*(y_k, h_k;\ X, \varepsilon_k) \equiv U_{ij}^* - U_{ik}^*,$$

where the subscript i denotes the individual, while j, k denote alternatives. In a discrete-choice model the choices j and k are assumed to be common across i, so this utility difference can be expressed as

$$(2) \qquad U_{ij}^* - U_{ik}^* = g(y_{ij}, y_{ik})(\overline{\psi} + \tilde{\psi}_i) + X_i\omega_{jk} + (\varepsilon_{ij} - \varepsilon_{ik}),$$

where $g(y_{ij}, y_{ik})$ is a row vector of differences of functions of the net incomes, and $\overline{\psi}$ reflects the mean tastes of the sample, $\overline{\psi}_i$ is a coefficient vector which shows how i differs from the mean, and $(\varepsilon_{ij} - \varepsilon_{ik})$ is an additive disturbance assumed to be independent and identically distributed (i.i.d.) across i but not necessarily across j.[36] The choice of $g(\ )$ is arbitrary, and, while in earlier work on lone mothers (Bingley *et al.* 1995) we use a quadratic to capture diminishing marginal utility, here we find that the linear local approximation can be accepted. Hours of work differences across states are constants across the sample (since, as is usual in discrete-choice modelling, all individuals are assumed to face the same discrete alternatives), but we allow the utility differences induced by the hours difference to vary with characteristics $\boldsymbol{X}$ which includes a constant term.

Keeping a linear form in ψ enables us to introduce random parameters as described in Hausman and Wise (1978). In this case, assuming that the error

terms are distributed multivariate normal and that the parameters are distributed independent normal is a natural choice and leads to tractable expressions for the probabilities. The model thus obtained belongs to the class of multinomial probit random utility models.

As usual in this class of model, only the utility differences between the number of alternatives minus one can be identified.[37] It is possible to interpret the parameters ω_{jk} as a gain (or a loss) in utility from having the characteristics X_i when one compares the alternative j to the alternative k, where the latter choice is the reference.

From (2), the probability of observing i in state j is given by

$$(3) \qquad P_{ij} = \Pr[U_{ij}^{*} > U_{ik}^{*}] = \Pr[g(y_{ij}, y_{ik})(\overline{\psi} + \tilde{\psi}_i) + X_i\omega_{jk} > (\varepsilon_{ij} - \varepsilon_{ik})] \quad \forall j \neq k.$$

The FES asks those with zero hours in the labour market whether they are actively looking for a job and we use this information to discriminate between voluntary non-participation and involuntary unemployment.[38] 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 labour supply modelling, this group of searchers is assumed to reveal that some positive hours state is preferred to zero. Furthermore, individuals observed in any positive hours labour market state are assumed to prefer their observed state to all alternatives and are not rationed in exercising this preference. Moreover, we know how long each person has been out of work during the current spell. For women this information is used conditional upon seeking work in order to distinguish true non-participants. For men this information is used unconditionally.[39] We use the generic term 'unemployment' for both men and women.[40] The unemployed are distinguished according to discrete measures of their unemployment duration which are determined by the following reduced-form latent and observed unemployment rationing equations:

$$(4) \qquad R_i^{s^*} = Z_i^s\tau^s + \upsilon_i^s, \text{ where } R_i^s = \begin{cases} 0 & \text{if} \quad R_i^{s^*} \leqslant 0 \\ ST & \text{if} \quad 0 < R_i^{s^*} \leqslant \mu_1^s \\ MT & \text{if} \quad \mu_1^s < R_i^{s^*} \leqslant \mu_2^s \\ LT & \text{if} \quad \mu_2^s < R_i^{s^*} \end{cases}$$

and $R_i^{s^*}$ is the latent variable corresponding to the observed rationing, R_i^s, of spouse s in couple i, Z_i^s is a matrix of demand-side variables, τ^s is a corresponding vector of parameters, and υ_i^s is a random error.[41] Details concerning stochastic specification, identification and likelihood contributions are relegated to an Appendix A.

V. ESTIMATES

Model estimates are presented in Table 2 to give an idea of sign, magnitude and significance. The direct interpretation of comparison-specific parameters in an unordered model is less than transparent, since the alternative-specific coefficients (on the alternative-invariant variables) tell us about the impact of characteristics on the probability of choosing one state rather than the

TABLE 2
LABOUR SUPPLY WITH ENDOGENOUS UNEMPLOYMENT DURATION

Spouse equation variable	Wife choice		Wife ration	Husband ration
	$PT \rightarrow NP$	$FT \rightarrow NP$		
Intercept$_0$	0.4105 (0.1926)	−1.7750 (0.6550)	2.1808 (0.1035)	1.9832 (0.0640)
Intercept$_1$			0.2244 (0.0115)	0.2422 (0.0078)
Intercept$_2$			0.4817 (0.0149)	0.8418 (0.0120)
Age	−5.9911 (0.4241)	0.1837 (1.3173)	3.7276 (0.3323)	6.2570 (0.5739)
Age^2	1.4359 (0.1012)	1.3979 (0.3422)	−0.7204 (0.0647)	−1.2251 (0.1303)
Education			1.0920 (0.1163)	0.1292 (0.2193)
Education^2			−0.0693 (0.0127)	0.0054 (0.0251)
Child 0–4	0.6173 (0.1252)	2.8738 (1.0759)	−0.2761 (0.0229)	−0.6311 (0.0368)
Child 5–10	−0.0030 (0.0959)	1.8387 (0.7706)	−0.2160 (0.0238)	−0.1791 (0.0406)
Child 11–18	−0.1835 (0.0515)	0.7412 (0.3567)	−0.0887 (0.0226)	−0.0123 (0.0403)
R^h*-short-term*	−0.0144 (0.1011)	0.2756 (0.2117)		
R^h*-medium-term*	0.3429 (0.1338)	0.7155 (0.3272)		
R^h*-long-term*	0.6859 (0.1664)	1.3097 (0.5289)		
Unemployment	0.2322 (0.0607)	0.1459 (0.0893)	−0.4657 (0.0587)	−0.3300 (0.1076)
Renter	0.0219 (0.0234)	0.0854 (0.0476)	−0.4077 (0.0196)	−0.2000 (0.0343)
North	−0.1747 (0.0539)	0.1979 (0.1397)	0.0523 (0.0531)	0.0412 (0.0958)
Yorkshire	−0.1594 (0.0425)	0.3008 (0.1695)	0.0175 (0.0400)	−0.0449 (0.0704)
N. West	−0.2261 (0.0429)	−0.0205 (0.0718)	0.0326 (0.0433)	−0.0042 (0.0768)

E. Midlands	−0.1142 (0.0380)	0.1411 (0.0987)	0.0431 (0.0384)	0.0093 (0.0668)
W. Midlands	−0.1256 (0.0404)	0.1159 (0.0920)	0.0576 (0.0407)	−0.0036 (0.0744)
E. Anglia	−0.1318 (0.0469)	0.2990 (0.1667)	0.1354 (0.0489)	−0.0285 (0.0812)
S. West	−0.1037 (0.0390)	0.2763 (0.1464)	0.0874 (0.0390)	−0.0938 (0.0648)
Wales, Scotland, N. Ireland	−0.0751 (0.0435)	0.0952 (0.0829)	0.1006 (0.0442)	−0.0290 (0.0787)
S. East	−0.1073 (0.0308)	0.1682 (0.1014)	0.0640 (0.0310)	0.0200 (0.0535)
1979–80	−0.0986 (0.0321)	0.0055 (0.0511)	−0.0093 (0.0366)	−0.1084 (0.0690)
1981–82	−0.1617 (0.0424)	0.0166 (0.0713)	−0.0090 (0.0449)	−0.2751 (0.0830)
1983–84	−0.2601 (0.0515)	−0.0688 (0.0776)	−0.0090 (0.0534)	−0.2228 (0.0992)
1985–86	−0.2069 (0.0527)	−0.0634 (0.0776)	0.2078 (0.0542)	−0.1343 (0.1009)
1987–88	−0.2478 (0.0434)	−0.2545 (0.0864)	0.1639 (0.0441)	−0.1420 (0.0820)
1989–90	−0.1996 (0.0378)	−0.2175 (0.0781)	0.2355 (0.0396)	−0.0417 (0.0732)
1991–92	−0.1866 (0.0381)	−0.2807 (0.1008)	0.1071 (0.0393)	−0.1536 (0.0722)
$\overline{\psi}$	1.3725 (0.4425)			
ψ	0.0867 (0.0410)			
$\rho_{\varepsilon,\upsilon^h}$	0.0732 (0.0360)	−0.1385 (0.0630)		
$\rho_{\varepsilon,\varepsilon}$	0.2441 (0.0426)			
σ	1	1.9182 (1.4955)	1	1
Log likelihood	−71280			
Observations	43531			

Note: Standard errors are in parentheses. The reference categories are no children, an employed husband, owner-occupier (including those paying a mortgage), Greater London, and 1978. Note that *Age* is defined as true age less 17, and *Education* is school-leaving age less 14. All continuous variables (*Income*, *Age*, *Education*, *Unemployment rate*) are scaled to have a mean between zero and one. See Tables A1 and A2 in Appendix B for a full set of descriptives.

reference (of voluntary non-participation). A positive sign implies that a variable is associated with increasing the probability of being in the destination state. For example, a positive coefficient on *renter* in the $FT \rightarrow NP$ equation means that living in rented accommodation makes one more likely to prefer NP to FT.

The interpretation of the coefficients on alternative-specific variables (income) is more direct. This measures the impact of the difference in the variable between states on the probability of being in any state. The positive coefficient $\overline{\psi}$ on the *income difference* means that more income is preferred to less. As well as estimating the mean of the *income difference* coefficient, the variance $\tilde{\psi}$ is estimated to allow for taste heterogeneity, and this appears to be supported by the model. Moreover, significant correlations between unobservables in the choice equations suggests that a multinomial probit would dominate a more restrictive simple multinomial logit, whereby alternatives are assumed to be independent.[42]

A number of estimated coefficients are worth remarking on at face value. Children of all ages deter full-time work, but to a lesser extent as they get older. Having a youngest child at secondary school increases part-time work. A short-term unemployed husband makes no difference to wife's labour supply. However, longer durations have the increasingly strong effect of reducing both full-time and part-time work. Husband employment status is found to be endogenous.[44] In particular, unobservables associated with having an unemployed husband are negatively correlated with the probability of part-time work (but positively correlated with full-time work and non-participation). This suggests that the focus of the traditional literature on the participation margin alone may be inappropriate since, even after controlling for endogeneity, it would reveal only the net effect which is of ambiguous sign.

A more transparent way to examine the implications of the estimated parameters is to choose a family as being representative of a group of interest and simulate the effects of changing some of its characteristics. Such a simulation exercise is performed in Table 3. The representative family has median or modal values for all characteristics. The family has weekly income (in 1992 prices) of £159, £213, £251 at NP, PT, FT respectively; lives in rented accommodation; has a youngest child at primary school (aged 5–10); faces a local unemployment rate of 5%; and lives in the South East in 1992. Both husband and wife are aged 29, having left school at age 16.

The simulated probabilities reveal some interesting behaviour. The effects of the economic variables accord with the theoretical predictions. Labour supply appears to be somewhat less wage elastic at high than at low hours in that hours are less responsive to income differences between NP and PT than between PT and FT. This is consistent with the results of Blundell *et al.* (1992) and with the view that incentive effects may be predominantly participation effects (Heckman 1993). The wage elasticity at low hours increases with husband's unemployment duration.

The age of youngest child has the strongest effect on labour supply. All else equal, women without children have quite similar participation probabilities whether their husband is employed ($93.7\% = 100 - 23.4 + 17.1$) or not ($88.1\% = 100 - 39.3 + 27.4$). The presence of a pre-school child creates the biggest difference in wife's labour supply. A child aged 0–4 reduces the wife's

TABLE 3
SELECTED SIMULATIONS (% expected in each state)

	Husband employed				Husband MT unemployed			
Variable	FT	PT	NP	UE	FT	PT	NP	UE
Reference	26.04	46.78	23.39	3.80	24.17	33.50	39.32	3.00
$Income_{NP}+£10$	−0.78	−1.79	2.70	−0.13	−0.94	−2.09	3.20	−0.17
$Income_{PT}+£10$	−0.94	2.39	−1.52	0.07	−0.78	2.43	−1.74	0.09
$Income_{FT}+£10$	1.59	−0.97	−0.65	0.03	1.56	−0.68	−0.93	0.05
Owner	2.76	−0.49	−1.03	−1.24	4.16	−1.56	−1.65	−0.95
Age_w+10	−10.85	10.68	1.55	−1.37	−10.39	8.72	2.81	−1.13
Age_h+10	0.24	−0.23	−0.01	0.00	0.65	−0.56	−0.09	0.00
$Education_w+2$	0.06	0.10	0.05	−0.20	0.04	0.06	0.07	−0.16
$Education_h+2$	0.35	−0.34	−0.02	0.00	0.97	−0.83	−0.14	0.01
Unempl. + 1%	−0.18	−0.64	0.60	0.22	−0.35	−0.54	0.73	0.16
Child 0–4	−14.41	−13.47	26.25	1.64	−14.44	−13.91	27.89	0.46
Child 11–18	26.10	−12.64	−12.81	−0.64	27.35	−8.16	−19.03	−0.16
No children	47.73	−30.06	−17.10	−0.57	49.37	−22.06	−27.36	0.04

Note: The likelihood is evaluated for each representative at the estimated parameter values. The simulations shown are unconditional on husband unemployment status. Conditional simulations differ from these only slightly. Confidence intervals for the simulations are not presented. These were created by perturbating the parameters of interest according to their estimated variance, and show only that house ownership status is occasionally insignificant at the 5% level. Unemployed women are grouped together (under the UE columns) for the purposes of exposition, regardless of duration. Their respective probabilities obtained from the simulation are just summed. Simulations for ST and LT unemployed husbands are presented in Appendix B, (Table A3).

labour supply by 43.4% (= 17.1 + 26.3) if the husband is employed compared with a reduction of 55.3% (= 27.9 + 27.4) if he is unemployed. The presence of children who need looking after appears to have a larger impact on women with an unemployed husband than those with an employed husband. One explanation for this perverse result is that they are unable to afford as much child care, since the husband lacks earnings, and her own net wage is much lower. Furthermore, unemployment rationing is higher for women with pre-school children, as the number of suitable job offers becomes more limited because of their care commitments.

Discouraged workers are accounted for by the regional monthly unemployment rate. A 1% increase in this reduces wife's employment by 0.8%, three-quarters of which is due to discouragement. As expected, this effect is stronger for women with an unemployed husband.

Having examined the properties of the model in detail and found them to be consistent with our theoretical priors, we examined the predictive properties of the estimates and found that the model fits the data reasonably well. The details can be found in Appendix C.

The remainder of this section is concerned with simulating the recent UI reform that introduced the Job Seeker's Allowance. The main feature of the reform was a move from a contribution based (UB) *individual* payment of £50 regardless of spouse income or family circumstances, to a means-tested (IS) payment to a *married couple* of £79 for individuals who had been unemployed for six months rather than the previous limit of 12 months.[45]

Table 4 presents the results of two simulation exercises conducted on a sample of households with a MT unemployed husband. The reference case is where a MT unemployed husband has no earned income and receives UI. The first simulation involves the move to JSA without any husband employment effects. For the sake of exposition, we shall denote this as a move from UB to IS ($UB \rightarrow IS$) for our population of interest. The second simulation involves the husband finding a job.[46] The effects of his employment can be decomposed into a 'pure' tax–benefit system effect (by only changing the budget constraint accordingly, denoted $Y^h \uparrow$) and an 'employed husband' effect *per se* (by changing his employment status indicator, denoted $R^h \rightarrow 0$). The former captures the effect of the differences in welfare treatment, while the latter captures complementarities through preferences.

Pre-reform probabilities are given by the first row of Table 4. The remaining rows show expected labour supply responses to the reforms, all of which are statistically significant. The second row shows that, if the husband does not find a job, the move to Income Support from Unemployment Benefit increases the wife's non-participation by 3.5%, mainly at the expense of part-time work. The third row shows that, if he finds work, the pure welfare system effect is to increase part-time and full-time work probabilities by 3.1% and 3.3% respectively. However, the full effect of the husband finding work in the final row is a 9.0% increase in full-time work, a 2.3% increase in part-time work, a 1.2% increase in involuntary unemployment (as more women want to work than there are suitable jobs are available) and a corresponding 12.5% fall in the proportion in the non-participant category.

These results suggest that the impact of the JSA reform on wife's labour supply depends crucially on its effect on husband's employment. The labour supply disincentive for women with husbands who remain unemployed have clearly been accentuated by the reform. From Table 4 it can be seen that more than 28% (= 3.48/12.54) of these medium-term unemployed husbands need to find work for the net effect on wives' labour supply to be positive. Thus, the overall impact of the reform depends critically on the extent to which it promotes shorter unemployment durations among husbands, and the existing literature on the effect of UI on duration suggests that this is likely to be modest.

TABLE 4

JSA REFORM SIMULATION (% expected in each state)

Reform	Reference state			
	FT	PT	NP	UE
$UB,\ Y^h = 0,\ R^h = MT$	26.28 (0.68)	27.35 (0.36)	40.93 (0.55)	5.43 (0.10)
$UB \rightarrow IS$	1.41 (0.96)	−4.49 (0.49)	3.48 (0.85)	−0.40 (0.13)
$Y^h \uparrow$	3.27 (0.98)	3.06 (0.52)	−6.38 (0.78)	0.05 (0.14)
$Y^h \uparrow,\ R^h \rightarrow 0$	8.96 (0.95)	2.34 (0.54)	−12.54 (0.67)	1.24 (0.17)

Note: Standard deviations are in parentheses. All (935) families with a medium-term unemployed husband throughout the sample period were timed forward to October 1996. This involved reflating all monetary values (housing costs, unearned income, predicted wage rates) by the appropriate indices. Taxes and benefits were computed immediately pre- and post-reform. The percentage expected in each labour supply state is computed from the mean of probabilities (×100) conditional on husband unemployment state. Standard deviations are of the probabilities (×100).

VI. Conclusion

This paper has been concerned with estimating a model of married women's labour supply and husbands' and wives' unemployment duration for married couples in the UK. The novel features of the modelling are that (i) we allow the husband's unemployment to be correlated with the unobservable determinants of the wife's labour supply, and (ii) we discriminate between non-participants and the involuntarily unemployed. Both are addressed by way of reduced-form auxiliary equations in order to control for potential endogeneity in the wife labour supply functions which are of primary interest. The model is not structural, in the sense that we have not attempted explicitly to model the search process among the unemployed; nor have we addressed intra-household decision-making. However, our approach does overcome some of the difficulties that have dogged previous analyses of the differential labour supply of married women according to their husbands' employment status.

We find that a husband's unemployment is negatively correlated with unobservables associated with part-time work and positively correlated with unobservables associated with full-time work. This suggests that focusing on the participation margin alone, as the added-worker-effect literature does, is likely to miss important behavioural effects. The discouraged-worker effect operates through the (regional) unemployment rate: we find that a 1% increase in the unemployment rate generates a 0.8% decrease in participants—about three-quarters of whom are discouraged.

We find the labour supply behaviour of women married to men who have been unemployed for over six months to be very different from that of other married women; also, young children seem to have a much stronger influence on the labour supply of women married to unemployed men, and about half of the difference in labour supply behaviour is explained by the welfare system, together with poor skills and high shadow wages.

Our simulations suggest that the success of the Job Seeker's Allowance reform on a wife's labour supply depends crucially upon its effect on her husband's employment. The disincentive to supply labour for women with husbands who remain unemployed have been clearly exacerbated by the policy reform. Therefore, unless JSA has an implausibly large effect on the unemployment of men, the overall effect on the work incentives of the wives of unemployed men will be detrimental.

APPENDIX A: LIKELIHOOD

Stochastic assumptions for the error terms are captured by the following variance–covariance matrix of a multivariate normal distribution:

$$V\begin{pmatrix} \varepsilon_1 - \varepsilon_2 \\ \varepsilon_1 - \varepsilon_3 \\ \upsilon_h \\ \upsilon_w \end{pmatrix} = \begin{pmatrix} 1 & \rho_{\varepsilon_{12}\varepsilon_{13}}\sigma_{\varepsilon_{13}} & \rho_{\varepsilon_{12}\upsilon_h} & 0 \\ \rho_{\varepsilon_{12}\varepsilon_{13}}\sigma_{\varepsilon_{13}} & \sigma^2_{\varepsilon_{13}} & \rho_{\varepsilon_{13}\upsilon_h}\sigma_{\varepsilon_{13}} & 0 \\ \rho_{\varepsilon_{12}\upsilon_h} & \rho_{\varepsilon_{13}\upsilon_h}\sigma_{\varepsilon_{13}} & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}.$$

The variance of the first error difference is normalized to one, so that the variance of $(\varepsilon_1 - \varepsilon_3)$ may be estimated up to scale. Unemployment duration is discretized and these error variances are normalized to one.[47] We assume wife unemployment error terms and

labour supply error terms are uncorrelated. This is motivated by a practical concern to keep the dimensionality of the problem down. Following Blundell *et al.* (1991), in order to capture discouragement we include demand-side variables (monthly regional total unemployment rate) in the choice equation.[48] This leaves education (directly) as the only variable in the ration equation that is not in the choice equation. (Indirectly it comes into the choice through the predicted wage, tax system and into net incomes.) We consider this too weak a motivation to identify the correlation.[49] However, husband unemployment correlation with female labour supply is identified through the education and age of the husband. Consider a typical likelihood contribution—say, in the case where the husband is medium-term unemployed:

$$
\begin{aligned}
L_{h\in MT} = \Bigg\{ & \prod_{w\in NP}\left[\Phi_3\left(X\omega_{12}, \frac{X\omega_{13}}{\sigma}, Z^h\tau^h+\mu_2^h\right)-\Phi_3\left(X\omega_{12}, \frac{X\omega_{13}}{\sigma}, Z^h\tau^h+\mu_1^h\right)\right] \\
& \prod_{w\in PT}\left[\Phi_3\left(-X\omega_{12}, \frac{X(\omega_{13}-\omega_{12})}{\sqrt{1+\sigma^2-2\rho_{\varepsilon,\varepsilon}\sigma}}, Z_h\tau^h+\mu_2^h\right)\right. \\
& \qquad \left.-\Phi_3\left(-X\omega_{12}, \frac{X(\omega_{13}-\omega_{12})}{\sqrt{1+\sigma^2-2\rho_{\varepsilon,\varepsilon}\sigma}}, Z_h\tau^h+\mu_1^h\right)\right]\Phi_1(Z^w\tau^w) \\
& \prod_{w\in FT}\left[\Phi_3\left(\frac{X(\omega_{12}-\omega_{13})}{\sqrt{1+\sigma^2-2\rho_{\varepsilon,\varepsilon}\sigma}}, \frac{-X\omega_{12}}{\sigma}, Z^h\tau^h+\mu_2^h\right)\right. \\
& \qquad \left.-\Phi_3\left(\frac{X(\omega_{12}-\omega_{13})}{\sqrt{1+\sigma^2-2\rho_{\varepsilon,\varepsilon}\sigma}}, \frac{-X\omega_{12}}{\sigma}, Z^h\tau^h+\mu_1^h\right)\right]\Phi_1(Z^w\tau^w) \\
& \prod_{w\in ST}\left[\Phi_3\left(-X\omega_{12}, \frac{-X\omega_{13}}{\sigma}, Z^h\tau^h+\mu_2^h\right)\right. \\
& \qquad \left.-\Phi_3\left(-X\omega_{12}, \frac{-X\omega_{13}}{\sigma}, Z^h\tau^h+\mu_1^h\right)\right][\Phi_1(Z^w\tau^w+\mu_1^w)-\Phi_1(Z^w\tau^w)] \\
& \prod_{w\in MT}\left[\Phi_3\left(-X\omega_{12}, \frac{-X\omega_{13}}{\sigma}, Z^h\tau^h+\mu_2^h\right)\right. \\
& \qquad \left.-\Phi_3\left(-X\omega_{12}, \frac{-X\omega_{13}}{\sigma}, Z^h\tau^h+\mu_1^h\right)\right][\Phi_1(Z^w\tau^w+\mu_2^w)-\Phi_1(Z^w\tau^w+\mu_2^w)] \\
& \prod_{w\in LT}\left[\Phi_3\left(-X\omega_{12}, \frac{-X\omega_{13}}{\sigma}, Z^h\tau^h+\mu_2^h\right)\right. \\
& \qquad \left.-\Phi_3\left(-X\omega_{12}, \frac{-X\omega_{13}}{\sigma}, Z^h\tau^h+\mu_1^h\right)\right][1-\Phi_1(Z^w\tau^w+\mu_2^w)],
\end{aligned}
$$

where Φ_1 and Φ_3 are respectively univariate and trivariate normal cumulative distribution functions. The likelihood is that of a trinomial probit (see Hausman and Wise 1978) for labour supply choice, with the extension of two ordered (probit) rationing functions, one (correlated) for husbands and the other (uncorrelated) for wives.

APPENDIX B: DATA

TABLE A1
DESCRIPTIVE STATISTICS BY FEMALE LABOUR SUPPLY AND UNEMPLOYMENT: MEANS (standard deviations)

		Choice				Ration	
Variable	All	FT	PT	NP	ST	MT	LT
$Wage_{PT}^{w}$	3.942 (1.224)	4.553 (1.428)	3.632 (1.027)	3.752 (1.040)	3.919 (1.150)	3.962 (1.026)	3.956 (1.169)
$Wage_{FT}^{w}$	4.175 (0.969)	4.468 (1.071)	4.191 (0.918)	3.923 (0.861)	4.127 (0.908)	4.010 (0.854)	4.108 (0.901)
$Wage_{OT}^{h}$	6.412 (2.198)	6.335 (2.074)	6.296 (2.046)	6.604 (2.414)	6.185 (2.177)	6.029 (2.216)	6.737 (2.482)
$Wage_{RT}^{h}$	6.224 (1.116)	6.252 (1.113)	6.238 (1.071)	6.253 (1.162)	6.106 (1.105)	6.004 (1.117)	6.315 (1.152)
$Income_{NP}$	0.159 (0.085)	0.158 (0.083)	0.163 (0.084)	0.155 (0.086)	0.150 (0.076)	0.149 (0.079)	0.152 (0.081)
$Income_{PT}$	0.213 (0.090)	0.222 (0.090)	0.215 (0.088)	0.205 (0.092)	0.205 (0.082)	0.203 (0.084)	0.205 (0.087)
$Income_{FT}$	0.251 (0.093)	0.259 (0.092)	0.257 (0.091)	0.238 (0.095)	0.242 (0.085)	0.238 (0.087)	0.238 (0.090)
Age_{w}	0.216 (0.106)	0.206 (0.108)	0.234 (0.094)	0.210 (0.113)	0.185 (0.108)	0.161 (0.110)	0.173 (0.105)
Age_{h}	0.243 (0.110)	0.233 (0.113)	0.259 (0.098)	0.238 (0.117)	0.208 (0.112)	0.187 (0.114)	0.196 (0.108)
$Education_{w}$	0.206 (0.198)	0.241 (0.218)	0.194 (0.193)	0.187 (0.182)	0.215 (0.191)	0.203 (0.179)	0.229 (0.190)
$Education_{h}$	0.207 (0.225)	0.229 (0.240)	0.190 (0.214)	0.205 (0.224)	0.227 (0.225)	0.216 (0.204)	0.222 (0.213)
Unempl.	0.892 (0.383)	0.861 (0.378)	0.876 (0.377)	0.923 (0.390)	0.958 (0.375)	1.033 (0.372)	1.007 (0.366)
No children	0.402	0.659	0.317	0.278	0.426	0.325	0.290
Y Kid 0–4	0.244	0.070	0.186	0.436	0.237	0.442	0.481
Y Kid 5–10	0.173	0.094	0.249	0.164	0.194	0.149	0.122
Y Kid 11–18	0.181	0.177	0.248	0.122	0.144	0.084	0.107
Renter	0.608	0.595	0.601	0.621	0.615	0.669	0.700
London	0.092	0.109	0.082	0.089	0.077	0.057	0.076
North	0.064	0.058	0.064	0.068	0.063	0.070	0.072
Yorkshire	0.093	0.079	0.099	0.098	0.099	0.108	0.102
N. West	0.112	0.116	0.113	0.106	0.120	0.136	0.138

(*continued*)

TABLE A1
CONTINUED

Variable	All	Choice				Ration	
		FT	PT	NP	ST	MT	LT
E. Mids	0.076	0.079	0.078	0.073	0.077	0.057	0.066
W. Mids	0.099	0.099	0.097	0.101	0.098	0.095	0.117
E. Anglia	0.037	0.035	0.040	0.035	0.035	0.016	0.038
S. West	0.073	0.070	0.077	0.073	0.088	0.079	0.061
Wales, Scotland, N. Ireland	0.166	0.159	0.149	0.184	0.194	0.233	0.199
S. East	0.188	0.197	0.201	0.173	0.148	0.149	0.130
1978	0.073	0.076	0.070	0.076	0.047	0.038	0.025
1979–80	0.140	0.140	0.147	0.138	0.121	0.111	0.063
1981–82	0.154	0.140	0.152	0.165	0.224	0.179	0.153
1983–84	0.141	0.127	0.141	0.148	0.145	0.190	0.186
1985–86	0.136	0.130	0.129	0.146	0.137	0.179	0.166
1987–88	0.129	0.136	0.127	0.124	0.115	0.149	0.188
1989–90	0.118	0.129	0.124	0.106	0.099	0.068	0.109
1991–92	0.109	0.121	0.111	0.097	0.110	0.087	0.110
Observations	43,531	12,241	15,084	14,596	634	369	607

TABLE A2

DESCRIPTIVE STATISTICS BY HUSBAND UNEMPLOYMENT DURATION: MEANS (standard deviations)

	Unemployment duration				
Variable	All	None	ST	MT	LT
$Wage_{PT}^{w}$	3.942 (1.224)	3.983 (1.254)	3.815 (1.123)	3.592 (0.841)	3.533 (0.751)
$Wage_{FT}^{w}$	4.175 (0.969)	4.218 (0.981)	4.028 (0.906)	3.816 (0.785)	3.777 (0.737)
$Wage_{OT}^{h}$	6.412 (2.198)	6.358 (2.140)	5.904 (1.958)	5.917 (2.157)	9.408 (1.952)
$Wage_{R}^{h}$	6.224 (1.116)	6.249 (1.114)	5.978 (1.055)	5.894 (1.050)	7.067 (0.938)
$Income_{NP}$	0.159 (0.085)	0.163 (0.086)	0.146 (0.077)	0.135 (0.070)	0.094 (0.037)
$Income_{PT}$	0.213 (0.090)	0.219 (0.090)	0.200 (0.081)	0.184 (0.075)	0.125 (0.047)
$Income_{FT}$	0.251 (0.093)	0.257 (0.093)	0.237 (0.083)	0.220 (0.077)	0.150 (0.046)
Age_{w}	0.216 (0.106)	0.217 (0.105)	0.210 (0.109)	0.213 (0.119)	0.203 (0.113)
Age_{h}	0.243 (0.110)	0.244 (0.109)	0.234 (0.114)	0.241 (0.125)	0.237 (0.120)
$Education_{w}$	0.206 (0.198)	0.212 (0.202)	0.189 (0.188)	0.149 (0.142)	0.141 (0.121)
$Education_{h}$	0.207 (0.225)	0.214 (0.230)	0.185 (0.209)	0.148 (0.170)	0.136 (0.141)
Unempl.	0.892 (0.383)	0.876 (0.379)	0.919 (0.384)	1.036 (0.385)	1.095 (0.386)
No children	0.402	0.409	0.387	0.383	0.266
Y Kid 0–4	0.244	0.234	0.269	0.306	0.380
Y Kid 5–10	0.173	0.172	0.178	0.168	0.199
Y Kid 11–18	0.181	0.185	0.167	0.143	0.155
Renter	0.608	0.593	0.618	0.726	0.870
London	0.092	0.095	0.076	0.066	0.084
North	0.064	0.060	0.086	0.083	0.089
Yorkshire	0.093	0.091	0.100	0.119	0.109
N. West	0.112	0.109	0.126	0.118	0.142
E. Midlands	0.076	0.077	0.076	0.091	0.052
W. Midlands	0.099	0.098	0.095	0.109	0.129
E. Anglia	0.037	0.038	0.027	0.029	0.022
S. West	0.073	0.076	0.068	0.055	0.047
Wales, Scotland, N. Ireland	0.166	0.160	0.181	0.200	0.233
S. East	0.188	0.197	0.165	0.130	0.094
1978	0.073	0.073	0.091	0.047	0.013
1979–80	0.140	0.143	0.162	0.091	0.038
1981–82	0.154	0.150	0.186	0.222	0.131
1983–84	0.141	0.135	0.146	0.194	0.216
1985–86	0.136	0.135	0.126	0.149	0.180
1987–88	0.129	0.128	0.105	0.145	0.209
1989–90	0.118	0.123	0.096	0.066	0.090
1991–92	0.109	0.112	0.087	0.086	0.124
Observations	43,531	36,767	4,285	935	1,544

TABLE A3

SELECTED SIMULATIONS FOR A REPRESENTATIVE INDIVIDUAL % EXPECTED BY STATE

	R^h short-term				R^h long-term			
Variable	FT	PT	NP	UE	FT	PT	NP	UE
Reference	27.34	43.30	25.65	3.71	17.58	24.52	55.74	2.15
$Income_{NP}+£10$	−0.75	−1.88	2.77	−0.14	−0.94	−2.07	3.17	−0.16
$Income_{PT}+£10$	−1.02	2.47	−1.53	0.08	−0.51	2.18	−1.77	0.09
$Income_{PT}+£10$	1.64	−0.95	−0.73	0.04	1.31	−0.40	−0.95	0.05
Owner	4.29	−1.89	−1.21	−1.20	3.30	−0.90	−1.73	−0.67
Age_w+10	−11.34	10.68	2.02	−1.36	−8.20	6.31	2.71	−0.82
Age_h+10	0.66	−0.62	−0.03	0.00	0.49	−0.39	−0.10	0.00
$Education_w+2$	0.06	0.09	0.05	−0.20	0.02	0.03	0.07	−0.12
$Education_h+2$	0.98	−0.93	−0.05	0.01	0.73	−0.58	−0.16	0.00
Unempl. + 1%	−0.31	−0.52	0.62	0.21	−0.31	−0.53	0.74	0.10
Child 0–4	−14.80	−13.38	26.80	1.38	−11.72	−12.81	24.65	−0.12
Child 11–18	27.12	−12.50	−14.07	−0.54	25.39	−3.73	−21.82	0.16
No children	48.81	−29.25	−19.10	−0.46	48.05	−14.74	−33.80	0.50

APPENDIX C: MODEL PREDICTION

Figure A1 shows the performance of the model over time. Parts (a) and (b) show that the labour supply model picks up the small annual movements very well. The main feature of the unemployment duration data is the move away from ST, which is picked up rather well in parts (c) and (d). Business cycle effects are evident, though less well

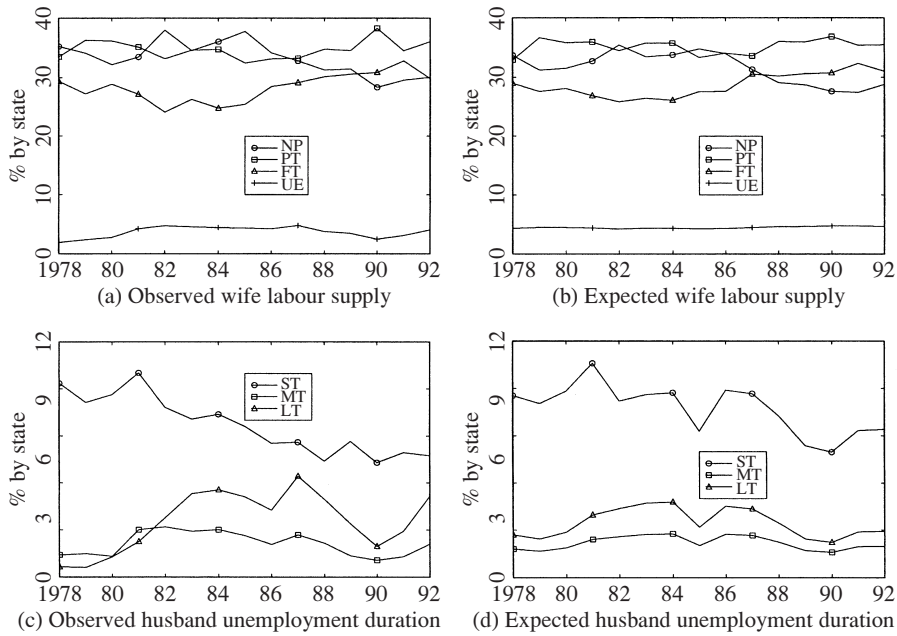

FIGURE A1. Model performance over time, 1978–92.

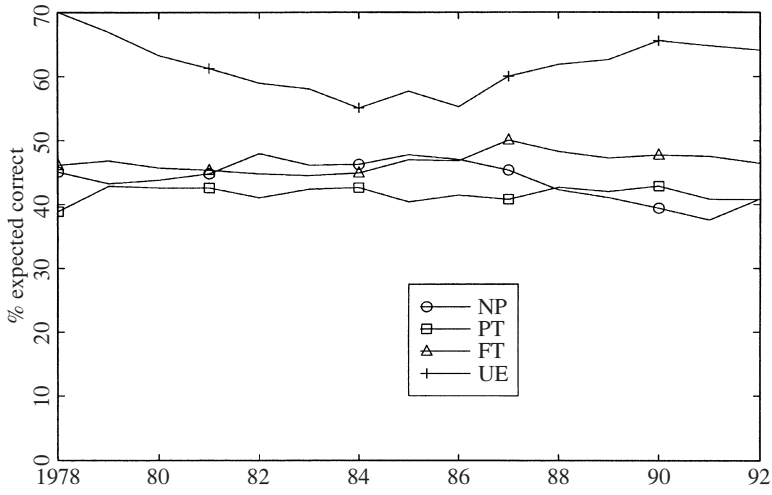

FIGURE A2. Model fit over time: wife labour supply goodness-of-fit, 1978–92.

tracked.[50] More revealing than following the aggregate time series is goodness-of-fit in terms of the proportion of women expected to be in their observed state.[51]

Figure A2 shows that the model fits persistently well, and that there is no change in model performance at the time of the 1988 Fowler reforms. This robustness check lends support to later simulations which are based upon the model estimates.

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NOTES

1. Such as Income Support (IS) in the UK and Temporary Assistance for Needy Families (TANF), formerly Aid for Families with Dependent Children (AFDC) in the USA.
2. For surveys of the recent welfare reforms, see Atkinson (1995) on the UK and Hoynes (1996b) on the USA.
3. UK transfer programmes are said to be insurance-related if entitlement to them is generated by virtue of claimants' being in a particular labour market position (e.g. unemployed) *and* having paid social security contributions (National Insurance contributions in the UK) for the requisite period of time prior to the spell out of work.
4. This is a prediction from the conventional model of family labour supply. Chiappori (1992) and others have developed alternative models based on individual utility maximization which would not necessarily have this property.
5. See Machin and Waldfogel (1994) and Juhn and Murphy (1996) on the contribution of a wife's earnings to household income for the UK and the USA, respectively.

6. Gruber and Cullen (1996) look at the 'crowding out' effect of UI on spousal labour supply in the USA.
7. However, when the budget constraint is nonlinear, the comparative statics are inevitably more complex. In particular, the kink associated with non-participation causes such complexities.
8. The UK has an intermediate system for UI which features an additional allowance for being married which is lost as soon as earnings of the wife exceed the level of this additional allowance.
9. Discouraged workers are individuals who would like to work but feel that no suitable job is available. Officially they are out of the labour force because they are not actively seeking work (OECD, 1996). OECD (1995) considers them to be a group of interest in themselves, representing an identifiable element of labour market slack since they can be considered as closer to the labour market than other non-participants.
10. See Moffitt (1992) for a general overview of the US welfare system and its incentive effects.
11. Maloney (1991) estimates a model of the wife's participation, conditional on observed employment status, as a bivariate probit. He attempts to control for potentially transitory observed unemployment by including residuals from a first stage probit of the husband's employment status in the second stage bivariate probit, as a proxy for the husband's unemployment risk. However, the estimation is misspecified in the second stage which relies on joint normality of second-stage error terms only.
12. For example, the labour supplies of husbands and wives may be correlated because of non-separability of utility or because of assortive mating.
13. It is assumed that credit markets are sufficiently imperfect for households with unemployed heads that consumption smoothing using credit is unlikely to be important. So dynamic issues are not addressed.
14. CPAG (1996) gives details of the October 1996 introduction of JSA.
15. See Atkinson *et al.* (1984), Narendranathan *et al.* (1985) and Micklewright (1985). Dilnot and Morris (1983) summarize the debate between Atkinson *et al.* (1984) and Nickell (1979) about robustness of the empirical relation between UI and unemployment duration.
16. Dilnot and Morris (1983) show that replacement rates rose over 1968–78 due to increased taxation and more generous benefits, but fell thereafter. Of interest for the re-employment decision of the unemployed is the marginal replacement rate, which decreases with duration. Abolition of the Earnings Related Supplement to UB and the taxation of transfer payments have lowered replacement rates for spells of up to six months, but have not affected longer-term ones.
17. In contrast, US studies indicate that the likelihood of an unemployed person leaving unemployment increases modestly in a period before benefit fall (UI exhaustion). Moffitt (1985) finds that increasing UI duration by one week increases mean duration by 0.1 week. Katz and Meyer (1990) find the same result but for 0.2 weeks. However, as Atkinson and Micklewright (1991) point out, the destination could be either employment or non-participation.
18. Atkinson (1995) describes the key institutional features of UI and UA in the UK and the USA. Although entitlement levels have effectively been indexed to the retail price index, their level relative to real earnings has fallen. Child additions were removed in 1984. Reduced rate benefits were abolished in 1986 so that those without a full contribution record received no UI, rather than a fraction as before. Moreover, from 1982 registration with the public employment agency was required, and from 1988 people were called for 'Restart' interviews every six months (see Dolton and O'Neill, 1995) and could be denied further UI if they failed to comply with the job search recommendations in the interview. Entitlements for youths have also been linked to training, and supplements for housing costs have been eroded. Micklewright (1985) discusses the Earnings Related Supplement (ERS) which was the part of UI linked earnings during the last tax year and payable during 2–26 weeks of unemployment. This was subject to a maximum, with additions for dependents. Its last year of full operation was 1980, when 20% of those unemployed received it and expenditure constituted about 15% of the UI programme.
19. For example, in 1986, of the (approximately 3 million) unemployed, 27% had insufficient contributions and 37% had exhausted their 12-month entitlement and so were reliant on UA.
20. Empirical studies for the USA show that the magnitude of the disincentive effects is very small and cannot explain female headship and non-marital child-bearing (Hoynes, 1996b). Current US reforms are for the equal treatment of two-parent families on welfare with the removal of the additional AFDC 100-hours rule.
21. Atkinson and Micklewright (1983) consider the deficiencies of the FES data in detail. It is difficult to use data prior to 1978 because of the absence of schooling information, and data beyond 1992 do not contain appropriate information about housing costs to deal with changes in the local tax system that occurred at this time.
22. The routine is based on the Institute for Fiscal Studies' TAXBEN programme, but is less complicated in that it considers only married couples, although more complicated in that it

considers not just tax benefits at the observed level of hours but also at other levels, and it deals with all of the changes that have taken place between 1978 and 1992. See Johnson *et al*. (1990) for details of TAXBEN.

23. The maintained assumption of our tax and benefit calculations is full compliance with tax liabilities and full take-up of benefit entitlements. This is potentially important if take-up is systematically related to labour supply because labour supply parameters may be biased as a consequence. While most of the labour supply literature also adopts the same maintained hypothesis, some recent studies have attempted to address the issue, for example Keane and Moffitt (1998). DSS estimates in DSS (1997) suggest that, for couples with children, IS take-up in 1995/96 was between 95% and 99%, and DSS (1999) has an estimate for couples with children for JSA (income-based) of 75%–90%. The figures for lone parents are higher and those for couples without children are a little lower. Thus, we feel comfortable in ignoring the issue. Moreover, addressing this issue adds considerably to the computational complexity involved and is beyond the scope of this paper.
24. It is important not to overstate the extent to which wives contribute to income inequality between couples. Borooah and McKee (1996) and Machin and Waldfogel (1994) find that wives contributed 31% and 27% to inequality in 1990 and 1993, respectively. Of the change in inequality over 1979–93, 27% was due to wives.
25. Gregg and Wadsworth (1996) look at 13 OECD countries 1983–94 and find that among two-adult households there is a decline in the proportion where only one partner works.
26. Short-term transfers are (or were): JSA, Earnings Related Supplement (ERS, a supplement to UI which depended on previous earnings), Sickness Allowance, and Statutory Sick Pay. Unemployment Benefit (which is what UI had been called in the UK) was payable in the short and medium term. In the medium and long term, Invalidity Allowance may be payable. In the long term (in any instance and earlier subject to means testing and according to circumstances) Income Support may be payable.
27. An important criticism of discrete choice modelling is the arbitrary nature of the definition of the alternatives. However, our estimated parameters were not significantly affected by shifting the PT–FT threshold until PT reaches 35 hours, which brings the FT hours peak into the PT range.
28. Mothers face one non-convexity arising from the Family Credit (FC) notch at 24 hours interacting with the 100% tax faced by those on IS, and another arising from FC eligibility ceasing as earnings rise. Women without children are ineligible for FC and face a fall in net income at the IS 24 hours limit. Regardless of the presence or absence of children, there exists a notch at the lower earnings limit for National Insurance contributions.
29. MaCurdy *et al*. (1990) take an approach that is based on estimating an hours equation where the budget constraint is approximated by a quadratic. However, the possibility of finding a suitable reasonable approximation to the constraint faced by UK women married to unemployed men is slim. A second approach can be found in Blundell *et al*. (1993), who sidestep the problem by taking a 'deep selection' of high earning women only and correcting for the resultant bias using some reduced form. The weakness of this approach is the absence of convincing exclusion restrictions to achieve identification.
30. Zabalza *et al*. (1980) characterize the choice over retirement, part-time or full-time work as an ordered probit with random parameters. They can do this because their sample exhibits kinked but convex budget sets. Moffitt (1984) estimates a discrete-choice model where there is gross wage endogeneity, which is modelled as a quadratic relationship between wages and hours. Hoynes (1996a) is a recent example.
31. A possible extension is to allow hours of work to deviate from these discrete values by introducing unobservable measurement error in hours. However, this would require integrating out net incomes over the feasible hours range, and would considerably increase the computational complexity because of the complicated tax and benefit rules that would have to be applied.
32. MaCurdy *et al*. (1990) show that inconsistent estimates may result from using predicted gross wages in a non-linear second-stage labour supply equation. One solution is to integrate out the prediction error in both the PT and FT wage equations, at the cost of increasing the dimensionality of the estimation problem. (Van Soest (1995) does this for the Netherlands, but using a simpler logit structure, and finds labour supply elasticities unchanged.) However, in view of the complex, highly nonlinear nature of the UK tax–benefit system, we regard the relative importance of errors in predicting wages to be sufficiently diminished for it to be reasonable for us to ignore them.
33. We compute incomes at 0, 24 and 40 hours respectively.
34. Fischer and Nagin (1981) denote this a random-coefficients, co-varying disturbances model.
35. ε_{hi} could represent unobserved attributes of alternatives or individuals which affect choice but are uncorrelated with V_{hi}. This may also be a pure random element of choice. Note that, by itself, an additive disturbance term allows no variation in tastes. Individuals with identical

observables may have different tastes, and this variance must be incorporated explicitly in the taste parameter. It can easily be shown that failure to incorporate taste variation induces a downward bias to estimates of taste parameters.

36. Hausman and Wise (1978) assume ε_{hi} to be i.i.d. across alternatives too.
37. See Pudney (1991) for a discussion.
38. Blundell *et al.* (1987, 1991) also exploit the availability of this information. We cannot use observed receipt of Unemployment Benefit (UK UI), since many (older) women in the UK have been able to opt to pay social security contributions at a reduced rate which does not provide them with a right to UI.
39. Of those out of work, the percentage of seekers is 95.7% and 10.0% for men and women respectively (including 7.9% and 0.9% who are ill but intending to seek). The non-seekers are partitioned into 1.9% and 1.7% retired; 1.2% and 3.5% ill and not intending to seek; and 1.2% and 84.8% unoccupied.
40. Men who are out of work but not seeking may be ill (in receipt of Statutory Sick Pay or Sickness Benefit), disabled (receiving Invalidity Allowance), in need of care (receiving Attendance Allowance or Disability Living Allowance) or retired (retirement pensioners are too old to be in our sample). Disney and Webb (1991) document the growing importance of transfers to the disabled in Britain.
41. The specification for the determination of female wages is $\log W_i^{wj} = Y_i^w \gamma^{wj} + {}_i^{wj}$, for $j = PT$, FT where PT and FT indicate part-time and full-time labour force status. We are simply interested in obtaining consistent wage predictions, so, although employment status is likely to be endogenous to the wage, we estimate the wage equations by including the Mills ratios from a bivariate probit model of participation *v.* non-participation and full-time *v.* part-time work conditional upon participation. We include the level of unearned income in the reduced form labour force status equations but not in the wage equations to achieve identification. Details are available on request.
42. A restrictive correlation structure is imposed between errors in the wife equations in order to reduce computational complexity. This may be considered overly restrictive, since husband and wife live in the same local labour market and our 12 regional unemployment indicators are unlikely to capture this adequately. A formal test of this restriction would involve testing down from the more complex model, which would defeat the object of imposing the restriction. The correlation matrix of residuals is computed as an informal test. The wife's unemployment errors turn out to be correlated with the wife's choice of PT *v.* NP, FT *v.* NP, and with husband's unemployment with respective correlation coefficients of +0.011 (standard deviation 0.007), −0.006 (0.005) and +0.115 (0.073). None of these correlations is significant at the 5% level, and this provides informal support for the restriction.
43. White (1982) proposes an information matrix test for heteroscedasticity and departures from normality. Applying Lancaster's (1984) implementation of Chesher's (1983) LM interpretation of the test, we find that our model is accepted only at a 30% significance level! In our defence, we appeal to the large sample size relative to other labour supply studies and note the absence of such specification tests in similar applied work. Furthermore, it is not obvious that alternative modelling approaches, such as generalizations of a multinomial logit, would fare any better in this regard.
44. A model with exogenous rationing for husband's unemployment provided starting values for the full model. The likelihood value is significantly increased, as can be seen from considering the likelihood ratio test statistic, λ, which is defined as $\lambda = -2(\ln L_{\rho_{\varepsilon,v}=0} - \ln L_{\rho_{\varepsilon,v}=\hat{\rho}_{\varepsilon,v}}) = -2 \times (71280 - 71360) = 160 \sim \chi^2_{(116-2)}$.This has a value of 0.00293. Hence we can reject the restriction of husband unemployment duration exogeneity.
45. Contribution-based payments were lower according to age (£30 for under-18s and £40 for those 18–24), but obviously double if both partners were unemployed. Means tests add an £11 family premium to parents of under 17s for example.
46. We need to predict a wage rate for husbands who are currently unemployed, in order to calculate employment earnings at 40 hours and run the tax–benefit system. The specification for the determination of male wages is similar to that used for female wages $\log W_i^{hj} Y_i^h \gamma^{hj} + e_i^{hj}$, for $j = RT$, OT where RT and OT indicate regular-time (hours 1–44) and overtime (hours 45+) labour force status. We are simply interested in obtaining consistent (regular hours) wage predictions, so, although employment status is likely to be endogenous to the wage, we estimate the wage equations by including the Mills ratios from a bivariate probit model of employment *v.* unemployment and overtime *v.* regular-time work conditional on employment. We include the level of unearned income in the reduced-form labour force status equations but not in the wage equations, and education only in the wage to achieve identification. Details are available on request.
47. Estimating weeks away from work directly would allow us to incorporate this additional information and identify these variances. Independent tobits for husband and wife

unemployment duration work well. However, estimating these jointly with the full model, we encountered convergence difficulties, and this setup was not pursued. Suggestions for an appropriate transformation of these variance terms are welcomed.

48. Blundell *et al*. (1991) estimate a bivariate probit for participation and conditional employment and use this as a selection into an hours equation. They put demand-side variables into the participation equation to identify discouraged workers.
49. Blundell *et al*. (1987) estimate a double hurdle model (using the same searching question) and find a significant correlation between the error terms. However, they go on to show that this makes little difference to the parameter estimates.
50. The probability of each individual being observed in each state is computed from the estimates. Expected sample percentages are simply the sums of the probabilities for each state and year.
51. The percentage expected correctly predicted is computed by summing over individuals the probability of a correct prediction. These are the marginals of the likelihood decomposition, according to labour supply and programme participation.

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