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A Dynamic Tobit Model of Female Labor Supply[#]

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Abstract: A dynamic Tobit model is applied to longitudinal data to estimate the hours of work of married women in Sweden during 1992-2001. Hours of work are found to be negatively related to fertility. Other characteristics of married women are also found to have an effect on labor supply. Inter- temporal labor supply decisions seemed to be characterized by a substantial amount of unobserved heterogeneity, first order state dependence and serially correlated error components. The findings suggest that the first order state dependence and unobserved heterogeneity are very sensitive to the initial condition.

Keywords: Female labor supply, state dependence, heterogeneity, dynamic Tobit.

JEL: J22; C23, C25.

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1 Introduction

The inter-temporal labor supply behavior of married women is a long standing interest in labor supply research (Heckman, 1974; Heckman and MaCurdy, 1980). It has been observed in such research that an individual who has experienced an event in the past is more likely to experience the event again in the future (Blank, 1989; Chay and Hyslop 1998; Hyslop, 1999). Heckman (1981a) calls this inter-temporal dependence "*true* state dependence", as opposed to another kind, *spurious* state dependence, generated by persistent individual heterogeneity. To analyze state dependence and distinguish true from spurious, Heckman (1981a) suggests using a dynamic model with unobserved individual specific effects. Such a model is applied here to estimate the effects of fertility and husband's earnings on labor supply decision (hours of work) of Swedish married women.

Hyslop (1999) analyses a similar model using US data to estimate the effects of the fertility decision and husband's earnings (a proxy for non-labor income) on labor-market participation. He proposes a general probit model with correlated random effects; auto correlated error terms and state dependence, and compares the results for different specifications. Islam (2005) investigates a similar model to Swedish participation data. Like Hyslop, substantial unobserved heterogeneity is found in the participation decision. In contrast to Hyslop, statistically significant positive serial correlation in the transitory errors, as well as negative but small state dependence is found in Islam's analysis.

Following Heckman's (1981a) suggestion but going beyond Hyslop's (1999) and Islam's (2005) analysis of participation, I investigate the inter-temporal labor supply (hours of work) behavior of married women in Sweden. In particular, I am interested to see the dynamic effects of having children on women's hours of work decision. I am also interested to know whether the husband's earnings are sensitive to women's hours of work decision in life cycle consideration.

According to the Heckman and MaCurdy's (1980) labor supply model, the censored model would be relevant if the sample consists of a random sample of individuals, with hours of work reported as 0 if the individual does not work. The techniques used in the estimation of linear panel data models are inappropriate due to censoring nature. The introduction of lagged dependent variables and serial correlation in the error term make the conventional estimation techniques even more difficult to apply in the Tobit model. Moreover, misspecification of the distribution of the unobserved variance yields inconsistent results (Arabmazar and Schmidt, 1982 Goldberger, 1983). Thus the challenging issue is to estimate a Tobit (standard censored regression) models with lagged dependent variables and serially correlated errors. However a random effect specification is applied in the Tobit model which allows for unobserved heterogeneity, first order state dependence and serial correlation in the error components. A finite mixture approach is used, in which individual specific effects can be handled flexibly without imposing a parametric structure. I follow Heckman and Singer (1984) approach in which only the constant term varies across the classes. For correlated disturbances, simulation based estimation (MSL) as proposed by Lerman and Manski (1981), McFadden (1989), and Pakes and Pollard (1989), among others is used. A standard approach to simulation draw from the specified distribution is applied.

The results provide the evidence that hours of work decisions are negatively related to the fertility decision. The effect of permanent income is significant, while the effect of transitory income is insignificant. Substantial unobserved heterogeneity, positive first order state dependence and negative serial correlation in the transitory errors are found. Other characteristics of married women are also found to have an effect on the labor supply decision. An overview of the paper is as follows.

A descriptive analysis of the characteristics of married women in Sweden is presented in Section 2, while Section 3 presents the model and empirical specification. Section 4 reports the empirical findings, Section 5 discuss sensitivity analysis and section 6 discusses simulation results. Finally section 7 summarises and draws conclusions.

2 Data and preliminary analysis

The data are drawn from the Swedish Longitudinal Individual Data (LINDA).[1] The sample used in this analysis consists of 98,210 continuously married couples, aged 20 to 60 in 1992. The sample contains eighty two percent observations for women with positive hours of work, while the remaining observations are for women who do not work for pay during the study period. The educational attainment is measured as the

[1] LINDA, a joint endeavour of the Department of Economics at Uppsala University, the National Social Insurance Board (RFV), Statistics Sweden, and the Ministries of Finance and Labour, is a register based data set consisting of a large panel of individuals and their household members; the main administrator is Statistics Sweden. The sampling procedure used ensures that each annual cross section is representative of the population of Sweden for that year.

highest level reported in 1992-2001.[2] Husband's earning is used as a proxy for non-labor income.[3] Annual earnings are expressed in constant (2000) SEK, computed as nominal earnings deflated by the consumer-price index.[4] A dummy variable for place of birth is included to see if there is any difference in the labor supply (hours of work) pattern between Swedish born and foreign born individuals. This dummy variable indicates the status of the individual, where 1 refers to native born and 0 otherwise.

Figure 1 shows the observed frequency distribution of number of years worked during the study period. The figure suggests that there is serial persistence in the participation decision of married women. For example the overwhelming majority of individuals either work in each year or never works, effectively ruling out the possibility that the process underlying the sequences is independent over time.

Figure 2 shows the distribution of observed annual hours of work. The distribution shows that married women have a varied pattern of hours worked with some bunching at 2000 hours and at the zero hour. This pattern suggests that hours of work are sensitive to changes in the structure of individual heterogeneity. One source of this heterogeneity can be differences in observable characteristics such as age, civic status, education, non-labor income and the number of children.

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[2] Three dummy-variables for educational attainment are used: One for women who have at most finished grundskola grade (9 years education); One for women who have more than 9 but less than 12 years of education; and one for women who have education beyond gymnasium (high school).

[3] Permanent non-labor income (y_{mp}) is the time average ($\bar{y}_{i.}$) of husband's earnings and transitory income (y_{mt}) is the deviation from the time average ($\bar{y}_{i.}$) of husband's earnings.

[4] 1 US Dollar = 8.94698 Swedish Kroner (June 1, 2000).

Table 1 reports observable individual characteristics for the full sample and various sub samples. It is observed that the women who work in all 10 years are better educated, have fewer young children, and have higher husband's earnings than those who never work. Woman with a single transition from work are older, less educated and have fewer dependent children than women with a single transition to work. The women who experience a single transition to work or who experience multiple transitions are younger than average, and have considerably more dependent children in all age groups. Their husband's earnings are slightly bellow average.

Figure 3 presents typical examples of the "raw" correlation between the age of youngest child and mother's annual hours of work for the years 1992, 1996, 1998, and 2001. As can be seen there is a distinct upward slope to these curves. This reproduces the almost universal finding that hours worked is increasing in the age of youngest child.

3 Empirical model and estimation methods

As mentioned earlier, the standard regression approach is not appropriate when the distribution of hours worked exhibits censoring at zero. In a dynamic random effect frame work, the Tobit model is described as:

$$y_{it}^{*} = x_{it}\beta + g(y_{it-1})\gamma + u_{it} \qquad (1)$$

$$y_{it} = \max\{y_{it}^{*}, 0\}$$

$$u_{it} = \alpha_i + \varepsilon_{it} \qquad t=1,\ldots,T \text{ and } i=1,\ldots,N$$

and

$$\varepsilon_{it} = \rho\varepsilon_{it-1} + v_{it}$$

$v_{it} \sim N(0, \sigma_v^2)$, orthogonal to α_i

where y_{it} is an observed response that equals zero with positive probability but is continuously distributed over strictly positive values. g(.) allows lagged values of the observed responses.[5] x_{it} is a vector of explanatory variables such as age, number of children, education, non-labor income, whether the women is an immigrant or Swedish born, etc. The component α_i is an unobserved individual specific random disturbance which is constant over time, and ε_{it} is an idiosyncratic error which varies across time and individuals. If the random effect is correlated with fertility and/or income variables, then

$$\alpha_i = \sum_{s=0}^{T} \left[\delta_{1s} \left(\# Kids0-2 \right)_{is} + \delta_{2s} \left(\# Kids3-5 \right)_{is} + \delta_{3s} \left(\# Kids6-17 \right)_{is} \right] + \sum_{s=0}^{T-1} \delta_{4s} y_{mis} + \eta_i \qquad (2)$$

where η_i is assumed independent of x_{it} and v_{it}. It is also assumed that $\eta_i / X_i \sim N(0, \sigma_\eta^2)$ (see Chamberlain, 1984; Jacubson, 1988; Hyslop, 1999).

A random effect specification is applied in the Tobit model which allows unobserved heterogeneity, first order state dependence and serial correlation in the error components. The draw back with the random effects approach comes from the difficulty in establishing a distribution of individual specific effects. The distribution of the unobserved component of the model for any one observation is linked through α_i to the unobserved components of all the other observations in the same cross sectional unit. Thus with the addition of α_i to the model, the likelihood function becomes somewhat more complicated than that of a simple Tobit model. Moreover, misspecification on the distributional assumption of unabsorbed heterogeneity may lead to inconsistent estimate

[5] The issue has been discussed in Wooldridge (2002).

(Arabmazar and Schmidt, 1982 Goldberger, 1983). An alternative approach used in this paper is to formulate a latent class model. The underlying theory of this model posits that individual behavior depends on observable attributes and on latent heterogeneity that varies with factors that are unobserved by the analyst (Greene and Hensher, 2002). I follow Heckman and Singer (1984) approach in which only the constant term varies across the classes. In this approach, the unobserved heterogeneity is incorporated in a very flexible way without imposing a parametric structure. I assume that the continuous distribution of unobserved individual specific effects can be approximated by estimating the location of the support points and the mass (probability) in each interval. In this case the integration is replaced by a summation over the number of support points for the distribution of unobserved heterogeneity. Associated with each support point is a probability, π_m, where $\sum_{m=1}^{M} \pi_m = 1$ and $\pi_m \geq 0$. To be specific, it is argued that there are M types of individuals and that each individual is endowed with a set of unobserved characteristics, for m=1,..,M. The implication of these unobserved heterogeneity parameters are straightforward, and a high value simply implies a high preference for work. The problem with this approach is that it requires a fairly rich panel. There should be a substantial amount of within group variation.

However, the likelihood function of the dynamic panel censored model is usually intractable since the dimension of an integral involved in its calculation is as large as the number of censoring periods in the model. Under such circumstances, for a model with general correlated disturbances, simulation based estimation (MSL) as proposed by Lerman and Manski (1981), McFadden (1989), and Pakes and Pollard (1989), among others, can be used (Lee, 1997; Lee, 1999). I used the standard approach to random draws from the specified distribution for the simulation based estimation method (MSL).[6] Simulated maximum likelihood method has also been applied to estimate the random effect Tobit model for normal (continuous) heterogeneity distribution (not reported here).

The initial condition problem in dynamic Tobit model with unobserved effects is an important theoretical and practical problem. A common approach is to assume that either the initial condition is exogenous and can be treated as fixed (e.g., Heckman 1978, 1981a, 1981c) or that the process is in equilibrium at the beginning of the sample period (e.g., Card and Sullivan, 1988). The assumption of the non randomness/fixed on initial condition implies that the disturbances that generate the process are serially independent. Unfortunately if the process has been in operation prior to the time it is sampled, or if the disturbances of the model are serially dependent as in the presence of individual specific random effects, the initial conditions are not exogenous (Hsiao, 2003). The assumption that the process is in equilibrium also raises problems in many applications, especially when time varying exogenous variables are driving the stochastic process (Hsiao, 2003). In order to overcome the practical problem of not being able to find the conditional distribution of the initial value, Heckman (1981) proposes approximating the conditional distribution of the initial condition. For the initial period the individual is observed (t=1), a static binomial probit model is estimated in Heckman (1981). This procedure approximates the initial conditions for the model. Heckman (1981) reports that this approximation performs well in a binary

[6] The draw back with this approach is that good performance requires a very large number of draws. With a large sample and a large model, this entails a huge amount of computation and is thus very time consuming.

choice model leading to only a small asymptotic bias. Following Heckman (1981), I approximate the initial conditions for the static Tobit model. In order to control for endogenous initial condition I also assume that the initial period is correlated with the other periods through the distribution of unobserved heterogeneity of initial and other period.

4 Results

The results for all specifications are reported based on 10% (random draw) sub-sample [7] Table 2 contains the results of the estimated static Tobit approach. The first column shows the results when I treat all years as pooled (standard Tobit). This result serves as a benchmark against which I can compare the results that use the panel structure. As expected, the presence of children reduces labor supply, and the presence of young children reduces hours of work even more. An additional child aged 0-2 reduces women's annual hours of work by -885 hours (marginal effect). The effect of permanent income is significantly positive while the coefficient on transitory income is insignificant.

In order to see the effect of individual unobserved heterogeneity, I estimate a random effect Tobit model by MLE using Gaussian quadrature. In column 2, when the individual specific effect is allowed, the result shows that 71% of the latent error variance can be explained by unobserved heterogeneity. Allowing unobserved

[7] 10% sub sample and full sample produce almost similar result in all specification in the static model. It is mentioned that good performance of simulated maximum likelihood method (MSL) requires a very large number of draws. And with a large sample and a large model, this entails a huge amount of computation and thus very time consuming. Therefore 10% sub sample has been used in the simulated maximum likelihood estimation methods and the results reported here are based on 10% sub-sample in all specification.

heterogeneity, the estimated effect of young children aged 0-2, 3-5, and, 6-17 drop 29%, 49%, and 32% respectively. In column 3, the random effect Tobit model is re-estimated by random intercept latent class Tobit model. In this approach it is assumed that the continuous distribution of unobserved individual specific effects can be approximated by estimating the location of the support points and the mass (probability) in each interval. I consider two support points.[8] The results show that the estimated support points and accompanying probabilities of unobserved heterogeneity variance are significant. The first estimated support point (θ_1 = 407.26) and the corresponding probability (π_1 = 0.83) indicate a relatively strong preference for work by 83% of the sample (compared to the sample information that 69% actually worked all 10 years of the study period). The second estimated support point (θ_2 =-1677.59) and the corresponding probability (π_2 = 0.17) indicates low preference for work by 17% (compared to the sample information that 11.3% don't work at all during the study period).

In column 4, the correlated random effect specification is estimated using simulated maximum likelihood (MSL) method. In this specification it is assumed that the fertility and/or income variables are correlated with unobserved taste. The Wald statistic (at the bottom in column 4) rejects the hypothesis of no correlation between the number of children aged 0-2 and the unobserved heterogeneity.[9] The $\chi^2(1)$ value is 44.11. The

[8] The model is also estimated with three classes and found that the model is fitted well with two classes (for this and other results concerning this issue, see Hansen and Lofstrom 2001, Cameron and Heckman 2001, Stevens 1999, Ham and Lalonde 1996, Eberwein, Ham and Lalonde 1997). This issue is also discussed in Heckman and Singer.

[9] Wald statistics are calculated for the fertility variables and for transitory income y_{mt}. The number of children aged 3-5 is dropped because of estimation problem.

hypothesis that the number of children aged 6-17 is uncorrelated can not be rejected by the Wald test. The $\chi^2(1)$ value is 0.41. The likelihood ratio tests (not reported) also show similar results.

Table 3 presents the results from the random effect Tobit models for inter-temporal labor supply model. The first, second, third, and fourth column pertain to the “no initial condition”, “exogenous initial condition”, “correlated initial condition”, and “correlated initial condition with AR(1)” specification respectively. The interaction term between lag dependent and the number of children aged 0-2 is included in these specifications. The estimated effects of initial parameter of corresponding specifications are presented in bold letters. In column 1 the random intercept latent class model with first order state dependence SD(1) is estimated. As expected, the estimated state dependence has a significant effect on the model and the coefficient is 72.98. However the state dependence in labor supply is quite large when the initial condition is allowed (column 2). The estimated coefficient (SD(1)) is 247.23. Including initial condition has significant effects on fertility and non-labor income. The results also show that the heterogeneity variance is very sensitive to the initial condition. The estimated probability of strong preference group is declined from 0.82 to 0.62 and the probability of low preference group is increased from 0.18 to 0.38.

In column 3, controlling for endogenous initial condition, the latent class model with first order state dependence is estimated. In this specification it is assumed that the initial period is correlated with the other periods through the distribution of unobserved heterogeneity. The results show that the estimated effects of the covariates are somewhat larger in magnitude than in the exogenous initial condition specification. The results also show that the estimated state dependence and unobserved heterogeneity is almost identical to before. However the second initial support point of heterogeneity variance is still insignificant which suggests that the model may not be well specified.

It is assumed that the disturbances of the model are serially dependent due to the presence of individual specific random effects. If this is the case then the initial conditions are not exogenous. In column 4, controlling for correlated initial condition, the latent class model with first order state dependence and serially correlated error components is estimated. For the AR(1) error component, simulation based estimation methods (MSL) is used in this specification. Allowing for correlation with initial condition, the results find a large and statistically significant AR(1) coefficient (-0.89). However, the effect of state dependence, unobserved heterogeneity and all covariate effects are each individually significant and very close to those in column 3 except the second support point of initial period which is insignificant in column 3 but significant in column 4.

5 Sensitivity analysis

So far I have focused on the Tobit model which is applicable only if the underlying dependent variable contains negative values that have been censored to zero in the empirical realization of the variables. In the Tobit analysis at least some of the observations (0's) must be censored, otherwise the observed dependent variable would always equal the latent dependent variable and the true model would then be a linear regression. Thus the OLS estimators are biased downward (e.g., Greene, 1997). To check whether the observed dependent variable is equal to the latent dependent variable, I re-estimate the model using OLS. In principle the OLS estimates would be similar to Tobit estimates if there is no data censoring.

Table 4 presents the results from the linear models. The first and second column presents the simple and random effect linear estimate. The results are consistent with Tobit specification. That is the presence of children reduces labor supply, and the presence of young children reduces hours of work even more. An additional child aged 0-2 reduces women's annual hours' of work by -698 in the simple linear model (Table 4 column 1) and -885 in the Tobit model (Table 2 column 1). Moreover 78% latent error variance can be explained by the unobserved heterogeneity in the linear model (Table 4 column 2). In contrast 71% latent error variance can be explained by the unobserved heterogeneity in Tobit specification (Table 2 column 2).

In column 3, the dynamic model with first order state dependence SD(1) is estimated.[10] The findings show that including state dependence has substantial significant effect on the model. The estimated state dependence effect is 175 in the dynamic model. Including first order state dependence, the unobserved heterogeneity effect declined from 0.78 to 0.41. In column 4 the dynamic model with first order state dependence SD(1) and serially correlated error components AR(1) is estimated. The results show that the addition of AR(1) coefficient has a positive and statistically significant effect on the model. The AR(1) coefficient is 0.38.

[10] The initial condition is not considered in this specification. The log of lag dependent variable is used in the right hand side variables

6 Simulated responses

Figure 4 shows simulated responses to a birth in year 1 for simple linear (OLS) and simple Tobit model. During the first year, the annual hours of work declined 54% and 58% in simple linear and simple Tobit model respectively. There is a distinct upward slope after the birth during the first year in both models. The women increase their annual hours of work with the age of youngest child. During first year the annual hours of work are 557 and 488 hours in simple linear and simple Tobit model respectively while that of 1494 and 1463 when the youngest child become 16 years old. The shift in hours of work at years 3 and 6 may indicate the pre-school and school going ages.

In Figure 5, the responses for random effect linear and Tobit model gives two distinct results in terms of average prediction of annual hours of work. Figure 6 shows the simulated responses to a birth in year 1 for dynamic linear and dynamic Tobit model. The women decrease their annual hours of work to 490 in the dynamic linear and 653 in the dynamic Tobit model.

Figure 7 shows simulated responses to a birth in year 1 for all linear models such as simple linear (OLS), RE linear and dynamic SD(1) linear. Similarly Figure 8 shows simulated responses to a birth in year 1 for all Tobit models such as simple Tobit, RE Tobit, RE latent class Tobit and dynamic SD(1) Tobit. The simulated responses from each of these models increase hours of work as the child ages. The differences of simulated hours of work from each of these models are quite noticeable. During the first year, an additional child reduces the annual hours of work by 54% in the simple linear

(OLS), 51% in RE linear and 42% in dynamic linear. However the annual hours of work in the Tobit models are reduced by 58%, 62% and, 48% respectively.

Figure 9, which is based on the dynamic with SD(1) Tobit model, shows remarkably stronger responses to a birth in year 1 for University educated (highly educated) women than for high-school educated (middle educated) women. While Figure 10 shows two distinct responses of immigrant and native born mothers in Sweden.

7 Summary and conclusions

This paper has analyzed the dynamic specification of labor supply model of married women in Sweden using longitudinal data LINDA. The empirical specification used is a dynamic model with endogenous initial condition, unobserved heterogeneity and serially correlated error components. A finite mixture model is formulated allowing for unobserved heterogeneity in very flexibly without imposing a parametric structure.

In both linear and Tobit specifications, the results indicate that hours of work are strongly affected (inversely) by the ages of children. Inter-temporal labor supply decisions seemed to be characterized by a substantial amount of unobserved heterogeneity, first order state dependence and serially correlated error components. The correlated random effects (CRE) Tobit specification rejects the hypothesis that the number of children aged 0-2 is exogenous to women’s hour’s decisions in the static model. The Tobit analysis suggests that the first order state dependence and unobserved heterogeneity are very sensitive to the initial condition.

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Table1: Sample Characteristics of Married Women Aged 20-64 in 1992-2001

	Full sample (1)	*Employed all 10 years* (2)	*Employed 0 years* (3)	*Single transition from work* (4)	*Single transition to work* (5)	*Multiple transitions* (6)
Age	44.78 (7.50)	46.17 (6.52)	45.70 (7.84)	47.11 (7.25)	38.32 (7.05)	37.40 (7.50)
Education[a] (Grundskola)	0.16 (0.37)	0.12 (0.32)	0.44 (0.50)	0.29 (0.45)	0.14 (0.35)	0.12 (0.33)
Education[a] (Gymnasium)	0.48 (0.50)	0.46 (0.50)	0.47 (0.50)	0.52 (0.50)	0.54 (0.50)	0.57 (0.49)
Education[a] (Universitet)	0.36 (0.48)	0.42 (0.49)	0.09 (0.29)	0.19 (0.39)	0.32 (0.47)	0.31 (0.46)
No. Children Aged 0-2 years	0.07 (0.28)	0.02 (0.14)	0.09 (0.32)	0.03 (0.20)	0.24 (0.51)	0.33 (0.53)
No. Children Aged 3-5 years	0.13 (0.38)	0.07 (0.27)	0.14 (0.40)	0.06 (0.26)	0.40 (0.60)	0.44 (0.58)
No. Children Aged 6-17 years	0.93 (1.00)	0.88 (0.97)	0.82 (1.04)	0.62 (0.88)	1.46 (1.10)	1.12 (1.03)
Husbands earnings (SEK1000)	268.16 (165.87)	278.71 (163.31)	223.35 (162.70)	263.89 (197.94)	258.66 (155.69)	252.43 (175.66)
Born in Sweden=1	0.92 (0.27)	0.94 (0.24)	0.85 (0.36)	0.88 (0.33)	0.90 (0.30)	0.93 (0.26)
Hours of work (h)	1414.10 (764.66)	1778.62 (386.37)	0.00 (0.00)	939.64 (817.21)	920.04 (800.67)	986.82 (753.66)
Sample size	98210	67720	11100	3160	8320	7910

Note: Standard errors in parentheses. Sample selection criteria: continuously married couples, aged 20-60 in 1992 with positive husband's annual earnings and hours worked each year.

(a) Three dummy variables for educational attainment are used: One for women who have at most finished Grundskola degree (9 years education); One for women who have Gymnasium degree (more than 9 but less than 12 years of education); and one for women who have education beyond Gymnasium (high school).

Table 2: Static Tobit Estimate of Married Women Aged 20-64 in 1992-2001

	Simple Tobit (1)	*Random Effect Tobit* (2)	*Random Effect Tobit (latent class)* (3)	*Correlated Random Effect Tobit (MSL)* (4)
Permanent income	11.62 (5.13)	9.98 (3.39)	5.55 (0.83)	9.59 (1.28)
Transitory income	-0.002 (7.78)	5.58 (3.62)	12.32 (1.05)	5.85 (4.43)
No. Kids aged 0-2	-935.85 (37.90)	-660.06 (21.35)	-792.21 (20.85)	-802.60 (19.86)
No. Kids aged 3-5	-315.48 (26.66)	-161.45 (15.50)	-211.19 (12.97)	-193.68 (15.39)
No. Kids aged6-17	-99.04 (10.69)	-67.01 (7.61)	-70.21 (5.30)	-79.88 (9.37)
Unobserved Heterogeneity				
Var(η_i)[(a)]	-	0.71	-	-
First support point (θ_1)	-	-	407.27 (69.43)	-
Second support point (θ_2)	-	-	-1677.59 (73.54)	-
Probability (π_1)	-	-	0.83	-
Probability (π_2)	-	-	0.17	-
Log likelihood	-72290.27	-66105.13	-67305.00	-67546.70
Wald statistic for H_0:CRE=0				
#kid0-2	-	-	-	44.11 (0.00)
#kid6-17	-	-	-	0.68 (0.41)
y_{mt}	-	-	-	1.64 (0.20)

Notes: Estimated standard errors in parentheses. All specifications include age, age-squared , educational status, number of kids aged 0-2, 3-5, and 6-17, permanent non labor income, transitory non labor income, place of birth, and a variable for a birth next year.

(a) Var (η_i) is expressed as a fraction of the total error variance.

Table 3: Dynamic Tobit Estimate of Married Women Aged 20-64 in 1992-2001

	Dynamic Tobit No initial condition (1)	*Dynamic Tobit Exogenous initial condition (2)*	*Dynamic Tobit Correlated initial condition (3)*	*Dynamic Tobit Correlated initial condition with AR(1) (4)*
Permanent income	-7.43 (0.43)	4.69(2.51) **18.77 (5.80)**	5.22 (2.54) **21.72 (10.21)**	5.23 (1.06) **21.75 (4.23)**
Transitory income	0.79 (0.02)	3.06 (1.49) **18.39 (10.45)**	4.64 (3.55) **18.15 (16.85)**	4.70 (0.68) **18.26 (3.59)**
No. Kids aged 0-2	-491.73 (14.51)	474.66(30.21) **-799.27(18.37)**	501.60(29.43) **-840.13(43.42)**	500.95(27.95) **-840.17(40.42)**
No. Kids aged 3-5	-188.89 (7.05)	-97.19(15.12) **-159.22(10.26)**	-75.19 (16.12) **-127.95(40.13)**	-75.59 (12.43) **-127.99(30.35)**
No. Kids aged6-17	-76.99 (2.58)	-42.72 (7.38) **-99.91(13.53)**	-34.45 (7.06) **-66.37 (16.94)**	-34.39 (5.79) **-66.30 (11.52)**
Unobserved Heterogeneity				
First support point (θ_{11})	-32.14 (1.17)	-974.39 (148.55)	-1124.58 (178.73) **-1535.67 (438.96)**	-1124.53 (107.26) **-1536.89 (65.84)**
Second support point (θ_{12})	-1645.64 (5.37)	-1541.99 (150.23)	-1592.99 (177.38) **436.53(437.27)**	-1593.19 (106.07) **437.10(67.42)**
Probability (π_1)	0.82	0.62	0.61	0.60
Probability (π_2)	0.18	0.38	0.39	0.40
Log of lag dependent (log h_{t-1})	72.98 (0.94)	247.23 (3.06)	251.78 (2.88)	251.44 (2.79)
(log h_{t-1})* (No. Kids aged 0-2)	-35.87 (2.96)	-165.85 (5.64)	-166.46 (5.43)	-166.39 (5.36)
AR1coefficient, ρ	-	-	-	-0.89 (0.16)
Log likelihood	-66800.60	-65510.20	-65346.00	-65342.70

Notes: Estimated standard errors in parentheses. All specifications include age, age-squared , educational status, number of kids aged 0-2, 3-5, and 6-17, permanent non labor income, transitory non labor income, place of birth, and a variable for a birth next year. The estimated coefficient of initial year of corresponding specifications is presented in bold letters.

Table 4: Linear Estimate of Married Women Aged 20-64 in 1992-2001

	Standard OLS (1)	*Random effect GLS (2)*	*Dynamic (4)*	*Dyamic with AR(1) (5)*
Permanent income	9.06 (4.12)	0.69 (11.56)	2.01 (4.89)	4.33 (5.03)
Transitory income	-0.99 (6.23)	2.31 (2.97)	2.61 (2.81)	8.98 (3.08)
No. Kids aged 0-2	-698.48 (28.55)	-496.33 (17.87)	182.44 (22.05)	189.58 (24.49)
No. Kids aged 3-5	-269.64 (21.40)	-149.40 (14.00)	-83.76 (13.16)	-121.51 (14.84)
No. Kids aged6-17	-86.33 (8.73)	-72.79 (7.64)	-52.34 (6.63)	-57.99 (7.63)
Var(η_i) [(a)]	-	0.78	0.41	0.44
Log of lag dependent (log h_{t-1})	-	-	174.98 (2.21)	154.32 (2.40)
(log h_{t-1})* (No. Kids aged 0-2)	-	-	-116.81 (4.01)	-117.38 (4.08)
AR1coefficient(ρ)	-	-	-	0.38

Notes: Estimated standard errors in parentheses. All specifications include age, age-squared , educational status, number of kids aged 0-2, 3-5, and 6-17, permanent non labor income, transitory non labor income, place of birth, and a variable for a birth next year.

(a) Var(η_i) is expressed as a fraction of the total error variance.

Figure 1: Distribution of Years of Work of Married Women Aged 20-64 in 1992-2001

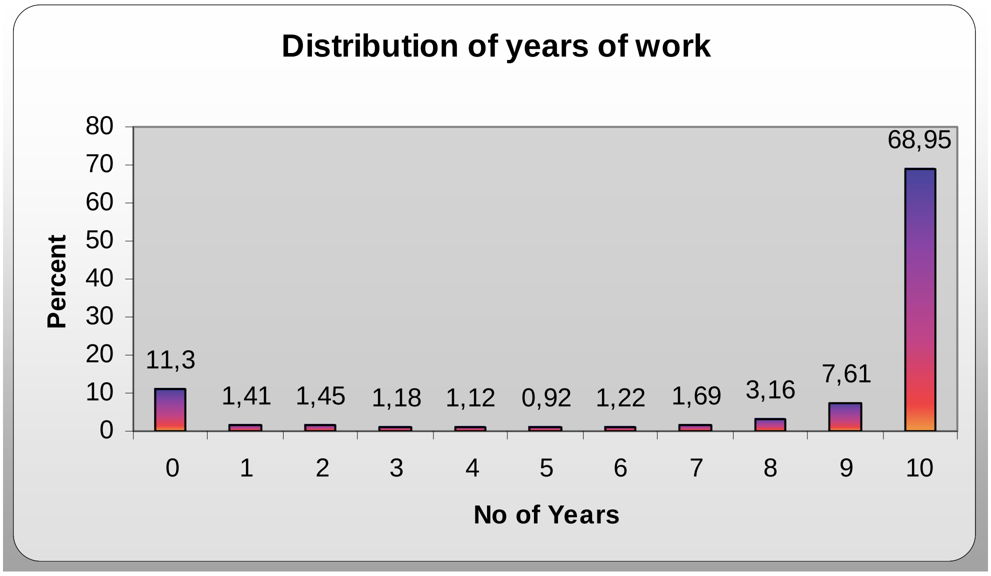
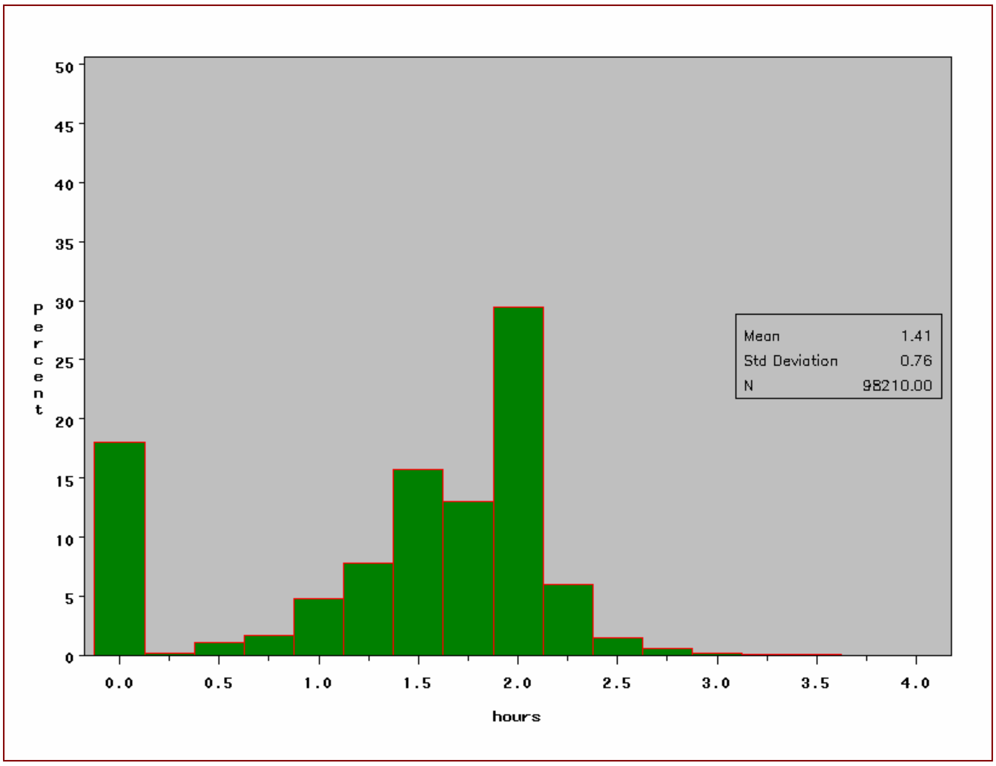


Figure 2: Distribution of Annual Hours of Work of Married Women Aged 20-64 in 1992-2001



Hours in thousand

Figure 3: Distribution of Hours of Work Against Age of Youngest Child of Married Women in Sweden.

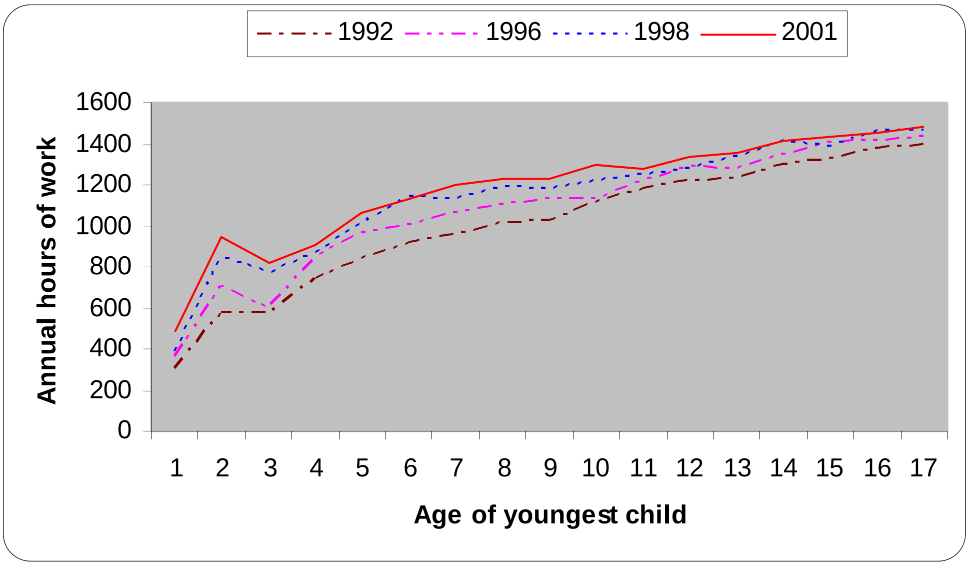


Figure 4: Simulated Response of Hours of Work to a Birth During First Year.

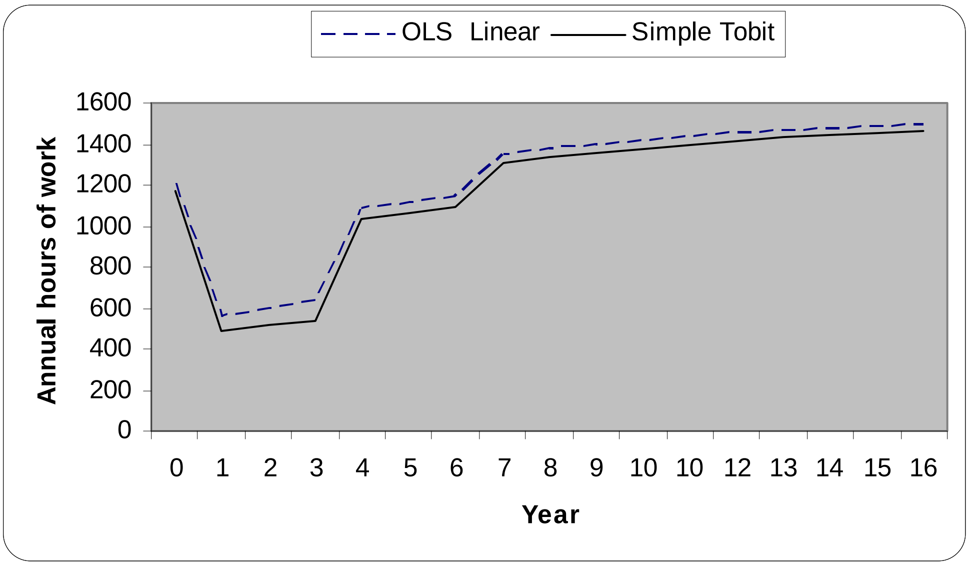


Figure 5: Simulated Response of Hours of Work to a Birth During First Year.

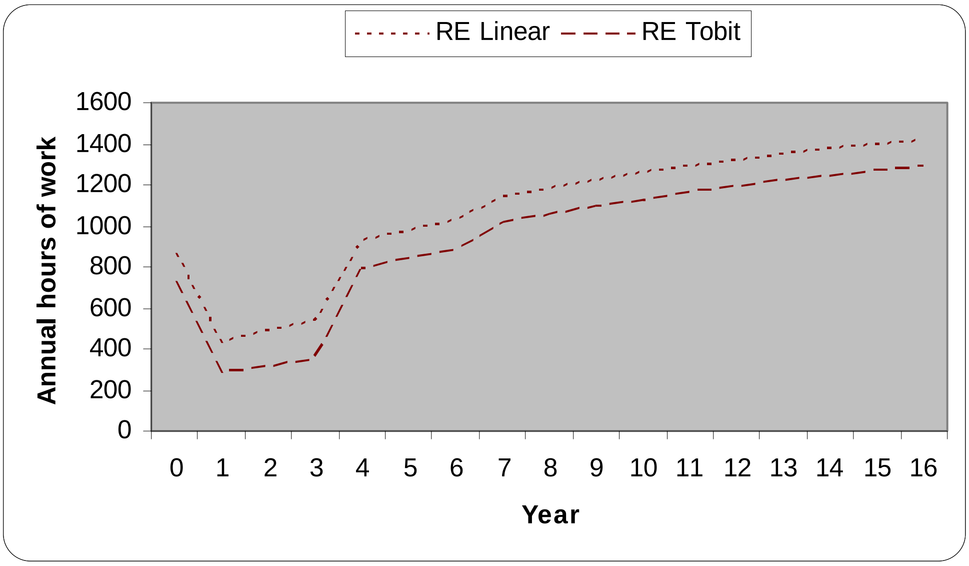


Figure 6: Simulated Response of Hours of Work to a Birth During First Year.

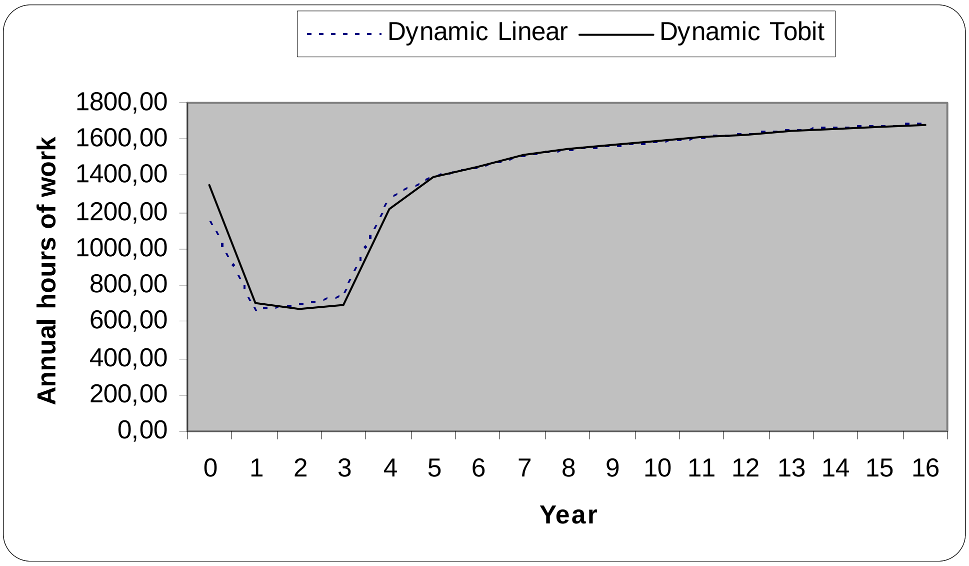


Figure 7: Simulated Response of Hours of Work to a Birth During First Year

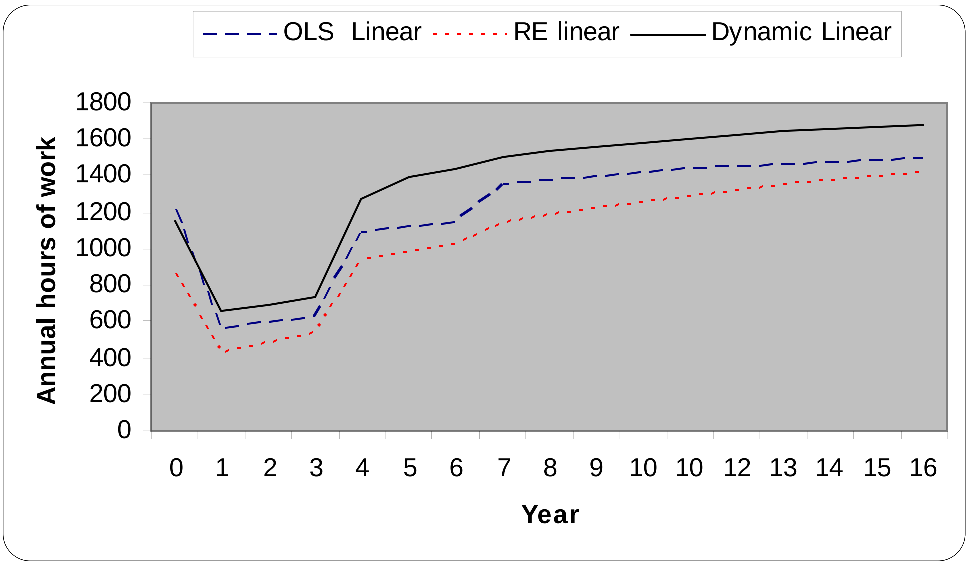


Figure 8: Simulated Response of Hours of Work to a Birth During First Year

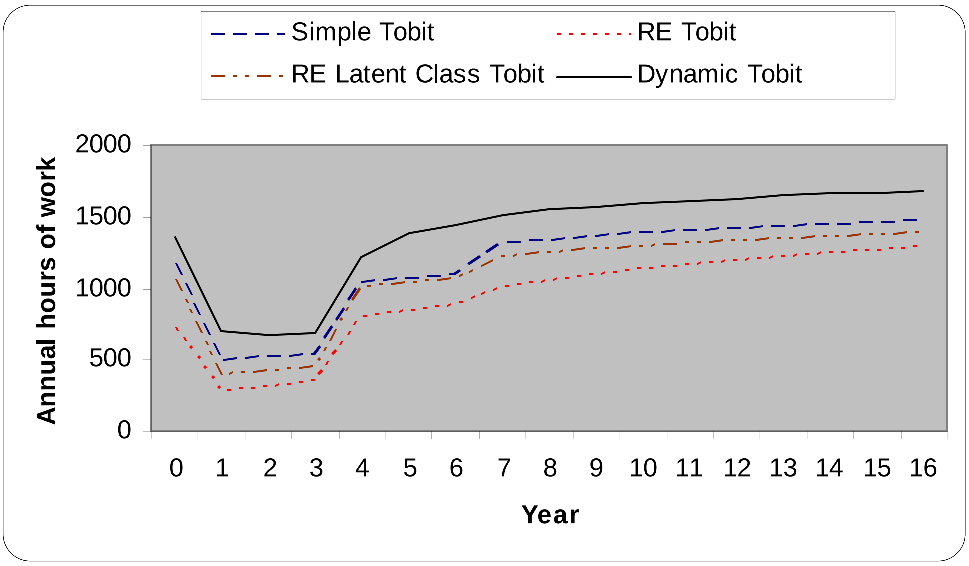


Figure 9: Simulated Response of Hours of Work to a Birth During First Year

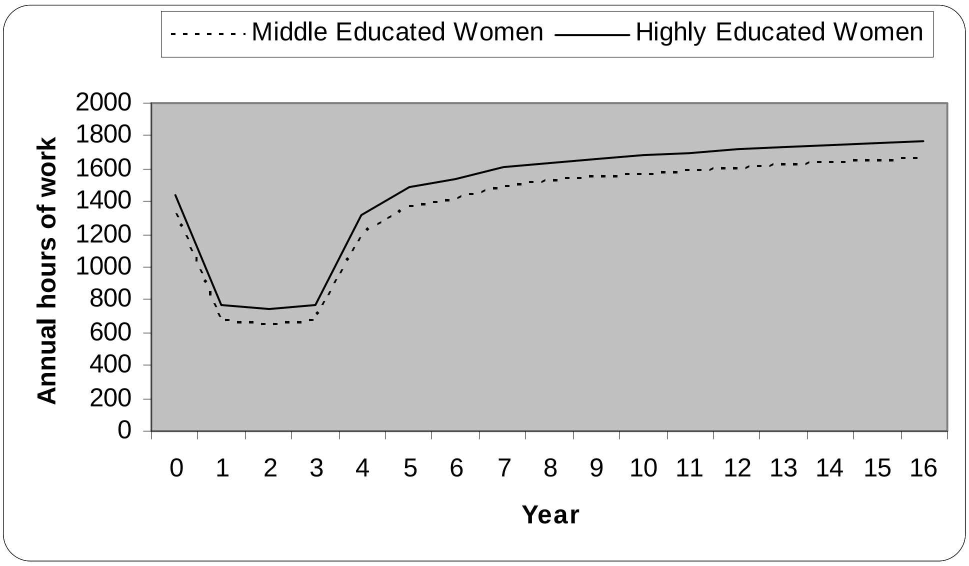


Figure 10: Simulated Response of Hours of Work to a Birth During First Year