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FEMALE LABOR SUPPLY AND THE DEMAND FOR HOUSING

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Female labor supply and the demand for housing

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Abstract

This paper uses data of the 1989 wave of the Dutch Socio-Economic Panel to analyze the relationship between female labor supply and housing consumption. We estimate a conditional demand system with female labor supply and other consumption as the dependent variables and housing consumption as the conditioning good. We conclude that separability of preferences between female labor supply and housing consumption cannot be rejected. Mortgage commitments have a significant positive effect on the labor supply of women.

Keywords: female labor supply, housing demand, limited dependent variables, simultaneous equations

JEL classification: *C34, D12, J22, R21*

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1 Introduction

In this paper we investigate the relationship between housing consumption and female labor supply. We set up a model that breaks down total household consumption into consumption of housing and consumption of all other goods, and distinguishes female leisure as a third good. We disregard the possible importance of investment demand for housing. For a discussion of consumption versus investment demand see e.g. Henderson and Ioannides (1987) or Ioannides and Rosenthal (1994). Since the house is by far the most important asset component in the portfolio of home-owners, many studies (Polinsky 1977, Henderson and Ioannides 1983) have looked at the demand for housing and at tenure choice.

As far as we know, only a few studies have been carried out which investigate the relationship between female labor supply and housing consumption. Fortin (1995) has examined the effect of liquidity constraints, in particular a mortgage qualification constraint, on the relation between the accumulation of housing assets and female labor supply. Using a life-cycle consistent model she tests the hypothesis that the labor supply of married women is constrained by the household's decisions regarding home-ownership and the purchase of mortgages. Her main conclusion is that mortgage commitments influence the labor supply decisions of married women. Yoshikawa and Ohtake (1989) have studied personal savings and female labor supply in Japan in relation to housing demand. They consider a three-period life-cycle model for tenants who buy a house in the second period in which they are assumed to be restricted by a down payment constraint and a model for tenants who do not buy a house during these three periods. Their analysis shows that the high house prices in Japan may induce married women in households with purchase plans to participate in the labor market and work more hours.

Our set-up is similar to Fortin (1995), but with some variations. The first variation is due to a difference in institutional environment. Fortin's study applies to Canadian households, where borrowers have to meet a down payment constraint (based on earnings) on the amount of mortgage they can take out at all stages of ownership[1]. We will use data from the Netherlands. As in the Netherlands mortgage contracts typically cover a very long time span (25 or 30 years), prospective home-owners will primarily be constrained in the year of purchase. To model the influence of such a constraint would require a longitudinal analysis of households starting well before the date of purchase of a house. Currently, this is beyond the scope of this paper. We therefore do not try to model the decision to take out a mortgage on a

[1]The length of mortgage contracts is typically very short in Canada (around 5 years).

house. Whether or not a household has a mortgage, and how high, is taken to be determined exogenously. In Fortin's model, the mortgage payments are also taken to be exogenous. Another difference between Fortin's study and ours is found in the sample selection. She restricts her sample to home-owners only, while we include tenants too, but we model the choice between renting and owning a house in a very simple way. The third major difference between both studies is the treatment of consumption. In our study we distinguish between non-housing consumption and housing consumption, while Fortin does not make such a distinction. Therefore we pay special attention to separability and consider a non-separable utility function of female labor supply, housing consumption, and non-housing consumption. A conditional demand system with female labor supply and other consumption as the dependent variables and housing consumption as the conditioning good is estimated. Fortin estimates a linear expenditure system and compares the situation in which both spouses' labor income is subject to a mortgage qualification constraint with the situation in which this constraint applies to the husband's earnings only.

The emphasis of this paper is on the interaction between female labor supply and housing consumption and we will focus on two points in particular. The first point is concerned with the influence of earning dependent liquidity constraints on the labor supply of women. In the presence of binding liquidity constraints the within period allocation of full expenditure between female labor supply and other consumption is affected. Secondly, we want to test if preferences are separable between housing consumption and female labor supply. In this paper we will restrict our sample to couples in which the husband has a job. We will only focus on female labor force participation because we expect the woman to be able to adjust the number of hours more easily than her partner. The men in the sample generally work full-time.

This introduction is followed, in Section 2, by a description of the data from the Socio-Economic Panel, conducted by Statistics Netherlands. Furthermore, some descriptive statistics provide prima facie evidence of a relation between the consumption of housing, mortgages, and female labor force participation. In Section 3 we derive a life-cycle consistent model in which housing consumption and labor supply is jointly determined. To allow for non-separability of female labor supply and housing consumption, we discuss a female labor supply function conditional on housing consumption. The empirical model is given in the fourth section. Section 5 presents the estimation results. A summary and concluding remarks are provided in the final section.

2 The description of the data

2.1 The survey

The Socio-Economic Panel (SEP) has been conducted bi-annually from 1984 until 1989 (in April and in October) by Statistics Netherlands. Since 1990 the survey has been conducted once a year, in May. The survey is representative of the population of Dutch households, excluding those who live in special institutions such as homes for the elderly and nursing homes. One wave covers about 5000 households[2] and all persons in a household who are at least 16 years old are regarded as respondents. Both the April and October waves contain information about socio-economic characteristics (e.g. labor force participation, hours of work), demographic and geographic characteristics. From 1987 onwards the April questionnaires include questions concerning assets and liabilities. The October interviews collect in particular information about income and income expectations.

From the April questionnaire we use geographic information and the self-reported market value of the house owned. The October wave provides the data on the household's accommodation, the interest paid on the mortgage, the redemption, the outstanding mortgage, the rent (for tenants), and other housing expenses (e.g. water, gas, electricity). The survey does not give information about property-taxes and imputed rents[3]. The data on family composition, education, employment status, number of working hours per week, and various income components are taken from the October wave.

2.2 Sample selection

The purpose of this paper is to get more insight in the interaction between the labor force participation decisions of women and housing decisions, in which we follow Fortin (1995). Her study is based on a cross-section of Canadian data of 1986. We decided to use the data of 1989 for the analysis, because this is the most recent year before the change in set-up of the questionnaire in 1990. Besides the change in set-up, the CBS decided not to supply any geographic information after 1989. Because this information is necessary for the estimation of our model, we cannot use later waves.

Merging the April 1989 and the October 1989 waves left us with 4709 households. Since we are interested in the possible joint decision of housing tenure and the wife's participation in the labor market we have made the following selection of households. In broad outline this selection is similar to the selection of Fortin (1995). The main difference is that we include tenants and exclude self-employed women. We removed 47 households who

[2]Before 1986, the SEP consisted of only 4000 households.

[3]Mortgage interest is tax-deductable in the Netherlands, but an imputed rent is added to a home owner's income for tax-purposes.

inhabited a free dwelling. (e.g. an official residence). Married or cohabiting women were included, whereas single individuals, single-parent families, and families in which the partners are of equal sex were removed. We had to remove an additional 307 households because the information on the partner was incomplete. Self-employed individuals maximize their profits and do not receive a regular wage. Since our theoretical model is derived from utility maximizing individuals who receive wages, we removed 65 households in which the woman reported to be self-employed. After these selections we were left with 3159 households in which both the head and the partner filled in the questionnaire. In nearly a quarter of the remaining households both head and partner did not have a paid job. The following jobs are not regarded as paid jobs: holiday jobs, incidental short-term jobs, and working while receiving unemployment benefits. In 3.2% of the 3159 households the woman is the sole earner. The main reasons why men stopped working were health or disability (36.5%) and (early) retirement (34.5%). Families in which the men did not work are removed from the analysis, because our focus is on the decision of married or cohabiting women to participate in the labor market, while the husband (and thus the family) receives a regular salary. Our working sample thus consists of 2296 households in which the overall labor participation rate of women was about 45% and the average number of hours the woman works per week is 24 compared to an average of 41 for men.

2.3 A discussion of descriptive statistics

Table 1 in the appendix gives the female labor force participation rates by six age classes and three tenures, home-owners having a mortgage, home-owners not having a mortgage, and tenants. In this table a distinction is made between women who are legally married with their partner and those who cohabit with their partner. The first thing to note from the table is the low participation of women in owner-families without a mortgage (30.2%) compared to the other two tenure types (about 46%). Secondly, the labor force participation of all women between the ages of 35 and 65 in families who own a house and have a mortgage is much higher (4% to 12%) than among women in the other families. Although the sub-sample of cohabiting women is small, we see a high participation of these women compared to married women. This simple cross-tabulation gives a first indication of a relationship between tenure and labor force participation of married and cohabiting women.

Yoshikawa and Ohtake (1989) have pointed out that the high house prices in Japan may have induced women to participate in the labor market. Table 2 does not indicate that there is a positive relation between the value of the house and the number of hours supplied by the woman in the Netherlands. On the other hand column 6 of table 2 presents a non-linear positive relation between the number of hours and the mortgage debt relative to total other family income, which is total family income exclusive of the woman's earnings. Women in households with mortgage debts seem to work more. Also, the table gives some evidence that women in households paying higher amounts of interest on the mortgage work more. Of course, the direction of the causality of supplying more labor and the mortgage commitments of the household cannot be analyzed from this table only, but it is clear that a positive relation exists. Panel data is needed to analyze the direction of causality, but this is beyond the scope of this paper.

In the Netherlands, down payments are not mandatory. In principle each household can borrow money to finance the purchase of a house. However, the maximal amount depends on the gross yearly income and the age of the head of the household. In 1992, lending institutions have changed their policies on this point so that also the wife's income could be taken into account to determine the borrowing limit. Prospective home-owners can borrow up to 3 to 4 times their gross yearly income and they will primarily be constrained in the year of purchase. Most mortgage contracts cover about 25 to 30 years.

Table 3 presents detailed information on the participation rates and the number of hours the woman works in different situations characterized by the obligation ratio, which is the sum of the interest paid on the mortgage relative to total other family income (r) and the home equity as a percentage of the value of the home (e). The table shows that on average the labor market participation rates and the number of hours of work increase non-linearly in r. In households where the interest payments are more than a quarter of total other family income, women's participation in the labor market is very high (75.9% compared to an overall average of 43.7%). Also the number of hours are much higher for all values of e. On average we find a significant increase of 35% from 17.9 hours to 27.8 hours per week if r rises from less than 0.1 to greater than 0.25. Even the change from an obligation ratio between .2 and .25 to an obligation ratio larger than .25 represents an increase in hours by 13%. Regarding e, we find that on average the labor force participation rate and the hours supplied are higher for small values of the home equity relative to the value of the home. However, this is not true for all columns separately. Households with a value of the home equity ratio smaller than a fourth are likely to be the more recent home-owners. The women in these households work on average 24.8 hours per week compared to an average of 18.3 hours for women in households with home equity ratio larger than three fourth.

3 Theoretical model

Our starting point is a simple dynamic model of female labor supply, housing consumption and other consumption. Male earnings are taken to be exogenous. Housing consumption will be viewed in the context of the household production theory (see e.g. Deaton and Muellbauer, 1980). In this approach, it is assumed that the household derives utility from housing consumption q which is produced through a production function

$$q = f(b;\theta) \tag{1}$$

with b a vector of characteristics of the house and θ a vector of parameters. Characteristics are for example the number of rooms in the house, the age of the house or region. It is not necessarily the case that all elements in b are choice variables. We will assume for instance that the choice of region is exogenous. We refer to the choice variables in b as y_1 and to the exogenous variables in b as y_2. The maximization problem of the household can be described as follows.

The household chooses the number of hours the woman works h_{ft}, the level of consumption of a composite good representing non-housing consumption c_t, and the level of housing consumption q_t, by maximizing expected lifetime utility subject to a production function, a lifetime budget constraint, and an earnings related liquidity constraint.

$$\max_{-h_{f\tau},c_\tau,q_\tau,y_{1\tau}} E_t \sum_{\tau=t}^{L}(1+\rho)^{t-\tau}U_\tau(-h_{f\tau},c_\tau,q_\tau) \tag{2}$$

$$\text{s.t.} \quad q_\tau = f_\tau(b_\tau;\theta_\tau) \tag{3}$$

$$A_\tau = (1+r_{\tau-1})A_{\tau-1} + m_\tau + w_{f\tau}h_{f\tau} - p_{c\tau}c_\tau - p'_{b\tau}b_\tau \tag{4}$$

$$A_\tau \geq \psi_0 + \psi_1(m_\tau + w_{f\tau}h_{f\tau}) \tag{5}$$

$$0 \leq h_{f\tau} \leq F \tag{6}$$

$$A_{t-1} \text{ given} \qquad A_L = 0 \tag{7}$$

with

E_t	expectation operator conditional on information at time t
A_τ	wealth at the end of period τ
r_τ	interest rate in period τ
m_τ	total family income exclusive of the female's earnings in period τ
$w_{f\tau}$	after-tax hourly wage rate of woman in period τ
$h_{f\tau}$	hours of work per week of woman in period τ
c_τ	composite good representing non-housing consumption in period τ
$p_{c\tau}$	price of the composite good in period τ
q_τ	consumption of housing in period τ
b_τ	vector of characteristics of the house in period τ
$p_{b\tau}$	price vector corresponding to b_τ in period τ
θ_τ	vector of parameters corresponding to b_τ in period τ
ρ	discount rate, fixed over time
L	length of life, fixed
F	time endowment of the woman, fixed

$U_\tau(-h_{f\tau}, c_\tau, q_\tau)$ is the intra-temporal utility function in period τ, strictly concave and monotonically increasing in its arguments and the function f is at least one time differentiable to y_1.

As implied by the inequality on A_τ, we assume that there is an earnings dependent borrowing constraint. We should stress that this is not a mortgage qualification constraint. In every period the borrowing limit is assumed to depend on income, including the labor income of the woman. We expect the borrowing limit to be inversely related to current earnings; $\psi_1 < 0$. It is expected that the constraint is more likely to be binding in cases where the household has high mortgage commitments, because the interest payments on the mortgage are negatively related to income. In these cases, we argue that the woman in the household can make the liquidity constraint non-binding by working more.

The inter-temporal additivity of the lifetime utility function greatly simplifies the maximization problem. The first-order conditions for period t are

$$U_{-h} = -\lambda_t w_{ft} - \psi_1 \mu_t w_{ft} + \nu_t - \kappa_t \tag{8}$$

$$U_c = \lambda_t p_{ct} \tag{9}$$

$$U_q = \upsilon_t \tag{10}$$

$$\upsilon_t \frac{\partial f_t}{\partial y_{1jt}} = \lambda_t p_{y_{1jt}} \tag{11}$$

$$\lambda_t - \mu_t = E_t \, \tfrac{1+r_t}{1+\rho} \lambda_{t+1} \tag{12}$$

$$q_t = f_t(b_t; \theta_t) \tag{13}$$

$$\mu_t(A_t - \psi_0 - \psi_1(m_t + w_{ft}h_{ft})) = 0; \quad \nu_t h_{ft} = 0; \quad \kappa_t(-h_{ft} + F) = 0 \tag{14}$$

$$\mu_t \geq 0; \qquad \nu_t \geq 0; \qquad \kappa_t \geq 0 \tag{15}$$

U_{-h}, U_c, and U_q denote the first-order derivatives of the utility function with respect to hours, non-housing consumption, and housing consumption respectively. The variables υ_t, λ_t, and λ_{t+1} denote Lagrange multipliers, whereas μ_t, ν_t, and κ_t are Kuhn-Tucker multipliers; υ_t corresponding to the production function (3), λ_t and λ_{t+1} corresponding to the budget constraint (4), μ_t corresponding to the liquidity constraint (5) and ν_t and κ_t to the time constraints (6). The first-order conditions (8) can be rewritten as follows

$$U_{-h} = -\lambda_t \tilde{w}_{ft} + \nu_t - \kappa_t \tag{16}$$

where

$$\tilde{w}_{ft} = (1 - \psi_1 \frac{\mu_t}{\lambda_t}) w_{ft} \tag{17}$$

Note that $\tilde{w}_{ft} \geq w_{ft}$, because $\psi_1 < 0$. If $\nu_t = \kappa_t = 0$, a labor supply equation can be derived from (16)

$$h_{ft} = \tilde{g}_1(\tilde{x}_t, \tilde{w}_{ft}, p_{ct}, p_{y_1t}, y_{2t}, \theta) \tag{18}$$

where $\tilde{x}_t = p_{ct}c_t + p'_{bt}b_t - \tilde{w}_{ft}h_{ft}$, i.e. full expenditures in period t. Similarly, using the first order conditions (9) one obtains

$$c_t = \tilde{g}_2(\tilde{x}_t, \tilde{w}_{ft}, p_{ct}, p_{y_1t}, y_{2t}, \theta) \tag{19}$$

The demand equation for characteristic j of the house can be derived using the first order conditions (11)

$$y_{1jt} = \tilde{g}_{3j}(\tilde{x}_t, \tilde{w}_{ft}, p_{ct}, p_{y_1t}, y_{2t}, \theta) \tag{20}$$

We are particularly interested in female labor supply conditional on x_t, housing consumption $q_t = q_t^*$, and on the vector of characteristics $y_{1t} = y_{1t}^*$. These can be obtained in principle by carrying out the maximization program (8)-(15) conditional on $q = q^*$and $y_1 = y_1^*$. The implied conditional functions are of the form:

$$\begin{aligned} h_{ft} &= g_1^*(x_t^*, \tilde{w}_{ft}, p_{ct}, q_t^*) && (21) \\ c_t &= g_2^*(x_t^*, \tilde{w}_{ft}, p_{ct}, q_t^*) && (22) \end{aligned}$$

where $x_t^* \equiv p_{ct}c_t - \tilde{w}_{ft}h_{ft}$

3.1 Separability

Many researchers have restricted household preferences to be (weakly) separable between goods and leisure. This restriction reduces the set of possible utility functions and may simplify the estimation procedures. Blundell and Walker (1982) have addressed the question of separability and they have concluded that the hypothesis of separability between commodities and labor supply had to be rejected. In the study of Browning and Meghir (1991) separability had to be rejected as well. Browning and Meghir (1991) have presented a new approach to testing for separability and to the estimation of demand systems under the alternative of nonseparability. Instead of estimating an unconditional joint commodity demand and labor supply system (e.g. Blundell and Walker, 1982), they followed a conditional approach, where one considers commodity demand conditional on a given amount of labor supply. They mention two advantages. First, their conclusions do not depend on the correct model specification of the determination of labor force participation and hours of work. Second, more general functional forms for preferences can be used and exact tests for separability are provided. As mentioned, we are particularly interested in the relation between housing consumption and female labor supply. Hence, we will test for separability of housing consumption and female labor supply. We follow Browning and Meghir (1991) in their approach and define the intra-temporal conditional cost function (conditional on housing consumption) as follows

$$\tilde{x} = c(\tilde{w}_f, p_c, q^*, u) = \min_{h_f, c} \left(p_c c - \tilde{w}_f h_f \mid U(h_f, c, q^*) = u\right)$$

The time-subscript has been dropped for notational convenience. Given a conditional cost function, a conditional demand system can be derived, identical to (21) and (22). We use the proposition put forward in Browning and Meghir (1991) and modify it for our problem with respect to using $\tilde{w}_f$ instead of w_f.

Proposition 1 : *Female labor supply (h_f) is weakly separable from housing consumption (q) if and only if the conditional cost function takes the form $\tilde{x} = c(\tilde{w}_f, p_c, g(q, u))$.*

Under weak separability, conditioning goods have only income effects. If preferences for hours of work of the female are weakly separable from the consumption of housing then the right hand side of equation (21) depends on q only indirectly through the dependence of x^* on q^*:

$$h_f = g^*(x^*, \tilde{w}_f, p_c) \tag{23}$$

The test for separability then amounts to testing whether the demand equation for the number of the woman's hours (h_f) depends on the quantity of housing consumption q^* other than through x^*.

We only observe w_f for participating women in our data, not $\tilde{w}_f$. In the next section, we will use the observed wages w_f and the obligation ratio instead of $\tilde{w}_f$. The obligation ratio is assumed to approximate the liquidity constrained part, $\psi_1 \frac{\mu_t}{\lambda_t}$ in $\tilde{w}_f$. In other words, we assume that $\psi_1 \frac{\mu_t}{\lambda_t}$ does not depend on q_t.

4 Econometric model

Consider the following cost function in which the log of housing consumption q is the conditioning good (see Stern (1986))

$$c(w_f, q^*, Z, u) = e^{-\gamma_2 w_f} u - \frac{\gamma_3 \log q^* + Z'\gamma_4}{\gamma_2} - \frac{\gamma_1}{\gamma_2} \log w_f + \frac{\gamma_1}{\gamma_2} e^{-\gamma_2 w_f} \mathrm{Ei}(\gamma_2 w_f)$$

where Z is a vector of socio-demographic variables that may affect preferences. Ei is the standard exponential integral $\int_{-\infty}^{x} (e^t/t)dt$. This specification for the cost function implies a semi-log labor supply function[4], which fits the data well:

$$h_f = \gamma_1 \log w_f + \gamma_2 x^* + \gamma_3 \log q^* + Z'\gamma_4 \tag{24}$$

The demand equation for non-housing consumption follows from adding up and will not be discussed further. Our test for separability of female labor supply and housing consumption is based on the significance of γ_3 in (24). We specify the stochastic structure of (24) and supplement it with a wage equation. Though it is possible to construct a consumption measure from the available data, we have not done this because this measure is relative noisy. Instead, we use total other family income for x^* in the female labor supply function. The labor supply equation and the wage equation together can be seen as a type 3 tobit model (see Amemiya (1985) for details). Female wages are only observed if the woman works. Besides, we specify the non-linear price relation (13). We use the rent[5] as a measure for q and consider it exclusive of expenses on water, electricity, gas, heating, and energy (e.g. oil, wood), inclusive of any charges for services and a possible antenna system and also inclusive of a rent subsidy possibly received by the household[6]. Since the rent is only observed for tenants we have also modelled the choice of households to rent or buy[7]. Equations (27) and (28) below can be seen

[4]Taking into account the fact that we only observe the wage of participating women, a more flexible labor supply function would complicate the estimation procedure substantially

[5]We have not made a distinction between the public housing sector and the private sector. In general rents are higher in the private sector.

[6]In the Netherlands, low income households may be entitled to a rent subsidy.

[7]We have not incorporated this discrete choice in our structural model, because that is beyond the scope of our paper. The choice between renting and owning is not the main focus of this paper.

as a type 2 tobit model. A subscript i now indexes the unit of observation.

$$h^*_{fi} = \alpha_1 \log w_{fi} + \alpha_2 \log q_i + z'_{1i}\beta_1 + u_{1i} \quad (25)$$

$$\log w_{fi} = z'_{2i}\beta_2 + u_{2i} \quad (26)$$

$$T^*_i = \alpha_3 \log w_{fi} + z'_{3i}\beta_3 + u_{3i} \quad (27)$$

$$\log q_i = y'_{1i}\alpha_4 + y'_{2i}\beta_4 + u_{4i} \quad (28)$$

u_{1i}, u_{2i}, u_{3i},and u_{4i} are assumed to be Normally distributed random disturbances with expectation 0 and the elements of the covariance matrix are $\sigma_1^2, \sigma_2^2, \sigma_3^2, \sigma_4^2, \sigma_{12}, \sigma_{13}, \sigma_{14}, \sigma_{23}, \sigma_{24}$,and σ_{34}. However, our estimation procedure, explained later, will not make use of this error structure explicitly. Notice that we have used the sybol θ for $(\alpha'_4, \beta'_4)'$ in the theoretical part.

Observations of the variable h_{fi}, the actual number of hours per week worked by female i, are censored; we only observe:

$$h_{fi} = \begin{cases} h^*_{fi} & \text{if } h^*_{fi} > 0 \\ 0 & \text{otherwise} \end{cases}$$

Moreover whether one rents a house ($T_i = 1$) or not ($T_i = 0$) is related to the latent variable T^*_i as follows

$$T_i = \begin{cases} 1 & \text{if } T^*_i > 0 \\ 0 & \text{otherwise} \end{cases}$$

The vector z_1 in (25) includes total other family income, the female unemployment rate in the 12 provinces, the socio-demographic variables age and age squared of the woman, a dummy variable for being married, the number of children younger than 7, between 7-12, and older than 13. Moreover the vector z_1 includes the obligation ratio and its square. As mentioned before, this variable is the ratio of the interest payments on the mortgage to total other family income[8]. We give the following justification for the inclusion of the obligation ratio. In our theoretical model we allowed for earnings dependent liquidity constraints. We argued that women in households with high mortgage commitments, may work more to make the liquidity constraint non-binding. In other words, the within period allocation of full expenditures between female labor supply and other consumption (cf. equations 21 and 22) is affected by the presence of binding liquidity constraints. Liquidity constraints are operating if μ_t is positive (see also Alessie et al. (1988)). The obligation ratio can be seen as a proxy for the presence of binding liquidity constraints. Thus instead of estimating a model which takes

[8]We recognize the potential problem of endogeneity of the obligation ratio. The main reason for assuming this ratio to be exogenous, is the lack of good instruments in our data. Del Boca and Lusardi (1996) treat 'having a mortgage' endogenously, while Fortin (1995) makes the comment that the problem of endogeneity of mortgage payments does not appear to be important in her study.

into account the liquidity constraints explicitly, we include the obligation ratio and its square in the labor supply function as an approximation.

The explanatory variables in the wage equation are age, education, and the female unemployment rates in the 12 provinces.

The vector z_3 in (27) includes total other family income, the age, age squared, and age cubed of the head of the household and a dummy for being married[9].

The fourth equation gives the relation between the log of rent and the characteristics of the house. Housing consumption is scaled so as to be equal to the rent paid. The theoretical model implies demand equations for housing characteristics given in (20). In equation (28) the characteristics need to be instrumented according to (20). The following specification for the characteristic j of the house is used:

$$y_{1ji} = \alpha_{4+j} \log w_{fi} + z_{4i}' \beta_{4+j} + u_{(4+j)i} \qquad \text{for } j = 1, \cdots, 7 \qquad (29)$$

where y_{11} is the log of the number of rooms in the house; y_{12} the log of the age of the house; y_{13} a dummy for detached house; y_{14} a dummy for semidetached house; y_{15} a dummy indicating whether or not the house is on a corner; y_{16} a dummy for apartment, and y_{17} is a dummy for the remainder category. A terraced house is used as the reference category. The vector z_4 includes total other family income, a polynomial in the age of the head of the household and of the woman, a dummy for being married, the number of children in the three age classes, dummies for region East, region South, and region West[10] (reference category is region North) and dummies for the degree of urbanization. We distinguish: rural municipalities, industrialized municipalities with less that 20,000 inhabitants, municipalities with more than 30% commuters, small towns having 2,000 to 30,000 inhabitants, middle sized towns having 30,000 to 100,000 inhabitants, and large towns having more than 100,000 inhabitants (reference category is rural municipalities).

The vector y_2 in equation (28) includes dummies for region East, South, and West, and the five dummies for the degree of urbanization. Moreover we include a variable denoting the number of years the family has lived at the same address[11]. This variable reflects the fact that recent home-owners may have higher housing consumption than home-owners who bought their home some time ago. We assume that the variables in y_2 influence the production of housing consumption, but they are not choice variables. Given

[9]The number of children in the three age classes are not included because these variables do not have a significant effect on the tenure choice.

[10]Region North exists of the provinces Groningen, Friesland and, Drenthe. Region East exists of the provinces Overijsel, Gelderland and, Flevoland. Region South exists of the provinces Zeeland, Noord-brabant and, Limburg. Region West exists of the provinces Noord-holland, Zuid-holland, and Utrecht.

[11]Del Boca and Lusardi (1996) use the years of tenure in the current home as an instrument for having a mortgage.

our scaling of housing consumption (by setting it equal to rent for non-home owners) the production of housing consumption is then more efficient in the North. For example, the house prices and rents are lowest in the reference category North. For identification of the model, at least one non-choice variable on the right hand side of the housing consumption equation must be excluded from the labor supply equation. The regional dummies and the dummies for the degree of urbanization are not included in the labor supply equation. Furthermore, for identification, the female wage rate and total other family income in the instrument equations (29) do not appear in the housing consumption equation. Finally, the exclusion of the education levels in the labor supply function, in the tenant equation, and in the instrument equations (29) is used for identification of the model. Table 4 in the appendix gives the mean values and the standard deviations of the variables used in the econometric specification.

Our complete model exists of 11 equations. The estimation of the structural model is not straightforward, mainly because endogenous variables which are not always observed appear on the right hand side. The approach adopted (for example, see Lee, 1995) is to estimate the reduced form of this model and apply Minimum Distance Estimation (MDE) to get the structural parameters. The complete model is written in the restricted reduced form (RRF) as follows:

$$h^*_{fi} = s'_{1i}\delta_1 + v_{1i} \tag{30}$$

$$\log w_{fi} = s'_{2i}\delta_2 + v_{2i} \tag{31}$$

$$T^*_i = s'_{3i}\delta_3 + v_{3i} \tag{32}$$

$$\log q_i = s'_{4i}\delta_4 + v_{4i} \tag{33}$$

$$y_{1ji} = s'_{5i}\delta_{4+j} + v_{(4+j)i} \qquad j = 1, ..., 7 \tag{34}$$

where s_1 exists of the variables in z_1, z_2, y_2, and z_4. s_2 equals z_2. s_3 exists of the variables in z_2 and z_3. s_4 exists of the variables in z_2, y_2, and z_4. s_5 exists of the variables in z_2 and z_4.

We have applied maximum likelihood estimation (MLE) to equations (30) and (31) jointly taking into account the possible correlation between the two equations. Also equations (32) and (33) are estimated jointly by MLE. For standardization we have set the variance of v_3 to 1. The correlation between v_3 and v_4 is estimated. Least squares estimation (LSE) is applied to y_{11} and y_{12}. The remaining equations are estimated by Probit MLE.

We have defined the k x k_j selection matrix J_j such that $z'J_j \equiv z'_j$ and the k x l_j matrix S_j such that $z'S_j = s'_j$ $(j = 1, ..., 5)$ and z includes all k exogenous variables in the model. From (30)-(34) we obtain the following restrictions between the reduced form parameters δ_j and the structural parameters $\alpha_1, \alpha_2, \alpha_3, \alpha_4 \equiv (\alpha_{41}, \alpha_{42}, ..., \alpha_{47})', \alpha_{4+j}, \beta_1, \beta_2, \beta_3, \beta_4, \beta_{4+j}$

$(j = 1, ..., 7)$:

$$\tilde{\delta}_1 = \alpha_1\tilde{\delta}_2 + \alpha_2\tilde{\delta}_4 + J_1\beta_1 \quad (35)$$
$$\tilde{\delta}_2 = J_2\beta_2 \quad (36)$$
$$\tilde{\delta}_3 = \alpha_3\tilde{\delta}_2 + J_3\beta_3 \quad (37)$$
$$\tilde{\delta}_4 = \sum_{j=1}^{7} \alpha_{4j}\tilde{\delta}_{4+j} + J_4\beta_4 \quad (38)$$
$$\tilde{\delta}_j = \alpha_j\tilde{\delta}_2 + J_5\beta_j \qquad j = 5, ..., 11 \quad (39)$$

where $\tilde{\delta}_j$ is defined such that $\tilde{\delta}'_j S_j \equiv \delta'_j$ for $j = 1, ..., 11$. Denoting the estimate of δ_j by d_j and defining $\tilde{d}_j$ such that $\tilde{d}'_j S_j \equiv d'_j$, the system (35)-(39) can be rewritten as follows:

$$\tilde{d}_1 = (\tilde{d}_2, \tilde{d}_4, J_1)(\alpha_1, \alpha_2, \beta'_1)' + \tilde{w}_1 \equiv \tilde{D}_1\phi_1 + \tilde{\omega}_1 \quad (40)$$
$$\tilde{d}_2 = J_2\beta_2 + \tilde{w}_2 \equiv \tilde{D}_2\phi_2 + \tilde{\omega}_2 \quad (41)$$
$$\tilde{d}_3 = (\tilde{d}_2, J_3)(\alpha_3, \beta'_3)' + \tilde{w}_3 \equiv \tilde{D}_3\phi_3 + \tilde{\omega}_3 \quad (42)$$
$$\tilde{d}_4 = (\tilde{d}_5, \tilde{d}_6, ..., \tilde{d}_{11}, J_4)(\alpha'_4, \beta'_4)' + \tilde{w}_4 \equiv \tilde{D}_4\phi_4 + \tilde{\omega}_4 \quad (43)$$
$$\tilde{d}_j = (\tilde{d}_2, J_5)(\alpha_j, \beta'_j)' + \tilde{w}_j \equiv \tilde{D}_j\phi_j + \tilde{\omega}_j \qquad j = 5, ..., 11 \quad (44)$$

with

$$\tilde{\omega}_1 = (\tilde{d}_1 - \tilde{\delta}_1) - \alpha_1(\tilde{d}_2 - \tilde{\delta}_2) - \alpha_2(\tilde{d}_4 - \tilde{\delta}_4)$$
$$\tilde{\omega}_2 = (\tilde{d}_2 - \tilde{\delta}_2)$$
$$\tilde{\omega}_3 = (\tilde{d}_3 - \tilde{\delta}_3) - \alpha_3(\tilde{d}_2 - \tilde{\delta}_2)$$
$$\tilde{\omega}_4 = (\tilde{d}_4 - \tilde{\delta}_4) - \sum_{j=1}^{7} \alpha_{4j}(\tilde{d}_{4+j} - \tilde{\delta}_{4+j})$$
$$\tilde{\omega}_j = (\tilde{d}_j - \tilde{\delta}_j) - \alpha_j(\tilde{d}_2 - \tilde{\delta}_2) \quad j = 5, ..., 11$$

Next we applied LSE to each of the equations (40)-(44) to get preliminary $\sqrt{N}$-consistent structural form estimates $\hat{\phi}_{jLS}$. $\tilde{\Omega}_j \equiv V[\sqrt{N}\tilde{\omega}_j]$ can be estimated with $\tilde{W}_j$ using the $\hat{\phi}_{jLS}$ (for details, see Lee, 1995).

The individual MDE $\hat{\phi}_j$ for ϕ_j is

$$\hat{\phi}_j \equiv (D'_j W_j^{-1} D_j)^{-1} D'_j W_j^{-1} d_j$$

where the matrix D_j equals the matrix $\tilde{D}_j$ in which the zero rows were deleted and in the covariance matrix $\tilde{W}_j$ we have deleted the zero rows and columns to obtain W_j.

The individual MDE $\hat{\phi}_j$ are consistent, but we can obtain more efficient estimates by considering the system MDE. Stacking equations (40) to (44) we get

$$d = D\phi + \omega \quad (45)$$

where $d \equiv (d_1, ..., d_{11})'$, $D \equiv \text{diag}(D_1, ..., D_{11})$, $\phi \equiv (\phi_1', ..., \phi_{11}')'$, and $\omega \equiv (\omega_1, ..., \omega_{11})'$ with $\tilde{\omega}_j' S_j \equiv \omega_j'$. Because of possible correlations between the ω_j it is more efficient to estimate (45) than (40)-(44) separately. The system MDE $\hat{\phi}$ can be obtained as follows

$$\hat{\phi} \equiv (D'W^{-1}D)^{-1}D'W^{-1}d \tag{46}$$

where $\Omega \equiv V[\sqrt{N}\omega]$ is estimated with W and $\sqrt{N}(\hat{\phi}-\phi) \cong N(0, (D'W^{-1}D)^{-1})$. The results of (46) can be found in Table 5.

To test the restrictions between the reduced form parameters and the structural parameters as defined in (35)-(39) we use the following test statistic for equation j:

$$\Xi_j \equiv (d_j - D_j\hat{\phi}_j)'(D_j'W_j^{-1}D_j)^{-1}(d_j - D_j\hat{\phi}_j) \tag{47}$$

which is asymptotically $\chi^2_{l_j-(k_j+g_j)}$ distributed with g_j the number of endogenous variables included on the right hand side of equation j. And to test the restrictions between the reduced form parameters and the structural parameters in all 11 equations jointly, the following test statistic is used:

$$\Xi \equiv (d - D\hat{\phi})'(D'W^{-1}D)^{-1}(d - D\hat{\phi}) \tag{48}$$

which is asymptotically χ^2_{n-m} distributed with $n = \sum_{j=1}^{11} l_j$ and $m = \sum_{j=1}^{11}(k_j + g_j)$.

5 Empirical results

In this section the results of the estimation of equations (25)-(29) are presented. Table 5 gives the results of the system MDE estimator defined in (46).

The outcomes presented in Table 5 are pretty much according to expectation. The presence of children has the usual negative impact on hours supplied by the female in the labor market. As noted before, the sample has been restricted to cohabiting and legally married couples in which the male is working. It is interesting to note the huge negative effect on female labor supply of being legally married. The significantly negative effect of unearned income on hours of work supplied by the female confirms that leisure is a normal good.

The test for separability of housing consumption and female labor supply amounts to a test of the significance of housing consumption in the labor supply equation. We find that separability cannot be rejected. In addition, we notice that female labor supply is significantly affected by the amount of interest the household has to pay on the mortgage. The result of the positive and significant effect of mortgage commitments on the hours the female works is in line with our argument that the inclusion of the obligation ratio can be seen as a proxy for the presence of liquidity constraints[12]. A Wald test for the joint significance of the obligation ratio and its square yields a value of the Wald statistic equal to 51.6 indicating that they are jointly significant.

The wage equation shows the usual positive effect of education on wages.

The negative and significant effect of female wages and of other total family income on the choice to rent a house shows that families with high total income will choose to buy their home. This is as expected, because of the advantages of tax deductibility of mortgage interest payments for home-owners.

Regarding the production function transforming house characteristics in housing consumption, we notice that housing consumption is higher when the house has more rooms and housing consumption is lower for older houses, although these effects are not significant. Of the characteristics, only having a detached house has a significant and positive effect on housing consumption. However, the test statistic of the Wald test for joint significance of all characteristics equals to 65.2, which exceeds the critical value of the chi-squared distribution with 7 degrees at any conventional significance level. This test indicates that the characteristics in the housing consumption equations are jointly significant. One also observes what might be called an "adjustment effect". The longer people live at the same address the lower is their housing consumption. Conceivably, these households' consumption still reflects past (mostly lower) income. The regional dummies confirm the generally lower house prices and rents in the North of the Country (the reference category).

The remaining columns of Table 5 give the results of the instrument equations for the characteristics of the house. Finally, the last two rows of the table give the results of the tests (47) and (48) for overidentifying restrictions. A high value of the test statistic indicates that the restrictions in (35)-(39) are not valid. The test for the restrictions in all 11 equations jointly indicates that these restriction have to be rejected. This is likely due to two equations, the overidentifying restrictions in the tenant equation and in the sixth instrument equation (apartment) are rejected. The critical value of the chi-squared distribution with 6 degrees of freedom at a 5% level is 12.6 and with 4 degrees of freedom it is 9.5.

[12] An alternative explanation would be that a high obligation ratio would indicate a low income, and hencepossibly low life time income. If leisure is a normal good, this induces a higher labor supply. Since many households with a high obligation ratio are at the beginning of the life cycle (so that they may expect their income to rise in the future) we do not find this explanantion very plausible.

6 Concluding remarks

This paper is a first attempt to investigate the relation between housing consumption and female labor supply using Dutch data. We have restricted our analysis to married and cohabiting couples in which the man has a job. We have derived a life-cycle consistent model in which housing consumption and labor supply is jointly determined. To test for separability of female labor supply and housing consumption, we have considered the female labor supply function conditional on housing consumption. Furthermore, we have paid special attention to the influence of liquidity constraints on the labor supply of women. For that we have included the ratio of interest payments to total other family income (exclusive of female's earnings) in the female labor supply function to approximate the presence of binding liquidity constraints. To estimate the model we have made use of a two-step procedure. In the first step we have estimated the reduced form parameters and in the second step we used minimum distance estimation to obtain estimates of the structural parameters.

Housing consumption turned out to be insignificant in the labor supply function, indicating that separability between female labor supply and housing consumption cannot be rejected. The empirical results showed also that the ratio of interest payments to total other family income has a large positive effect on the number of hours supplied by the woman, indicating the presence of liquidity constraints. Moreover the positive effect of the obligation ratio is much larger than the negative effect of young children on female labor supply.

Housing consumption has been modelled as a scalar variable "produced" by a production process where house characteristics are inputs. Alternatively, one could set up a model where the house characteristics enter the utility function directly and an equation like (13) would be interpreted as hedonic price relation. In the budget constraint (4) the term $p'_{b\tau}b_\tau$ is then replaced by q_τ. It turns out that for the econometric model this alternative interpretation does not make a difference.

The results we have presented in this paper rely on a cross-section of households. As we have mentioned, prospective home-owners will generally be constrained in the year of purchase only. To analyze the effect of a constraint that households can borrow 3 or 4 times their gross yearly income, panel data is needed. A natural extension of this study is to develop a dynamic model in which such a constraint can be taken into account. Further, a dynamic model can be used to investigate possible changes in occupational choice of the wife due to the plans of households to buy a house. Another important aspect is to check the causality between mortgage commitments and female labor supply. The results in this paper showed that high mortgage commitments have a positive effect on the labor supply of women. This relation could also be reversed: do households choose to have a high mortgage commitment, because the wife has a preference for supplying a high level of labor? Using panel data, attention can be paid to the direction of this causality. Our future research will be focused on the relation between housing decisions and the occupational choice of the wife in a dynamic framework taking the points mentioned above into account.

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Appendix

Table 1: Female labor force participation rates by age and family tenure*

Age of woman		All	Married	Cohabitation
	Home-owners with a mortgage			
≤ 24		83.9	78.1	100
25-34		48.2	45.0	83.3
35-44		44.0	43.2	
45-54		42.9	42.6	
55-64		22.5	22.5	
All		46.2 (638/1381)	44.1 (578/1312)	87.0 (60/69)
	Home-owners without a mortgage			
≤ 34		52.9		
35-44		40.9		
45-54		30.8		
55-64		11.1		
All		30.2 (32/106)		
	Tenants			
≤ 24		76.4	64.8	88.5
25-34		49.0	41.9	87.8
35-44		34.7	43.5	
45-54		32.8	33.1	
55-64		10.8	10.8	
All		46.8 (379/809)	40.9 (286/699)	84.5 (93/110)

* the ratio of the number of participating women to the total number of women in any given category in parentheses. Cells are empty if the total number of women in the category is less than 10.

Table 2: Means and standard deviations by number of hours the woman works*

	#	market value of the house (1)	mortgage debt (2)	interest paid on the mortgage (3)
nonparticipant	592	163536 (78069)	97332 (64599)	6977 (4485)
$0 < \text{hours} \leq 8$	57	157842 (62769)	89457 (54738)	6364 (4100)
$8 < \text{hours} \leq 16$	95	151190 (60658)	93075 (48888)	6784 (3796)
$16 < \text{hours} \leq 24$	113	175205 (75378)	104588 (55044)	7543 (3956)
$24 < \text{hours} \leq 32$	76	151908 (60898)	89806 (44910)	6899 (3622)
$32 < \text{hours} \leq 40$	107	156151 (65393)	108328 (50598)	7783 (3805)
$\text{hours} > 40$	11	179182 (50945)	136548 (48137)	10153 (3900)
all	1051	161937 (73095)	98286 (59267)	7097 (4235)

	#	total other family income (4)	obligation ratio** (5)	(2) / (4) (6)
nonparticipant	592	49114 (21739)	0.145 (0.074)	2.074 (1.608)
$0 < \text{hours} \leq 8$	57	41611 (14294)	0.151 (0.076)	2.139 (1.025)
$8 < \text{hours} \leq 16$	95	40154 (10777)	0.170 (0.084)	2.311 (1.071)
$16 < \text{hours} \leq 24$	113	43584 (16085)	0.178 (0.085)	2.486 (1.229)
$24 < \text{hours} \leq 32$	76	38421 (13563)	0.194 (0.107)	2.583 (1.435)
$32 < \text{hours} \leq 40$	107	36294 (11967)	0.220 (0.091)	3.122 (1.347)
$\text{hours} > 40$	11	43197 (8226)	0.242 (0.106)	3.245 (1.241)
all	1051	45162 (19144)	0.164 (0.085)	2.300 (1.496)

* for home-owners with a mortgage. Standard deviation in parentheses. The difference in the number of observations 1051 compared to 1381 in Table 1 is due to missing values of the variables in this table. The main conlusions of table 1 do not change when the analysis is based on the fewer observations.
** the obligation ratio is the ratio of the sum of interest paid on the mortgage to total other family income (this is exclusive of female earnings)

Table 3: Labor force participation of married and cohabitating women home-owners with a mortgage

Labor force participation (%)*						
Home equity as a percentage of the value of the home	$r^{\#} \leq 0.1$	$0.1 < r \leq 0.15$	$0.15 < r \leq 0.2$	$0.2 < r \leq 0.25$	$r > 0.25$	all
$e \leq 0.25$	52.2 (12/23)	34.4 (22/64)	32.7 (37/113)	50.0 (64/128)	72.9 (70/96)	48.3 (205/424)
$0.25 < e \leq 0.50$	23.1 (6/26)	36.3 (29/80)	38.3 (41/107)	45.8 (22/48)	79.3 (23/29)	41.7 (121/290)
$0.50 < e \leq 1$	28.5 (55/193)	44.4 (36/81)	62.5 (25/40)	54.5 (6/11)	91.7 (11/12)	39.5 (133/337)
all	30.2 (73/242)	38.7 (87/225)	39.6(103/260)	49.2 (92/187)	75.9 (104/137)	43.7 (459/1051)
Mean hours per week**						
Home equity as a percentage of the value of the home	$r \leq 0.1$	$0.1 < r \leq 0.15$	$0.15 < r \leq 0.2$	$0.2 < r \leq 0.25$	$r > 0.25$	all
$e \leq 0.25$	23.3 (12.0)	23.9 (12.2)	21.5 (12.4)	24.7 (12.4)	27.2 (12.5)	24.8 (12.4)
$0.25 < e \leq 0.50$	22.5 (15.1)	21.5 (11.1)	23.1 (10.5)	23.5 (12.8)	29.1 (11.5)	23.9 (11.6)
$0.50 < e \leq 0.75$	15.1 (9.1)	22.1 (11.3)	26.1 (13.7)	20.5 (14.8)	28.2 (8.7)	22.5 (12.1)
$0.75 < e \leq 1$	16.7 (9.2)	21.7 (2.9)	29.0 (12.7)	20.0 (7.1)	32.0 (0)	18.3 (9.5)
all	17.9 (10.5)	22.3 (11.2)	23.3 (12.0)	24.2 (12.4)	27.8 (11.8)	23.5 (12.0)

* the ratio of the number of participating females to the total number of females in any given category in parentheses

** standard deviation in parentheses

\# the obligation ratio r is the ratio of the sum of the interest paid on the mortgage to total family income excl. of female earnings

Table 4: Means of variables used in the econometric model of section 4

Variable	Mean	S.D.
Age of woman	37.45	9.58
Age of head of household	39.77	9.51
Total family income excl. of female's earnings[1]	40518	19010
Obligation ratio (home-owners with a mortgage only)	0.16	0.09
Rent per year (tenants only)	6085	1966
Number of years the family lives at the same address	8.78	7.44
Number of children aged 0-6[2]	1.52	0.65
Number of children aged 7-12[2]	1.39	0.56
Number of children aged 13 and older[2]	1.61	0.74
Regional female unemployment rate (in %)	5.72	0.99
Education level of woman (0-5)	2.42	0.95
Being married (0-1)	0.93	0.26
Home-owner with a mortgage (0-1)	0.62	0.49
Home-owner without a mortgage (0-1)	0.05	0.21
Tenant (0-1)	0.33	0.47
North (0-1)	0.11	0.32
East (0-1)	0.22	0.42
South (0-1)	0.25	0.43
West (0-1)	0.42	0.49
Rural municipality (0-1)	0.14	0.34
Industrialized municipality less than 20,000 inhabitants (0-1)	0.25	0.43
Municipality with more than 30% commuters (0-1)	0.15	0.36
Small towns: 2,000-30,000 inhabitants (0-1)	0.13	0.33
Middle sized towns: 30,000-100,000 inhabitants (0-1)	0.17	0.37
Large towns: 100,000 inhabitants or more (0-1)	0.17	0.37
Detached house (0-1)	0.16	0.36
Semidetached house (0-1)	0.15	0.36
Corner house (0-1)	0.17	0.38
Terraced house (0-1)	0.38	0.49
Apartment/flat (0-1)	0.11	0.31
Remaining category (0-1)	0.03	0.17
Number of rooms in the house	4.64	1.04
Age of the house	27.66	24.13
Hourly after tax wage of the woman[1,3]	13.27	6.64
Number of hours the woman works per week[3]	24.13	12.02

[1] in Dutch guilders
[2] conditional on having children in that age class
[3] conditional on participating in the labor market

Table 5: Results of the MDE of the first four equations in (45)

	hours eq		wage eq.		tenant eq.		hous.cons. eq.	
	coeff.	t-val	coeff.	t-val	coeff.	t-val	coeff.	t-val
ln (wage)	50.336	4.37			-1.201	-3.96		
ln (hous.cons.)	1.139	0.12						
constant	-69.270	-1.66	1.754	8.53	9.074	4.70	3.888	5.956
age head /10					-3.794	-2.69		
age head ^{2} /1,000					8.784	2.63		
age head ^{3} /10,000					-6.582	-2.57		
other inc. /1,000	-15.769	-3.17			-1.297	-14.68		
age /10	-0.126	-0.01	0.362	3.64				
age ^{2} /1,000	-12.537	-0.95	-0.399	-3.18				
married	-15.290	-3.74			-0.234	-1.78		
# children age 0-6	-12.058	-6.56						
# children age 7-12	-7.951	-4.52						
# children age $\geq$ 13	-0.921	-0.51						
obligation ratio	32.698	2.63						
obligation ratio ^{2}	13.572	0.39						
education level 2			0.026	0.80				
education level 3			0.133	4.19				
education level 4			0.287	7.42				
education level 5			0.524	5.01				
unemployment rate	-2.181	-2.31	-0.014	-1.01				
characteristics:								
# rooms							0.283	0.66
age of house							-0.045	-0.48
reference: terraced								
detached							0.223	2.67
semidetachted							-0.183	-0.99
corner house							0.018	0.17
apartment/flat							-0.134	-1.61
remaining category							-0.047	-0.61
# years same addr.							-0.018	-10.00
reference: north								
east							0.241	2.52
south							0.242	3.12
west							0.274	2.54
reference: rural								
industrialized							0.053	0.91
> 30% commuters							0.307	3.14
small towns							0.268	2.61
middle sized towns							0.265	3.03
large towns							0.230	2.19
overidentifying								
restrictions test: Ξ_j	6.04 (14 df)		0 (0 df)		40.98 (6 df)		2.80 (8 df)	
model: Ξ	76.68 (56 df)							

Table 5: Results (cont.) of the MDE of the instrument equations, i.e. equations 5-11 in (45)

	# rooms		age house		detached		semi-detached		corner		apartment		remaining	
	coeff.	t-val	coeff.	t-val	coeff.	t-val	coeff.	t-val	coeff.	t-val	coeff.	t-val	coeff.	t-val
ln (wage)	0.144	2.96	-0.383	-1.83	0.597	1.77	0.958	2.83	0.275	0.83	-0.912	-2.28	0.259	0.24
constant	0.890	3.03	4.270	3.37	-2.575	-1.09	-5.154	-1.89	0.727	0.28	5.299	1.81	-5.16	-0.94
other inc. /1,000	0.119	7.26	-0.296	-4.29	0.595	5.79	0.151	1.43	0.045	0.38	-0.518	-3.12	-0.065	-0.25
age /10	0.032	0.47	0.230	0.75	0.423	0.86	0.442	0.79	-0.626	-1.11	-0.248	-0.37	-1.474	-1.37
age ^{2} /1,000	-0.018	-0.22	-0.266	-0.75	-0.471	-0.81	-0.595	-0.89	0.877	1.24	-0.059	-0.07	1.818	1.54
married	0.022	0.90	-0.429	-4.52	0.005	0.03	0.238	1.15	0.464	2.84	-0.539	-3.37	-0.188	-0.45
# children age 0-6	0.049	7.62	0.063	1.99	-0.032	-0.68	-0.012	-0.21	0.006	0.12	-0.15	-2.02	0.036	0.33
# children age 7-12	0.043	6.42	0.043	1.23	-0.081	-1.43	0.045	0.74	-0.076	-1.27	-0.23	-2.21	-0.004	-0.03
# children age $\geq$ 13	0.046	6.29	0.032	1.23	-0.110	-2.30	-0.035	-0.68	0.001	0.01	-0.029	-0.42	0.148	1.39
age head /10	-0.015	-0.07	-0.575	-0.63	-0.518	-0.29	0.554	0.27	-1.291	-0.67	-2.548	-1.15	3.977	1.04
age head ^{2} /1,000	0.052	0.10	2.116	1.01	1.594	0.40	-1.435	-0.30	3.422	0.74	5.508	1.02	-8.721	-1.07
age head ^{3} /10,000	-0.003	-0.01	-1.690	-1.07	-1.151	-0.38	1.334	0.38	-3.126	-0.87	-3.570	-0.83	6.268	1.10
east	-0.003	-0.20	-0.358	-4.69	-0.507	-3.92	0.279	2.16	0.019	0.15	-0.211	-0.76	-0.062	-0.26
south	0.005	0.32	-0.363	-4.91	-0.378	-3.07	0.238	1.87	-0.070	-0.54	-0.235	-0.84	-0.246	-0.95
west	-0.053	-3.40	-0.181	-2.47	-0.863	-6.99	-0.695	-5.00	0.091	0.75	0.822	3.26	-0.118	-0.45
industrialized	-0.026	-1.73	-0.119	-1.65	-0.193	-1.67	-0.006	-0.05	-0.057	-0.46	0.371	1.37	-0.279	-1.30
> 30% commuters	-0.015	-0.92	-0.198	-2.45	-0.686	-4.66	-0.042	-0.29	0.029	0.22	0.614	2.41	-0.169	-0.64
small towns	-0.027	-1.52	-0.184	-2.21	-0.773	-5.40	-0.117	-0.82	0.146	1.08	0.813	3.08	-0.417	-1.66
middle sized towns	-0.050	-3.35	0.015	0.19	-0.864	-6.08	-0.213	-1.53	-0.212	-1.58	1.003	4.05	-0.212	-0.80
large towns	-0.080	-5.00	0.200	2.53	-1.020	-6.37	-0.577	-3.75	-0.264	-1.94	1.659	7.06	-1.014	-1.56
Ξ_j	1.82 (4 df)		7.98 (4 df)		3.37 (4 df)		0.99 (4 df)		6.70 (4 df)		11.72 (4 df)		1.72 (4 df)	

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