Endnotes

1. The reservation wage is the highest wage-rate at which the wife will not work.

2. This implies that the presence of children in the family has a behavioural effect on the labour force behaviour of married women.

3. The value of the Lagrange multiplier constitutes a measure of the effect of a change in the full income budget constraint on the optimal level of utility; that is, the effect of an increase in F on the optimal level of utility (Chiang, 1984, pp. 376-377).

4. We discuss this issue in greater depth in the specification of the empirical model.

5. In a preliminary analysis, we included additional regressors which are believed to influence a wife's participation decision. We then estimated the participation equation with our standard variables and compared the results from both models. We concluded that "more" is not necessarily "better" since our standard model performed as well as our more complex model.

6. This, in essence is what the studies by Kalachek, Raines and Larson (1978), Johnson and Pencavel (1984), and Nakamura and Nakamura (1985) accomplish.

7. Lagged employment may also reflect partial demand-side effects.

8. Estimating labour force participation equations from a provincial perspective did not suggest that aggregating across provinces would create a problem.

9. Since farm wives are included in past studies of female labour supply, we include them in this analysis to facilitate comparisons across studies.

10. Since the average number of children in a family, regardless of the work status of the wife, is consistently higher than the average number of children in a family where the wife works, we conclude that working wives have, on average, fewer children than non-working wives. This may be shown accordingly:

let #CWW ≡ number of children - working wives
#CNW ≡ number of children - non-working wives
#NW ≡ number of non-working wives
#WW ≡ number of working wives
A#CNW+WW ≡ average number of children - non-working wives and working wives
A#CWW ≡ average number of children - working wives
A#CNW ≡ average number of children - non-working wives

From Tables 3 and 4, we know that

A#CNW+WW > A#CWW,

and therefore,

$$\frac{\#CWW+\#CNW}{\#NW+\#WW} > \frac{\#CWW}{\#WW}$$

or,

$$\#WW(\#CWW+\#CNW) > \#CWW(\#NW+\#WW),$$

which may be reduced to

$$\#WW \cdot \#CNN > \#NW \cdot \#CWW$$

or $$\frac{\#CNW}{\#NW} > \frac{\#CWW}{\#WW}.$$

Thus,

$$A\#CNW > A\#CWW.$$

11. The percent of correct predictions for $Y_i=j$, $(j=0,1)$ is defined as the ratio of the number of wives for which both the actual and predicted values of Y_i equal j to the number of wives for which the actual value of Y_i equals j (West, Ryan, and Von Hohenbalken, 1978, p. 28).

12. See Heckman (1981, p. 95) for an intuitive interpretation of state dependence.

13. Alternatively, the labour supply schedule could be flat.

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This study examines the hypothesis that once past labour force behaviour is controlled for, child status variables, and possibly other standard variables will play a less significant role in predicting the current labour force status of married Canadian women. This hypothesis relies on the premise that those aspects of a wife's personality which change slowly, or not at all, are responsible for a major portion of the variability in labour force participation of married women.

Our analysis involves estimating selectivity-bias corrected labour supply equations for working wives. We consider the effect of including selectivity terms generated from different specifications of the participation model on the estimated coefficients and gross wage elasticities of the annual hours equation. The empirical estimation of our labour supply schedule involves a two-stage least squares estimation procedure.

Evidence from this study supports the hypothesis that past work behaviour may proxy for fixed or slowly changing individual specific effects. We conjecture that the estimated coefficients of the child status and education variables are upward biased (in absolute value) if we do not control for previous work behaviour. Also, we find that both of our methods for controlling for past work behaviour in the participation equations are equally effective. However, we observe that the labour supply equation is sensitive to the particular derivation of the sample selection term; that is, the method by which past labour force behaviour is controlled for in the participation model.

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1. INTRODUCTION

Over the past thirty years, the labour force participation of married women has risen at an unprecedented rate. In 1950, 9.5 percent of all married Canadian women over 20 years of age worked for pay or profit; by 1981, this figure had risen to 55.9 percent (Canada Yearbook, 1950; 1981). Traditionally female-oriented occupations - teaching, clerical, medicine and health-care, and especially the service sector - have seen an increased proportion of married women. A once predominantly male oriented work force has evolved to a point where employment opportunities are significantly less dependent on sex or marital status.

This dramatic change in the labour market behaviour of one demographic group has generated a great deal of interest for labour economists and econometricians. Advanced econometric techniques were developed by individuals such as Gronau, Heckman, and others to apply to this situation where existing techniques were not appropriate. Gronau (1974) extended the frontier of econometric methodology in the area of selectivity bias, and Heckman (1974) examined the joint distribution of hours and wages within censored samples.

Yet, as the methodological base for modelling labour force behaviour expands, so must its theoretical counterpart. Married women who participate in today's work force may have started, or continued to work for a variety of reasons. In certain instances, a wife may work to help out with short-term financial obligations or because her husband's income is not sufficient to cover family expenses. Some wives work to fulfill career aspirations whereas others become involved in volunteer work and rely solely on their husband's income to support the family.

Life-cycle participation patterns of married women have been scrutinized in order to provide a better understanding of when and why married women enter and leave the work force. Many women join the labour force immediately after completing school and work fairly continuously until retirement. Others, on the other hand, spend little if any time in the labour market (Heckman and Willis, 1977; Mincer and Ofek, 1979).

A woman enters or re-enters the work force when the wage offered to her by a potential employer is greater than her reservation wage.[1] Subsequently, she will increase the hours of work until the marginal value of time for market and non-market activities have been equated (Schultz, 1978). If the offered wage is below the asking wage, she will choose not to work and will be classified as voluntarily unemployed. Individuals receive offered wages based on their specific demographic or regional characteristics. Personal or family constraints as well as taste factors influence a wife's preference for market or non-market activities. A time preference for either market or non-market activities is often referred to as the work-leisure trade-off.

As in most female labour supply studies, we are interested here in the effect of personal and family characteristics on work behaviour. However, our major concern is how the effects of these explanatory variables change when we include variables which quantify women's attitudes toward market or non-market activities. One source of this information is past behaviour. For example, a housewife's long-standing preference for non-market activities may reflect time priorities which are a product of the life-long development of personal attitudes regarding time allocation. Similarly, previous work behaviour of a market-oriented woman will quantify person-specific attitudes.

If long-standing tastes and preferences do determine the labour force behaviour of married women, one might presume that the predictive strength of certain long-standing explanatory variables in labour economics may have been overstated. For example, in many studies child status variables have played an important role in determining the labour force behaviour of married women. Both the number and timing of the children are shown to affect the wife's future market activity. Studies have indicated that children younger than six have a greater impact on female labour force behaviour than older children (Nakamura, Nakamura, Cullen, Grant, and Orcutt 1979).

It seems clear that child status variables have played an important role in predicting the labour force behaviour of married women. However, we might argue that the significance of these variables lies not only with their true state dependence,[2] but with what they reveal about a wife's time preferences. A wife's predisposition for market versus non-market activities may be reflected by the presence or absence of children in the family. Thus, after controlling for her labour preferences, the child status variables may explain little of the variability in current labour force behaviour.

In a study of earnings equations, R.K. Filer (1983) included measures of the individual's tastes as an explanatory variable. The data on "tastes" included ranking the importance of job satisfaction, security, power, occupational prestige, social prestige, income, family life, religious activities, community activities, freedom for travel and recreation, and contribution of job to society. Filer concluded that:

> "In almost all cases the coefficient on a taste variable was much further removed from zero in the female equation, a result not unexpected in a society where it is anticipated that all able-bodied men will participate in the labor market and strive to succeed, but that only some

women will choose to both participate and attempt to excel. In such a world, women whose tastes are for non-career areas may choose to focus elsewhere, an option not available to men with similar tastes. In addition, it may indicate that some women in the labor market (perhaps regarding themselves as ancillary wage-earners) may consider themselves freer to give rein to their tastes and to sacrifice salary for nonpecuniary labor market rewards. The power of the taste variables is certainly intriguing and suggests profitable areas for future research." (p. 94).

Thus, Filer's results indicate that tastes are a major component in determining what occurs in the labour market. He found that the omission of tastes leads to overestimation, or inflated coefficient estimates. We shall attempt to prove that by controlling for a wife's tastes for market or non-market activities, our explanatory variables (particularly the child status variables) do not have as significant an effect on determining the labour force participation, or labour supply of married women.

Labour supply theorists have developed a standard set of explanatory variables for predicting the work behaviour of married women (see, for example, Robinson and Tomes, 1985; or Nakamura and Nakamura, 1983 for Canadian studies of female labour supply). Included in this set are variables such as child status, the wife's highest level of education, and the husband's employment income. The aim of this essay is to determine whether the estimated impacts of these variables differ systematically in participation and labour supply equations if we can control for unobservable, individual-specific factors such as tastes or preferences for work.

The classical labour supply theorists (1960's and early 1970's) were not concerned with incorporating fixed or persistent individual-specific unobservable factors in models of labour force participation (Leuthold, 1968). They viewed the work decision as a product of an individual's utility maximizing behaviour subject to personal or family time and income constraints. However, these models cannot explain sufficiently the differences in labour supply which exist even when all individuals face the same constraints. Labour supply differences could theoretically be a product, <u>ceteris paribus</u>, of differing tastes for work. Thus, to correctly specify a behavioural model of female labour supply, we must account for latent individual effects. Latent variables are defined as "random variables which cannot be measured directly, but which play essential roles in the description of observable quantities" (Brillinger and Preisler, 1981, p. 31). The latent variable we consider here is one's taste for work which, we argue in our model, is an unobservable and slowly changing individualistic feature.

The traditional approach to eliminate persistent individual effects is to transform the data into deviations from the mean (e.g. Maranto and Rodgers, 1984). Those aspects of an individual which are persistent over time will be eliminated from the model during the transformation process. However, this method may cause serious bias problems since errors-in-variables, a common problem in the formation of, for example, wage variables, will be exacerbated by the transformation (Hausman and Taylor, 1981, p. 1377). A further drawback of this method rests on the fact that all parameters associated with time-invariant random variables will be zero (Maranto and Rodgers, 1984, p. 350). For example, we would be unable to obtain an estimate for the coefficient associated with an education variable, since years of schooling does not change for most adults.

An alternative method, and one which is employed in this essay, is to include variables which account, in a proxy sense, for tastes and other slowly changing unobservable factors. The concept of including surrogates for latent variables has been utilized in empirical research by Griliches (1977), Kalachek, Raines and Larson (1979), Johnson and Pencavel (1984), and Nakamura and Nakamura (1985).

Although this study is based on a cross-sectional analysis of married women, we shall argue that with a limited amount of past information on work behaviour we are able to control for slowly changing individual-specific effects. The remainder of this study is comprised of five major sections. In the first section we present a one-period lifetime model of labour supply and a theoretical model of labour force participation and labour supply, we discuss sample selectivity, and we consider the possible estimation techniques. In the second section, we consider the empirical specification of the participation and labour supply models, describe the variables, discuss the theoretical basis for including these variables in our model, and examine how they have been used in past research. The third section includes definitions of the various labour supply and income or wage variables that can be computed from the Canadian census. In this section we comment on how we handle idiosyncrasies in this data set. In the fourth section, the empirical findings of this study are presented and compared with those obtained in past studies of labour supply. The final section contains a summary of findings, conclusions and some suggested directions for further research.

2. THE THEORETICAL MODEL: SPECIFICATION AND OVERVIEW

2.1 One-Period Lifetime Model

Static models of labour supply examine the utility maximizing behaviour of households subject to certain financial or time constraints. We shall assume that the ith household in our sample maximizes a utility function U(B) where B is a composite commodity from which utility is gained. B is, in turn, a function of market goods and services (S) and the leisure time of the husband (t^m) and wife (t^f) such that $B = b(S, t^m, t^f)$ and,

(1) $U = U[b(S, t^m, t^f)] = U^*(S, t^m, t^f)$.

Thus, the ith household consumes the amounts of S, t^m and t^f which maximize (1) subject to the time and budget constraints given by

(2) $T^m = t^m + H^m$

(3) $T^f = t^f + H^f$

(4) $P \cdot S = W^m \cdot H^m + W^f \cdot H^f + V$

where V is non-labour income, H^f and H^m represent the time supplied to the market by the female and male respectively, W^f and W^m denote their respective wage rates, P is the unit price of S, and $T(=T^m=T^f)$ denotes the time available in a given period. We should also note that labour supplies (H^m and H^f) are a function of the offered wage rate, non-wage income and a taste factor (τ).

Substituting the constraints on time [(2) and (3)] into the financial constraint (4), we have:

(5) $W^m(T^m - t^m) + W^f(T^f - t^f) + V = P \cdot S$

which defines the budget constraint for the household. To simplify this constraint we denote by F the household's full money income which is defined as the maximum amount a husband and wife could earn if they spent all available time at work ($F = W^m \cdot T^m + W^f \cdot T^f + V$). Now, in order to maximize (1) subject to (5) by choosing S, t^m and t^f, we form the Lagrangian:

(6) $L = U^*(S, t^m, t^f) + \lambda[F - P \cdot S - W^m \cdot t^m - W^f \cdot t^f]$

where λ is the Lagrange multiplier[3] and the first order conditions are

(7) $U^*_S - \lambda P = 0$

(8) $U^*_{t^m} - \lambda W^m = 0$

(9) $U^*_{t^f} - \lambda W^f = 0$

(10) $F = P \cdot S + W^m \cdot t^m + W^f \cdot t^f$

Equation (5) tells us that regardless of the activity, any non-market enterprise has an opportunity cost of W^m and W^f for the husband and wife respectively. Rearranging (9), we denote the opportunity cost of the wife's leisure time as

(11) $W^f = \dfrac{U^*_{t^f}}{\lambda}$,

and

(12) $U^*_{t^f} = \dfrac{\partial U}{\partial B} \cdot \dfrac{\partial B}{\partial t^f} = MU \cdot MP_{t^f}$

where MU is the marginal utility of an extra unit of the composite commodity and MP_{t^f} is the marginal product of leisure. Substituting (12) into (11), we have

(13) $W^f = \dfrac{MU}{\lambda} \cdot MP_{t^f} = \Pi \cdot MP_{t^f}$

where Π is the shadow price of commodity B. B does not have a market price because it is not purchased in the market place. However, it does have a shadow price (Π) which is equal to the cost of the goods and time spent to produce the commodity (Becker, 1981, p. 8).

If the wife is working, then we know that certain first order conditions for utility maximization will be satisfied. First, her indifference curve (U) will be tangent to the budget line at $H^f<T^f$ and second, the budget constraint (10) will hold. Combining (7) and (9), we can see that the tangency condition implies the marginal rate of substitution of S for t_f must equal the wife's real wage i.e., $U^*_{t^f}/U^*_S = W_f/P =$ w. This equality may be represented by a point such as A in Figure 1.

The Work-Leisure Trade-Off

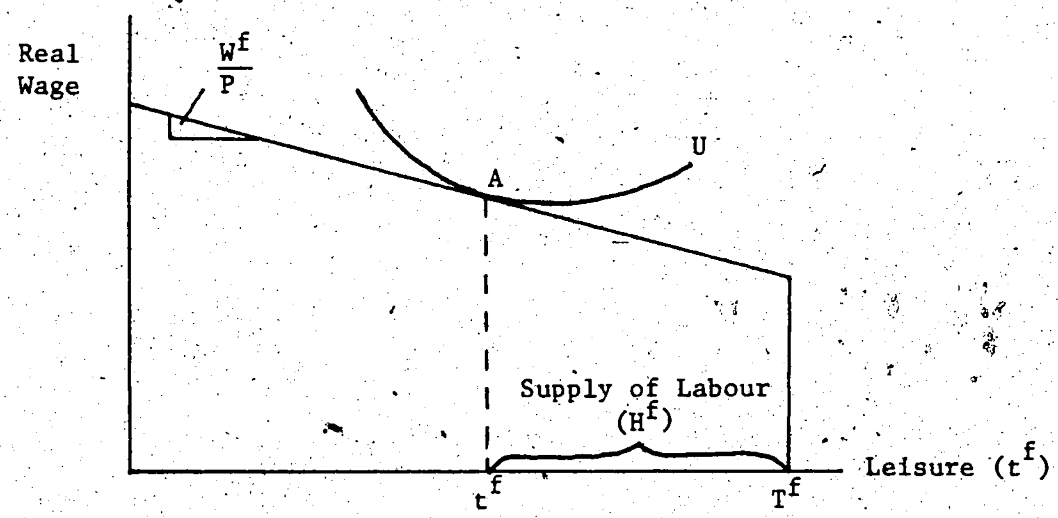

FIGURE 1

In Figure 2, the wife's indifference curve (U) is tangent to the budget line at point B. At this point, the wife is not working, i.e., $H^f=0$. The wife's reservation, or asking wage (w*), is the highest wage rate, evaluated at zero hours of work (point B), at which the wife will not work. If the wife is not working, the slope of the indifference curve, evaluated at zero hours of work, will be greater than the slope of the budget constraint; that is, $U^*_{t^f}/U^*_S > w$ or $w^* > w$, where w is the offered wage. Thus, a wife will work if and only if the offered wage is greater than the asking wage, evaluated at zero hours of work ($w > w^*$).

Participation Decision

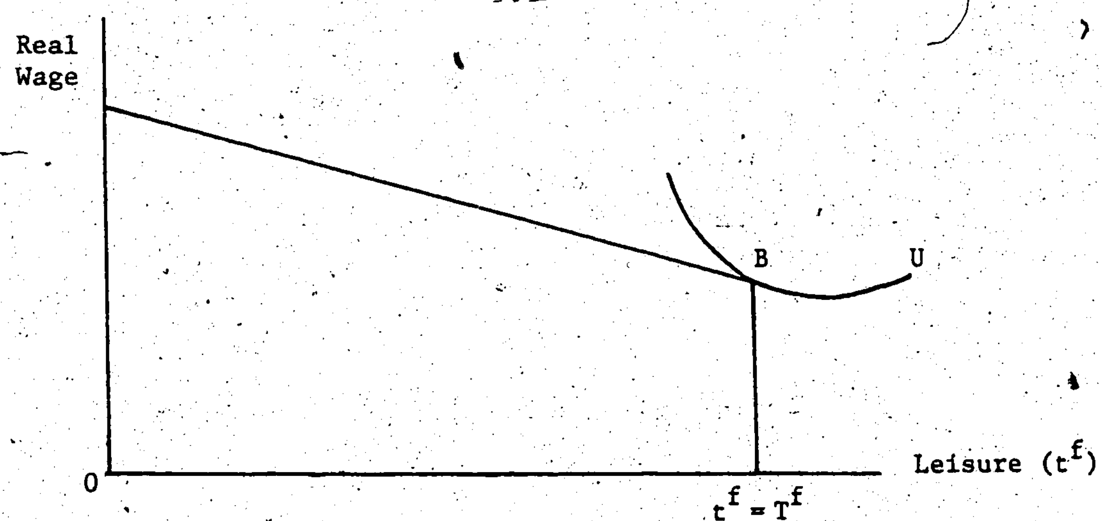

FIGURE 2

Figure 3 represents a case where, at zero hours of work, $w = w_1 < w^*$ i.e., the wife is not working. If we assume the offered wage rate increases from w_1 to w_2, we see that $U^*_{t^f}/U^*_S < w_2$ evaluated at zero hours of work. Thus, the analysis of the relationship between the offered and asking wage rates evaluated at zero hours of work provides us with information on whether or not a wife is a labour force participant. If this critical threshold is crossed ($w > w^*$), the next step is to determine the wife's supply of labour to the market.

Labour Supply

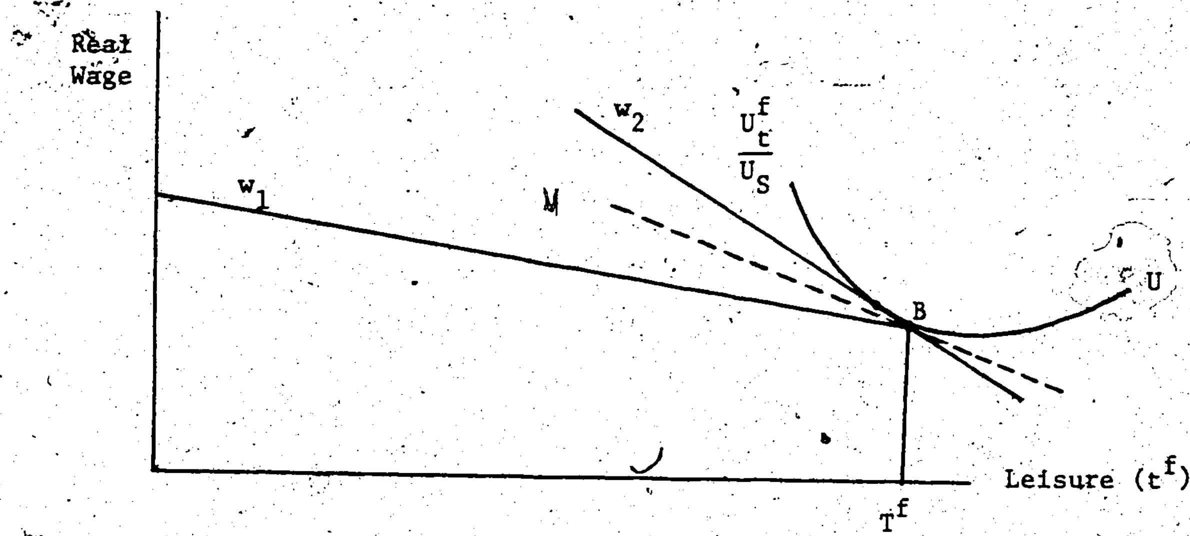

FIGURE 3

If a wife is a labour force participant, we know that she is achieving a higher level of utility by working than by staying home. This is evident from the first order condition $U^*_{t^f}/U^*_S = w$. If $U^*_{t^f}/U^*_S < w$, evaluated at zero hours of work, the wife can increase her level of utility by supplying hours of labour to the market up to the point where $U^*_{t^f}/U^*_S = w$. Thus, the hours of work for a wife are adjusted until the first order condition ($U^*_{t^f}/U^*_S = w$) is satisfied (Schultz, 1978).

Typically, information on actual wages is only available for working individuals. However, structural determinants of the wage rate (e.g. education), are generally available for both working and non-working individuals. This implies that we can express the offered wage as a function of variables which are observable for individuals regardless of their current labour force status (Killingsworth, 1983, p. 148). Thus, $w = w[X, e_{(w)}]$, where X is a vector of observable structural determinants of w, and $e_{(w)}$ is a mean-zero random error term. We express the wage-function as linear in X, where the dependent wage variable is measured in logarithms (for similarly defined wage functions, see Landes, 1977; Cogan, 1980b, 1981; Schultz, 1978; Sandell and Shapiro, 1980; or Nakamura, Nakamura, and Cullen, 1979). The theoretical grounds for expressing the wage equation in log-linear form, as developed by Mincer (1974), assume that market wages are determined by a semi-log earnings function. The practical advantage of a log-linear wage equation is that we avoid negative predicted wage rates. Hence,

(14) $w = \alpha_0 + \alpha_1 X + e_{(w)}$.

We may also express the wife's marginal rate of substitution of work for leisure in a general functional form,

(15) $M = m[w^m \cdot H^m + w^f \cdot H^f + V;\ t^f,\ Z,\ e_{(M)};\ \tau]$

By expressing this function as linear in the wage (w^f), hours of work (H^f), non-wage income (V), and observable variables (Z) which are believed to influence a wife's taste for work, we have:

(16) $M = \beta_0 + \beta_1 V + \beta_2 Z + \beta_3 H^f + \beta_4 w^f + e_{(M)}$.

The determination of the husband's wage and hours of work are disregarded in the remainder of this analysis, and we treat the labour supply of a married woman as conditional on the husband working full time as is customary for men. The husband's income is the only source of non-wage income (i.e. income that the wife did not earn herself) that is considered in the empirical portion of this study.[4]

If the wife works, then the hours of work may be determined by equating (16) with (14) and solving for H^f (Killingsworth, 1983, p. 149). Hence,

(17) $H^f = \frac{1}{\beta_3}\left[(\alpha_0 - \beta_0) + \alpha_1 X - (\beta_1 V + \beta_2 Z + \beta_4 w^f) + (e_{(w)} - e_{(M)})\right]$

The reservation wage is the value of M evaluated at zero hours of work.

Thus, rewriting equation (16) for the case where H^f equals zero, and w^f is not observed and assumed to be zero, we have:

(18) $w^* = \beta_0 + \beta_1 V + \beta_2 Z + e_{(w^*)}$

The implications of equations (14) through (17) may be expressed in a labour force participation equation as follows:

(19) Prob(wife works) = Prob(H^f>0) = Prob(w>w*) = Prob(w−w*>0)

$= \text{Prob}[e_{(w)} - e_{(w^*)}] > -[(\alpha_0-\beta_0) + \alpha_1 X - (\beta_1 V+\beta_2 Z)]$

$= \text{Prob}\ [e_{(D)}] > -[(\alpha_0-\beta_0) + \alpha_1 X - (\beta_1 V + \beta_2 Z)]$

where $e_{(D)}=(e_{(w)}-e_{(w^*)})$ is a mean-zero random variable with variance $\sigma_D^2=\sigma_w^2+\sigma_{w^*}^2-2\sigma_{w,w^*}$ (Killingsworth, 1983, p. 154). As we shall discuss in the following section, (19) may be estimated using standard probit analysis.

This static model introduces two equations which we will examine during the course of our study. First, we examine the participation decision (equation (19)) of married women in each of the four age groups 20 to 24, 25 to 29, 30 to 34, and 35 to 39 years. In Chapter 3, we address the issue of why we consider these particular age groups. Three models will be estimated on each group using probit analysis. The latter two models differ from the first by the inclusion of additional regressors. The additional regressors, one of which is a variant of the other, are included in the model to control for persistent, or slowly changing individual specific effects. We discuss the implications of these regressors in Chapter 3.

Second, we examine labour supply equations (17) for annual hours worked, given that the individual worked. Here, we address the issue of selectivity bias and how to correct for it, and the implications of using selectivity bias correction terms generated from alternative specifications of the participation model. These issues are covered in Section 2.3 of this chapter.

2.2 Labour Force Participation

In the empirical analysis of the participation decision we are dealing with a binary choice variable - that is, whether a particular wife is working, or not working. Alternatively, this binary variable may be expressed as an underlying response defined as the desire to work. If a wife's desire to work (Y*) exceeds a crucial threshold such that w>w*, then she works and we can observe an offered wage. If the wife's desire to work does not surpass this threshold, she does not work and we are unable to observe the offered wage.

In this study, a probit model is used for the probability that the aforementioned threshold is crossed given certain personal and family characteristics. Thus, we may define the form of this relationship for the ith wife as

(20) $Y^* = X'\beta + u$

where Y* is unobservable, and the dummy random variable Y=1 if Y*>0 (the wife works) and Y=0 otherwise. Consequently, the relationship $E(Y^*|X)$ may be expressed in the form

(21) $\text{Prob}(Y=1) = \text{Prob}(Y^*>0) = \text{Prob}\left(\frac{u}{\sigma} > -\frac{X'\beta}{\sigma}\right)$

where σ^2 is the variance of the error term, u.

Prob(Y>0) may be depicted diagrammatically by the probability density function of u/σ:

where

(22) $\text{Prob}(Y=1) = 1 - \text{Prob}\left(\frac{u}{\sigma} < \frac{-X'\beta}{\sigma}\right) = 1 - F\{-X'\beta/\sigma\},$

Probability Density Function

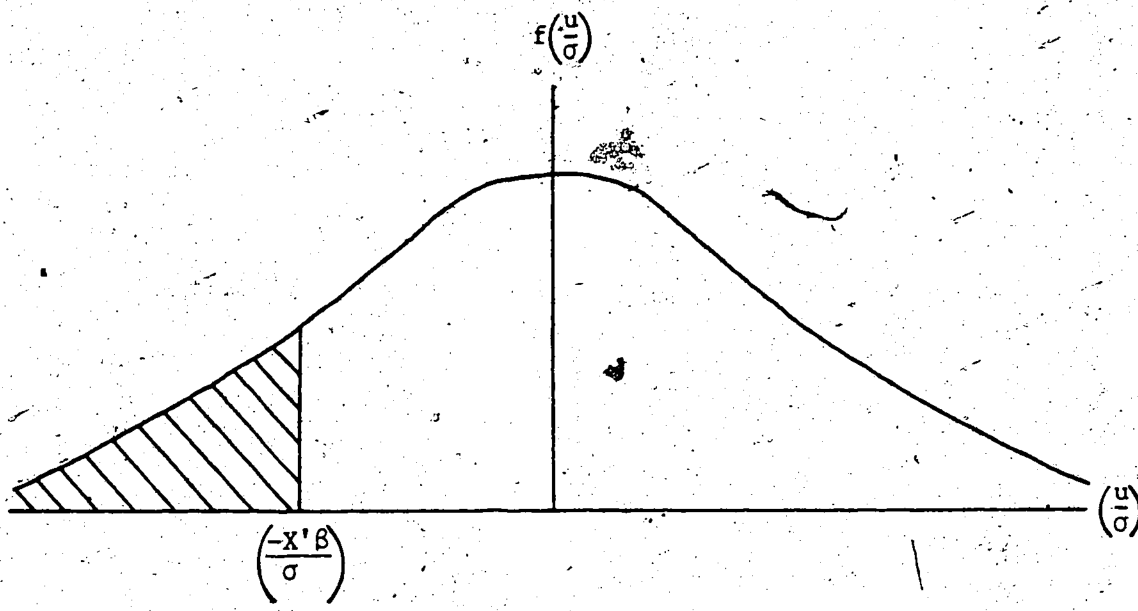

FIGURE 4

is the probability that the wife will work and is given by the unshaded area under the curve to the right of $\{-X'\beta/\sigma\}$; Prob $(Y = 0) = F\{-X'\beta/\sigma\}$, the probability the wife will not work, corresponds to the shaded area to the left of $\{-X'\beta/\sigma\}$, and $F(\cdot)$ is the cumulative density function. The joint probability density function of X may then be defined as:

$$(23) \quad g(X) = F\left(\frac{X'\beta}{\sigma}\right)^{Y} \cdot \left[1-F\left(\frac{X'\beta}{\sigma}\right)\right]^{1-Y}$$

since $F(-t)=1-F(t)$. The probit model is based on the assumption that u is identically and independently normally distributed with mean zero, and variance σ^2. If this is the case then u/σ is identically and independently distributed $N(0,1)$ and the standard normal cumulative density function (or distribution function) is defined as:

(24) $$F(z) = \int_{-\infty}^{z} \frac{1}{\sqrt{2\pi}} \cdot e^{-t^2/2} \cdot dt$$

The likelihood function for the probit model is defined for the N observations on working married women as:

(25) $$L = \prod_{i=1}^{N} \left[F\left(\frac{X_i'\beta}{\sigma}\right)^{Y_i} \cdot \left\{1-F\left(\frac{X_i'\beta}{\sigma}\right)\right\}^{1-Y_i} \right].$$

The parameters of the likelihood function may be estimated by maximizing the function with respect to (β/σ). β and σ are not separately identified when the probit model is estimated.

2.3 Sample Selectivity

As previously mentioned, the second stage of our analysis involves estimating labour supply equations (annual hours worked), given that all wives are working. Deliberately confining our analysis to individuals who are currently working leads to certain econometric complications which are referred to as sample selectivity. These difficulties emerge because selecting individuals on the basis of endogenous factors implies that the error term of the subsample does not have a zero mean. Therefore, any estimator whose desirable properties derive from the assumption that the error term is a mean-zero random variable will not have these properties. When estimation is based on a sample selected in this way, the ordinary least squares (OLS) estimates are said to suffer from sample selectivity bias (Judge et.al., 1985, p. 780).

To explain the sample selectivity problem, we rewrite the equation for hours of work, derived as (11), taking account of the fact that not all wives are working. Thus, we obtain:

(26) $$H_i = X_i'\beta + e_{i(H)} \quad \text{if } w_i > w_i^*,$$
$$= 0 \quad \text{otherwise}$$

in our selected sample. The regression function for this scenario may then be written as,

$$(27)\quad E(H_i \mid X_i,\ w_i > w_i^*) = X_i'\beta + E(e_i \mid w_i > w_i^*) \quad i = 1,\ldots,N-q$$

(Judge et.al., p. 780).

The least squares estimator of β will be unbiased provided the conditional expectation of the error term is zero. However, if e_i are independently and normally distributed random variables with mean zero and variance σ^2, then

$$(28)\quad E(e_i \mid w_i > w_i^*) = E(e_i \mid H_i > 0) = E(e_i \mid e_i > -X_i'\beta) = \sigma\lambda_i$$

where

$$(29)\quad \lambda_i = \frac{f\left(\frac{-X_i'\beta}{\sigma}\right)}{1-F\left(\frac{-X_i'\beta}{\sigma}\right)}$$

and $f(\cdot)$ and $F(\cdot)$ are the standard normal and cumulative density functions respectively (Heckman, 1976). Figure 5 expresses the relationship $e_i \sim N(0,\sigma^2)$ diagrammatically. From Figure 6 we see that the distribution is truncated at the point of positive hours. To take account of this truncation, we express the regression function as

$$(30)\quad E(H_i \mid X_i,\ H_i > 0) = X_i'\beta + \sigma\lambda_i + v_i, \quad i = 1,\ldots,N-q$$

where $E(v_i \mid H_i > 0) = 0$.

If the second term of (30) is ignored in using OLS to estimate (26) for a the subsample of workers, the estimated coefficients will be biased and inconsistent.

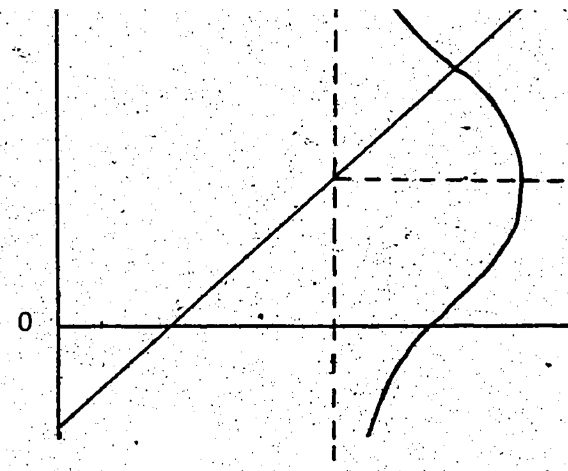

FIGURE 5

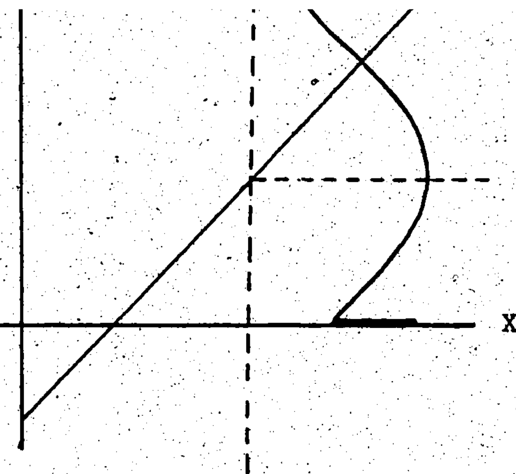

FIGURE 6

Since λ is unknown, the consistent estimator of β/σ generated from the probit estimation in (25) is used to form a consistent estimator of λ by substituting in (29) (Judge et al., 1985, p. 891). Thus, to compensate for the inadequacies of the least squares estimation procedure, a consistent estimator of λ is constructed from the probit estimates generated from the maximization of equation (25), and included as an additional regressor in the hours equation.

The estimated coefficients of the offered wage function (equation (14)) may also be biased and inconsistent. As the earlier discussion of selectivity bias suggests, an analysis which is restricted to working individuals may result in an error term ($e_{1(W)}$), which does not have a mean of zero. This is probable in the case of an offered wage equation since, "...on average, persons who work are persons with above average w values - that is, persons who got above average wage offers, other things being equal." (Killingsworth, p. 93).

Thus, to compute a selection bias-corrected regression for the

$$= \alpha_0 + \alpha_1 X_i + E\left(e_{i(w)} \middle| e_{i(H)} > -(\alpha_0 - \beta_0) + \alpha_1 X_i - (\beta_1 V_i + \beta_2 Z_i)\right)$$

$$= \alpha_0 + \alpha_1 X_i + E\left(e_{i(w)} \middle| \frac{e_{i(H)}}{\sigma_H} > \frac{-[(\alpha_0 - \beta_0) + \alpha_1 X_i - (\beta_1 V_i + \beta_2 Z_i)]}{\sigma_H}\right)$$

$$= \alpha_0 + \alpha_1 X_i + \left(\frac{\sigma_{w,H}}{\sigma_H}\right) \lambda_i(e_{i(w)})$$

where $\sigma_{w,H} = E(e_{i(H)}, e_{i(w)})$ is the covariance between $e_{i(H)}$ and $e_{i(w)}$ and σ_H is the standard deviation of H (Heckman, 1976, pp. 478–479).

2.4 Labour Supply

Many hours equations follow the conventional "proportionality" hypothesis (Heckman, 1974, 1976) which asserts that hours of work are "...(I) proportional to the difference between w and w* whenever the former exceeds the latter and (II) zero otherwise" (Killingsworth, 1983, p. 153). Thus, if we define the offered wage (w_i) to be a linear function of X_i, where X_i is a vector of observable variables which influence the offered wage (e.g. education level), such that (and as in equation (14))

(32) $$w_i = \alpha_0 + \alpha_1 X_i + e_{i(w)},$$

and the asking wage as a function of personal and family considerations such that, (and as in equation (17))

(33) $$w_i^* = \beta_0 + \beta_1 V_i + \beta_2 Z_i + e_{i(w^*)}$$

our labour supply equation may be expressed as,

(34) $$H_i = c(w_i - w_i^*) = \delta_0 + cw_i + \delta_1 V_i + \delta_2 Z_i - ce_{i(w^*)}$$

where (33) is substituted for w_i^*, $\delta_0 = -c\beta_0$, $\delta_1 = -c\beta_1$, and $\delta_2 = -c\beta_2$.

would like to allow for the possibility that the least number of hours worked by a particular wife may be greater than zero since a great deal of evidence exists to support this hypothesis. Studies by Hanoch (1980), Cogan (1980b, 1981) and Heckman (1980) all find a discontinuity in the labour supply schedule.

By calculating the probability of being a worker, then estimating a selectivity corrected hours equation for workers, we impose no assumptions that requires the lower limit on the number of hours worked to be zero. In terms of Figure 7, the probit analysis tells us that the wife will work if her wage rate exceeds some point such as 'a'; and, the hours of work will be zero if the wage rate is below 'a'. Thus, the selection bias-corrected regression is consistent with a discontinuous labour supply schedule.

Discontinuous Labour Supply Schedule

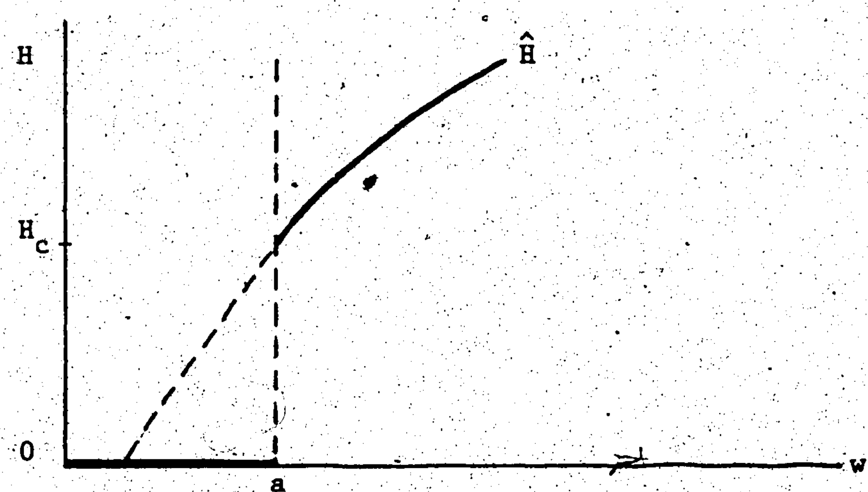

FIGURE 7

We are now in a position where we can draw on the discussion in Chapter 2 to explain our method of estimating a labour supply model. First, we use the probit estimates discussed in Section 2.2 using all wives (workers and non-workers) to construct our selectivity bias term ($\hat{\lambda}_i$). Next, we use $\hat{\lambda}_i$ and data on X_i to compute a selection bias corrected regression for the offered wage using data on workers only:

$$(35) \quad w_i = \alpha_0 + \alpha_1 X_i + \alpha_2 \hat{\lambda}_i + v_{i(w)}$$

where $v_{i(w)}$ is a mean-zero random error term and $\hat{\alpha}_2$, the estimated coefficient on $\hat{\lambda}_i$, may be interpreted as the covariance between $e_{i(w)}$ and $e_{i(D)}$, where $e_{i(D)} = e_{i(w)} - e_{i(w*)}$ (Killingsworth, p. 159). Finally, the imputed wage ($\hat{w}_i$) from (35) is substituted into the selection bias-corrected hours equation for working wives yielding:

$$(36) \quad H_i = a + b\hat{w}_i + cV_i + dZ_i + \zeta\hat{\lambda}_i + v_{i(H)}$$

The rationale for using an imputed wage is discussed in greater detail in section 5.3.

Thus, the empirical estimation of our labour supply schedule involves a two-stage least squares estimation procedure. From the first stage, we determine the fitted values of $\hat{w}_i$ which will, by construction, be independent of the error terms $v_{i(w)}$ and $v_{i(H)}$ (Pindyck and Rubinfeld, p. 191). In the second stage, the annual hours equation is estimated by replacing the value of $\hat{w}_i$ with the first stage fitted values of $\hat{w}_i$. OLS estimation of the second stage will yield a consistent estimate of the coefficient on the wage variable in equation (34)

First, we discuss the participation equations to be estimated, and second, the labour supply equations. Within each section, we define and consider the impacts of each of the explanatory variables. In Section 1, we present a standard set of explanatory variables included in previous studies and discuss why we believe these variables account for only a small fraction of cross-sectional variation in labour supply among individuals. We then argue that including limited amounts of past information about work behaviour in our model controls for a significant portion of the variability in labour force behaviour across individuals.

The motivation behind this approach stems from articles by Kalachek, Raines and Larson (1978), Johnson and Pencavel (1984) and Nakamura and Nakamura (1985). The similarity behind these three studies lies in the fact that they all use panel data. This enables the researchers to specify a dynamic model of labour supply which includes lagged hours of work as an explanatory variable. As we discuss later in this chapter, the nature of our data source does not permit us to include a lagged hours variable in our labour supply model. However, we are able to include the number of weeks worked in the previous year as an explanatory variable in the participation model. We also take an alternative approach to control for past labour force behaviour by including a dummy variable set equal to one if the wife worked in the previous year. Heckman (1978) originally speculated that a lagged participation dummy variable might substantially improve the performance of the model.

In Section 2, we present the models of labour supply to be estimated. In two of the three probit models, we control for past labour generate the selectivity bias terms which are included in the hours of work equations. Thus, although we cannot control for hours of work in the previous year, we may observe indirect effects of previous labour force behaviour through the sample selection bias term.

3.1 Labour Force Participation

Three different model specifications will be estimated by the probit procedure. The first model will serve as a control and may be viewed as a conventional participation model of labour supply. Rewriting (20), we may express our first model (M1) as:

$$(37) \quad Y_i^* = \beta_0 + \beta_1 CHA_i + \beta_2 CHB_i + \beta_3 EDSP_i + \beta_4 EMHD_i + U_{i(M1)}$$

where CHA ≡ number of children under 6 years of age

CHB ≡ number of children between 6 and 14

EDSP ≡ wife's highest level of education

EMHD ≡ husband's employment income

and $Y_i = 1$ if $Y_i^* > 0$

$= 0$ otherwise

(where $Y_i = 1$ indicates that the ith wife is employed).

The explanatory varibles in M1 have been well-established in the labour economics literature (see, for example, Schultz, 1978; Nakamura and Nakamura, 1981). Thus, we shall refer to these variables (i.e., CHA, CHB, EDSP, and EMHD) as our standard variables. We believe that these standard variables account for the main factors which influence a wife's decision to work.[5] The offered wage variable is not included as an explanatory variable in the participation equation (37) because the asking wage is evaluated at zero hours of work; that is, the participation equation (20) as they do in the hours equation (17).

The binary dependent variable (Y*) reflects the wife's current labour force status. If she is working, we assume that the offered wage is greater than the asking wage, evaluated at zero hours of work. Thus, the estimation of this model determines the probability that a wife is currently working, given particular individual and family characteristics.

The importance of child status variables in predicting the labour force behaviour of married women has been exemplified in numerous studies (e.g. Schultz, 1978). Aspects such as the number, timing, and age of the children affect both the probability and number of hours worked. Child status variables are included in labour supply and participation models because they are believed to affect the wife's asking wage. This hypothesis assumes the more children a wife has, the higher her asking wage will be, since family expenses (e.g. child care services) inevitably increase with the number of children.

Drawing on earlier studies (e.g. Heckman and MaCurdy, 1980; Nakamura and Nakamura, 1981), we characterize family composition by measuring the number of children in the family in two age categories: under 6 years, and between 6 and 14 years. Our expectation is that the presence of pre-school children will have a greater effect on the participation decision of the mother than will the presence of elementary school children for whom the school system provides an accepted substitute for the mother's time.

As we previously mentioned, our study examines the participation decision and labour supply of married Canadian women in each of the four age groups: 20 to 24, 25 to 29, 30 to 34, and 35 to 39. Our motivation variables; that is, we are interested in the effect that pre- or elementary school children have on the probability that a wife is currently working. Thus, we include only those women who normally have young children.

The third explanatory varible in M1 is the wife's highest level of education. This variable is included in the participation equation because of its effect on the offered wage. "It is usually argued that the more education an individual has, the larger the individual's stock of human capital is and hence, the higher the individual's offered wage will be." (Nakamura and Nakamura, 1985, p. 124). Thus, the wife's highest level of education should have a strong influence on the probability that she will work. This variable directly affects wage rates as women with higher levels of education have a higher expected, or asking wage. If the wage rate is correlated with the number of hours a woman works, then the education variable will indirectly affect the number of hours she chooses to work. We hypothesize that a wife's level of education will positively affect the offered wage and thus, the higher the level of education, the greater the probability that a wife will work.

The final explanatory variable in M1 to consider is the husband's employment income. To hypothesize the direction of the relationship between the husband's employment income and the labour force participation of the wife, we must examine the cross-substitution and income effects associated with a change in the husband's employment income; or wage rate.

The cross-substitution effect associated with an increase in the husband's wage rate depends on the relationship between the husband's and the wife's time. If their leisure time is considered to be substiband's and wife's time are complements, then the cross-substitution effect will be negative (Killingsworth, 1983, pp. 32-34).

The total effect of a change in the husband's wage on the wife's labour supply also involves an income effect, which may be expressed as:

$$(38)\quad \left(\frac{dt^f}{dw^m} \cdot \frac{w^m}{t^f}\right) = \left(\frac{w^m}{t^f} \cdot \frac{dt^f}{dF} \cdot \frac{dF}{dw^m} \cdot \frac{F}{w^m} \cdot \frac{w^m}{F}\right)$$

$$= \left[\left(\frac{w^m}{F} \cdot \frac{dF}{dw^m}\right) \cdot \left(\frac{F}{t^f} \cdot \frac{dt^f}{dF}\right)\right] = \frac{w^m \cdot T}{F} \cdot \eta_{t^f,F}$$

$$= \frac{w^m \cdot T}{w^m \cdot T + w^f \cdot T + V} \cdot \eta_{t^f,F} = \frac{T}{T + \left(\frac{w^f}{w^m}\right) \cdot T + \left(\frac{V}{w^m}\right)} \cdot \eta_{t^f,F}$$

This implies that if the husband's wage rate increases, (V/w^m) and $\left(\frac{w^f}{w^m}\right)$ will decrease, and $\frac{T}{T + \left(\frac{w^f}{w^m}\right) \cdot T\left(\frac{V}{w^m}\right)}$ will increase thus yielding a larger income effect. It is this phenomenon which, in certain cases, leads to a backward bending supply curve. At low wage rates, the labour supply curve has a positive slope as the substitution effect outweighs the income effect. As the wage rate increases the income effect becomes larger and larger until it overtakes the substitution effect. At this point, the supply curve begins to bend back, for example at point A in Figure 8.

Thus, we hypothesize that the cross-substitution effect and the income effect from an increase in the husband's wage (or employment income) will increase the wife's demand for leisure, or synonymously, decrease her supply of labour, if their time is substitutable. Otherwise, the effect of an increase in the husband's wage is indeterminate.

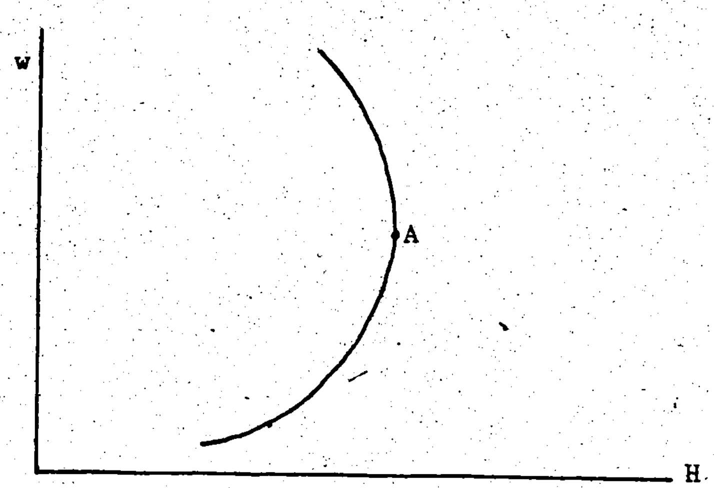

FIGURE 8

The second (M2) and third (M3) probit models include the standard variables, as well as an additional regressors. In (M2), the additional variable is the number of weeks worked during the previous year; in (M3), we include a dummy variable set equal to one if the wife worked during the previous year. These variables are included to control for persistent differences between individuals' personal characteristics.

In Chapter 2, we included the taste factor (τ) in the general functional form for the wife's marginal rate of substitution of work for leisure. Economists rest a large part of their theory of choice on differences in taste (Becker, 1976, p. 133). Indeed, the explanation of observed behaviour may rely solely on variations in taste. However, since this factor itself is never quantified, researchers are forced to use proxies such as education, family age-structure, etc. Thus, we might argue that each of our standard variables provides some information about the wife's taste for work.

as additional regressors. Heckman and Willis (1977) have noted that "...individuals who have experienced an event in the past are more like- to experience the event in the future than are individuals who have not experienced the event" (Heckman, 1981, p. 91). Heckman (1981) points out that there are two explanations for this phenomenon. First, the structural relationship between past and future labour force participation gives rise to true state dependence. State dependence in the context of lagged employment implies that a wife with past work experience will respond differently to an employment opportunity than a woman without work experience.

The second explanation rests on the assumption that wives may differ on the basis of certain unmeasurable variables which influence their probability of working, but not on the basis of past work experience. That is, a wife's taste for work may influence the probability of working, but past work experience does not influence the decision to work in the future. We believe that past labour force behaviour proxies for a wife's taste for work. We will not, however, rule out the possibility that our measures of past labour force behaviour reflect some degree of state dependence.

The economic relationships in advanced labour supply modelling are seldom exact. For example, we assume the employment response is a function of both observable and unobservable variables. Thus, to ensure the correct specification of the labour supply model, we must be successful in stipulating how unobservable individual-specific factors may be incorporated in the model. This may be very complicated since theoretical or abstract variables implicit to the model may be measured either imperfectly or not at all. In this discussion, we examine the implications of controlling for, versus ignoring the effects of unobservable variables, such as tastes for work.

One of the major problems associated with estimating models of labour supply is that unobservable, individual specific factors may be correlated with the explanatory variables (Hausman and Taylor, 1981). To compensate for this factor, researchers typically pool time-series and cross-section data so that they can control for individual-specific effects; that is, by using panel data, researchers are able to "track" individuals over several years.[6] If we cannot control for the presence of such correlations, both ordinary least squares (OLS) and generalized least squares (GLS) will produce biased and inconsistent estimates of all parameters (Hausman and Taylor, 1981; Heckman and Willis, 1977; Nickell, 1981).

To consider a specific example, let the true model be:

(39) $Y = Z\beta_0 + X^*\beta_1 + \varepsilon$

where Y is an (Mx1) vector of observations on the dependent variable, ε is an (Mx1) vector of equation errors, Z is an (MxN) matrix of observations on demographic variables measured without error, X^* is an (Mx1) vector of observations on an unobservable variable, β_0 is an (Nx1) vector of unknown parameters, and β_1 is an unknown scalar. Suppose that the observed variable X is closely related to X^* and may thus act as its proxy. Since there is a discrepancy between X and X^*, we write

(40) $X = X^* + v.$

Substituting the proxy variable in place of the unobservable variable in (39), we have

(41) $Y = Z\beta_0 + X\beta_1 + e \; ; \; e = (\varepsilon - \beta_1 v).$

Alternatively, we could omit the unobservable variable (X^*) in which case, the resulting equation would be

(42) $Y = Z\beta_0 + \eta$.

According to Theil (1957), the estimators of β_0 in (41) and (42) are biased and inconsistent since both equations have mis-specified (39). We are therefore concerned with which equation provides us with the "better" estimator of β_0. If we assume that v is independent of X^*, e, and Z, then the bias associated with the OLS estimation of β_0 in (42) is always greater than the bias of the OLS estimator of β_0 in (41) (McCallum, 1972; Wickens, 1972). Similarly, the degree of inconsistency of $\hat{\beta}_0$ in (42) is always larger than that of $\hat{\beta}_0$ in (41) (McCallum, 1972; Wickens, 1972). Thus, including proxies for the unobservable variables implicit in our labour supply model leads to smaller bias and inconsistency problems than if we omit the unobservable factors from our model.

We hypothesize that once past labour force behaviour is controlled for, the child status variables, and possibly other standard variables will play a less significant role in predicting the current labour force status of the wife. This expectation relies on the premise that those aspects of a wife's personality which change slowly, or not at all (e.g. taste for work), are responsible for a major portion of the variability in labour force participation of married women.

The second probit model (M2) may be expressed similarly to (37):

(43) $Y^* = \beta_0 + \beta_1 CHA_i + \beta_2 CHB_i + \beta_3 EDSP_i + \beta_4 EMHD_i + \beta_5 WWSP_i + u_i$

where WWSP = number of weeks worked during the previous year and,

$Y = 1$ if $Y^* > 0$

$= 0$ otherwise.

The lagged employment behaviour (WWSP) included in (43) is introduced to control for persistent differences between individuals' personal characteristics.[7]

The third probit model (M3) also attempts to control for slowly changing or persistent individual effects. However, in M3 our major concern is not the amount of time spent at work, but merely whether or not one worked. Thus, M3 may be expressed as,

$$(44)\quad Y_i^* = \beta_0 + \beta_1 CHA_i + \beta_2 CHB_i + \beta_3 EDSP_i + \beta_4 EMHD_i + \beta_5 DUM_i + u_i$$

where $DUM_i = 1$ if $WWSP_i > 0$

$= 0$ otherwise,

and $Y_i = 1$ if $Y_i^* > 0$

$= 0$ otherwise.

In this model, previous behaviour is assumed to be representative of one's taste for market versus non-market activities. If a wife worked in the previous year, then we define her taste for work as positive and let DUM_i=1. Thus, in model (M3), the variable WWSP in (37) is replaced by DUM_i.

In models M1, M2, and M3 the probability that a wife is currently working is based on particular personal and/or family characteristics. "Work" in this context implies working for pay or profit and thus, to exclude cases such as volunteer work, the wife must have both positive hours and employment income. Probit analysis differs from linear regression analysis in that a one unit change in an explanatory variable does not change the value of the dependent variable by an amount equal to the coefficient. This can be seen by examining the effect of a change in the jth explanatory variable, X_{ij}, on the probability that the ith wife is currently working. Using equation (22), we see that

$$(44)\quad \frac{\partial Prob(Y_i=1)}{\partial X_{ij}} = \frac{-\partial F(-X_i'\beta)}{\partial X_{ij}} = \beta_j f(-X_i'\beta)$$ where $f(\cdot)$ is the proba-

bility density function for u and β_j is the coefficient on X_{ij} in equation (20) (West, Ryan, and Von Hohenbalken, 1987, p. 13). Thus, although the sign is clear, it is very difficult to see from the estimated coefficients what the increase or decrease would be in the probability that a wife is working given a specified change in one of the explanatory variables. This is because the multiplication of the probit coefficients by the appropriate values of the explanatory variables for a particular wife, and summing these results, leads to an index value rather than a probability. To calculate the probability that a wife is working, we use the cumulative normal probability table to find the probability of getting an index value at least this large.

For purposes of comparison, we must analyze the relative magnitude of the coefficients in M1, M2, and M3, rather than their absolute values (Pindyck and Rubinfeld, p. 285). We may also examine expected changes in the proportion of working wives resulting from specific changes in the explanatory variables. By comparing this information for the different models we can examine the effects of controlling for previous work behaviour on the probability that a wife is currently working. The following table summarizes our hypotheses about the factors which affect the probability that a wife is currently working and the expected direction of their effects on this probability.

Table 1. Summary of Hypotheses

	Explanatory Variables	Expected Sign of Impact
1.	Number of Children less than 6 years of age	-
2.	Number of children 6-14 years of age	-
3.	Years of Education	+
4.	Husband's employment income	-
5.	Number of weeks worked in the previous year	+
6.	Dummy variable for previous years work behaviour	+

3.2 Labour Supply

Stage II of our analysis involves estimating labour supply equations (hours worked), based on all individuals who are working. Four separate labour supply functions will be estimated using ordinary least squares (OLS). The first model, which we shall refer to as H1, serves as a comparison model. The second, third and fourth models are corrected for sample selectivity by including $\hat{\lambda}$ generated from one of M1, M2, or M3. These models also include an imputed wage which is corrected for sample selection bias via a selectivity bias term generated from M1, M2, or M3 respectively. The annual hours and wage rate equations for H1, and each subsequent model (which we refer to as H2.1, H2.2, and H2.3) are defined as follows:

$$\text{H1}: \quad H_i = \beta_0 + \beta_1 BAB_i + \beta_2 EDSP_i + \beta_3 EMHD_i + \beta_4 FULL_i + \beta_5 \hat{WRC}_i + V_{i(H1)}$$

where

$$WRC_i = \alpha_0 + \alpha_1 CHA_i + \alpha_2 CHB_i + \alpha_3 EDSP_i + \alpha_4 FULL_i + e_{i(WRC)}$$

$$\text{H2.1}: \quad H_i = \beta_1 + \beta_1 BAB_i + \beta_2 EDSP_i + \beta_3 EMHD_i + \beta_4 FULL_i + \beta_5 \hat{WR1}_i + \beta_6 \hat{\lambda}_i + V_{i(H2.1)}$$

where

$$WR1_i = \alpha_1 + \alpha_1 CHA_i + \alpha_2 CHB_i + \alpha_3 EDSP_i + \alpha_4 FULL_i + \alpha_5 \hat{\lambda}1_i + e_{i(WR1)}$$

$$\text{H2.2}: \quad H_i = \beta_0 + \beta_1 BAB_i + \beta_2 EDSP_i + \beta_3 EMHD_i + \beta_4 FULL_i + \beta_5 \hat{WR2}_i + \beta_6 \hat{\lambda}2_i + V_{i(H2.2)}$$

where

$$WR2_i = \alpha_0 + \alpha_1 CHA_i + \alpha_2 CHB_i + \alpha_3 EDSP_i + \alpha_4 FULL_i + \alpha_5 \hat{\lambda}2_i + e_{i(WR2)}$$

$$\text{H2.3}: \quad H_i = \beta_0 + \beta_1 BAB_i + \beta_2 EDSP_i + \beta_3 EMHD_i + \beta_4 FULL_i + \beta_5 \hat{WR3}_i + \beta_6 \hat{\lambda}3_i + V_{i(H2.3)}$$

where

$$WR3_i^* = \alpha_0 + \alpha_1 CHA_i + \alpha_2 CHB_i + \alpha_3 EDSP_i + \alpha_4 FULL_i + \alpha_5 \hat{\lambda}3_i + e_{i(WR3)}$$

such that,

BAB = dummy variable set equal to one if the wife has ever had children; set equal to zero otherwise

FULL = dummy variable set equal to one if the wife works full-time; set equal to zero for part-time.

WRC = log of the wife's offered wage; not corrected for sample selection bias.

WR1/2/3 = log of the wife's offered wage; corrected for sample selectivity where the selectivity correction term is generated from M1/M2/M3.

$\hat{\lambda}$1/2/3 = selection bias correction term; generated from the probit model M1/M2/M3.

CHA, CHB, EDSP = same definition as in the participation model.

The wage variables WRC, WR1, WR2, and WR3, are measured as the wife's employment income from the previous year divided by the annual hours worked. Since an observation on annual hours is not directly available from the census, we generate it by multiplying hours worked during the survey week with weeks worked during the previous year. Similarly defined dependent variables may be observed in studies by Cogan (1981), Dooley (1982), Hanoch (1980), Hausman and Wise (1976)), Nakamura, Nakamura and Cullen (1979), Nakamura and Nakamura (1981), and Schultz (1980). Due to the method of generating the hourly wage-rate and annual hours variables, there exists little doubt that there are errors associated with the measurement of w and H. Our motivation for using the imputed wage is to avoid the problem of correlation between such measurement errors in w and errors in the measurement of H (Pindyck and Rubinfeld, p. 191).

The offered wage variable in the hours of work equation incorporates two effects. First, the substitution effect implies that an increase in the offered wage will entice an individual, ceteris paribus, to work more hours. Second, the income effect implies that given a higher hourly wage rate, an individual can work fewer hours to earn a given level of income (Ehrenberg and Smith, 1982, pp. 159-163). Thus, the sign of the coefficient on the wage variable will indicate which of these two effects is stronger. If the substitution effect outweighs the income effect, the estimated coefficient will be positive and if the opposite relationship holds, the estimated coefficient will be negative. If the two effects are comparable in size, we would expect the coefficient to be insignificant.

The sign of the estimated coefficient for the dummy variable in the hours equation which represents the part-time/full-time work status of the wife is hypothesized to be positive in the hours equation, and indeterminate in the offered wage equation. The expected positive sign of the coefficient on this variable may be rationalized in the following way. Consider a married woman with two children. If she decides to enter, or re-enter the work force, there are certain costs associated with this action that she must consider. If we assume there are fixed costs to entering the labour force, and leisure is a normal good, the pecuniary gains associated with a part-time job, ceteris paribus, must be substantially higher than those associated with a full-time job. We know this to be true, since the reservation wage increases as the fixed costs of entry rise (Keely, 1981, p. 32). That is, the wife would demand a higher hourly salary to compensate her for the "overhead" associated with a part-time job which is the same as that of a full-time job. Thus, our expectation is that the asking wage will be higher for the part-time job.

Since full-time employment, ceteris paribus, is associated with a lower asking wage, we hypothesize that the full-time/part-time dummy variable will have a positive coefficient in the hours of work equation. The reason for this is, as we have discussed, because the relationship between an explanatory variable and the asking wage must be the opposite of that between the same explanatory variable and annual hours.

We have no clearly defined expectation of the effect of part-time/full-time work status on the offered wage. In some instances, an employer may offer a higher wage to an employee, ceteris paribus, who works part-time because the cost to the firm (in terms of benefits, etc.) is lower than for full-time workers. On the other hand, part-time work may require less skill and/or experience on the part of the employee. Thus, the employer may be in a position where he/she can hire semi-skilled workers at a lower rate for part-time work.

The second dummy variable in our annual hours equation is the children/childless dummy. Our expectation is that a reduction in labour supply is associated with the presence of children in a family. We hypothesize that the presence or absence of children in a family is indicative of a wife's long-standing preferences for a particular way of life. In this sense, we believe that we can control for this factor by including a dummy variable set equal to one if the wife has ever been a mother.

The wife's highest level of education and the husband's employment income influence the wife's annual hours of work in the same manner as they influence the wife's participation decision. Thus, Table 2 summarizes our hypothesis about the factors which affect the wife's annual hours of work and the expected direction of their effect on this variable.

Table 2. Summary of Hypotheses

	Explanatory Variables	Expected Sign of Impact
1.	Children ever born (Dummy Variable)	-
2.	Highest level of education	+
3.	Husband's employment income	-
4.	Full/Part-time work status	+

4. DATA AND VARIABLE DEFINITIONS

The data used in this study were obtained from the 1971 and 1981 Public Use Sample Tapes of the Canadian census. Our motive for using two data sets rests with the assumption that testing our hypotheses on two different data sets should lend more credibility to our results. Our expectation is that the estimated parameters of our standard variables will be significantly affected by including a measure of lagged work behaviour. With two data sets, we are able to test our hypothesis that past labour force behaviour should be controlled for in participation models, and draw conclusions which are not specific to one particular data set.

The data contained in the Family (1971) and Household/Family (1981) files of the census give a detailed summary of demographic information on Canadian household occupants. The information was collected for nine provinces; Newfoundland, Nova Scotia, New Brunswick, Quebec, Ontario, Manitoba, Saskatchewan, Alberta and British Columbia. Data from Prince Edward Island, the Yukon, and the Northwest Territories are not available as these areas did not meet the minimum population criterion which is set forth in the census. Thus, the married women examined in our study reside in one of the aforementioned nine provinces. We do not analyze the labour supply or labour force participation of married women on a provincial level.[8]

Many of the variables present in the 1971 Family File have been replicated in the 1981 Household/Family File. However, in an attempt to improve this source of information, Statistics Canada has added, deleted, or refined certain variables. Despite these changes, we attempt to maintain consistency in the variables across the two samples. This will afford us the opportunity to compare the estimated coefficients of a given variable across samples.

The families incorporated in this study were selected according to certain criteria. First, they must be a primary family; this requires the census family to be maintained from within their own household; that is, the person responsible for household payments is a member of the family. This specification is necessary since the model presented in Section 1 of Chapter 1, is formulated explicitly for a primary family. We are not concerned with multiperson households or extended families which are comprised of a number of working adults. The family must be composed of a husband and wife (with or without children) as opposed to a one-parent family and, any wife under 20, or over 40 years of age was excluded from the study. The remaining women are viewed as those who are capable of bearing children, or those who have borne children. As we previously discussed, this sample allows us to examine the effects of child status on married women's participation and labour supply decisions. One-parent families are excluded from the study because our model is designed to examine the labour supply of married women, with or without children. The remaining families are grouped into one of four categories according to the wife's age: 20 to 24, 25 to 29, 30 to 34, and 35 to 39.

The variables utilized in the statistical analysis are explained as follows:

<u>Number of children under 6 years of age</u> (CHA) - refers to the number of children in the family between the ages of 0 and 6. The actual number is presented up to three; then the number of children is recorded as equal to four for four or more children less than 6.

Number of children at home 6-14 years of age (CHB) - refers to the number of children at home who are 6 to 14 years of age. [illegible] is presented up to and including five or more children at [illegible] 6 and 14.

As we discussed in Section 1 of Chapter 2, our expectation is that the number of children in a family under six years of age will have a greater influence on the participation decision of the wife than the number of children at home between 6 and 14 years of age. We believe that accounting for the presence, as well as the number, of children within an age group, provides us with vital information which may affect the wife's participation decision. If, for example, we used a procedure where we defined a dummy variable equal to one for a family with children under six years of age, we would be ignoring what we believe to be useful information in terms of predicting the wife's participation decision.

Number of children ever born (BAB) - refers to a dummy variable set equal to one if the wife has ever had a child and set equal to zero otherwise.

Labour force status of wife (LFSP) - refers to a dummy variable set equal to one if the wife worked in the week prior to enumeration and set equal to zero otherwise. For the purpose of this study, we shall consider the wife to have worked for pay or profit if she is classified as employed in the armed forces or as a civilian (either worked for pay or profit, or with a job but not at work). The unemployed, or those not in the labour force, will be classified as unable to work for pay or profit during the week prior to enumeration.

Weeks worked during 1970/1980 by wife (WWSP) - 1970: includes work for pay or profit, self-employment, unpaid work on a family farm[9] or business, and work for payment "in kind" in a non-family enterprise. 1980: includes weeks of vacation or sick leave with pay or paid absence on training courses. In the 1981 data, the actual number of weeks worked are reported, ranging from zero to 52. Work does not include volunteer or unpaid family work. Only interval data is reported for 1971. Thus the weeks worked were taken to be the mid-points of the specified regions:

a. did not work during 1970 - 0

b. 1 to 13 weeks - 7

c. 14 to 26 weeks - 20

d. 27 to 39 weeks - 33

e. 40 to 48 weeks - 44

f. 49 to 52 weeks - 51

Nakamura, Nakamura and Cullen (1971) also used these mid-points for weeks worked.

<u>Hours usually worked each week/Hours worked in reference week</u> (HRSP) - 1980: actual number of hours worked in the week prior to enumeration. Included in this variable is hours worked for wages, salary, tips or commission, in their own business, farm or professional practice, or hours worked without pay in a family business or farm owned by a relative in the same household. Volunteer work and unpaid family work such as housework is excluded.

1970: refers to the number of hours usually worked (either in the week before enumeration or the job of longest duration since January 1, 1970), whether for pay or profit in cash or kind, or without pay in the operation of a family business. For 1971, only interval data are available. Thus, hours of work per week are taken to be the mid-points of the specified regions:

a. 1 to 19 hours - 10

b. 20 to 29 hours - 25

c. 30 to 34 hours - 32.5

d. 35 to 39 hours - 37.5

e. 40 to 44 hours - 42.5

f. 45 to 49 hours - 47.5

g. 50 or more - 50

Highest level of schooling of wife (EDSP)

The following numeric values will approximate the highest grade of elementary school, secondary school, or university attended by the wife:

a. no schooling - 0

b. below grade 5 - 2.5

c. grade 5 to 8 - 6.5

d. grade 9 to 10 - 9.5

e. grade 11 - 11

f. grade 12 - 12

g. grade 13 - 13

h. university, 1 to 2 years - 14.5

i. university, 3 to 4 years without degree - 16

j. university, 3 to 4 years with degree - 17

k. university, 5 or more years without degree - 18

l. university, 5 or more years with degree - 19

Total employment income of husband (EMHD)

1970: Wages and salaries, net income from business or professional practice and/or net farm income received by the head of the household during 1970. Actual income is presented up to and including $49,999, then $50,000 for any amount over $50,000.

1980: Total employment income of husband is derived by combining the husband's wages and salaries variable with his self-employment income. Wages and salaries are defined as gross amounts before deductions. Military pay and allowances, tips, commissions, bonuses, and piece-rate payments as well as occasional earnings in 1980 are included. Self-employment income refers to total income received during 1980 as net income from non-farm self-employment and net income from farm self-employment.

Total employment income of wife (EMSP)

1970: Refers to wages and salaries, net income from business or professional practice and/or net farm income received during 1970. For the Atlantic region, actual income is specified up to and including $24,999, then $25,000 for any amount of $25,000 or more. For the remaining provinces, actual income is specified up to and including $49,999, then $50,000 for any amount of $50,000 or more.

1980: Total employment income of wife is derived by combining the wife's gross wages and salaries before deducting such items as income tax, pensions, unemployment insurance premiums, etc., (included is military pay and allowances, tips, commissions, bonuses and piece-rate payments as well as occasional earnings in 1980), and the wife's self-employment income. (Self-employment income is defined as total income received as net income from non-farm self-employment and net income from farm self-employment.)

The upper bound placed on the recorded value of the husband's and wife's employment income in the 1971 census deserves some comment. Since the actual income value for any amount over $50,000 ($25,000 for the wife) is not observed, we may interpret this as a truncation problem. To determine the properties of the OLS estimator when we have a truncated variable, let us consider a simple model with only one explanatory variable:

(45) $Y = X'\beta + u$

We shall define (45) as our true model, where Y is an nx1 vector of observations on the dependent variable, X is an nx1 vector of the husband's employment income, and β is an unknown scalar. We can re-write the true model as:

$$(46)\quad \begin{pmatrix} Y_1 \\ \cdots \\ Y_2 \end{pmatrix} = \begin{pmatrix} X_1 \\ \cdots \\ X_2 \end{pmatrix} \beta + \begin{pmatrix} u_1 \\ \cdots \\ u_2 \end{pmatrix}$$

where the subscripts 1 and 2 denote the first n_1 and n_2 observations, respectively, and X_2 represents all $(n_2=n-n_1)$ husbands earning over \$50,000 per year. The researcher's model may be defined as:

$$(47)\quad \begin{pmatrix} Y_1 \\ \cdots \\ Y_2 \end{pmatrix} = \begin{pmatrix} X_1 \\ \cdots \\ \bar{X}_2 \end{pmatrix} \beta + \begin{pmatrix} u_1 \\ \cdots \\ \bar{u}_2 \end{pmatrix} = X_*'\beta + u_*$$

where $\bar{X}_2=k$ and $X_2 \geq \bar{X}_2$ for all n_2 observations, and $\bar{u}_2=u_2+(X_2-\bar{X}_2)\beta$. The OLS estimate of $\hat{\beta}$ from equation (47) gives us

$$(48)\quad \hat{\beta} = (X_*'X_*)^{-1}X_*'Y$$

$$= (X_*'X)^{-1}X_*'(X\beta+u).$$

Now, assuming $Cov(u,X_*) = 0$, and taking the expectation of (48) yields:

$$(49)\quad E(\hat{\beta}) = (X_*'X_*)^{-1}X_*'X\beta \neq \beta.$$

Using the researcher's model, we know that

$$(50)\quad X_*'X = (X_1' \vdots \bar{X}_2') \begin{pmatrix} X_1 \\ \cdots \end{pmatrix} = X_1'X_1 + \bar{X}_2'X_2$$

$$(51)\quad \bar{X}_2 = k\begin{pmatrix}\vdots\\1\end{pmatrix},$$

$$(52)\quad \bar{X}_2'X_2 = k(1\ldots1)(X_2) = k\sum_{i=n_1+1}^{n} X_{2i}$$

and

$$(53)\quad \bar{X}_2'\bar{X}_2 = k(1\ldots1)\cdot k\begin{pmatrix}1\\\vdots\\1\end{pmatrix} = k^2 n_2.$$

Substituting (50), (51), (52), and (53) into (54), we have

$$(54)\quad E(\hat{\beta}) = \left(\frac{X_1'X_1 + \bar{X}_2'X_2}{X_1'X_1 + \bar{X}_2'\bar{X}_2}\right)\beta$$

$$= \left(\frac{a + k\sum_{i=n_1+1}^{n} X_{2i}}{a + k^2 n_2}\right)\beta$$

where $a = X_1'X_1$. Since by definition $X_2 \geq \bar{X}_2$, or $X_2 \geq k$, for the last n_2 observations, we know that

$$(55)\quad \sum_{i=n_1+1}^{n} X_{2i} \geq n_2 k$$

$$\text{so}\quad a + k\sum_{i=n_1+1}^{n} X_{2i} \geq a + n_2 k^2$$

and hence

$$E(\hat{\beta}) \geq \beta$$

Thus, the estimated parameter of $\hat{\beta}$ are upward biased, unless $X_2 = \bar{X}_2$.

Our study involves a sample of 2000 observations in each of the age groups analyzed using 1971 and 1981 census data. The random sample include any families where the husband or wife earned under $50,000 or $25,000 per year, respectively. Thus, the parameter estimates will be unbiased in this respect (Philips and Wickens, p. 202).

Annual hours worked (AHRS) - refers to the annual hours worked by the wife. This variable is calculated by multiplying weeks worked during the previous year with hours usually worked each week (1970), or hours worked in the reference week (1980).

Wage rate (WR) - refers to the hourly wage-rate received by the wife. The wage rate is calculated by dividing the wife's total employment income by the annual hours worked.

Full-time/Part-time (FULL) - refers to a dummy variable set equal to one if a wife worked full-time during the previous year and set equal to zero if she worked part-time during the previous year.

The majority of these variables have been well-established in the labour economics literature. The most prominent, and those included in M1 are the wife's highest level of education, the number of children under 6 years of age, the number of children between the ages 6 and 14, and the husband's employment income. M2 and M3 include the number of weeks worked during the previous year, and a dummy variable set equal to 1 if the wife worked in the previous year, respectively, as additional variables. It would have been preferable to use a lagged hours variable as opposed to lagged weeks worked. However, for 1981, lagged hours would have had to be computed using hours worked in the reference week which is used as a current, rather than a lagged hours variable in calculating HRSP. Annual hours would be generated by multiplying the number of weeks worked by the average number of hours worked per week. For 1981, the actual hours worked is given for the week prior to enumerillness or holidays, for example, the annual hours would be incorrectly specified as zero.

It is very difficult to develop a behavioural model for married women which will incorporate the main factors which affect their work decision. One of the major disadvantages of using cross-sectional data stems from our inability when using such data to capture fixed personal factors or tastes which may affect labour force behaviour over either short or extended periods of time. This creates a lack of continuity in expressing variables such as employment status. For a select demographic group such as married women, the inability to control for unobservable factors which may be correlated with the explanatory variables may result in serious bias problems (Heckman and Willis, 1977). Thus, the inclusion of proxies for our unobservable "taste for work" variable is a necessary condition to achieve unbiased estimates.

The signs of our estimated coefficients for the models are compared with sign expectations based on established labour theory and the empirical findings of others. Labour economists have established the existence of clear underlying patterns in labour force participation of married women. For example, women's labour force participation rates have been found to be highly correlated with measures of fertility, marriage, schooling, and men's income (Michael, 1985). The higher the income of the husband, the less likely it is that the wife will work while those wives who do work will have fewer expected hours of work. (Heckman, 1974, 1976; Nakamura, Nakamura and Cullen, 1979). Therefore, the husband's level of income is hypothesized to have a negative impact on the work behaviour of the wife. The higher the level of the husband's employment income, the lower the probability that the wife will work.

that the husband's and wife's time at home is substitutable.

5. RESULTS

In this chapter, we present the results from the estimated participation and labour supply equations. Our discussion will begin with a comparison of the mean values of the explanatory variables for all wives, whether working or not (Table 3). We will then examine the mean values of the explanatory variables for wives who worked (Table 4). The variables included in Table 4 are used in the wage, and/or labour supply equations. The second section includes a comparison of the estimates obtained from the probit models M1, M2 and M3. Within this discussion, we consider the relative magnitudes of the estimated coefficients prior to, and after controlling for past labour force behaviour. We also compare the signs of the coefficient estimates with those hypothesized, examine the goodness of fit for the equations, and discuss the importance of our findings within the context of a participation model. In the third section, we discuss the estimated wage and labour supply equations. As we discussed at the beginning of Chapter 3, the empirical estimation of our labour supply schedule involves a two-stage least squares procedure. From the first stage, we determine the fitted values of $\hat{w}_i$ which are subsequently included as a regressor in the annual hours of work equation. We therefore present the estimated equations for both the wage-rate, and the annual hours worked.

The main impetus for this study lies within the participation equation. It is there that we are able to include a variable (WWSP or DUM) which controls for previous labour force behaviour. We have argued that past labour force behaviour proxies for slowly changing, unobservable individual-specific factors which would otherwise bias the coeffienumeration, and the number of weeks worked during the previous year are used to generate the annual hours variable. Thus, including a measure of past labour force status (WWSP) in the hours of work equation would violate one of the assumptions of OLS estimation; that is, the covariance of WWSP and the error term would not be zero.

Recalling our discussion on sample-selectivity in Chapter 2, the probit estimates are used to generate a selectivity-bias term which is included in the hours equation. Thus, although we are unable to directly control for past labour force status, we may find that selectivity bias terms generated from different probit models have varying impacts on our estimated hours equation. Our expectation is that the participation model which we believe to be mis-specified (i.e. M1), should generate a biased selectivity term which, in turn, shculd yield poor results in the hours equation.

The final section in this chapter involves a discussion of the uncompensated wage elasticities generated from the hours equations. Since labour supply and demand for leisure are counterparts, and since the demand for leisure is a Marshallian demand, we know the wage elasticity, evaluated at the mean, is uncompensated (Deaton and Muellbauer, 1980, p. 16). This also implies that the estimated labour supply schedule is an uncompensated labour supply schedule.

The elasticities generated from the 1971/1981 sample for H1, H2.1, H2.2 and H2.3 are compared to the elasticities reported in five different studies. Two of these studies suggest that married working women have upward sloping labour supply schedules. The remaining three studies report the supply schedule to be backward bending. Thus, our analysis should indicate which of these two formulations is appropriate

5.1 Analysis of Means

In Table 3, we show the mean value of the explanatory variables for all wives, whether working or not. Comparing the 1971 and 1981 means, we see that on average, the 1981 families have fewer children under six and between 6 and 14 years of age than the 1971 families. We should also note that families with wives between 25 and 29 years of age have, on average, the most number of children between the ages of 6 and 14.

In Table 4, we present the mean values of the explanatory variables for wives who worked. The variables included in this table are all used to generate the wage, or the labour supply equations. Examining the child status variables for those wives that work, we see that the characteristics within, and across age categories, parallel our findings in Table 3. However, we note a significant decline in the average number of children in families where the wife works versus families where the wife does not work.[10] We draw similar conclusions with respect to the wife's highest level of education. That is, married women in our 1981 sample are more highly educated than those found in our 1971 sample; however, women who work are, on average, more highly educated than women who do not work.

The husband's employment income (EMHD), and all other income variables in Tables 3 and 4, are in constant 1971 dollars. This enables us to compare the relative magnitude of means across years. The average income for husbands in the 1981 sample is slightly higher than those husbands in the 1971 sample. Also, we observe that on average, those women that work have husbands who earn slightly less than average.

Table 5. Mean Values of Explanatory Variables for All Wives

	1971				1981			
	20-24	25-29	30-34	35-39	20-24	25-29	30-34	35-39
LFSP	.43	.36	.34	.32	.59	.57	.55	.56
CHA	.77	1.12	.85	.53	.61	.91	.72	.29
CHB		.62	1.68	1.95		.37	1.12	1.35
EDSP	10.88	10.60	10.19	9.57	11.51	12.18	11.78	11.24
EMHD	6145.6	7671.8	8653.8	8962.6	6484.4	8155.1	9096.9	10861.0
WWSP	23.54	17.34	15.98	15.14	27.67	25.95	24.52	24.90
DUM	.58	.41	.39	.36	.74	.69	.63	.63

Source: Calculated from 1971/1981 Census of Canada, Public Use Sample Tape - Family/Household File.

LFSP ≡ proportion of working to non-working wives
CHA ≡ number of children under 6 years of age
CHB ≡ number of children between 6 and 14
EDSP ≡ wife's highest level of education
EMHD ≡ husband's employment income

Table 4. Mean Values of Explanatory Variables for Wives Who Worked

	1971				1981			
	20–24	25–29	30–34	35–39	20–24	25–29	30–34	35–39
CHA	.40	.64	.57	.31	.26	.63	.54	.20
CHB		.41	1.42	1.63		.27	1.05	1.24
EDSP	11.43	11.63	10.76	10.27	12.11	12.67	12.51	11.80
WR	2.46	3.06	3.10	2.7[illegible]	2.96	4.30	4.94	4.37
FULL	.88	.79	.69	.65	.83	.75	.73	.66
EMHD	5907.4	7594.5	7925.3	8443.0	6658.9	7882.8	[illegible]8.5	10652.0
EMSP	3577.1	4266.0	3699.1	3665.6	3899.0	4652.1	4648.[illegible]	4845.4
WWSP	40.73	41.89	40.81	42.07	41.24	40.96	42.25	43.14
HRSP	37.7	35.30	33.65	33.62	35.85	33.95	33.19	32.50
BAB	.34	.61	.84	.86	.16	.28	.21	.15
AHRS	1547.8	1509.4	1409.7	1444.0	1497.1	1435.3	1433.2	1441.4
N	1088	780	704	627	1021	991	943	1004

Source: Calculated from 1971/1981 Census of Canada, Public Use Sample Tape - Family/Household File.

WR ≡ wife's hourly wage rate
FULL ≡ proportion of full-time to part-time working wives
WWSP ≡ number of weeks worked during the previous year
HRSP ≡ hours normally worked each week
BAB ≡ proportion of women who have ever had a child
AHRS ≡ annual number of hours worked
N ≡ number of observations

Other variables as defined in Table 3.

In Table 4, we report the proportion of full-time working wives (FULL) and in Table 3, the proportion of labour force participants (LFSP). Within specific age categories, the proportion of working women in our 1971 sample ranges from 32 to 43 percent, whereas the proportion of working women ranges from 55 to 59 percent in our 1981 sample. Of those women that work, 65 to 88 percent worked full-time (as opposed to part-time) during 1970, and 66 to 83 percent worked full-time during 1980. The number of weeks worked during the previous year, the number of hours worked during the reference week, and the annual hours averages are all quite similar, regardless of the age group or year.

One of the more interesting features of our analysis of the mean values of our variables relates to our children/childless dummy variable. Eighty-five percent of those women between the ages of 30 and 39 who worked during 1971 have had children. However, of those women between the ages of 30 and 39 that worked during 1981, only .18 percent of them, on average, have ever had children. Thus, it appears that the characteristics of families with working wives are significantly different with respect to child status for our 1971 and 1981 samples.

5.2 Probit Estimation

The probit coefficients of M1, M2 and M3 for 1971 and 1981 are presented in Table 5 and Table 6 respectively. Examining those coefficients in M1 that are significant at the 5% level, we observe that a wife is more likely to work if she has a higher level of education, has fewer children under six years of age, has fewer children between the ages of six and fourteen (for wives 25-39), and has a husband with a lower employment income. We draw the same conclusions with respect to

Table 5. 1971 Probit Estimates

1971 Probit	20-24 M1	20-24 M2	20-24 M3	25-29 M1	25-29 M2	25-29 M3	30-34 M1	30-34 M2	30-34 M3	35-39 M1	35-39 M2	35-39 M3
Constant	-.356* (.15)	-.343** (.18)	-1.316** (.18)	-.382** (.14)	-1.325** (.17)	-1.26** (.17)	-.209 (.13)	-1.306** (.16)	-1.29** (.16)	-.414** (.12)	-1.296** (.14)	-1.31** (.14)
CHA	-.825** (.05)	-.468** (.05)	-.539** (.05)	-.639 (.04)	-.236** (.05)	-.307** (.05)	-.553** (.04)	-.353** (.05)	-.388** (.05)	-.505** (.05)	-.329** (.06)	-.34[illegible]** (.05)
CHB				-.145** (.04)	.0054 (.04)	-.012 (.04)	-.151** (.03)	-.058* (.03)	-.063* (.03)	-.116** (.02)	-.035 (.03)	-.031 (.03)
EDSP	.081** (.01)	.074** (.01)	.067** (.01)	.093 (.01)	.056** (.01)	.054** (.01)	.077** (.01)	.066** (.01)	.063** (.01)	.070** (.01)	.046** (.01)	.039** (.01)
EMHD ('000)	-.021* (.01)	-.026* (.01)	-.016 (.01)	-.030 (.08)	-.028** (.01)	-.028** (.01)	-.039** (.01)	-.026** (.01)	-.025** (.01)	-.032** (.01)	-.023** (.01)	-.022** (.01)
WWSP		.033** (1.6)			.041** (.002)			.042** (.002)			.043** (.002)	
DUM			1.383** (.08)			1.736** (.08)			1.747** (.07)			1.914** (.07)
% of right predictions	73.8%	78.4%	77.3%	75.6%	84.4%	83.9%	71.8%	83.5%	83.1%	70.2%	84.9%	85.2%

1. Numbers in parentheses are standard errors.
* Coefficient is significant at the 5% level.
**Coefficient is significant at the 1% level.
Number of observations = 2000.

Source: Calculated from 1971 Census of Canada, Public Use Sample Tape - Family File.

Table 6. 1981 Probit Estimates

1981 Probit	20–24 M1	20–24 M2	20–24 M3	25–29 M1	25–29 M2	25–29 M3	30–34 M1	30–34 M2	30–34 M3	35–39 M1	35–39 M2	35–39 M3
Constant	-.389* (.18)[1]	-1.05** (.20)	-1.18** (.21)	.236 (.16)	-1.097** (.20)	-1.394** (.21)	-.476** (.13)	-1.472** (.18)	-1.578** (.17)	-.241* (.11)	-1.456** (.16)	-1.403** (.15)
CHA	-.746** (.04)	-.365** (.05)	-.530** (.05)	-.541** (.04)	-.199** (.05)	-.269** (.05)	-.47[illegible] ([illegible])	-.305** (.05)	-.332** (.05)	-.430** (.05)	-.137* (.07)	-.267** (.07)
CHB				-.308** (.05)	-.054 (.06)	-.170** (.06)	-.153** (.03)	-.012 (.04)	-.049 (.04)	-.169** (.03)	-.068 (.04)	-.103** (.04)
EDSP	.092** (.02)	.046** (.02)	.046** (.02)	.060** (.01)	.037* (.01)	.031* (.01)	.109** (.01)	.059** (.01)	.058** (.01)	.089** (.01)	.071** (.01)	.041** (.01)
EMDH ('000)	.0064 (.01)	-.0024 (.01)	-.012 (.01)	-.020** (.01)	-.019* (.01)	-.013 (.01)	-.019** (.005)	-.0045 (.01)	-.011 (.01)	-.023** (.005)	-.032** (.01)	-.024** (.01)
WWSP		.039** (.002)			.050** (.002)			.053** (.002)			.059** (.002)	
DUM			1.683** (.09)			2.21** (.09)			2.143** (.08)			2.418** (.08)
% of right predictions	71.8%	79.9%	79.4%	67.4%	83.1%	84.2%	64.8%	84.4%	85.1%	61.4%	87.4%	87.5%

1. Numbers in parentheses are standard errors.
* Coefficient is significant at the 5% level.
**Coefficient is significant at the 1% level.

Source: Calculated from 1981 Census of Canada, Public Use Sample Tape - Household/Family File.

the standard variables in M2 and M3 and, in addition, conclude the wife is more likely to work if she worked during the previous year or worked a greater number of weeks during the previous year.

As we mentioned earlier, we can only use the relative magnitudes of the estimated coefficients for purposes of comparison. We cannot infer that the value of the estimated coefficient reflects the impact of a unit change in the explanatory variable on the probability that the wife will work. From equation (44), we know that a unit change in the explanatory variable is $\beta_j f(-X_i'\beta)$, not β_j, as in a linear regression model. Thus, for any given age group, the relative impacts of the explanatory variables on the probability that wife is working depends on the magnitude and relative units of measurement of the explanatory variables. We are unable to make direct comparisons across age groups, or determine what the increase or decrease would be in the probability that a wife is working given a specific change in the size of one of the explanatory variables because $f(-X_i'\beta)$ will vary across groups. Therefore, although we can look at the sign and relative magnitudes of β_j across ages, $\beta_j f(-X_i'\beta)$ tells us how a unit change in the explanatory variable affects the probability of working. Tables 7 and 8, which are discussed later, show the expected changes for each age group in the proportion of working women given specific changes in the mean values of the explanatory variables.

The expected signs of the significant probit coefficients in Tables 5 and 6 correspond with the hypothesized signs as discussed in Chapter 3. In particular, of those coefficients significant at least at the 5% level, an increase in the number of children in either of the two age categories has a negative impact on the probability that the wife will work. Similarly, an increase in the spouse's income will decrease the probability that the wife will work. Those variables which are positively related to the probability that the wife will work are the highest level of education, the number of weeks worked during the previous year, and whether or not she worked during the previous year.

It is interesting to note that within each age category, the relative magnitude of the estimated coefficients for the husband's employment income are very similar regardless of the model specification (M1, M2 or M3), or year (1971/1981). The magnitude of the education variable does not, however, remain as consistent across models. With specific reference to the 1981 results, we note that the relative size of the estimated coefficients on this variable decrease in absolute value by as much as 50% once we control for past labour force behaviour. The coefficient estimates for the 1971 data on the other hand drop by a comparable amount in only two of the four age categories (25-29 and 35-39 yrs). The coefficient estimates of the 1971 education variable decline by 14% and 17% for the age categories 20-24 years and 30-34 years respectively.

An obvious question is why controlling for the previous year's work status affects the magnitude of the probit estimates for the education variable but not for the husband's employment income variable. One possible explanation is that the estimated coefficients for the husband's income reflect true state dependence in M1, M2, and M3, whereas some sort of spurious relationship exists between past work behaviour and educational attainment (Heckman, 1981, p. 92). This relationship is not all that surprising since the education variable embodies complex and multidimensional features. Specifically, education, which is indicative of years of schooling, stands for a great deal more than the training one receives between the ages of six and eighteen, or six and ences, as well as tapped and untapped intellectual capabilities. Thus, we might argue that the previous year's labour force behaviour controls for these slowly changing or fixed individual specific effects and as a result, the magnitude of the estimated coefficients decrease in magnitude.

We observe similar results with the estimated coefficients of the child status variables. In M2 and M3, the relative size of the coefficients is small in comparison to the estimates from M1. Quite often, the magnitude of the coefficients decreases by more than 50%. Again however, we must delve into the complex nature and attributes of this variable to explain why controlling for past labour force activity plays such an influential role in the relative magnitude of the coefficients.

First, we must realize that a family's child status is indicative of a great deal more than financial obligations or basic economic stability. Child status variables proxy for several omitted variables such as preference for home versus market oriented activities. The number and timing of children may reflect more about a wife's personality, tastes, and preferences, than does the education variable. However, if the number of pre-, or elementary school children reflect characteristics of a woman's personality, or attitude towards work, the relevant question is not how great a role the number or timing of children play in a wife's career decisions, but what, if any, role they play once we account for past labour force attachment.

We may classify wives into one of three groups: 1) pure market oriented - no children, 2) home oriented - no job, or 3) career mothers. If a wife falls in either category 2) or 3), we may argue that her choice of category was based on an ingrained desire for a given orientacantly alter her attitude toward home or market oriented activities. Under this hypothesis we would therefore expect the relative importance of child status variables to decline once past labour force preferences are taken into consideration. This then, is one possible explanation of why the magnitudes of the estimated coefficients for the child status variables show such a large decline once we control for past labour market behaviour.

In both our 1971 and 1981 results, the percentage of correct predictions is substantially higher for M2 and M3 than M1.[11] For example, the percentage of correct predictions in the 1971 probit analysis for 35 to 39 year olds jumps from 70.2% in M1, to 84.9% and 85.9% in M2 and M3 respectively. Within each age category, this jump is virtually the same regardless of our method of controlling for the previous year's work behaviour; that is, whether we include weeks worked or a dummy variable. This is an important result since, as we shall see, the particular method used to control for past work behaviour in the probit analysis has a substantial impact on the results obtained when we analyze annual hours worked.

To obtain further insight into the implications of the probit coefficients, in Table 7 and 8 we show for each age group the expected changes in the proportion of working women, as a result of specific changes in the mean values of the explanatory variables. To find the expected probability that a wife will work, we calculate the appropriate index value given her particular characteristics. We then use the cumulative normal probability table to determine the probability of obtaining a value less than or equal to the index value. This is the probability that she is currently working.

Table 7. Expected Changes in the Proportion of Working Wives Given Specific Changes [illegible] the Mean Value of Each Explanatory Variable

1971	20–24			25–29			30–34			35–39		
CHA	−.273	−.172	−.194	−.26	−.197	−.189	−.174	−.119	−.131	−.157	−.108	−.11
CHB				−.144	−.097*	−.109*	−.056	−.024	−.024	−.042	−.015*	−.01
EDSP	.063	.029	.026	−.067	−.081	−.080	.026	.022	.021	.025	.017	.01
EMHD	−.008	−.009	−.006*	−.109	−.108	−.108	−.017	−.014	−.014	−.012	.008	−.0[illegible]
WWSP		.013			−.086			.013			.016	
DUM			.414			.484			.509			.6[illegible]
Actual proportion of working wives in each age group	.4326			.3600			.3357			.3172		

* Associated probit coefficients are not significant at the 5% level.

Table 8. Expected Changes in the Proportion of Working Wives Given Specific Changes in the Mean Value of Each Explanatory Variable

1981	20–24			25–29			30–34			35–39		
CHA (+1 child)	-.292	-.148	-.212	-.215	-.083	-.111	-.185	-.124	-.132	-.117	-.056	-.1
CHB (+1 child)				-.127	-.023*	-.071	-.061	-.005*	-.021*	-.068	-.028*	-.0
EDSP (+1 yr Ed.)	.031	-.023	-.023	.020	.012	.008	.042	.023	.023	-.008	-.012	-.0
EMHD ('000)	.001*	-.003*	-.007*	-.011	-.011	-.007*	.274	-.003*	-.005*	-.010	-.013	-.0
WWSP		.012			.016			.019			.023	
DUM			.381			.424			.44			.4
Actual proportion of w[illegible]g wives in each age group.	.5903			.5669			.5447			.5559		

* Associated probit coefficients are <u>not</u> significant at the 5% level.

A given change in the value of the index will have varying effects on the probability of work depending on the size of the initial index value. If the initial index value lies in the tail of the distribution, a change of +.05 in the index will have a different impact on the probability of work than if the initial index value lies near the centre of the distribution. If Prob (Y=1) from equation (21) equals or exceeds 0.5, then Y is predicted to be unity; otherwise Y is predicted to be zero. (West, Ryan, Von Hohenbalken, 1987, p. 19). For example, if the proportion of women who work in an age group is small, say 10%, the corresponding index value for the group is -2.325. If the value of the index increased by +1.0, the expected probability of working would increase by +.051. If the proportion of women who work is quite large, say 60%, the corresponding index value for the group is +.2526. If the value of this index increased by +1.0, the expected probability of working would increase by +.295. Thus, we begin by examining the actual proportion of working wives in each age group. This proportion has a corresponding index value as defined in the cumulative normal probability table. It is this table which links the proportion of working women to the probability of work.

For those changes in Tables 7 and 8 which are associated with probit coefficient estimates that were found to be significant at the 5% level, we observe that 1) the number of children under six has the greatest negative impact on the probability of work, 2) the negative impact of the child status variables becomes less negative once we control for past labour force behaviour, and 3) the largest positive increase in the probability of working is associated with whether or not the wife worked during the previous year. To emphasize the difference between the actual probit estimates, and their impact on the probability of working, consider the coefficient of WWSF for the 1971, 20 to 24 year age group. The probit estimate in Table 5 is calculated as .033, whereas an increase in the number of weeks worked in the previous year corresponds to .013 increase in the proportion of working women.

5.3 Wage Equation

Tables 9, 10, 11, and 12 summarize our results for the estimated wage and hours equations. As discussed earlier, the estimated rather than the actual offered wage appears in the hours of work equation. The rationale for this approach relies on the assumption that the estimated values of the offered wage reflect the influence of only those variables we specifically control for in our wage equation. If we include the actual wage variable in our hours equation, it would most assuredly be correlated with omitted variables in the hours equation, therefore violating the OLS assumption that the covariance between an explanatory variable and the error term be zero for unbiased estimates. Thus, we use an imputed wage in our hours equation.

The education variable is included in the offered wage equation as an indicator of each wife's stock of human capital. Researchers argue that the higher the level of education, the greater the stock of human capital and hence, the higher the offered wage will be (Becker, p. 122). The number of years of experience is also a factor which is believed to affect one's stock of human capital and thus the offered wage. A common method of generating the experience variable is to subtract the number of years of schooling plus 7, from the wife's current age (e.g. Anderson, 1982). However, this method is likely to be haphazard since it is based on the overwhelming assumption of continuous, full-time work status. Thus, we have chosen to proxy for work exper-

Table 9

Ordinary Least Squares Estimates for the Log of Offered Wage Equation

1971	20-24				25-29				30-34				35-39			
Constant	.196 (2.20)[1]	.299 (1.50)	.118 (.76)	.292 (1.40)	-.045 (.41)	-.334 (1.56)	-.092 (.50)	-.377 (1.58)	.296 (2.37)	.270 (.91)	.468 (1.98)	.034 (.11)	.398 (3.20)	.088 (.39)	.129 (.65)	.088 (.37)
CHA	-.067 (2.64)	-.087 (2.01)	-.055 (1.74)	-.079 (2.26)	-.026 (.89)	.019 (.48)	-.022 (.70)	-.0066 (.21)	-.103 (2.51)	-.100 (1.80)	-.121 (2.62)	-.080 (1.65)	.010 (.20)	.043 (.81)	.030 (.60)	.031 (.61)
CHB					-.090 (3.16)	-.081 (2.80)	-.090 (3.15)	-.091 (3.19)	-.075 (3.21)	-.074 (2.89)	-.077 (3.30)	-.072 (3.05)	-.056 (2.31)	-.045 (1.80)	-.053 (2.20)	-.052 (2.17)
EDSP	.059 (9.36)	.061 (8.65)	.058 (8.91)	.060 (8.93)	.084 (11.19)	.078 (9.04)	.084 (10.94)	.081 (1[illegible].50)	.077 (8.58)	.077 (7.65)	.079 (8.53)	.074 (7.81)	.045 (4.76)	.041 (4.26)	.043 (4.55)	.043 (4.60)
FULL	-.082 (1.73)	-.083 (1.75)	-.085 (1.79)	-.082 (1.74)	.064 (1.22)	.054 (1.03)	.059 (1.10)	.056 (1.08)	-.184 (2.87)	-.185 (2.87)	-.172 (2.61)	-.186 (2.90)	.008 (.13)	.010 (.15)	-.007 (.11)	.011 (.17)
λ_1		.097 (.58)				.299 (1.58)				.025 (.10)				.308 (1.64)		
λ_2			.070 (.62)				.041 (.32)				-.147 (.86)				.225 (1.71)	
λ_3				-.082 (.51)				.274 (1.57)				.213 (.93)				.240 (1.55)
R^2	.094	.094	.094	.094	.184	.187	.185	.187	.124	.124	.125	.126	.046	.050	.051	.050

1. Numbers in parentheses are t-statistics. A coefficient is significant at the 5% level if the t-statistic is greater than or equal to 1.96.

Table 10

Ordinary Least Squares Estimates for the Log of the Offered Wage Equation

1981	20-24				25-29				30-34				35-39			
Constant	.326 (2.55)[1]	.822 (2.24)	.423 (1.99)	.514 (1.40)	.725 (4.98)	.821 (2.74)	1.235 (5.72)	1.013 (3.28)	.614 (4.26)	1.120 (3.20)	.727 (2.99)	1.188 (2.80)	.384 (3.51)	.130 (.45)	.331 (1.59)	−.089 (.27)
CHA	.199 (5.36)	.107 (1.45)	.189 (4.60)	.179 (3.43)	−.023 (.66)	−.034 (.74)	−.045 (1.26)	−.035 (.95)	−.027 (.65)	−.084 (1.53)	−.030 (.72)	−.054 (1.19)	−.039 (.77)	−.014 (.24)	−.037 (.73)	−.023 (.45)
CHB					−.196 (4.42)	−.203 (4.21)	−.213 (4.81)	−.205 (4.55)	−.151 (5.12)	−.170 (5.35)	−.152 (5.14)	−.154 (5.21)	−.059 (2.33)	−.048 (1.76)	−.058 (2.31)	−.052 (2.05)
EDSP	.019 (2.03)	.028 (2.49)	.020 (2.08)	.021 (2.10)	.030 (3.15)	.032 (3.08)	.034 (3.50)	.032 (3.28)	−.048 (5.38)	.061 (5.07)	.049 (5.40)	.052 (5.57)	.058 (7.65)	.052 (5.70)	.057 (7.59)	.056 (7.32)
FULL	.157 (3.11)	.156 (3.09)	.162 (3.16)	.156 (3.09)	−.057 (.92)	−.032 (3.08)	−.016 (.26)	−.056 (.91)	−.129 (2.05)	−.126 (2.00)	−.123 (1.91)	−1.27 (2.02)	−.022 (.42)	−.021 (.40)	−.026 (.48)	−.0211 (.40)
EMHD ('000)	.028 (5.24)	−.031 (5.41)	.028 (5.26)	.028 (5.26)	.020 (3.67)	.020 (3.68)	.021 (3.93)	.021 (3.78)	.027 (5.55)	.026 (5.22)	.027 (5.55)	.027 (5.55)	.014 (3.30)	.015 (3.42)	.014 (3.30)	.015 (3.40)
λ_1		−.467 (1.45)				−.084 (.37)				−.497 (1.59)				.237 (.94)		
λ_2			−.080 (.57)				−.422 (3.19)				−.090 (.57)				.039 (.29)	
λ_3				−.151 (.55)				−.225 (1.05)				−.440 (1.44)				.342 (1.53)
R^2	.060	.062	.061	.061	.063	.063	.073	.064	.133	.136	.134	.136	.091	.091	.091	.094

1. Numbers in parentheses are t-statistics. A coefficient is significant at the 5% level if the t-statistic is greater than or equal to 1.96.

The highest R^2 value using 1971 data is .187, correspond-
to 29 year age group, while for the 1981 data it is 0.136,
to the 30 to 34 year age group. These figures imply that,
.7% and 13.6% of the variability within our dependent
1971 and 1981 respectively) is explained by the regres-
the particular age group. Thus, we may conclude that the
tion for the wife's offered wage rate explains only a
on of the variation in a factor which plays an important
oour supply decision.

ld not, however, be disappointed or discouraged by these
ring for factors which affect the offered wage is very
often impossible. For example, we attempt to proxy for an
evious labour force experience since specific data in
t available. It may be impossible to proxy for other
s specialized training. Thus, our explanatory variables
wage equation should on average, control for differences
behaviour between wives rather than specifically account
rs (i.e. training, etc.).

rs

1 and 12 summarize the results for the estimated hours
r sets of results are presented for each age category.
ese represents our control model (H1). Neither the im-

Table 11. Ordinary Least Squares Estimates for the Annual Hours Equation

1971	20–24				25–29			
	H1	H2.1	H2.2	H2.3	H1	H2.1	H2.2	H2.3
Constant	917.82 (5.96)[1]	790.94 (4.28)	-896.42 (7.57)	801.07 (3.97)	1129.0 (11.00)	771.79 (4.24)	-575.65 (4.26)	221.22 (4.29)
BAB	-265.87 (4.58)	-255.71 (4.39)	-173.16 (3.88)	-268.75 (4.63)	-294.20 (6.63)	-269.38 (5.78)	-122.24 (3.16)	-301.68 (7.06)
EDSP	-38.13 (1.00)	-1.28 (.03)	287.58 (7.46)	-15.37 (.39)	17.54 (.63)	47.16 (1.84)	-20.19 (.85)	35.27 (1.36)
EMHD	.016 (3.13)	.014 (2.70)	-.0075 (1.90)	.014 (2.70)	.0016 (.37)	.0015 (.35)	-.00031 (.08)	.0016 (.38)
FULL	856.40 (12.32)	800.71 (11.94)	194.34 (2.91)	822.06 (11.92)	895.85 (18.08)	910.85 (18.94)	703.68 (16.28)	907.14 (18.75)
lnWRC	401.55 (0.60)				-391.09 (1.27)			
lnWR1		-303.76 (.48)				-811.32 (2.76)		
lnWR2			-5802.7 (8.72)				-142.37 (.54)	
lnWR3				-30.47 (.05)				-606.88 (2.08)
λ_1		259.07 (1.79)				331.84 [illegible]		
λ_2			2798.3 (25.01)				1515.2 (17.07)	
λ_3				180.00 (1.24)				128.60 (.84)
R^2	.292	.293	.583	.292	.393	.399	.559	.396

1. Numbers in parentheses are t-statistics. A coefficient is significant at the 5% level if the t-statistic is greater than or equal to 1.96.

Table 11. Ordinary Least Squares Estimates for the Annual Hours Equation (continued)

1971	30–34 H1	30–34 H2.1	30–34 H2.2	30–34 H2.3	35–39 H1	35–39 H2.1	35–39 H2.2	35–39 H2.3
Constant	1011.62 (9.27)	797.07 (4.68)	-343.00 (2.49)	771.64 (4.12)	1205.5 (7.79)	1040.1 (6.92)	150.52 (1.09)	1084.6 (6.69)
BAB	-152.55 (2.30)	-148.16 (2.23)	-147.12 (2.58)	-174.08 (2.65)	-112.28 (1.27)	-128.64 (2.03)	-72.68 (1.20)	-126.92 (1.98)
EDSP	-23.54 (1.28)	-11.39 (.58)	20.53 (1.35)	-7.76 (.40)	22.77 (1.43)	38.14 (2.42)	20.64 (1.43)	31.58 (2.03)
EMHD	.0014 (.35)	.0022 (.55)	-.00082 (.24)	.00132 (.33)	-.0025 (.71)	-.0023 (.63)	-.0070 (2.06)	-.0021 (.57)
FULL	1003.1 (17.59)	959.07 (15.24)	727.84 (14.85)	954.75 (15.33)	985.72 (22.78)	989.59 (23.03)	912.41 (22.46)	990.04 (22.94)
lnWRC	94.98 (.43)				-664.17 (2.06)			
lnWR1		-115.16 (.45)				-1075.4 (3.16)		
lnWR2			-660.82 (3.59)				-690.47 (2.32)	
lnWR3				-145.41 (.58)				-875.82 (2.74)
λ_1		260.28 (1.64)				322.94 (2.08)		
λ_2			1337.2 (15.33)				900.70 (8.79)	
λ_3				249.47 (1.60)				154.56 (1.23)
R^2	.468	.470	.608	.470	.475	.480	.539	.478

Table 12. Ordinary Least Squares Estimates for the Annual Hours Equation

1981	20-24 H1	20-24 H2.1	20-24 H2.2	20-24 H2.3	25-29 H1	25-29 H2.1	25-29 H2.2	25-29 H2.3
Constant	1354.8	2746.0	-3070.2	842.95	1128.1	1328.1	-720.98	[illegible]3
	(7.47)[1]	(2.72)	(14.35)	(1.59)	(6.99)	(6.00)	(3.39)	([illegible].87)
BAB	-202.65	-203.22	-126.08	-214.15	-323.83	-355.93	-196.46	-331.67
	(2.24)	(2.25)	(1.94)	(2.36)	(7.10)	(6.89)	(4.88)	(6.99)
EDSP	20.71	59.59	-35.73	11.93	3.88	5.73	-5.41	4.12
	(1.83)	(1.92)	(4.16)	(.83)	(.37)	(.54)	(.60)	(.39)
EMHD	.029	.063	-.039	.021	-.003	-.004	-.0046	-.003
	(2.52)	(2.14)	(4.29)	(1.40)	(.45)	(.66)	(.96)	(.47)
FULL	670.82	824.71	202.86	630.81	719.59	731.36	544.49	723.96
	(9.55)	(5.80)	(3.67)	(7.66)	(14.99)	(15.10)	(13.45)	(15.09)
lnWRC	-880.10				-60.41			
	(2.49)				(.31)			
lnWR1		-1872.8				7.83		
		(2.11)				(.04)		
lnWR2			862.02				-226.66	
			(3.15)				(1.48)	
lnWR3				-614.68				-25.91
				(1.34)				(.14)
λ_1		-1005.5				-228.79		
		(1.48)				(1.47)		
λ_2			3159.1				1633.9	
			(25.01)				(15.56)	
λ_3				342.83				-163.48
				(1.07)				(1.00)
R^2	.208	.208	.591	.210	.317	.319	.522	.318

1. Numbers in parentheses are t-statistics. A coefficient is significant at the 5% level if the t-statistic is greater than or equal to 1.96.

Table 12. Ordinary Least Squares Estimates for the Annual Hours Equation (continued).

1981	30–34 H1	30–34 H2.1	30–34 H2.2	30–34 H2.3	35–39 H1	35–39 H2.1	35–39 H2.2	35–39 H2.3
Constant	957.81 (6.19)	653.07 (2.30)	-1761.9 (9.14)	664.50 (1.69)	865.89 (5.17)	752.24 (3.71)	-935.68 (5.36)	834.91 (3.08)
BAB	-158.19 (2.31)	-129.54 (1.75)	-70.06 (1.24)	-145.94 (2.05)	3.96 (.06)	-21.42 (.32)	-74.35 (1.24)	-10.22 (.15)
EDSP	2.40 (1.9)	-4.27 (.30)	-15.16 (1.43)	-.737 (.05)	-15.92 (.74)	9.13 (.37)	9.55 (.50)	-4.65 (.19)
EMHD	-.014 (2.21)	-.013 (2.07)	-.014 (2.68)	-.015 (2.28)	-.0005 (.08)	.008 (.99)	.007 (1.29)	.0023 (.35)
FULL	799.01 (13.95)	790.56 (13.87)	627.81 (13.24)	798.99 (13.96)	994.53 (24.31)	987.96 (23.95)	840.57 (22.49)	993.63 (41.01)
lnWRC	86.43 (.47)				100.32 (.28)			
lnWR1		80.88 (.45)				-435.96 (.91)		
lnWR2			72.65 (.49)				-462.92 (1.43)	
lnWR3				114.64 (.61)				-103.00 (.25)
λ_1		300.67 (1.40)				292.88 (1.20)		
λ_2			2160.1 (19.94)				1569.2 (5.36)	
λ_3				213.24 (.85)				76.39 (.31)
R^2	.257	.258	.499	.257	.387	.388	.522	.387

puted wage, nor the hours equation are corrected for sample selectivity in this model. The second column of results for each age category (representing model (H2.1)) are for the estimated annual hours equation which has been corrected for sample selectivity using the selectivity term generated from the probit analysis M1. The imputed wage included in this regression was corrected for selectivity using the same term. The third and fourth columns of results for each age category (representing models (H2.2) and (H2.3)) are calculated in the same way as the second column except that the sample selectivity terms included in these wage and hours equations were generated from the probit analyses M2 and M3.

The offered wage variable in the hours of work equation incorporates two effects. First, the substitution effect implies that an increase in the offered wage will entice an individual, <u>ceteris paribus</u>, to work more hours. Second, the income effect implies that given a higher hourly wage-rate, an individual can work fewer hours to earn a given level of income. Thus, the sign of the coefficient [illegible] variable will indicate which of these two effects is stronger. [illegible] substitution effect outweighs the income effect, the estima[illegible]fi-cient will be positive and if the opposite relationship holds, the estimated coefficient will be negative. If the two effects are comparable in size, we would expect the coefficient to be insignificant.

The estimated coefficients of the offered wage rates in Table 11 are either negative and significant at the 5% level, or are insignificant. The only age group that reports consistently negative and significant coefficient estimates for the different models is the 35 to 39 year age group. This implies that on average, a rise in the hourly wage would result in fewer hours of labour being supplied to the work force.

The estimated coefficients of the offered wage rate in Table 12 are insignificant at the 5% level except for models H1, H2.1, and H2.2 in the 20 to 24 year age bracket. For this group, the wage coefficients in H1 and H2.1 are both significant and negative whereas the estimated coefficient in H2.2 is significant and positive. Past research is not especially helpful in indicating which sign is appropriate since both significantly positive (Heckman, 1976) and significantly negative (Nakamura, Nakamura and Cullen, 1979) coefficients have been reported.

The sample selectivity correction term (λ) is included in the hours equation to compensate for the fact that non-workers are excluded from the analysis, and thus to allow us to obtain consistent estimates. In Section 2.3 of Chapter 2, we defined the coefficient on λ as an estimate of a standard deviation. This implies that the sign of this coefficient should be positive in each of our estimated equations. This hypothesis is substantiated by the estimated coefficients of λ which are significant at the 5% level. All of the estimated coefficients on the selectivity term λ_2 are significant at the 5% level whereas none of the estimated coefficients on λ_3 are significant. The coefficients on λ_1 are significant only in 1971 in the regressions for the age groups 25 to 29 and 35 to 39.

The remaining explanatory variables included in the hours equation results in Tables 11 and 12 are all believed to influence a wife's asking wage. If a variable is believed to be positively related to a woman's asking wage (e.g. husband's employment income), we expect it will be negatively related to the annual hours of work. As in the case of the offered wage variable, the estimated coefficient for the husband's employment income is significant and positive for H1 and H2.1, and significant and negative for H2.2. In this instance however, the inconsistency can be resolved through the support of past research and economic theory; an increase in the husband's employment income will, holding everything else constant, decrease the number of hours of work a wife would be willing to supply to the market.

Thus, these results suggest that the signs of the estimated coefficients for the husband's employment income in the 1981 H1 and H2.1, age 20 to 24 results are incorrect while the signs of the coefficients in H2.2 are correct. This phenomenon is a result of the method used to control for sample selectivity. We assert that the selectivity term $(\hat{\lambda}_2)$ which includes a measure of previous work behaviour is a good indicator of how the estimated coefficients of the annual hours equation would be affected if we were able to include a lagged hours variable.

The two dummy variables included in the hours equation are the full-time/part-time, and children/childless dummies. All of the estimated coefficients for the full-time/part-time dummy variable are significant at the 5% level. The expected sign of this variable (positive) may be rationalized in the following sense. Consider an average married woman with two children. If she decides to enter, or re-enter the work force, there are certain costs associated with this action that she must consider. If we assume there are fixed costs to entering the labour force, we can understand why the pecuniary gains associated with a part-time job must be substantially higher than those associated with a full-time job. That is, the wife would demand a higher hourly salary to compensate her for the inconvenience of say, travelling to and from work within a very short time frame. Thus, since the "overhead" associated with the part-time job is the same as that of the full-time job, the asking wage is higher for the part-time job.

Since the full-time job is associated with a lower asking-wage, ceteris paribus, we hypothesized that the full-time/part-time dummy variable must have a positive coefficient in the hours of work equation. The reason for this is, as we have discussed, because the opposite relationship from the explanatory variable and asking wage must hold for the same explanatory variable and annual hours. The only notable characteristic of the estimated coefficients on this variable is the obvious decline in the magnitude of the coefficient in H2.2. It appears that H1, H2.1, and H2.3 all over-estimate the size of the coefficient, or H2.2 under-estimates it.

The second dummy variable to consider is the children/childless dummy. As we previously argued, the presence of children in a family should increase the wife's asking wage. This implies that the sign of the estimated coefficient in the hours equation should be negative. This hypothesis is supported by our results in Tables 11 and 12, where we again observe a smaller estimated coefficient in H2.2 than H1, H2.1 or H2.3. Thus, as in the case of the full-time/part-time variable, either the estimated coefficients of the children/childless dummy in H1, H2.1 and H2.3 are upward biased, or they are downward biased in H2.2.

The final variable to discuss is the highest level of education. One of the most surprising results in the analysis of annual hours worked is the relative insignificance of this variable after taking account of previous work behaviour. The 1971 estimated coefficients for the highest level of education are only significant at the 5% level in H2.2, age 20 to 24, and in H2.1/H2.3, age 35 to 39. In the 1981 results, the only significant education variable is in H2.2, age 20 to 24. The significance of the wife's highest level of education for the youngest age group (20 to 24) likely reflects the importance of education on an individual's wage offer before they become established. As one gains experience and seniority, the educational attainment becomes less indicative of one's achievements.

The goodness of fit measure (R^2) for the annual hours equation displays an obvious pattern. Whereas the R^2 for H1, H2.1 and H2.3 are all virtually identical, the R^2 from H2.2 jumps by as much as .3831 (1981; 20–24). In each age category, H2.2 explains a proportionately larger percentage of the variability in the annual hours variable than any of the other models. This is a very interesting result since H2.1, H2.2 and H2.3 all contain the same number of explanatory variables. The result is even more puzzling since if the R^2 in H2.2 increased, one would have expected the R^2 in H2.3 to increase. We would have expected this to be the case, since the only difference between the two models is the method used to control for the previous year's work behaviour in the probit analysis. Since the percentage of correct predictions for the probit equations increased dramatically for both methods, we would expect the R^2 in the annual hours equation to rise in H2.3 as well as H2.2. Since this is not the case, we must conclude that the additional information included in the variable – w[illegible]n the previous year – is the crucial factor which ensures the estimated coefficients in the annual hours equation will not be upward biased.

5.5 Wage-Elasticities

As we discussed in Chapter 3, the offered wage variable in the hours of work equation incorporates two effects. First, the income effect may be expressed as the ratio of employment income to full money income, multiplied by the full income elasticity $(\frac{w \cdot H}{F} \cdot \eta_{c,F})$. If leisure is a normal good, then the income effect will be positive.

(Boskin, 1973, p. 176). Second, the substitution effect measures the effect of an increase or decrease in the wife's wage rate on the wife's labour supply. The own substitution effect is negative since an increase in the wife's wage-rate, holding real income constant, will result in a decrease in the wife's demand for leisure (supply of labour). Thus, "...the effect of an uncompensated increase in earnings on hours worked would depend on the relative strength of the substitution and income effects. The former would increase hours, the latter reduce them; which dominates cannot be determined a priori" (Becker, 1976, p. 98).

The uncompensated wage elasticity of labour supply may be computed by differentiating the labour supply function (equation (17)) with respect to the wife's own wage, and dividing by H^f/w_f. Thus,

$$(56) \quad \frac{\partial H^f}{\partial w^f} \cdot \frac{w^f}{H^f} = \eta^{un}_{H,w}$$

In Table 13, the uncompensated wage elasticities from five different studies are presented alongside the estimates obtained here using our two data sets. Each of the five published analyses use a method of estimation similar to that used in our study; that is, an imputed wage is substituted into a selection-bias corrected hours equation where the wage variable is in log-form. Thus, differences in the measures of elasticity will not be attributable to differences in functional form.

The uncompensated wage elasticities for working Canadian women as presented in Nakamura, Nakamura and Cullen (1979), Nakamura and Nakamura (1981), and Robinson and Tomes (1985) are consistently negative. These results lend considerable support to a backward bending supply schedule for married Canadian women. Robinson and Tomes (1985) concluded that

"...in terms of the underlying theoretical model, these findings suggest that although the earnings of men typically exceed those of women, which, <u>ceteris paribus</u>, implies a larger income effect for men, the other crucial parameters - the income elasticity of leisure and the substitution elasticity differ between the sexes. The markedly backward-bending character of the labour supply schedule of working women suggests that the income elasticity of demand for leisure is larger relative to the substitution effect for women than for men." (Robinson and Tomes, 1985, p. 162).

However, studies by Hanoch (1980) and Layard, Barton and Zabalza (1980) which use U.S. data reveal positive uncompensated wage elasticities. This suggests that married women have positively sloped (uncompensated) labour supply functi[illegible]. In Nakamura and Nakamura (1981), the wage elasticities for U.S. d[illegible]ell below the range of positive elasticities reported by Hanoch (1[illegible], Layard, Barton and Zabalza (1980) and many other researchers.

Killingsworth (1983) conjectures that negative wage elasticities for married women may be a result of the specification of the labour supply model. He views negative elasticities to be a product of less than adequately defined wage functions. For example, since a measure of actual work experience is not available in many data sources, Killingsworth feels that proxies for work experience may not reflect actual experience and as a result, the estimated elasticities may be overstated. However, Robinson and Tomes (1985) use a superior data set to that used by Nakamura, Nakamura and Cullen (1979), and find support for the hypothesis of a backward-bending supply curve.

The uncompensated wage elasticities for this study are presented at the bottom of Table 13. Aside from the 20 to 24 year age group in

Table 13. Elasticities

	Uncompensated Wage Elasticities U.S.	Canada			
Nakamura, Nakamura and Cullen (1979)					
Age 20-24		-0.194			
25-29		-0.313			
30-34		-0.173			
35-39		-0.199			
Hanoch (1980)					
Assuming no corner solution (<52 weeks)	0.640				
Average, allowing for corner solution in weeks	0.417				
Layard, Barton and Zabalza (1980)	0.08				
Nakamura and Nakamura (1981)					
Age 25-29	-0.390	-0.370			
30-34	-0.244	-0.270			
35-39	-0.165	-0.305			
Robinson and Tomes (1985)					
Hourly wage sample		-0.849			
Hourly paid sample		-0.437			
		H1	H2.1	H2.2	H2.3
1971 Age 20-24		0.199	-0.151	-2.879	-.015
25-29		-0.241	-0.500	-0.088	-.374
30-34		-0.056	-0.068	-0.392	-0.086
35-39		-0.356	-0.577	-0.370	-0.470
1981 Age 20-24		-0.542	-1.152	0.530	-0.378
25-29		-0.049	0.006	-0.183	-0.021
30-34		0.074	0.070	0.063	0.099
35-39		0.078	+0.338	-0.359	-0.080

model H1, the wage elasticities generated from 1971 data are all negative. Thus, the estimates obtained in this study also lend support to the hypothesis that married women work fewer hours per year when they are paid more per hour.

The sign of the uncompensated wage elasticity is not as consistent for the 1981 results. In the 20 to 24, 25 to 29, and 35 to 39 year age groups, one of the four models, in each age group, yields a positive wage elasticity. For example, in the 20 to 24 year age group, H1, H2.1, and H2.3 all have negative wage elasticities, whereas H2.2 has a positive elasticity. For the 25 to 29, and 35 to 39 year olds, H2.1 and H1 respectively have positive wage elasticities.

One age category, 30 to 34, reports positive uncompensated wage elasticities regardless of the model specification. Thus, wives in this age bracket work a higher number of hours per year when they are paid more per hour. This implies that the labour supply function is upward sloping. We should also note that the elasticity estimates range from 0.063 to 0.099 for the four models. This narrow range is consistent with the estimate obtained by Layard, Barton and Zabalza (1980).

The wide range of elasticity estimates in the other three age categories may be indicative of the sensitivity of estimates to the empirical specification. Borjas and Heckman (1978) argue that "the range of estimates in existing studies can be considerably narrowed by eliminating studies that have particularly serious statistical flaws" (Keeley, 1981, p. 97). Thus, within our four different model specifications, we argue that elasticity estimates associated with H1 should not be considered since the model has not been corrected for sample selection bias. Eliminating H1 from further consideration, we observe that only the 35 to 39 year age group report negative elasticity estimates in all remaining models (H2.1, H2.2, and H2.3).

Of those models which include a sample selectivity correction* (H2.1, H2.2 and H2.3), we have conflicting signs on the estimated wage elasticities. However, for the 25 to 29 year age group, the range (-0.183 to .006) is quite narrow. This implies that, depending on the model specification, we are evaluating the elasticity at a point either slightly below, or slightly above point A in Figure 8 of Chapter 3. If we consider the fact that nearly 70% of the 25 to 29 year old women in our sample work full time, we may argue that the elasticity estimates for this age category are not out of line. This implies that most women working 35 to 40 hours per week are not willing to sacrifice their remaining leisure time to increase their earnings. In terms of our discussion in section 3.1, the income effect and the substitution effect are very close in magnitude.

6. CONCLUSION

The model employed in this study incorporates past labour force behaviour in participation equations for married Canadian women between the ages of 20 and 39. Evidence from this study supports the hypothesis that past work behaviour may proxy for fixed or slowly changing individual specific effects. That is, the results verify our conjecture that models of labour force participation are misspecified if they do not control for past labour force behaviour.

This study also produced interesting results with respect to the labour supply equations. Our expectation that selectivity bias correction terms generated from alternatively specified probit models have varying effects on the coefficient estimates of the labour supply equation was supported. However, we did not expect that one derivation of the sample selection term would influence the labour supply equation in a manner superior to another. Specifically, we found that, although one method of controlling for past work behaviour in the participation equation was as effective as the other, the labour supply equation was sensitive to the particular derivation of the sample selection term; that is, the method by which past labour force behaviour was controlled for in the participation equation.

Heckman (1978) originally speculated that including a measure of past work behaviour in labour supply equations might substantially improve the performance of the model. He felt that lagged participation might serve as a good proxy for unobservable fixed or persistent factors. This parallels the approach used here in the participation model M3 where lagged participation (DUM) indicates to whether or not the wife worked in the previous year. Thus, we find that our participation models which include a dummy variable for lagged work experience to be superior to those which do not.

The second measure of lagged participation which we incorporate in a participation model is lagged weeks worked; that is, the number of weeks worked in the previous year. As we discussed in Chapter 4, there exist a limited number of dynamic studies of labour supply which include measures of past work performance. For example, Johnson and Pencavel (1984) include lagged hours of work to proxy for permanent differences in tastes for work across families; Nakamura and Nakamura (1985a) include lagged log of hours worked and lagged log of the hourly wage rate.

Both measures of past labour force behaviour employed in this study improve the performance of the standard model (M1). The percent of correct predictions increases substantially from M1 to M2 or M3 for both the 1971 and 1981 data sets. The percentage increase in the percent of correct predictions (moving from M1 to M2 or M3) is larger for the 1981 results mainly because M1 does not "fit" the 1981 data as well as the 1971 data. Thus, we find support for the hypothesis that limited amounts of past information on work behaviour controls for a significant portion of the variability in labour force participation across individuals.

In view of the fact that the estimated probit coefficients of the child status, and education variables decrease in absolute value when we control for fixed effects, we believe that unobservable, individual specific factors are of major concern when estimating participation models. We argue that a decline in the relative importance of the child status variables is indicative of the fact that a woman's attitude toward home or market orientations is based on an ingrained desire for a given particular orientation. Second, we conjecture that as well as controlling for fixed, or slowly changing individual specific factors, lagged work status variables reflect a measure of true state dependence.[12] This implies that past labour force experience has a behavioural effect on a wife's future labour force status.

The signs of the probit coefficients which are significant at the 5 percent level correspond with those hypothesized. In particular, those variables which are positively related to the probability that the wife will work are: the highest level of education, the number of weeks worked during the previous year, and whether or not the wife worked during the previous year. Those variables found to be negatively related to the probability that the wife will work are: the number of children in either of the two age groups, and the spouse's income.

Due to the nature of our data source, we are unable to control for past work behaviour in the labour supply equations. However, we feel that including sample selectivity terms generated from models which control for past work behaviour in the hours equations will be indicative of the influence that would occur if we controlled for such behaviour directly. Thus, directly controlling for past work behaviour in the hours equation (as is done in the dynamic studies previously mentioned), would be an ideal next step in this cross-sectional analysis.

To accomplish this task, the questions asked in the Canadian census would have to discriminate between current, or last year's labour force status, and labour force behaviour in previous years. For example, to generate the annual hours variable, we use a current (HRSP) as well as a lagged (WWSP) variable. Thus, if we included lagged weeks worked as an additional regressor in the annual hours equation, we would be violating one of the assumptions of OLS estimation. That is, the covariance of WWSP and the error term would not be zero and therefore, the estimated coefficients would be biased. Thus, annual hours would have to be the actual hours worked in a given year, or individuals would have to supply information as to their work status for up to two years prior to the census.

The uncompensated wage elasticities presented in Table 13 give a fairly clear indication that a general consensus does not exist as to the expected sign of the uncompensated wage elasticities for married women. In the past, uncompensated elasticities for women and men were expected to be positive for the former and negative for the latter. However, a recent trend in Canadian studies leans towards an acceptance of the 'backward-bending' supply curve.

We too support this hypothesis with our 1971 results. However, given the inconsistencies in signs across age categories for the 1981 data, we hypothesize that the elasticity has shifted to a negative/small-positive range. Thus, depending on our model specification, the elasticity estimate pivots somewhere around point A in Figure 8.[13]

Since macro-factors are exogenous to our model, we are unable to determine the impact of government programs such as tax credits for child care expenses, or subsidies for child care services. The impacts of these programs are not merely limited to changes in hours of work, or wage rates, but may delve into family traditions or social philosophies. That is, government programs would benefit only those wives who take advantage of the child care subsidies. Thus, the justification for public funding may lie in a welfare issue with respect to individual wives who might utilize the services.

It is obvious from our discussion at the beginning of Chapter 5 that the family characteristics of working women have changed between 1971 and 1981. The most dramatic change lies with whether or not the wife has ever had children. Since, on average, only 18% of working wives between the ages of 30 and 39 have children, we are naturally interested in whether or not less expensive, or improved child care services would entice women within this age group who have children to enter or re-enter the work force. It is possible that married women within this age bracket have developed a preference for home versus market oriented activities. However, the causal significance of our findings is often unclear. For example, working women in 1981 have, on average, fewer children than their 1971 counterparts. Our study suggests that the impact of children on the market orientation of the mother is over-emphasized if past labour force activity is not considered. However, we can only speculate whether or not improving child care services would entice women with larger families into the work force. The results from our study lead us to believe that this would not have any dramatic impact on the labour supply of married women with children because children, in general, are not the deciding factor for whether or not a wife works. The wife must have a strong disposition towards working before increased child care services would affect her decision to enter, or re-enter [illegible]rce.