Labour supply estimates for low-income female heads of household using Mincome data

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Abstract. In this paper we present labour supply estimates for low-income female heads of households using data generated by the 1974 baseline survey of the Manitoba Basic Annual Income Experiment (Mincome). A simultaneous equations model of the labour market is specified and estimated by a procedure that accounts for the simultaneous equations nature of the model and for the possibility of sample selection bias. The major empirical findings are that wages net of child care costs rather than gross wages determine the supply of hours. Total unearned income and for married women the husband's gross wage have a negative influence on hours supplied. The presence of young children also has a negative influence, but children between six and fifteen years of age apparently do not. Formal education is found to be an important determinant of the wage offer available to women.

Mesures de l'offre de travail des femmes à bas revenu qui sont chefs de famille à partir des résultats de l'enquête Mincome. Ce mémoire présente des mesures de l'offre de travail des femmes à bas revenu qui sont chefs de famille à partir des résultats de l'enquête de 1974 – Manitoba Basic Annual Income Experiment (Mincome). Les auteurs développent un modèle du marché du travail à l'aide d'un système d'équations simultanées et le calibrent à l'aide d'une procédure qui prend en compte à la fois le caractère simultané du modèle et la possibilité de biais de sélection dans l'échantillonnage. Les principaux résultats empiriques sont les suivants : ce sont les salaires nets (décantés des coûts de la garde des enfants) plutôt que les salaires bruts qui déterminent le nombre d'heures de travail; le revenu total non-gagné – et pour les femmes mariées le salaire brut du mari – ont une influence négative sur le nombre d'heures de travail

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fournies; la présence de jeunes enfants a aussi le même effet, encore que la présence d'enfants entre six et quinze ans ne semble pas avoir cet impact; le degré d'instruction formelle semble aussi être un élément déterminant du salaire offert aux femmes.

INTRODUCTION

In this paper we present labour supply estimates for low-income female heads of households using data generated by the 1974 baseline survey of the Manitoba Basic Annual Income Experiment (Mincome).[1] This unique Canadian experiment, patterned on the Denver and Seattle Income Maintenance experiments in the United States, yielded a rich source of cross-sectional and longitudinal data on labour supply and personal and family characteristics. Our study has two objectives. First, we present new labour supply estimates using variables that have not hitherto been available in Canada. In particular, we show that daycare expenses play a significant role in the labour supply decision of women. Second, this study will alert other researchers to a new and potentially powerful source of data for analysis in labour markets.

Our model of labour supply is similar to that of Heckman (1974). Heckman's model recognizes that the number of hours that individuals actually work is the result of both supply and demand factors. On the demand side of the market there is an individual-specific wage offer that depends on the individual's labour market characteristics such as education and experience. The supply of labour is the result of utility maximization in which leisure time is balanced against the benefits of extra wage income. The reservation wage is a product of this maximization problem and depends on a general set of individual characteristics which includes factors such as the number and age of children within the household. In the static model of labour supply that we present in the next section these individual characteristics are treated as being exogenous. That is to say, labour supply decisions are assumed to be made conditional on family composition and the level of education.

An important feature of the model is that it explicitly recognizes that corner solutions are possible; that is, not all potential workers actually supply positive hours of labour. In particular, those women whose reservation wage exceeds their wage offer will not supply labour. It has been well recognized in the literature (see, for example, Heckman, 1974 and 1976; and Nakamura and Nakamura, 1981 and 1983) that this separation of the total sample into

1 There are several documents describing Mincome Manitoba. See, for example, Hum, Laub, and Powell (1979). Briefly, the objective of the experiment was to test the effect of a guaranteed annual income on the work behaviour of recipients. The experiment, administered over the four-year period 1974-8, was conducted in three sites: Winnipeg, Dauphin, and rurally dispersed. Out of 24,000 families screened initially, 3,400 low-income families were selected for an intensive baseline interview and 1,700 were eventually enrolled in the experiment. The data used in the present study were collected during the pre-experiment baseline interview. The participants who were enrolled in the experiment were subsequently interviewed at four-monthly intervals over a period of four years. This series of interviews should provide a detailed work history of participating family units.

subsamples of workers and non-workers is not a random process. Failure to account for this in the estimation procedure leads to some degree of selectivity-bias in the estimated coefficients. Consequently, an appropriate method of estimating labour supply must account for the simultaneous nature of the model and the non-random sample selection process that separates workers from non-workers. Heckman (1974) employed maximum likelihood methods. Here, we shall follow a two-step procedure based on the discussion in Heckman (1976).

MODEL SPECIFICATION AND METHODS OF ESTIMATION

In general terms the model can be written as follows. The demand side is described by

$$W_i = X_i^1\alpha + X_i^2\beta + e_i, \qquad (1)$$

where W_i is the wage offer available to individual i, X_i^1 and X_i^2 are row vectors of individual characteristics with associated parameter vectors α and β. The random disturbance term, e_i, is assumed to be a normal variate with classical properties for all i. The supply side is described by two equations:

$$W_i^* = X_i^1\gamma^* + X_i^3\delta^* + e_i^*, \qquad (2)$$

where W_i^* is the ith individual's reservation wage. This is a function of the individual characteristics contained in the row vectors X_i^1 and X_i^3; γ^* and δ^* are the associated parameter vectors. The random disturbance term, e_i^*, is assumed to be a normal variate with classical properties for all i. The final equation shows that the number of hours of labour supplied by individual i is a discontinuous function of the wage offer; the discontinuity being at the point of equality between the wage offer and the reservation wage.

$$\left.\begin{array}{ll} H_i = \theta W_i + X_i^1\gamma + X_i^3\delta + u_i & \text{for } W_i > W_i^* \\ H_i = 0 & \text{for } W_i \leqq W_i^* \end{array}\right\}. \qquad (3)$$

There is of course a connection between (2) and (3), since the reservation wage, W_i^*, equals the greatest wage offer consistent with zero hours of labour supply. Consequently, $\gamma^* = -\gamma/\theta$, $\delta^* = -\delta/\theta$ and $e_i^* = -u_i/\theta$.

An interesting extension to this model is to account for the role of child care costs that one would expect to influence the labour supply decisions of both single and married women with young children. It can be argued that the wage offer determined by equation (1) is the gross wage, but the relevant wage in the labour supply equation is the wage net of child care costs. We treat child care costs as exogenous and simply subtract them from the gross wage to arrive at the net wage. The results of estimating both versions of the model are reported in the next section.

There are two potentially serious difficulties in using ordinary least squares (OLS) to estimate the parameters of the hours equation. Simultaneous equation bias arises from our inability to rule out a priori the possibility of a non-zero covariance between u_i and e_i. Such a situation implies a non-zero correlation between the wage offer and the disturbance term in the hours equation leading to inconsistent OLS parameter estimates. The second difficulty for OLS estimation applies to both the hours and the wage offer equations and arises from the fact that both are estimated using data on the subsample of workers only. For this subsample the means of e_i and u_i are not in general zero. Consider the expected wage offer for workers only

$$E(W_i|W_i > W_i^*) = X_i^1\alpha + X_i^2\beta + E(e_i|d_i > D_i),$$

where $d_i = (e_i - e_i^*)$ and $D_i = X_i^1(\gamma^* - \alpha) - X_i^2\beta + X_i^3\delta^*$. The term $E(e_i|d_i > D_i)$ can be written as $(\sigma_{ed}/\sigma_{dd}^{1/2})\lambda_i$, where $\sigma_{ed} = E(e_id_i)$, $\sigma_{dd} = E(d_i^2)$ for all i. The variable λ_i, usually referred to as the inverse Mills ratio, is equal to $f(D_i/\sigma_{dd}^{1/2})/[1 - F(D_i/\sigma_{dd}^{1/2})]$ where $f(\ )$ and $F(\ )$ are the normal density and cumulative density functions, respectively. Restricting the wage offer equation to workers only effectively requires the introduction of the variable λ_i. In this way, Heckman (1976) has cast the censored sample problem in terms of an omitted variable problem. A similar argument applies to the hours equation.

The first stage of Heckman's two stage procedure is to use Probit analysis of the work decision. From this it is possible to construct the variable λ_i for each individual and to introduce this variable into the wage and hours equations. The use of OLS to estimate the augmented wage equation will provide consistent parameter estimates, because there are no right-hand-side endogenous variables in this equation. In the case of the hours equation we have used predicted wages as an instrument for actual wages in order to avoid the simultaneous equation bias of the OLS estimator. The predicted wage is obtained from the appropriate reduced-form equation for wages, which includes the sets of regressors X^1 and X^2 and the Mills ratio λ. Note that the set of variables X^3, which appears in the hours equation, does not appear in the reduced-form equation for wages. This follows from the model's structure, which specifies a one-way dependence (wages affect the supply of hours but hours do not affect the wage offer). The model is not recursive, however, because we do not assume the structural disturbances are independent. Of course, if this strong independence condition were satisfied, the OLS estimator would not suffer from simultaneous equation bias.

THE DEFINITION OF VARIABLES AND EMPIRICAL RESULTS

The sample of females (excluding single person households) for whom complete baseline information is available consists of 290 single and 957 married women. Of the single women 182, or 63 per cent, supplied positive hours of labour. Within the group of married women 430, or 45 per cent, reported positive hours. In this study the two groups of women are treated separately to allow for the possibility of different labour supply behaviour. The

TABLE 1

Estimated gross wage equations[a]

	Married females		Single females	
CONSTANT	1.635*	1.850*	2.243*	1.995*
	(0.226)	(0.131)	(0.227)	(0.180)
AGE < 25	−0.270*	−0.263*	−0.283*	−0.309*
	(0.086)	(0.086)	(0.116)	(0.115)
AGE26-34	−0.035	0.017	−0.151	−0.153
	(0.100)	(0.090)	(0.100)	(0.100)
AGE50+	−0.143	−0.116	−0.460*	−0.431*
	(0.130)	(0.128)	(0.114)	(0.113)
EDUC	0.089*	0.081*	0.067*	0.081*
	(0.014)	(0.012)	(0.018)	(0.017)
SITE1	−0.227*	−0.211*	−0.283*	−0.280*
	(0.085)	(0.085)	(0.097)	(0.100)
SITE2	−0.150	−0.142	−0.058	−0.086
	(0.109)	(0.109)	(0.118)	(0.118)
MILLS	0.192		−0.246	
	(0.164)		(0.139)	
R^2	0.132	0.130	0.257	0.244
No. obs.	430	430	182	182

* Indicates the null hypothesis of a zero coefficient is rejected at the 5 per cent level of significance.

[a] The standard errors that appear in parentheses are estimated under the null hypothesis of no selectivity bias and are approximate if this hypothesis is invalid.

first stage of the estimation procedure is the probit analysis of the work decision. The estimated probit equations for the two subgroups of married and single women are reported in table 1A of the appendix. From each of these equations an inverse Mills ratio variable is constructed and used in the subsequent estimation of the wage offer and labour supply equations.

We consider first the wage offer equation. The dependent variable is the gross hourly wage, which is the relevant concept for the wage offer.[2] In addition to the variable MILLS, which has already been discussed, the explanatory variables are as follows. Education (EDUC) is measured by the number of years of formal schooling. Experience is measured by three age dummy variables: AGE < 25 = 1 if age is twenty-five years or less, AGE26-34 = 1 for women twenty-six to thirty-four years and AGE50+ = 1 for women of fifty years or older; otherwise these variables take the value zero. Finally two location dummy variables are included to allow for locational differences in wage rates. The base case is the city of Winnipeg, SITE1 = 1 for the Dauphin site, and SITE2 = 1 for rural areas.

The results of the second-stage OLS estimation of the wage equations are reported in table 1. The coefficients on the inverse Mills ratio variables in

2 Many studies have used the logarithm of the wage rate. We found virtually no differences at all in the linear and logarithmic specifications and report only the former.

table 1 are not significantly different from zero, and indeed the other coefficients change surprisingly little when this variable is omitted. As we would expect, the education variable's coefficient is the most highly significant for both single and married women. In addition, the corresponding coefficients in the two wage offer equations are very similar in size. However, the overall fit as measured by the R^2 is considerably higher in the case of single women.

We turn now to the labour supply equations. The results are presented in table 2. The dependent variable is defined as the average number of hours worked per week during 1974 from the beginning of January to the date of the baseline interview. The explanatory variables include the own wage (WAGE) which is defined as either the gross wage or the wage net of child care costs. For women in double-headed households the husband's wage (HWAGE) is included. This is expected to have a negative influence on female labour supply, as is the level of other household income (OINC).[3] In order to capture a measure of wealth, we include a home ownership dummy variable (HOME), which takes the value of unity if the residence is owned and zero otherwise.

The impact of children on labour supply behaviour is captured by three variables: the actual number of children between six and fifteen years of age CHLDRN6-15, and two dummy variables for children under six (CHILD $< 6 = 1$ if the household has one such child and CHLDRN $< 6 = 1$ if there are two or more such children). We have also included the two dummy variables SITE1 and SITE2 which control for potential locational differences. Finally, the inverse Mills ratio variable (MILLS) is included to account for the non-random selection problem that arises when the data are confined to those who supply positive hours.[4]

Consider first the results for married women. Clearly the gross wage performs much less well than the wage net of child care costs, indicating that child care costs are indeed a relevant factor in the labour supply decisions of females.[5] The two net wage equations suggest that the MILLS variable does have a role to play. Its omission substantially reduces the importance of the own wage, husband's wage, other income and the presence of children under six years of age. It is interesting that children between the ages of six and fifteen have virtually no affect at all on the labour supply decision of females. This finding agrees with Heckman (1974).

Turning to the single female heads, it is again clear that the wage net of child

3 This variable includes income from manpower training allowances, family allowances, pensions, annuities, old age security, workmen's compensation, alimony, private support, and public welfare from municipal or provincial governments.

4 Of course it is not appropriate to include the data on zero hours in the regression, even though these were actually observed, because to do so would be to ignore the discontinuity in the supply function.

5 We have tested the hypothesis that the coefficients on the gross wage and the child care costs are equal in size but opposite in sign. The t-statistics are 0.9 and -0.6 in the single women and married woman subsamples, respectively. Consequently, the hypotheses are not rejected.

TABLE 2

Estimated hours equations[a]

	Married females			Single females		
	Gross wage	Net wage		Gross wage	Net wage	
CONSTANT	19.616*	15.315*	20.244*	11.259	19.729*	20.851*
	(9.853)	(5.387)	(4.498)	(11.266)	(7.128)	(6.467)
WAGE	3.397	5.023*	3.997*	8.759*	6.158*	5.741*
	(3.642)	(1.777)	(1.685)	(3.830)	(2.467)	(2.439)
HWAGE	−1.357	−1.447*	−0.952			
	(0.747)	(0.611)	(0.522)			
OINC	−2.613*	−2.979*	−2.199*	−2.945*	−2.493*	−2.487*
	(0.923)	(0.801)	(0.629)	(1.132)	(1.089)	(0.620)
HOME	0.475	−0.045	0.521	0.742	−0.303	−0.301
	(1.500)	(1.502)	(1.453)	(2.292)	(2.210)	(2.004)
CHILD < 6	−3.809	−3.035	−1.050	−3.724	−1.637	−1.679
	(2.192)	(2.069)	(1.598)	(2.390)	(2.279)	(2.263)
CHLDRN < 6	−6.746*	−5.548*	−3.224	−8.121*	−5.258	−5.434
	(2.745)	(2.697)	(2.204)	(3.932)	(4.005)	(3.917)
CHLDRN6-15	−0.043	−0.003	−0.009	0.327	0.191	0.210
	(0.058)	(0.556)	(0.553)	(0.967)	(0.956)	(0.906)
SITE1	1.940	2.309	3.682	0.698	−0.286	−0.411
	(2.116)	(2.119)	(1.906)	(2.590)	(2.359)	(2.332)
SITE2	−2.157	−1.695	−1.056	2.035	2.638	2.568
	(2.321)	(2.325)	(2.276)	(2.863)	(2.840)	(2.733)
MILLS	6.163	7.799		3.604	0.198	
R^2	(5.707)	(5.034)		(6.149)	(5.515)	
No. obs.	0.064	0.079	0.073	0.187	0.195	0.192
	430	430	430	182	182	182

* Indicates that the null hypothesis of a zero coefficient is rejected at the 5 per cent level of significance.

[a] The standard errors that appear in parentheses are estimated under the null hypothesis of no selectivity bias and are approximate if this hypothesis is invalid.

care costs performs very much better than the gross wage. Moving to this wage concept raises R^2 from 0.187 to 0.195. However, the MILLS variable does not play such an important role. The deletion of this variable has a very small effect on the other coefficients. The most important variables affecting the labour supply decision of single females are the own wage net of child care and other income. The data suggest that children under six do have a negative influence on labour supply, but the effects are smaller and of weaker statistical significance in the case of single females. Again, children between the ages of six and fifteen have a negligible effect on female labour supply. Finally, the R^2 statistics imply the unsurprising result that the model is better able to explain the labour supply decisions of single female heads than of married women.

In conclusion, the econometric estimates of female labour supply using Mincome baseline survey data are both plausible and consistent with theoretical expectations. Formal education is a key variable in the wage offer available to females, and this market wage net of child care costs is a strong positive factor in determining the hours of labour supplied. Total unearned income and, for married women, the husband's gross wage have a significant negative influence on hours supplied. The presence of small childen also has a negative influence, but children between six and fifteen years of age apparently do not.

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APPENDIX

TABLE 1A

Variable name	Probit coefficients and *t*-statistics				Means of variables[a]	
	Married women		Single women		Married women	Single women
	Coeff.	*t*-stat.	Coeff.	*t*-stat.		
CONSTANT	0.19	0.75	−0.48	−1.11		
HWAGE	−0.12	−3.47			3.49	
AGE < 25	0.09	0.59	−0.34	−1.19	0.36	0.18
AGE26-34	−0.19	−1.53	0.28	1.19	0.24	0.28
AGE50+	−0.40	−2.41	0.22	0.82	0.08	0.18
EDUC	0.06	3.37	0.13	3.46	10.19	9.87
CHILD < 6	−0.45	−4.34	0.08	0.33	0.30	0.27
CHLDRN < 6	−0.57	−4.39	0.23	0.66	0.13	0.07
CHLDRN6-15	0.03	0.75	0.12	1.41	1.00	0.96
SITE1	−0.30	−2.70	−0.04	−0.18	0.21	0.22
SITE2	−0.15	−1.06	−0.15	−0.19	0.11	0.14
OINC	−0.12	−3.45	−0.33	−6.19	0.85	1.52
HOME	0.04	0.38	0.38	1.82	0.49	0.36
GROSSW					2.52	2.54
NETW					2.36	2.38
HOURS					24.64	30.25
MILLS					0.82	0.48
No. obs.	957	290			430	182

[a] The means are computed for those women with positive hours of labour supply.