Female labour supply and mortgage-related borrowing constraints

Empirical Study

by

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Abstract

This paper uses data from the 1996 Canadian Family Expenditures Survey to examine the relationship between female labour supply decisions and mortgage-related borrowing constraints in a life-cycle model. The analysis is restricted to married couples in which the husband has a job. Estimation is based on a simultaneous equations model in which female labour supply decisions and mortgage decisions are jointly determined. The empirical evidence shows that high mortgage commitments have a positive and significant impact on the labour force participation rate and labour supply of married women.

1. Introduction

This paper is inspired by recent work of Del Boca and Lusardi (2003), but with Canadian data. The objective of this study is to analyze the interaction between female labour supply and mortgage-related borrowing constraints. I set up a life-cycle consistent model in which households choose female labour supply and consumption, subject to a lifetime budget constraint and a mortgage-related borrowing constraint. Female labour supply is taken to be an endogenous choice variable which has the effect of making borrowing constraints less binding. Particularly, since the housing asset is usually by far the largest single asset in most households' portfolios, it provides a good opportunity to examine the effect of mortgage-related borrowing constraints on female labour supply decisions. When a

mortgage is taken out, households normally face two types of institutional constraints: a minimum down-payment constraint (in Canada, a conventional mortgage loan often requires a minimum down-payment of 25 per cent of the purchase price)[1] and a mortgage qualification constraint (in the form of a maximum ratio of mortgage payment to the household's annual earned income)[2]. Hence, there exists a mortgage-related borrowing constraint based on earnings in this context.

The empirical analysis uses data from the 1996 Canadian Family Expenditures Survey (FAMEX). The supply of mortgages in Canada is plentiful, and mortgage lending rules are uniform across the country, which are set largely by the Canada Mortgage and Housing Corporation (CMHC). Home purchasing in Canada usually involves mortgage lending, and the borrowers normally face a qualification constraint which is typically earnings dependent. All these facts make Canada a good setting to study the effect of the mortgage market on labour supply behaviour. I model the labour market participation of married women based on a static model which is estimated utilizing a single cross-section data, and thus we relied on a static-level analysis. The working sample will be restricted to couples in which the husband has a job. I will only focus on female labour force participation because I expect the wife to be able to adjust the number of hours with greater ease than the husband. A standard probit model will be estimated to consider the direct impact of having a mortgage on the probability of married women working, taking the mortgage decision as exogenous.

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[1] Typically a minimum down-payment of 5% is required for a high-ratio mortgage. These types of mortgage loans are required to be insured against default.

[2] In Canada, usually 32% of household income will be used to help determine how much of a mortgage it qualifies for.

Most of the literature that is concerned with the relationship between mortgage commitments and labour supply decisions takes mortgage choice as exogenous (e.g. Fortin 1995, Aldershof et al 1997 and Bottazzi 2002). This paper will address the endogeneity issue in the presence of a mortgage-related qualification constraint. Mortgage commitments are in fact potentially endogenous in labour supply decisions. It may be, for example, that households with working wives are more likely to qualify for a mortgage, or the temporal attachment in labour markets allows the household to assume a high level of mortgage commitments. By allowing for simultaneity in modeling labour supply and mortgage decisions, I will estimate a multivariate probit equation model with continuous latent variables. Joint decisions over participation and mortgages are assumed to hold at each period, and the participation decision can directly influence the probability of having a mortgage. The empirical evidence shows a significant impact of mortgages on women's participation in the labour market. Moreover, as a contribution to the literature, I use a recursive simultaneous equations tobit model to investigate the relationship between weeks worked by women and mortgage commitments. For this model, there is no evidence that the parameters that determine the weeks of work for participating females are different from the parameters that determine participation.

Since I do not have access to panel data for Canada, I cannot investigate further into the direction of causality in the relationship between mortgage commitments and labour supply. It is difficult to distinguish the wives who choose a high level of labour supply because of high mortgage commitments from wives who choose high levels of mortgage ratio because they exhibit a high level of labour

supply. However, the empirical evidence from the multivariate probit model indicates that there is only a small significant effect of the propensity of the wife to work on the propensity to have a mortgage. That finding is in line with Del Boca (2003), whose estimation results show no evidence of nonrecursiveness in the sample.

The structure of this paper is as follows: Section 2 presents a discussion of the previous related literature. Section 3 contains the theoretical framework that is used as a guide in the interpretation of the empirical results. A mortgage-related borrowing constraint is incorporated into the traditional life-cycle model, and female labour supply and mortgage use are jointly determined. Section 4 describes the data set as well as sample selection issues. Section 5 provides descriptive statistics on the relationship between participation and mortgage commitments by means of cross tabulations. Section 6 presents the details of econometric specification and a discussion of the estimation methods. The empirical results are discussed in Section 7. Finally, Section 8 gives a short summary and concluding remarks.

2. The literature review

There is an extensive literature that has analyzed the interaction between borrowing constraints and different types of household decisions such as savings, housing tenure[3], and labour supply. Early studies (Artle and Variaya 1978) have documented the role of housing assets in life-cycle model of consumption and labour supply. Recent studies (Engelhardt, 1996; Caplin et al., 1997) focused on the effects of imperfections in the mortgage market on saving decisions. Other studies

[3] All occupied housing units are classified in terms of four tenure types: owned without a mortgage, owned with (a) mortgage(s), rented and mixed tenure-owned.

show that households use various ways such as intra-family transfers to overcome liquidity constraints in housing purchases (Haurin et al. 1995; Guiso and Jappelli 2002; Engelhardt and Meyer 1994). Ermisch and Halpin (2000) also report important effects of family characteristics in determining homeownership in Great Britain.

Imperfections of credit markets can also affect the labour market. Bernhardt and Backus (1990) show the impact of borrowing constraints on the choice of occupation. Other papers (Evans and Jovanovic 1989; Holtz-Eakin et al., 1994; Blanchflower and Oswald 1998; Fairlie 1999) also show that probability of self-employment depends upon financial constraints. More relevant for this paper, Yoshikawa and Ohtake (1989) examine household savings, labour supply of married women, and the demand for housing within a three-period life-cycle model, which incorporates an additional constraint related to the down-payment for home-owners. The paper's main focus is on renters, and it finds that a change in the household's tenure choice brings about a substantial change in saving and labour supply behavior. From a cross-section data of the Japanese National Survey of Family Income and Expenditure, they estimate the savings function and the female labour supply function for two tenure types (renting or owing), and find that switching from home-owners to renters decreases the savings rate and increases the wife's labour supply in Japan.

Fortin (1995) uses data from the 1986 Canadian Family Expenditures Survey to estimate a life-cycle consistent model of female labour supply and consumption, and analyses the relationship between labour supply and the mortgage qualification constraint based on family earnings. Empirical result of a reduced form model of

female labour supply on a set of housing variables indicates a positive relationship between the wife's labour market participation (and hours of work) and the ratio of mortgage charges to other family income. Moreover, two labour earnings equations associated with the theoretical model are estimated. The estimates indicate that the labour supply of married women is constrained by mortgage commitments, and a household's mortgage choices depend significantly on the existing level of the wife's labour earnings. Particularly, the results of generalized selectivity models indicate that the positive effect of high mortgage commitments exceeds the negative effect of young children on labour supply.

Along these lines, Aldershof et al. (1997) use panel data from the Netherlands and examine the relationship between female labour supply and mortgage constraints by developing a life-cycle consistent model. It is found that mortgage commitments have a significant positive effect on the labour supply of women. Additionally, a test for separability of labour supply and housing consumption is conducted and the separability of the two preferences cannot be rejected. Dau-Schmidt (1997) provided additional evidence on the impact of debt commitment on labour supply in the US. He uses a two period life-cycle model of workers' intertemporal labour supply and reports evidence of a modest impediment to labour supply due to the borrowing constraint.

Bottazzi (2002) analyzes mortgage commitments and female labour participation in a general life-cycle framework using panel data from the UK. The empirical evidence from a conditional logit analysis shows similar findings with the previous literature, except that the negative effect of having a young child on female

participation is very strong, and the combined effect of children and mortgage commitments on participation can be even negative.

More recently, Del Boca and Lusardi (2003) examine whether imperfections in the mortgage market spill over to the labour market by using the 1989 and 1993 cross-sections from the Italian Survey of Household Income and Wealth. Italy experienced changes in the mortgage market brought about by the 1992 European unification and other institutional shifts. Such changes are used as an exogenous source of variation in lending terms and practices to identify the spillover effect of financial markets on the labour market. In particular, mortgage commitments are assumed to be potentially endogenous in labour supply decisions, and estimation is based on a simultaneous equations model involving latent variables. The results indicate a significant impact of mortgages on women's participation in the labour market. Moreover, while assuming bi-directional causality between labour supply and mortgage decisions, the estimates show that there is only a small direct effect of the propensity to participate in the labour market on the likelihood of having a mortgage.

3. Theoretical Framework

Given that most of the male workers may already work full-time, and their labour supply is not as flexible as that of women, the framework in which my empirical estimation is based is a simple dynamic inter-temporal model of female labour supply and consumption. I disregard the possible importance of investment demand for housing (see Ioannides and Rosenthal 1994 for a discussion) for simplicity. This

set-up is similar to Bottazzi (2002), but allows for mortgage choices, which may vary over time, to be endogenous. A household chooses female labour supply and consumption to maximize the following additive separable utility function:

$$\underset{C_t,H_t,M_t}{Max}\sum_{s=t}^{T}\beta^{s-t}[U(C_t,H_t)] \quad (1)$$

subject to a liquidity and income constraint and a mortgage-related borrowing constraint[4]:

$$A_s = (1+r_s)\left[A_{s-1} + Y_{s-1} + w_{s-1}H_{s-1} - C_{s-1} - M_{s-1}\right] \quad (2)$$

$$k(Y_s + w_s H_s) \geq M_s \quad (3)$$

where:

C = consumption

H = hours of work

Y = unearned income (husband's income)

A = assets at the beginning of period t

w = female wages

r = the interest rate between period t and period t+1

β = consumer's discount factor

M = mortgage payment

T = indicates the terminal period

U (.)= intra-temporal utility function at period t

k = the maximum proportion of eligible income to be allocated to mortgage payments. (0<k<1)

[4] The mortgage lending constraint(also mortgage-related borrowing constraint) has been introduced following Fortin (1995).

We assume that there is no uncertainty. The utility function, $U(\cdot)$, is assumed to be strictly concave and monotonically increasing in C and decreasing in H. The amount of the mortgage, M, is assumed to be jointly determined with labour supply. The maximization is subject not only to a labour supply budget constraint, but also to a mortgage-related borrowing constraint which indicates that household borrowing cannot go beyond a certain maximum proportion of eligible income. The earnings-related mortgage borrowing constraint applies to households that have not yet taken out mortgages. If capital markets are imperfect, households might not be able to borrow as much as they would like to if they want to finance their housing loan by a mortgage, and the sum they can borrow is based on earned income. Home buyers have to meet a down-payment constraint on the amount of mortgage they can take out based on Canadian regulations, and moreover, they also typically have to face an income test to qualify for a mortgage. A mortgage qualification constraint is binding if a household's income does not meet the required level imposed by the mortgage lender, and if it does not have any other assets to offer as collateral. Since high earnings which reflect high human capital can be used as mortgage collateral, individuals who earn more can borrow up to a higher sum than people that earn less. As a result, in a household with the binding borrowing constraint, the wife might work more to make the constraint less binding if the husband's labour supply is inflexible.

Although the institutional mortgage qualification constraint should apply only when the mortgage is taken out, it is also possible to think that it may hold at every period. The mortgage-related borrowing constraint also applies to households that

have taken out mortgages. Based on the Canadian institutions in the housing and mortgage market, Fortin (1995) suggests that there might be a couple of underlying reasons of why the mortgage qualification constraint may hold in subsequent periods. For example, a household that obtained a mortgage on the basis of the husband's income could face an increase in interest rates or a decrease in husband's income, which makes the mortgage-related borrowing constraint binding. Since a fixed proportion of household income has to be allocated to mortgage payments, this would probably force the wife to participate in the labour market or increase her labour supply in order to lessen the effect of the binding borrowing constraint. The fact that variations in interest rates are associated with variations in the wife's participation provides some support for this hypothesis. Alternatively, the household could refinance the mortgage, but in that case it would face the mortgage qualification constraint again. Hence, the earnings-related mortgage constraint should be met not only when the mortgage is taken out but also in subsequent periods, and the binding constraint might affect household consumption and labour supply decisions as a result.

The first order conditions for the household's utility maximizing problem for period t are as follows:

$$U_C = \beta(1+r_{t+1})\lambda_{t+1} \tag{4}$$

$$U_H = -\beta(1+r_{t+1})\lambda_{t+1}w_t - \mu_t k w_t \tag{5}$$

$$\lambda_t = \beta(1+r_{t+1})\lambda_{t+1}, \quad \mu_t = \beta(1+r_{t+1})\lambda_{t+1} \tag{6}$$

$$\mu_t[k(Y_t + w_t H_t) - M_t] = 0, \mu_t \geq 0 \tag{7}$$

where λ denotes the Lagrange multiplier associated with the budget constraint, μ is

the Kuhn-Tucker multiplier associated with the borrowing constraint, and U_C and U_H denote the first derivatives of the utility function with respect to consumption and labour supply, respectively.

There is an interior solution for female labour supply only in the case in which no constraints are binding and $\mu_t=0$, and female labour supply does not depend on mortgage payment. Using the first order conditions (4)-(7), we can derive optimal female labour supply of an extremely general form:

$$H_t = H_t(\lambda_t, w_t, C_t, Y_t)^5 \qquad (9)$$

A specific parametric form of female labour supply depends on the specific utility function one is using. Particularly, for analytical convenience, I adopt the following Cobb-Douglas utility function in which the total time endowment per period is normalized to one:

$$U(C_t, H_t) = k_0 C_t^a (1-H_t)^b$$

Using this specific utility function, one can then solve the first-order conditions to get female labour supply demand functions for H_t:

$$H_t = 1 - \frac{b}{a}\frac{C_t}{w_t}, \mu_t = 0$$

On the other hand, if the borrowing constraint is binding and $\mu_t>0$, H_t will be determined by a function of mortgage payment:

$$H_t = \frac{1}{w_t}\left(\frac{M_t}{k} - Y_t\right), \mu_t > 0 \qquad (8)$$

It is expected that the borrowing constraint is more likely to be binding in cases

[5] In this equation, λ is assumed to capture all the information from other periods in order to obtain the optimal female labour supply in the current period.

where the households have high mortgage commitments. "Families who have a large amount of mortgage are more likely to be close to the binding limit, and are more likely to modify labour supply".[6] An additional unit of labour can decrease the probability of a binding borrowing constraint. In each period the borrowing constraint depends on total family income. It is well known that constrained households will consume less than unconstrained households[7]. So it is easy to demonstrate that constrained households will also work more than unconstrained ones to make the borrowing constraint less binding. Therefore one can see that, given that the husband's labour supply is not so flexible, the wife will work more if the constraint is close to the limit. This has the effect of pushing the constraint higher.

In the empirical work that will be introduced later, we model female labour supply as a function of variables such as demographics, other family income, the ratio of mortgage payment to other family income, and a dummy variable indicating whether the household has a mortgage or not. I will estimate a standard probit model assuming that mortgage use is exogenous, and female labour market participation will be modeled as a function of demographics, other family income, and housing variables. In addition, a simultaneous equations system will be analyzed assuming that female labour supply decisions and mortgage use are jointly determined. Finding a positive effect of the mortgage variable on participation will be taken as evidence that the mortgage borrowing constraint is binding and affects the female labour supply decisions.

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[6] Del Boca and Lusardi (2003)

[7] That is because marginal utility of consumption in the current period is greater than the value of

subsequent periods.

4. Data

The data I use are drawn from the public-use micro data file of 1996 Canadian Family Expenditure Survey (FAMEX), which is the latest available survey of FAMEX. The survey was carried out in January, February and March 1997 and refers to calendar year 1996. The 1996 Survey is the first national survey since 1992. The survey is designed to provide information for persons living in private households in the ten provinces of Canada as well as the cities of Whitehorse and Yellowknife.

The survey contains both household and individual information. At the individual level, in addition to demographic characteristics such as age, region and education, there is detailed information about occupation, number of weeks worked part-time or full-time, and labour earnings. At the household level, it reports information about housing expenditure, tenure type[8], mortgage payments and various financial variables. In particular, detailed housing information is provided, such as type of dwelling, number of rooms, estimate of the value of the house owned, balance of mortgage outstanding, and purchasing or selling price of the house in the current year.

Since this study seeks to analyze the effect of mortgage-related borrowing constraints on female labour supply, we only consider people who are in couples and of the opposite sex. The original FAMEX sample contains observations on 10,417 households. 4,009 observations are removed, which are accounted for by single individuals, single-parent families, or other non-family units. The self-

[8] All occupied housing units are classified in terms of four tenure types: owned without a mortgage, owned with (a) mortgage(s), rented and mixed tenure-owned.

employed are also excluded because they don not receive a fixed wage, a condition that is explicitly assumed in this study. The number of observations thus drops from 6408 to 5424. I select households in the age range of 21-59 for men and 21-55 for women in order to exclude individuals who are in school or close to retirement age, because above this range the mortgage-related constraints are unlikely to be binding. This leaves us with 3903 observations. Since our focus is on home-owners with or without a mortgage, renters and free renters are removed. Finally, families in which the husband did not work or had negative income are removed from the analysis. After these omissions, the final working sample contains 2404 households. A summary of selection criteria is shown in Table 1 in Appendix A.

5. Descriptive statistics

First we explore the relationships between the female participation rates[9] of home owners with and without a mortgage compared with renters. Since owners without a mortgage comprise 24% of the sample and owners with a mortgage comprise 51% of the sample, we can rule out the possibility that the following result is attributable to anomalous observations within a small sample.

Table 2 illustrates labour force participation rates of married women by 8 age groups and 3 different types of tenure choices. A striking feature in line with Fortin's findings based on 1986 data is that high labour force participation prevailed in the labour market in 1996. The second important thing to note from the table is that average female participation for households that financed their home purchase with

[9] A woman is a labour market participant if the number of weeks she worked full-time or part-time is greater than zero.

a mortgage is about 9.2 percentage points higher than households without a mortgage. The average participation rate for women in households with and without a mortgage is 83.7% and 74.5% respectively. When controlling for age (and thus for stage of life cycle), we can also see that participation rates are significantly higher in each age group for females in households that have a mortgage. Particularly in the age group of 25-29, the participation rate is strikingly higher for women with a mortgage, at 88.9%. One might conjecture that the borrowing constraint is more likely to be binding for young women in the age group of 25-29, and labour supply decisions are strongly related to the presence of a mortgage. Contrary to Fortin (1995)[10], the participation rates of renters appear to be the lowest among the three types of tenure before age 55.

Table 3 reports a relationship between tenure and mean weeks the wives worked conditional on participating in the labour force. We can see that the average weeks women supplied per year (39 weeks) are only slightly higher for wives with a mortgage than the other two tenure types (37.5 weeks for wives without a mortgage and 33.5 for renters). In some age ranges (25-29, 40-44, 55+), the average weeks supplied are even lower for wives when they own a home with a mortgage than without. These findings signal that female labour supply conditional on participating in the labour force does not change significantly with different types of tenure.

In what follows I focus on the working sample that excludes renters. Table 4 gives another indication of a relationship between tenure and labour force participation. When controlling for income of the husband and the presence of

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[10] Fortin (1995) found that the participation rate of tenants is close to that of owner with a mortgage.

children, it is still true that females with a mortgage have a higher participation rate than those without. On the other hand, one can see that a high female labour force participation rate is associated with a low number of children and low levels of husbands' income, as the existing literature indicates.

Yoshikawa and Ohtake (1989) argued that the high house prices in Japan could have induced high labour market participation. Table 5a does not indicate the significant positive relationship in Canada. For each age group, there is no evidence that higher house prices could increase the labour force participation rates of married women. Table 5b, however, presents a positive relationship between the balance of principal on mortgage outstanding and the participation status. Women in households with a high balance of mortgage debts (≥$75,700) are more likely to participate in the labour force (participation rate at 89% on average). However, in the age group of 45-55, the participation rate is strikingly lower for women with low balance of mortgage debts (≤$42,000), at 68.7% on average. Table 5c also shows a positive relationship between regular mortgage payment and participation. Women in households paying high monthly mortgage payments (e.g. more than $881 per month) are more likely to work (participation rate at 86%) on average to make the borrowing constraint less binding. Women in households paying low monthly mortgage payments (e.g. less than $590 per month) have a low participation rate, at 77.5%.

Tables 6 and 7 illustrate the female participation among owners with a mortgage according to different levels of obligation ratio (k2) and home equity ratio where the presence of children is controlled for. The home equity ratio is defined as the ratio of

home equity[11] to the value of the property, and the obligation ratio is the ratio of regular monthly mortgage payment to monthly total family income, exclusive of the wife's labour income.[12] This ratio has other family income in the denominator rather than total family income. It captures the effect of mortgage-related borrowing constraints on labour supply decisions. From Table 6, one can see that both labour force participation and mean weeks worked are increasing linearly with the obligation ratio approaching the allowable limit in each group. Holding fertility constant, we still obtain the expected positive effect between the obligation ratio and the labour force participation rate. The participation rate stays at the highest level, 98%, for the group without children and with the highest level of obligation ratio. Even in the presence of more than 2 children, a rising obligation ratio will still increase the participation rate from 73% to 90% and the weeks supplied from 26.88 to 35.4 weeks.

A low home equity ratio indicates that the households are likely to be the more recent buyers and the borrowing constraint is more likely to be binding. Table 7 reports that female labour force participation is higher the lower the home equity ratio. In households where there are no children, and the home equity ratio is less than a quarter, women's participation can be as high as 92%. Aldershof et al. (1997) found that low levels of home equity ratio are also associated with high levels of labour supply in the Netherlands. However, this is not true with our data in Canada. From the lower panel of Table 7, we can see that mean weeks worked by women do not change significantly with the home equity ratio in the three classes. We see that

[11] Home equity is the market value of the house less the balance of principal on mortgage outstanding.
[12] In particular, monthly total family income is not available in the survey. It is recovered by dividing the

the level of female labour supply stays at about 40 working weeks, even with a home equity ratio greater than .74. Fortin (1995) suggests that "very high levels of home equity ratios could signal the continued attachment of these wives to the labour market." She argued that there may be a segment of the population for which housing demand is driven by investment demand. In this case, I think of the home equity ratio as housing assets investment. High levels of home equity ratios could force the wives' labour supply to stay at a high level. Thus our findings are consistent with Fortin's.

The direction of the causality of the female participation and the mortgage commitments cannot be analyzed empirically without panel data. It is difficult to distinguish the wives who choose a high level of labour supply because of the high mortgage debt ratio from wives who choose high levels of mortgage ratio because they exhibit a high level of labour supply. Tables 8 and 9, however, present some evidence that housing choices of higher mortgage debt are associated with stronger wives' labour force attachment. Tables 8a and 8b compare some descriptive statistics of personal characteristics and housing variables between working and non-working wives. They both show that working wives are much younger, have higher education, have fewer children, and have lower husband's income. Compared with Table 8a, however, Table 8b shows that wives in the household with a mortgage are younger, more educated, have more children, and own a cheaper house. Moreover, Table 8b examines some housing variables on only those home-owners with a mortgage. While the standard deviations are relatively high, it is seen that households in which the wife is working have a more expensive house, have a

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sum of total family income in the year by 12.

higher mortgage debt, higher mortgage interest paid per year, and all higher k2, k3[13] and k4[14] ratios than the nonparticipating. Table 9 represents descriptive statistics of housing variables by different levels of the wives' labour force attachment. Except for the value of the house[15], we can see that all the relevant housing variables are increasing with the level of labour force attachment approaching the limit. Particularly, the balance of mortgage debt increases from $57,200 for the household with nonparticipating wives to $70,200 for the household with wives working full year, while the obligation ratio increases from 0.2612 to 0.3221.

All these results indicate a positive relationship between mortgage-related constraints and female labour force participation. The analysis of this relationship in a regression framework will be carried out in the next sections.

6. Econometric specification

I adopt a simultaneous equations model with continuous latent variables, known as the multivariate probit model first proposed by Heckman (1978). Heckman's model expands the classic multivariate probit model of purely discrete choice variables[16] by encompassing continuous latent variables. When some or all of the dependent variables are binary, latent variable models provide a useful statistical framework to interpret the relationships between discrete random variables.

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[13] k3 ratio is the mortgage debt ratio defined as the ratio of the balance of principal on mortgage outstanding to total family income, exclusive of the wife's labour income.

[14] k4 ratio is the debt service ratio defined as the ratio of the sum of the interest paid on the mortgage per year relative to total other family income, exclusive of the wife's labour income.

[15] Due to the relatively high heterogeneity with cross-sectional data, the value of house owned is not significantly different among non-participants and working wives.

In the model that follows, I take the propensity of the wife to participate in the labour market (y_{1i}^*) and the propensity of the family to hold a mortgage (y_{2i}^*) as latent variables. The values of the latent variables are unobserved. Additionally, discrete endogenous variables (d_i, a_i) are generated (or observed) by continuous latent variables crossing certain thresholds.

I estimate two special cases of the simultaneous equations model. The general structure of the model is:

$$y_{1i}^* = X_{1i}\alpha_1 + d_i\beta_1 + y_{2i}^*\gamma_1 + U_{1i}, \qquad (10)$$

$$y_{2i}^* = X_{2i}\alpha_2 + a_i\beta_2 + y_{1i}^*\gamma_{21} + U_{2i}, \qquad (11)$$

where:

d_i = 1 iff $y_{2i}^* > 0$

d_i = 0 otherwise

a_i = 1 iff $y_{1i}^* > 0$

a_i = 0 otherwise

and

$E(U_{ki})=O$, $E(U_{ki}^2)=\sigma_{kk}$, $E(U_{1i}U_{2i})=\sigma_{12}$, $k = 1, 2$; $i = 1, \ldots, N$.

a_i takes the value 1 if the wife in household i is participating in the labour market and 0 otherwise; d_i takes the value 1 if household i is currently holding a mortgage and 0 otherwise. X_{1i} and X_{2i} are vectors of exogenous variables in the participation and mortgage equations, respectively. In particular, if a_i and d_i are greater than zero, structural equations (10) and (11) are shifted by an amount β_1 and β_2 respectively. Shift effects are the effects on the dependent variables caused by the values of the

[16] The multivariate probit model of Zellner and Lee (1965) is a widely used model.

latent variables exceeding certain thresholds.

First, I consider a standard probit model (a specific case of the general model) in which $\beta_2=\gamma_1=\gamma_2= 0$, and there is no correlation between U_{1i} *and* U_{2i}. Thus equation (10) and (11) may be written as:

$$y_{1i}^{*} = X_{1i}\alpha_1 + d_i\beta_1 + U_{1i}, \tag{12}$$

$$y_{2i}^{*} = X_{2i}\alpha_2 + U_{2i}, \tag{13}$$

There are no endogenous variables on the right side of these two equations since the error terms are assumed to be uncorrelated. Thus there is no simultaneity in this specification. Mortgage choices are assumed to be exogenously given. Having a mortgage will affect the propensity to participate in the labour market, but not the other way around. Estimation of equations (12) and (13) can be executed by standard probit techniques. Then we can apply a probit estimation procedure sequentially to the above two equations and obtain consistent and efficient estimates.

Second, I also estimate the model assuming that the correlation between the disturbances is nonzero, but that $\beta_1=\beta_2=0$. Equations (10) and (11) correspond to the classical multivariate probit model without structural shifts (β_1, $\beta_2=0$).[17] The model becomes:

$$y_{1i}^{*} = X_{1i}\alpha_1 + y_{2i}^{*}\gamma_1 + U_{1i}, \tag{14}$$

$$y_{2i}^{*} = X_{2i}\alpha_2 + y_{1i}^{*}\gamma_{21} + U_{2i}, \tag{15}$$

and the reduced form of the model may be written as:

$$y_{1i}^{*} = X_{1i}\pi_{11} + X_{2i}\pi_{12} + V_{1i}, \tag{16}$$

$$y_{2i}^{*} = X_{1i}\pi_{21} + X_{2i}\pi_{22} + V_{2i}, \tag{17}$$

where

$$\pi_{11} = \frac{\alpha_1}{1-\gamma_1\gamma_2},\ \pi_{12} = \frac{\alpha_2\gamma_1}{1-\gamma_1\gamma_2},\ \pi_{21} = \frac{\alpha_1\gamma_2}{1-\gamma_1\gamma_2},\ \pi_{22} = \frac{\alpha_2}{1-\gamma_1\gamma_2},$$

$$V_{1i} = \frac{U_{1i} + \gamma_1 U_{2i}}{1-\gamma_1\gamma_2},\ V_{2i} = \frac{U_{2i} + \gamma_2 U_{1i}}{1-\gamma_1\gamma_2} \tag{18}$$

Random variables U_{1i} and U_{2i} are assumed to be bivariate normal random variables. Accordingly, the joint distribution of V_{1i} and V_{2i} is a bivariate normal and:

$E(V_{1i})=0$, $E(V_{2i})=0$, $E(V_{1i}^2)=w_{11}$, $E(V_{2i}^2)=w_{22}$, $E(V_{1i}V_{2i})=w_{12}$.

Given these assumptions, the reduced form parameters of (18) can also be estimated consistently by using probit techniques. However, subject to the standard requirements for identification and existence of probit estimates[18], one should normalize all the estimates by the standard deviation in each equation, that is:

$$\pi_{kj}^{*} = \frac{\pi_{kj}}{\sqrt{w_{kk}}}, k = 1,2,\ j = 1,2,3,4, \tag{19}$$

where w_{KK} is the variance of V_{ki}. If some exogenous variables that appear in X_{1i} do not appear in X_{2i}, one can use equation (16) to solve for the normalized structural-form parameters of equations (14) and (15):

$$\alpha_1^{*} = \alpha_1 / \sqrt{w_{11}},\ \ \gamma_1^{*} = \gamma_1 * \sqrt{w_{22}} / \sqrt{w_{11}}$$

$$\alpha_2^{*} = \alpha_2 / \sqrt{w_{22}},\ \ \gamma_2^{*} = \gamma_2 * \sqrt{w_{11}} / \sqrt{w_{22}} \tag{20}$$

Thus the simultaneous equations model can be estimated consistently.

Finally, using censored data, we will examine the relationship between weeks

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[17] See Heckman (1978) and Zellner and Lee (1965).
[18] See Nerlove and Press (1976).

of work and mortgage commitments by estimating a tobit model, which may be embedded in a recursive simultaneous equations model:

$$y_{1i} = X_{1i}\alpha_1 + y_{2i}\gamma_1 + U_{1i}, \quad (19)$$

$$y_{2i} = X_{2i}\alpha_2 + U_{2i}, \quad (20)$$

where y_{1i} denotes the number of weeks worked by women, and it is censored in the sense that the value on y_{1i} is available only when it is greater than zero. y_{2i} is a dummy variable defined on the basis of whether the household owns a home with a mortgage. Random variables U_{1i} and U_{2i} are assumed to be correlated, and so there is simultaneity in this specification. The two equations can be estimated consistently by the single equation tobit method. However, this is inefficient in that it ignores the correlation between the disturbances. Instead the model is estimated by the full information maximum likelihood method by allowing for simultaneity in two equations.

7. Empirical estimation

First, the association between mortgage commitments and the labour market participation of married women is explored using a standard probit model, taking mortgage choices as exogenous. Three different specifications are estimated separately among all home owners. I use two different indicators for mortgage commitments. Specification I includes a dummy variable indicating whether the household has a mortgage debt, and specification II includes the obligation ratio captured by the ratio of regular monthly mortgage payment to monthly other family

income[19] (exclusive of the wife's labour income). In specification III, I include a dummy variable indicating whether a household has a mortgage debt and two interaction terms. The first one is the interaction between the obligation ratio and the dummy indicating the presence of young children in the household, which is meant to capture a different effect of mortgage commitments for households with and without young children. The second one is the interaction between the obligation ratio and the wife's age, which is meant to capture a different effect of the mortgage related borrowing constraint at different stages of the life-cycle. A set of variables is also introduced as candidates for exogenous determinants of female labour market participation. We include wife's age, wife's and husband's years of schooling, a dummy variable indicating the presence of children, and a dummy variable indicating the region of residence[20]. I include the log of the wife's unearned income, since it is necessary to control for income effects relative to other family income. The log of home equity is also included as an additional control variable. Home equity could possibly be the largest single asset in most households' portfolios, and it captures the income effect on female labour force participation to some extent.

The parameter estimates together with their standard errors and corresponding log-likelihood values for the three specifications are reported in Table 10. The results are pretty much according to expectations. Younger women are more likely to work, while the presence of young children has the usual negative impact on the probability of working. The schooling of the wife is positive and very significant, while living in a rural area decreases the probability of working. The impact of other

[19] Obligation ratio is used to capture the effect of mortgage burden on the wife's labour supply decision. It takes the value of 0 if the household owns a house without mortgage.

family income is always negative and significant, which confirms that leisure is a normal good. It is interesting to note that female labour market participation is not significantly affected by the value of home equity. This is not in line with our argument that home equity could be the largest single asset in most households' portfolios and acts as an indicator of wealth. In specification I, the dummy variable indicating that the household has a mortgage debt is positive and significant. Thus, even after controlling for many variables that affect participation, I still find that having a mortgage has an effect on the wife's labour market participation. In specification II, the obligation ratio has a positive effect on participation, but it is insignificant. It seems that the inclusion of the obligation ratio cannot be seen as a proper proxy for the presence of liquidity constraints.[21] The estimated coefficients on the interactions in specification III are both negative and significant. The negative sign on the interaction of the obligation ratio with children shows that the mortgage qualification constraint decreases the impact of the presence of children on participation, and the negative sign on the interaction of the obligation ratio with age suggests that the constraint has a decreasing impact on participation over the life cycle. In addition, the estimated coefficient of the obligation ratio is marginally significant. Hence, a comparison among the three specifications shows that the effect of the dummy variable indicating that the household has a mortgage is larger and more significant.

The relationship between the mortgage qualification constraint and female labour market participation is also examined using a multivariate probit model with continuous latent variables. The results are presented in Table 11. This specification

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[20] Equal to 1 if they live in a urban area and 0 for a rural area.

[21] However, a regression that includes dummies for the different classes of the obligation ratios may yield

shows evidence of simultaneity in female labour supply and mortgage decisions. The correlation between the structural disturbances is estimated to be -0.682. The estimated coefficients related to personal characteristics are generally similar to those of the standard probit models. The impact of living in the urban areas on participation is positive and a little more significant, while the estimate of the wife's age becomes a little less significant. Children have a stronger impact on female participation. The results indicate that, ceteris paribus, the probability of the average woman working increases by 40% (34% in the standard probit models) in a household with children than the woman in a household without children. The impact of the wife's schooling is positive and more significant, while the impact of other family income is negative and more significant too. The estimate of the log of home equity turns significant, while it is insignificant according to the standard probit model. This result is in line with our argument that home equity could act as an indicator of wealth. Most importantly, the estimate related to the propensity to have a mortgage changes substantially. The magnitude of the coefficient is larger and much more statistically different from zero (it is now 0.32407 with a 0.07 standard error). The positive effect of having a mortgage almost offsets the decrease in the probability of the woman working attributed to having young children. It takes the average woman 1.6 additional years of schooling to offset the increase in the probability of the woman working attributable to having a mortgage.

In the mortgage equation of the simultaneous equations model, we include the husband's age, the husband's schooling, a dummy variable indicating the presence of children, and a dummy variable indicating the region of residence. We also

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significant and unbiased estimates (Fortin 1995).

include the log of total household's income and the log of the home equity. The estimated coefficients are reported in Table 11. The husband's age is negative and significant, while the husband's education increases the probability of having a mortgage. Total family income has a positive and significant impact on mortgage decisions, while home equity has a negative and very significant effect. Women living in an urban area are more likely to hold a mortgage, while having children increases the probability of having a mortgage. Interestingly, the propensity of the wife to work has a positive effect on the mortgage propensity, but the estimated coefficient is only marginally significantly different from zero. The value of the estimate is 0.26945 with a 0.12869 standard error. This implies that there is no strong evidence of nonrecursiveness in the simultaneous equations model. The propensity of the wife to work has a less strong effect on the propensity to have a mortgage than the propensity to have a mortgage on the propensity to work.

We re-estimate the simultaneous equations model for the sample of young women (wives younger than 38). The sample size drops from 2404 to 1057. Estimation results are presented in Table 12. The outcomes are coherent with the results presented for the whole sample. However, an important difference is that the effect of the mortgage propensity on the wife's participation decision is larger and more significant (0.405 with a standard error of 0.119, the coefficient is almost four times the standard error), and the probability of women working is also more significant in the mortgage propensity (1.9514 with a 0.82598 standard error). For younger households, there are reasons to expect that mortgage-related constraints are more likely to be binding. The wife's labour supply decisions and the

household's housing decisions may be more important among younger households, who are likely to have lower levels of assets. My results show that these two types of decisions have a more significant effect on each other for younger wives who are those most likely to need a mortgage when buying a home. Thus, I believe that this adds evidence of the positive effect of having a mortgage on the likelihood of female labour market participation.

The association of mortgage commitments and the labour supply of married women is further investigated by estimating a tobit model, which may be embedded in a recursive simultaneous equations model. I include weeks worked by the wife as the dependent variable, and estimate the model using full information maximum likelihood. Table 13 reports the empirical results. The coefficients of age, education, children, region and other family income have the expected sign, while the log of home equity is not significantly different from zero. The dummy variable related to mortgage debt is positive and very significant. The average woman works 5.46 more weeks in the household with a mortgage than in the household without a mortgage. These findings indicate that wives with a mortgage have stronger labour force attachment. Based on this model, there is no evidence that the parameters that determine the weeks of work for participating females are different from the parameters that determine participation. However, the normalized estimate of the coefficient associated with mortgage debt is 0.225, which is smaller in magnitude than the estimates in previous probit models. This shows that the effect of mortgage-related constraints on labour supply is less important than it is on labour market participation. This is due partially to the different effect of leisure rationing on

labour supply and labour market participation. The labour supply of the average participating woman may not be significantly affected by the fact that the household buys a house with a mortgage, while there is an increased probability that the non-participating wife will enter the labour market.

8. Conclusions

This paper uses cross-sectional data to examine the relationship between female labour market participation and mortgage qualification constraints in a life-cycle model. We have restricted our analysis to married couples in which the husband has a job. We have derived a life-cycle consistent model in which female labour supply decisions and mortgage decisions are jointly determined. In the empirical analysis, we have used two different variables to approximate the presence of the binding liquidity constraint. One is the dummy variable indicating whether the household has a mortgage debt, and the other is the ratio of regular monthly mortgage payment to monthly total family income (exclusive of the wife's labour income).

I first estimate three different specifications using a standard probit model, and find a significant impact of holding mortgages on female labour market participation decisions. A comparison among the three specifications shows that the effect of the dummy variable indicating that the household has a mortgage is larger and more significant. As opposed to most previous studies that have assumed the mortgage commitments to be exogenous, I further investigate the relationship by allowing preferences towards work to be correlated with mortgage decisions. This is done by

a multivariate probit model with continuous latent variables. The empirical results show also that the propensity to have a mortgage has a large positive effect on patterns of women's labour supply. The positive effect of the mortgage commitments even offsets the negative effect of young children on female labour supply. On the other hand, the propensity of the wife to work also has a positive effect on the probability of having a mortgage, but the estimated coefficient is only marginally significant. The estimation results show no evidence of nonrecursiveness in the sample. I re-estimate the simultaneous equations model for the sample of young women, and the outcomes are consistent with the results presented for the whole sample. In contrast, the jointness of the labour supply decisions and the housing decisions are much more significant for younger wives, who are those most likely to need a mortgage when buying a home. Finally, I estimate a recursive simultaneous equations tobit model using full information maximum likelihood. Estimation results indicate that the presence of a mortgage qualification constraint induces participating women to work more weeks, so as to make the constraint less binding. However, the estimates show that the effect of the constraint on labour supply is less important than it is on labour market participation.

To summarize, the empirical evidence presented above clearly shows that high mortgage commitments have a positive and significant impact on the labour force participation rate and labour supply of married women. These findings are pretty much consistent with most previous studies. The mortgage debt is more important than any other type of debt in our context, in that the mortgage debt value is much higher than other forms of debt, and the duration and terms of mortgage debt are

different from those of other debts.

A natural extension of this study is to develop a dynamic model using panel data. Issues of women's entry and exit from the labour market could then be further investigated. If borrowing constraints could matter and induce women to work, it would also be interesting to study issues of women's entry and exit from the labour market in relation to changes in house prices, mortgage interest rates and housing policies.

Endogeneity problems could still exist due to endogeneity between participation and fertility decisions. It is necessary to check a structural dynamic model by allowing for endogeneity of female labour supply decisions and fertility decisions. Another way to investigate further the issue of which households are more likely to have a binding borrowing constraint is to exploit a dynamic model with endogenous participation, housing tenure and fertility decisions.

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Appendix

Table 1: Sample selection

Selection Criteria	Number of Observations Deleted	Number of Observations Remaining
1.Original observations	0	10,417
2.Singles, single-parent families and non-family units	4,009	6,408
3.Self-employed husbands or wives	962	5,424
4.Not in the age range 21-59 for husbands and 21-55 for wives	1,521	3,903
5.Renters and mixed tenure-owned	1,110	2,793
6.Sold or bought the house in 1996	122	2,671
7.Husbands not working in 1996	266	2,405
8. Husbands negative after taxes income	1	2,404

Table 2: Female labour force participation rates by age and tenure

Age of women	All		Home-owners without a mortgage		Home-owners with a mortgage		Renters	
	#	%	#	%	#	%	#	%
<25	215	73.0	5	80.0	45	82.2	149	68.5
25-29	528	81.1	35	68.6	253	88.9	193	74.1
30-34	725	79.4	79	78.5	409	85.3	198	67.7
35-39	827	80.2	151	80.1	503	83.9	142	69.0
40-44	791	80.0	220	74.5	448	85.9	99	65.7
45-49	718	75.8	298	76.2	312	79.8	100	61.0
50-54	436	72.0	198	68.2	179	76.5	54	70.4
≥55	52	67.3	24	62.5	23	65.2	3	100.0
All	3350 (4292)	78.1	752 (1010)	74.5	1819 (2172)	83.7	644 (938)	68.7

* The total number of participating women in parentheses.

Table 3: Mean weeks women worked (labour supply) by age and tenure

Age of women	All		Home-owners without a mortgage		Home-owners with a mortgage		Renters	
	#	mean	#	mean	#	mean	#	mean
<25	157	28.47	4	24.00	37	32.22	102	26.78
25-29	428	35.24	24	37.90	225	36.32	143	33.23
30-34	576	35.08	62	32.69	349	36.26	134	33.92
35-39	663	38.06	121	36.40	422	39.65	98	34.51
40-44	633	39.92	164	41.30	385	40.17	65	35.62
45-49	544	39.86	227	37.85	249	42.14	61	38.82
50-54	314	39.68	135	38.70	137	41.65	38	36.99
≥55	35	38.21	15	41.80	15	39.97	3	27.83
All	3350	37.54	752	38.10	1819	39.04	644	33.52

*The number of weeks worked are computed conditional on women participate in the labour force
*The number of weeks worked is calculated as the sum of the number of weeks worked full-time plus half the number of weeks worked part-time.

Table 4: Female Labour force participation rates by number of children, husband's income and tenure

Income of husbands (1000$)	Home-owners without a mortgage						Home-owners with a mortgage					
	No children		1 children		≥2 children		No children		1 children		≥2 children	
	#	%	#	%	#	%	#	%	#	%	#	%
≤15	27	74.1	13	92.3	7	100	25	92.0	32	90.6	23	82.6
15-30	157	77.1	40	77.5	56	80.4	243	88.9	163	89.6	207	88.9
30-40	115	79.1	45	82.2	41	68.3	188	86.7	129	81.4	190	83.2
40-50	72	79.2	30	70.0	30	70.0	108	86.1	61	78.7	100	74.0
≥50	61	70.5	22	63.6	24	54.2	79	77.2	41	75.6	75	68.0
All	432	76.9	150	76.7	158	72.2	643	86.5	426	84.3	595	81.7

*Children here means persons under 15 years of age

Table 5a: Female Labour force participation rates by value of home owned

Age of women	Value of dwell owned at Dec.31, 1996 (1000$)					
	≤95		95-145		≥145	
	#	%	#	%	#	%
<25	20	.75	6	1.00	6	.67
25-29	90	.90	78	.94	49	.80
30-34	121	.84	110	.89	83	.83
35-39	140	.84	128	.80	132	.87
40-44	88	.86	104	.87	132	.86
45-49	68	.72	69	.86	94	.84
50-54	44	.64	44	.80	46	.87
55	4	.50	5	.60	3	1.00

Table 5b: Female Labour force participation rates by balance of principal on mortgage outstanding

Age of women	Balance of principal on mortgage outstanding (1000$)					
	≤42		42-75.7		≥75.7	
	#	%	#	%	#	%
<25	9	.78	10	.70	13	.85
25-29	43	.86	72	.89	102	.90
30-34	71	.82	123	.85	120	.88
35-39	136	.79	131	.83	133	.89
40-44	127	.85	104	.90	93	.85
45-49	98	.76	70	.80	63	.90
50-54	64	.73	42	.76	28	.86
55	7	.57	3	.67	2	1.00

Table 5c: Female Labour force participation rates by regular mortgage payments

Age of women	Regular mortgage payments					
	≤590		590-881		≥881	
	#	%	#	%	#	%
<25	15	.73	8	.88	9	.78
25-29	67	.85	75	.95	75	.87
30-34	88	.82	112	.88	114	.87
35-39	140	.81	129	.78	131	.92
40-44	103	.85	111	.87	110	.87
45-49	86	.78	70	.79	75	.87
50-54	51	.69	43	.79	40	.85
55	6	.67	6	.67		

Table 6: Female labour force participation rates and labour supply by number of children and obligation ratio

Obligation ratio	No children		1 children		≥2 children	
	#	%	#	%	#	%
≤.16	154	.77	84	.71	94	.73
.16-.22	112	.86	93	.78	128	.73
.22-.28	122	.90	83	.89	128	.83
.28-.38	133	.85	78	.91	123	.87
≥.38	122	.98	88	.92	122	.90
Mean weeks worked:						
	#	Mean	#	Mean	#	Mean
≤.16	154	31.90	84	26.99	94	26.88
.16-.22	112	35.21	93	28.04	128	23.25
.22-.28	122	38.68	83	34.22	128	28.92
.28-.38	133	38.08	78	37.74	123	34.38
≥.38	122	46.41	88	41.16	122	35.40

Table 7: Female labour force participation rates and labour supply by number of children and home equity ratio

Home equity ratio	No children		1 children		≥2 children	
	#	%	#	%	#	%
≤.25	119	.92	89	.87	126	.87
.26-.41	107	.91	104	.89	120	.79
.42-.55	134	.88	82	.90	118	.82
.56-.73	136	.80	81	.81	116	.79
≥.74	147	.84	70	.70	115	.80
Mean weeks worked:						
	#	Mean	#	Mean	#	Mean
≤.25	109	44.83	77	39.33	110	35.44
.26-.41	97	41.75	93	41.71	95	37.13
.42-.55	118	42.07	74	38.49	97	32.87
.56-.73	109	45.17	66	39.10	92	40.11
≥.74	123	44.53	49	39.69	92	37.48

Table 8a: Descriptive statistics of personal characteristics variables and housing variables for home-owners without a mortgage

Variable	Home-owners without a mortgage			
	Nonparticipating wife		Participating wife	
	Mean	Std. Deviation	Mean	Std. Deviation
Value of home owned(1000$)	157.4	145.6	147.7	126.8
Wife's Age	44.72	6.764	43.42	6.833
Wife's education	2.65	1.149	3.23	1.235
Children under 15	.69	.843	.61	.803
Husband's income	47674.86	60424.413	37714.62	40477.254
Wife's income	0	0	21980.75	13797.561
Wife's other income	52201.12	61116.034	41512.66	41431.053
Sample size	179		561	

Table 8b: Descriptive statistics of personal characteristics variables and housing variables for home-owners with a mortgage

Variable	Home-owners with a mortgage			
	Nonparticipating wife		Participating wife	
	Mean	Std. Deviation	Mean	Std. Deviation
Value of home owned(1000$)	131.2	82.5	137.3	94.1
Balance of Principal on Mort. outstanding	57201.10	42173.934	66931.07	44404.053
Regular monthly mort. Payment	755.05	757.723	818.74	516.480
Mortgage interest paid	4582.88	3568.935	5211.46	4402.265
Age	39.35	7.908	37.98	7.540
Years of schooling	2.90	1.179	3.27	1.183
Children under 15	1.08	.861	.95	.861
Husband's income	40770.72	19674.960	34310.49	16229.946
Wife's income	0	0	21904.14	12560.040
Wife's other income	43880.61	23327.420	37090.29	17684.747
Obligation ratio (k2)	.2612	.59789	.3082	.26228
Mortgage debt ratio (k3)	1.7898	5.51611	2.1357	2.07803
Debt service ratio (k4)	.1503	.53707	.1680	.19915
Sample size	263		1401	

*Mortgage debt ratio is the ratio of the balance of principal on mortgage outstanding to total family income, exclusive of the wife's labour income.

*Debt service ratio is the ratio of the sum of the interest paid on the mortgage per year relative to total other family income, exclusive of the wife's labour income.

Table 9: Descriptive statistics of housing variables by levels of the wife's labour force attachment

Variable	Nonparticipant		Weeks worked 1-25		Weeks worked 26-38	
	Mean	SD	Mean	SD	Mean	SD
Value of home owned(1000$)	131.2	82.6	122.1	67.2	128.0	64.8
Balance of Principal on Mort. Outstanding(1000$)	57.2	42.2	61.7	40.2	63.1	40.7
Regular monthly mort. Payment	755.05	757.723	718.75	334.561	772.74	381.656
Mortgage interest paid	4582.88	3568.935	4542.97	3161.629	4972.52	3493.449
Obligation ratio (k2)	.2612	.59789	.2682	.23747	.3080	.36533
Mortgage debt ratio (k3)	1.7898	5.51611	1.9520	2.42611	2.1304	2.70515
Debt service ratio (k4)	.1503	.53707	.1457	.18739	.1722	.28631
Sample size	263		268		243	
Variable	Weeks worked 39-51		Weeks worked ≥52			
Value of home owned (1000$)	135.0	87.4	146.0	109.1		
Balance of Principal on Mort. Outstanding (1000$)	65.2	39.9	70.2	47.3		
Regular monthly mort. Payment	799.31	376.973	871.65	611.353		
Mortgage interest paid	4730.75	3606.719	5601.24	5068.950		
Obligation ratio (k2)	.3098	.23686	.3221	.23284		
Mortgage debt ratio (k3)	2.1189	1.67675	2.2045	1.75082		
Debt service ratio (k4)	.1558	.18036	.1765	.16993		
Sample size	126		764			

Table 10: Standard probit model, y= female labour force participation

Variable name	Specification I		Specification II	
	Estimates	S.E.	Estimates	S.E.
Wife's age	-0.16722E-01	0.49989E-02	-0.20047E-01	0.49133E-02
Wife's education	0.20082	0.31234E-01	0.20224	0.31206E-01
Husband's education	0.19741E-01	0.29761E-01	0.18944E-01	0.29767E-01
Dummy for children	-0.34263	0.73754E-01	-0.32668	0.73351E-01
Dummy for region	0.90831E-01	0.92857E-01	0.12783	0.92183E-01
Log of family other income	-0.42193	0.67020E-01	-0.41270	0.71560E-01
Log of home equity	-0.26163E-02	0.20142E-01	-0.20398E-01	0.19823E-01
Obligation ratio			0.17549E-01	0.97295E-01
Dummy for mortgage use	0.23356	0.71061E-01		
CONSTANT	5.3232	0.69859	5.6647	0.75212
Sample size	2404		2404	
Log likelihood	-1074.5		-1079.9	

Variable name	Specification III	
	Estimates	S.E.
Wife's participation equation		
Wife's age	-0.19729E-01	0.51501E-02
Wife's education	0.19453	0.31440E-01
Husband's education	0.18911E-01	0.29943E-01
Dummy for children	-0.21737	0.83544E-01
Dummy for region	0.79725E-01	0.63189E-01
Log of family other income	-0.41966	0.73405E-01
Log of home equity	-0.15495E-02	0.20443E-01
Children*ob	-0.77559	0.24087
Wife's age*ob	-0.23111E-01	0.81600E-02
Obligation ratio	0.18873	0.89472E-01
CONSTANT	5.3893	0.75278
Sample size	2404	
Log likelihood	-1068.9	

Table 11: Simultaneous equations model with continuous latent variables, y= female labour force participation and propensity to have a mortgage

Participation equation	Estimates	S.E.
Wife's age	-0.16322E-01	0.50607E-02
Wife's education	0.20453	0.31276E-01
Husband's education	0.20671E-01	0.29830E-01
Dummy for children	-0.39945	0.74028E-01
Dummy for region	0.88103E-01	0.93188E-01
Log of family other income	-0.46204	0.73208E-01
Log of home equity	-0.15495E-01	0.60443E-02
Mortgage propensity	0.32407	0.70021E-01
CONSTANT	5.6175	0.75158
Mortgage equation		
Husband's age	-0.42777E-01	0.48339E-02
Husband's education	0.22301E-01	0.25906E-01
Dummy for children	0.20202	0.68993E-01
Dummy for region	0.66197	0.92998E-01
Log of home equity	-0.86775	0.48598E-01
Log of total family income	0.69315	0.92205E-01
Participation propensity	0.26945	0.12869
CONSTANT	4.2452	0.87291
Correlation between the structural disturbances	-0.68211	0.25258
Sample size	2404	
Log likelihood	-1099.0	

Table 12: Simultaneous equations model for young women,
y= female labour force participation and propensity to have a mortgage

Participation equation	Estimates	S.E.
Wife's education	0.21034	0.50169E-01
Husband's education	0.21782E-01	0.48059E-01
Dummy for children	-0.65731	0.14567
Dummy for region	0.19715	0.13719
Log of family other income	-0.42038	0.10816
Log of home equity	-0.12843E-01	0.60553E-02
Mortgage propensity	0.40463	0.10911
CONSTANT	4.6681	1.1368
Mortgage equation		
Husband's age	-0.32971E-01	0.11629E-01
Husband's education	0.15808E-01	0.50059E-01
Dummy for children	0.19826	0.60598E-01
Dummy for region	1.0338	0.15518
Log of home equity	-0.97902	0.84421E-01
Log of total family income	0.34174	0.16819
Participation propensity	1.9514	0.82598
CONSTANT	10.077	2.2867
Correlation between the structural disturbances	-0.65407	0.18190
Sample size	1057	
Log likelihood	-421.66	

Table 13: Recursive simultaneous equations tobit model, y=weeks of work

Variable name	Normalized estimates	S.E.
Wife's age	-0.15311E-01	0.46607E-02
Wife's education	0.13405	0.20879E-01
Husband's education	0.18667E-01	0.20245E-01
Dummy for children	-0.31291	0.46644E-01
Dummy for region	0.18109	0.65095E-01
Log of family other income	-0.28387	0.49962E-01
Log of home equity	0.79606E-02	0.13440E-01
Dummy for mortgage use	0.22535	0.54348E-01
CONSTANT	3.6167	0.51223
Number of weeks worked	0.41241E-01	0.69516E-03
Sample size	2404	
Log likelihood	-9534.8413	