# Analysis of Unmarried Female Labour Supply Using Unbalanced Panel Data
## - A Comparative Microeconometric Study of the USA and the FRG

**by**

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# 1. Introduction

In recent econometric work, most analyses of female labour supply consider married women, whereas the results for unmarried women are provided rather as a by-product (Burtless/Greenberg, 1982, Johnson/Pencavel, 1984, Leu/Kugler, 1986, Merz, 1990,). When the particular interest is focused on unmarried women, data of the seventies or rather simple econometric models are used (Keeley et al., 1978, Hausman, 1980, Coverman/Kemp, 1987) . Often very specific populations are examined, like for example lone mothers in Blundell/Duncan/Meghir (1992), Jenkins (1992), Staat/Wagenhals (1993) or Laisney et al. (1993).

Analysing the economic behaviour of unmarried women, one is confronted with the problem that the term 'unmarried' is not clearly defined. It includes single, divorced, separated and widowed women. They live in different types of households, like one-person households or family households, where they occupy different economic positions as for example head of the household or relative of the head.

The present work considers unmarried female heads of household. We assume that the dominant economic position as head of household, voluntarily or involuntarily occupied, forces these women to a similar behaviour independent from their family status. Thus they are taken together in the analysis from the different family statuses: single, divorced, separated and widowed.

Being unmarried often is regarded as a temporary state, voluntarily or involuntarily, for example in the case of young women before marriage or in the case of divorced women after their separation. Nevertheless the demographic development shows the increased importance of unmarried women in the population during the last decades. In the USA the portion of female headed households raised from 21,1% in 1970 to 26,2% in 1980 and 29,0% in 1992 (Statistical Abstracts of the United States, 1993. Own calculations). In the FRG, female headed households constitute 26,4% of total households in 1970, 27,4% in 1980 and 30,1% in 1992 (Stat.Bundesamt, FS 1, Reihe 3, 1970, 1980, 1992).

Therefore it seems an interesting topic to analyse the labour supply behaviour of unmarried female heads. Especially the question whether the labour supply of unmarried women resembles rather that of married women or of prime-age males is of particular interest.

Another purpose of this analysis is to apply modern econometric panel data models with special emphasis on the problem of unbalanced panel data. Most panel data analyses are carried out using balanced panel data, which is no problem if the selection process could be ignored and if enough cases are available to guarantee efficient estimation. Especially the last point was crucial for the present analysis of unmarried females. In the available panel data sets the unmarried female heads constitute only a rather small population. Therefore the estimation techniques were modified to take missing observations of the individuals into account.

The paper is organized as follows: In section 2 the underlying theoretical model of intertemporal labour supply under uncertainty is shortly presented. Section 3 deals with the econometric specification and estimation techniques where the use of unbalanced panel data is considered. Section 4 contains the data description with a particular look on the unbalancedness of the samples. In the last section 5 the empirical results are presented. We compare the estimated parameters for the unmarried women between the USA and the FRG and also analyse the differences between unmarried and married women. Moreover a comparison between different samples of unmarried women is provided.

## 2. The Theoretical Model

The theoretical backround of this empirical analysis is the intertemporal labour supply model with uncertainty, presented by MaCurdy (1983, 1985). Because this model is well known and widely applied (Altonji, 1986, Blundell, 1987, Hujer/Grammig, 1994) only some important aspects should be considered here. The individual i chooses leisure $L_{ik}$ and consumption $C_{ik}$ to maximise in period t the expected value of his discounted sum of present and future utility $U_{it}$:

$$U_{it} = E_t \left\{ \sum_{k=t}^{T} \frac{1}{(1+\rho)^{k-t}} \left( K_{ik}(C_{ik}) + a_{ik} \cdot L_{ik}^{\alpha} \right) \right\} \tag{2-1}$$

subject to the budget constraint

$$(1+r_{k+1})^{-1} A_{ik+1} - A_{ik} = w_{ik}^{*}\left(\overline{L} - L_{ik}\right) - C_{ik} \qquad k = t, \ldots, T \tag{2-2}$$

In the utility function (2-1) $L_{ik}$ and $C_{ik}$ are assumed to be strongly separable, which restricts the direct relation between the two variables. This assumption is inevitable for our empirical analysis, because individual consumption data are not available in the data set of the FRG. $K_{ik}(C_{ik})$ is a monotonically increasing function, $a_{ik}$ denotes an individual-specific taste shifter and $\rho$ in the discount factor stands for the rate of time preference. The budget constraint (2-2), refers to the beginning of period *k*. On its left side, the term $(1+r_{k+1})^{-1} \cdot A_{ik+1} - A_{ik}$ represents the individual savings in period *k*. $A_{ik}$ denotes the stock of financial assets at the beginning of period *k*, whereas $(1+r_{k+1})^{-1} \cdot A_{ik+1}$ denotes the discounted stock of financial assets at the beginning of period *k+1*. It is assumed that the stock of assets at the end of period *k* earns a rate of interest $r_{k+1}$ at the beginning of period *k+1*. Per definition, the savings of period *k* must be equal to the labour income $w_{ik}^{*}(\overline{L} - L_{ik})$ minus the consumption $C_{ik}$ in period *k*, where $w_{ik}^{*}$ and $(\overline{L} - L_{ik})$ denote the real wage and the hours of labour supply, respectively. The maximal available time for leisure is limited by $\overline{L}$ .

Under uncertainty future wages, prices, preferences and other variables are not exactly known to the individual. We assume that only from the beginning of each period the exact realisations of these variables for the actual period are known. The individual expects realisations for future periods based on the information available in the actual planning period. The resulting permanent replanning process could be formulated in the framework of dynamic optimization, using the Bellman equation as follows:

$$\max_{C_{it},L_{it}}\left(K_{it}\left(C_{it}\right)+a_{it}L_{it}^{\alpha}+\frac{1}{1+\rho}E_t\left(V_{it+1}\right)\right) \qquad (2\text{-}3)$$

with

$$V_{it+1}=V\left(A_{it+1}\right)=\max\left[E_{t+1}\left\{\sum_{k=t+1}^{T}\frac{1}{\left(1+\rho\right)^{k-t-1}}\left(K_{ik}\left(C_{ik}\right)+a_{ik}\cdot L_{ik}^{\alpha}\right)\right\}\right]$$

The maximisation of (2-3) is carried out subject to the above budget constraint (2-2). It should be noted that the expectation operator $E_t$ represents the assumption of rational expectations, which means that the individual uses <u>all</u> information available in period t. Systematic prediction errors are excluded by assumption; only random prediction errors occur. The value function for the future period $V_{it+1}$ is formulated as a function of $A_{it+1}$ to indicate that the decision about the financial assets in period t is a date for the decision process in period t+1, and therefore could be regarded as the crucial link between two periods in an intertemporal separable framework.

The labour supply equation could be derived from the first order conditions for a maximum of (2-3). We assume that the individual-specific taste-shifter $a_{it}$ is a function of individual-specific time-constant preferences $a_i$, individual characteristics $x_{it}$ and a random variable $\upsilon_{it}$ for unobservable effects: $\ln a_{it}=a_i+x_{it}'\cdot\delta+\upsilon_{it}$ . After several transformations of the first order conditions the following empirical $\lambda$ -constant labour supply equation is obtainted (cf. MaCurdy, 1985, Hujer/Grammig, 1994 or Grammig, 1994 for a detailed presentation):

$$H_{it}^{*}=\ln\overline{L}-\gamma\ln\alpha+\gamma\overline{b}_t+\gamma(\ln\lambda_{i0}-a_i)+\gamma\ln w_{it}^{*}-\gamma x_{it}'\delta+\gamma(\sum_{j=1}^{t}\varepsilon_{ij}-\upsilon_{it}) \qquad (2\text{-}4)$$

with

$$\gamma=-\frac{1}{(\alpha-1)}$$

$$\overline{b}_t=\sum_{j=0}^{t}b_j \quad \text{with} \quad b_j=\ln\left(\frac{1+\rho}{1+r_j}\right)-\ln\left[E_{j-1}\left(\exp(\varepsilon_{ij})\right)\right]$$

$H_{it}^{*}$ denotes the transformed desired hours with $H_{it}^{*}=\ln\overline{L}-\ln L_{it}$ (Jakubson, 1988). The Lagrange-multiplier $\lambda_{i0}$ in equation (2-4) is interpreted in the life cycle framework as the marginal utility of initial assets $A_{i0}$. It represents the impact of the expected future wages, interest rates and preference-affecting factors, based on information available at period 0, on the actual labour supply $H_{it}^{*}$ (MaCurdy, 1985) and is substituted in (2-4) using the recursive relation $\ln\lambda_{it}=b_t+\ln\lambda_{it-1}+\varepsilon_{it}$ of the first-order conditions. The impact of additional information on labour supply, which arises with every new time period and requires adjustment of the expectations about future wages, interest rates and preference-affecting factors is represented by the one-period forecast error $\varepsilon_{it}$ .The crucial parameter of the above equation is the intertemporal elasticity of leisure $\frac{1}{(\alpha-1)}$ , which also could be interpreted as the $\lambda$ -constant wage elasticity.

The central problem of the intertemporal labour supply model is that observed worked hours could not be explained satisfactorily if the individuals are constrained in their labour supply. In this case individuals are not able to realise their desired labour supply and therefore have to work more or less hours or, as an extreme case, could be involuntary unemployed. Economic theory provides several approaches to explain this phenomenon. Following the Neokeynesian theory, labour supply constraints or involuntary unemployment could occur when in case of price-inflexibility, exogenous shocks from the industry's supply side are carried over to the labour market. The segmentation approach assumes the existence of a dual labour market, which is established due to the accumulation of firm-specific human-capital and firm-sociological aspects (Doeringer/Piore, 1971). Only the individuals of the secondary market are exposed to hours constraints and unemployment risk.

According to the theory of implicit contracts (Rosen, 1985) workers accept hours constraints or temporary lay-offs caused by unexpected business cycle fluctuations, when a constant labour income is guaranteed during these business cycle fluctuations. The insider-outsider theory (Lindbeck/Snower, 1988) states that it could be optimal if the employed workers use their bargaining power as 'insiders' to prevent potential competitors from entry into the firm. In the efficiency wage theory involuntary unemployment is caused as a by-product because firms pay higher wages to increase productivity which leads to a higher labour supply.

Following Ham (1986) we include demand-side indicators $x_{Dit}$ based on these theoretical approaches into the hours equation. This leads to the following relation between observed hours $H_{it}^{obs}$ and desired hours $H_{it}^{*}$ :

$$H_{it}^{obs} = H_{it}^{*} + x'_{Dit} \cdot \delta_D \qquad (2\text{-}5)$$

Only if the parameter vector $\delta_D = 0$ , the individual could realise his desired labour supply. Note, that in this formulation the demand side constraints are implicitly incorporated. Considering the effect of demand side constraints on labour supply explicitly an additional equation for modelling the participation decision is necessary (Zabel, 1993, Hujer/Grammig, 1994).

Another important aspect of our model is the endogenity of the wages, which is considered by the following equation:

$$\ln w_{it}^{*} = x'_{2it} \cdot \delta_2 + v_{2it} \qquad (2\text{-}6)$$

Besides the usual explanatory variables from the human capital theory, like years of schooling and years of labour market experience, the vector $x'_{2it}$ could also include variables related to the theoretical approaches explaining inter-industrial wage differentials (Wagner, 1991). One reason for the existence of these wage-differentials could be industry-specific high unemployment risk, which requires to offer wage-compensations. To attract workers transitory wage differentials could be paid by expanding industries during periods of structural changes. Another explanation is related to the efficiency wage theory, where the presence of wage differentials could depend on the relation between shirking of employees, monitoring and capital intensity or on the perception of a ‘fair wage’ by the employees inducing profitable industries to pay higher wages.

Considering these theoretical approaches makes the identification of parameters in the two-equation model of hours and wages easier, because industry-specific variables explaining the wage differentials are providing a theoretical based foundation of the necessary overidentifying restrictions.

## 3. Econometric Specification and Estimation using Unbalanced Panel Data

Althought in practice unbalanced data are rather the rule than the exception, most of the applied microeconometric work is devoted to the estimation with balanced data, especially in the area of the non-linear discrete-choice- or Tobit-models.

The following section treats some important econometric problems arising if the estimation of non-linear panel-models is based on unbalanced instead of balanced panel data. First, we discuss the importance of the missing data mechanism for the estimation, before we are turning to the econometric specification of our theoretical model from section 2. Finally an appropriate estimation procedure in a quasi-maximum likelihood framework is presented.

### 3.1. The role of the missing data mechanism in unbalanced data econometrics

This part deals with the important question, under which conditions the missing-data mechanism, causing the unbalancedness of the data set, could be ignored in maximum likelihood estimation. There are several reasons for incomplete data. Nonresponse could be caused by the usual panel mortality (refusal, death, removal, etc.), by inability of response or by the researchers sample-design decisions.

Our main interest is focused on the case, where unbalanced or incomplete data are characterized by the absence of <u>all</u> information for a certain individual in a certain panel wave.[1]

This could be expressed more formally, as follows: For the i-th individual (i = 1,...,N) of the panel sample-population N all information ($y_{it}$, $x_{it}$) are available for wave t (t= 1,..T), if the binary indicator variable $d_{it}$=1, otherwise $d_{it}$ =0. (Verbeek and Nijman, 1992) Furthermore denote the individual's panel length $T_i$ ( $T_i \in \{1,...,T\}$ ) as the sum of the number of panel waves, the individual 's data are available $T_i = \sum_{t=1}^{T} d_{it}$ .

We start from the general assumption, that the outcomes of a dependent variable $y_{it}$ and the binary missing data indicator $d_{it}$ are determined by the joint density function $f\left(y_{it}, d_{it} \mid x_{it}, \theta_t, \psi_t\right)$ conditional on a vector $x_{it}$ of explanatory variables and a set of parameters $\theta_t$ for $y_{it}$ and $\psi_t$ for $d_{it}$ . As well known, this could be written as the product of the marginal density $f\left(y_{it} \mid x_{it}, \theta_t\right)$ and the conditional density $f\left(d_{it} \mid y_{it}, x_{it}, \psi_t\right)$ :

$$f\left(y_{it}, d_{it} \mid x_{it}, \theta_t, \psi_t\right) = f\left(y_{it} \mid x_{it}, \theta_t\right) \cdot f\left(d_{it} \mid y_{it}, x_{it}, \psi_t\right) \qquad (3\text{-}1)$$

Now the missing data mechanism is definded to be ignorable, if the conditional density of $d_{it}$ is independent of $y_{it}$ , (Little and Rubin, 1987):

$$f\left(d_{it} \mid y_{it}, x_{it}, \psi_t\right) = f\left(d_{it} \mid x_{it}, \psi_t\right) \qquad (3\text{-}2)$$

In this case the joint density in (3-1) reduces to the product of the marginal densities. $y_{it}$ and $d_{it}$ are independent random variables (cf Spanos, p.87) so that the likelihood function for $y_{it}$ could be ob-

[1] For other cases with the absence of information on some variables only a lot of literature and applications are available (cf. Maddala, 1983, Amemiya, 1985).

tained from its marginal distribution conditional on $x_{it}$. It should be noted, that the distribution of $d_{it}$ need not to be independent of the explanatory variables $x_{it}$ for $y_{it}$ (Little and Rubin, 1987).

A generalization for panel data is easily obtained assuming the missing data mechanism to be a multivariate process (Verbeek and Nijman, 1992). Denote $d_i=(d_{i1},...,d_{it},...,d_{iT})$' the T-dimensional vector of the individual binary missing data indicator and $y_i=(y_{i1},...,y_{it},...,y_{iT})$' resp. $x_i=(x_{i1},...,x_{it},...,x_{iT})$' the stacked vectors of the dependent variable resp. the explanatory variables. Then the condition, that the missing data mechanism could be ignored, changes from (3-2) into:

$$f\left(d_i \mid y_i, x_i, \psi\right) = f\left(d_i \mid x_i, \psi\right) \qquad (3\text{-}3)$$

with the parameter vector $\psi$. Due to the assumption of a multivariate distribution this condition is stronger than the validity of (3-2) jointly for all panel waves, because it does not allow for the intertemporal effects usually existing in a multivariate distribution (Verbeek and Nijman, 1992). It should be mentioned that this condition always has to be imposed when panel data are analysed ignoring the missing data mechanism, whether an unbalanced data or a balanced data set is used. Nevertheless in the latter case the problem of the missing data mechanism is often neglected.

## 3.2. Econometric Specification

The simultaneous equation system for labour supply and wage determination derived in the theoretical section could be formulated in the line of the Tobit-III-model (cf. Amemiya, 1985), which is extended for the panel purposes by the individual-specific effects $c_{1i}$ and $c_{2i}$ and the time-specific effects $c_{1t}$ and $c_{2t}$ .

$$\tilde{H}_{it} = H^*_{it} = c_{1i} + c_{1t} + x'_{1it}\beta_1 + \gamma \ln w^*_{it} + u^*_{1it} \qquad \text{if } H^*_{it} > 0 \qquad (3\text{-}4)$$

$$\tilde{H}_{it} = 0 \qquad \text{else}$$

$$\ln w_{it} = \ln w^*_{it} = c_{2i} + c_{2t} + x'_{2it}\beta_2 + u^*_{2it} \qquad \text{if } H^*_{it} > 0 \qquad (3\text{-}5)$$

$$\ln w_{it} = 0 \qquad \text{else}$$

for
$i = 1,..., N$
$t = 1,..., T_i$

$\beta_1$ and $\beta_2$ denote the vectors of the slope parameters, $\gamma$ is the wage parameter. The error terms $u^*_{1it}$ and $u^*_{2it}$ are assumed to be normally distributed with $N(0, \sigma^2_{u^*_{tg}})$ ( g = 1,2)

Whereas the time-specific effects $c_{1t}$ and $c_{2t}$ could easily be estimated as fixed parameters, an important question for panel models is whether the individual-specific effects $c_{1i}$ and $c_{2i}$ should be treated as fixed or random. In addition to the usual problems of the individual-specific fixed-effect approach (cf. Hsiao, 1986), the application in the context of unbalanced panel data could lead to a substantial loss of cases, especially in short panels. This is due to the fact that estimating the individual fixed effects requires at least two observations per individual (cf. Wansbeek and Kapteyn, 1989).

Specifying the individual-specific effect as random avoids this problem. The parameters could be estimated consistently, if the assumed distribution of the random effects is correct and if $c_{1t}$ and $c_{2t}$ are uncorrelated with the explanatory variables (Jakubson, 1988, Hujer/Schnabel, 1991). Moreover, the advantage that all individuals participating in the panel could be brought into the analysis implies a gain in efficiency.

Considering the problem of correlation between random effects and regressors, Chamberlain (1984) suggests an often used specification where the individual random effect $c_i$ is specified as a linear function of the correlated regressors from all time periods (Hujer/Schnabel, 1991).

$$c_i = x'_{\alpha i1}\tau_1 + x'_{\alpha i2}\tau_2 + \ldots + x'_{\alpha it}\tau_t + \ldots + x'_{\alpha iT}\tau_T + \eta_{it} \qquad (3\text{-}6)$$

$x_{\alpha it}$ denotes the vector of the correlated regressors, $\tau_t$ is the corresponding parameter vector and the error term $\eta_{it}$ is normally distributed as $N(0, \sigma_\eta^2)$

Obviously, this procedure could not be applied to the unbalanced estimation, because of the missing data for a non-ignorable part of the panel population (i.e. for individuals with $T_i < T$).

Instead an alternative procedure suggested by Mundlak (1978) could be used for unbalanced data estimation with correlated random effects. In this specification the parameter vector $\tau_t$ ist restricted to $\tau_t = \frac{1}{T_i}\tau$ (Schnabel, 1994) .Therefore the random effect could be written as a linear function of the means over time of the correlated regressors. Formally, equation (3-6) reduces to:

$$c_i = \overline{x}'_{\alpha i}\tau + \eta_{it} \qquad (3\text{-}7)$$

with $\overline{x}'_{\alpha i} = \frac{1}{T_i}\sum_{t_i=1}^{T_i} x'_{\alpha it_i}$ , $\qquad t_i = 1,\ldots,T_i$

Note, that it is possible to compute the mean over time for the correlated regressors $\overline{x}'_{\alpha i}$ for every individual from the available individual panel waves $T_i$. In the special case of $T_i=1$ the mean $\overline{x}'_{\alpha i}$ corresponds to the observed value $x_{it}$.

Including Mundlak's correlated random effects specification for the hours equation the following model is obtained:

$$\tilde{H}_{it} = H^*_{it} = c_{1t} + x'_{1it}\beta_1 + \overline{x}'_{\alpha i}\tau + \gamma \ln w^*_{it} + u_{1it} \qquad \text{if } H^*_{it} > 0 \qquad (3\text{-}8)$$

$$\tilde{H}_{it} = 0 \qquad \text{else}$$

$$\ln w_{it} = \ln w^*_{it} = c_{2t} + x'_{2it}\beta_2 + u_{2it} \qquad \text{if } H^*_{it} > 0 \qquad (3\text{-}9)$$

$$\ln w_{it} = 0 \qquad \text{else}$$

$$u_{1it} = \left(u_{1it}^{*} + \eta_{it}\right) \quad (3\text{-}10)$$

$$u_{2it} = \left(u_{2it}^{*} + c_{2i}\right) \quad (3\text{-}11)$$

$i = 1,..., N$; $t = 1,..., T_i$

For the composite error terms $u_{1it}$ and $u_{2it}$ the absence of correlation between individuals is assumed:

$$E\left(u_{git} u_{g'i't'}\right) = 0 \qquad \text{for } i \neq i' \quad (3\text{-}12)$$

$g, g' = 1, 2 \quad i, i' = 1,..., N \quad t, t' = 1,..., T$

The random vector $u_i=(u_{1it},u_{2it},...., u_{1iT},u_{2iT})$ is assumed to follow a 2T-variate normal distribution with

$$E\left(u_i\right) = 0 \qquad \text{and} \qquad E\left(u_i u_i'\right) = \Sigma_u \quad (3\text{-}14)$$

where the intertemporal correlation matrix $\Sigma_u$ is allowed to vary freely between equations and time periods ( Hujer/Schnabel, 1994).

## 3.3. Estimation in a Quasi-Maximum-Likelihood-Framework

In this part we will present an estimation strategy for the described econometric model using unbalanced panel data. In the area of unbalanced panel estimation most of the literature deals with linear models (Hsiao, 1986, Wansbeek/Kapteyn, 1989, Baltagi/Chang, 1993, Verbeek/Nijman, 1992,) where the problem appears, that the formulation of simple linear estimators becomes difficult or impossible, if unbalanced data are used. Therefore the intention is to develop alternative relatively simple estimators, without referring to non-linear iterative techniques. In contrast, we already apply the censored regression model in a non-linear iterative estimation framework, so that this problem of the linear models does not occur and estimation using unbalanced panel data is a rather straightforward extension.

Under the assumption that the missing data mechanism is independent of the hours of labour supply and the wage rate, the labour supply decision and wage rate determination are characterized by the usual 2T-variate normal distribution, according to the above distributional assumptions for the error terms (cf. Hujer/Schnabel, 1994). Consistent estimation of the parameters applying the Full Information Maximum Likelihood (FIML)-method succeeds only if the assumed probability model (i.e. the intertemporal multivariate normal distribution) is correct (Jakubson, 1988, p.310). Furthermore FIML reveals the problem of calculating multidimensional integrals (Jakubson, 1988, Hujer/Schnabel, 1994) which is possible (Börsch-Supan/Hajivassiliou, 1994) but burdensome (cf Hujer/Grammig, 1994 or Grammig, 1994 for a detailed discussion). In the case of unbalanced panel data an additional complication supports the rejection of direct FIML-estimation: Due to the different numbers of available individual observations the individual likelihood contributions get variable dimensions.

Alternatively a Quasi-Maximum-Likelihood approach (QML), suggested by White (1982), could be used, which explicitly gives up the assumption of an intertemporal multivariate normal distribution. The resulting estimator is less efficient than the FIML-estimator but has several advantages: Besides less computational burden and an easier restriction testing the expansion to unbalanced panel data is straightforward.

The basic idea of the QML-approach is to minimize the deviations from the true structure or as White (1982) points out: „ ...(to) minimize our ignorance about the true structure“ (p.4). Following this idea Chamberlain (1984) used a two-step procedure, which has been widely applied (Jakubson, 1988, Hujer/Schnabel, 1994 u.a.). This procedure should be shortly described for the present econometric model, where special emphasis is laid to the application on unbalanced panel data.

In the first step, estimation is based on the reduced-form equation system of the above structural model (3-8) to (3-14), because of the censoring of the wage rate, which enters as an explanatory variable in the hours equation. The reduced-form equation system is written as:

$$\tilde{H}_{it} = x_{it}^{'} \cdot \pi_{1t} + \bar{x}_{2i}^{'} \cdot \tau + e_{1it} \qquad if\ H_{it}^{*} > 0 \qquad (3\text{-}13)$$

$$\tilde{H}_{it} = 0 \qquad \text{else}$$

$$\ln w_{it} = x_{it}^{'} \cdot \pi_{2t} + e_{2it} \qquad if\ H_{it}^{*} > 0 \qquad (3\text{-}14)$$

$$\ln w_{it} = 0 \qquad \text{else}$$

with:

$$\pi_{1t} = (c_{1t} + \gamma \cdot c_{2t},\ \beta_1 + \gamma \cdot \beta_2)^{'}$$

$$\pi_{2t} = (c_{2t},\ \beta_2)^{'}$$

$$e_{1it} = u_{1it} + \gamma \cdot u_{2it}$$

$$e_{2it} = u_{2it}$$

where $e_{it} = (e_{1it}, e_{2it})'$ is i.i.d. normal $e_{it} \sim \mathrm{N}\,(0, \Sigma_{e_t})$

with $\Sigma_{e_t} = \begin{pmatrix} \sigma_{1t}^2 & \sigma_{12t} \\ \sigma_{12t} & \sigma_{2t}^2 \end{pmatrix}$ for t = 1,...,T

In contrast to the structural model, the assumption of possible correlations between time-periods is offset, so that the underlying 2T-variate normal distribution of the error terms is reduced to the product of T marginal bivariate normal distributions. Therefore the resulting log-QML-function could be written as:

$$Q(\xi | H, \ln w) = \sum_{t=1}^{T} \ln L_t(\xi_t | \widetilde{H}_t, \ln w_t) \;= \sum_{t=1}^{T}\sum_{i=1}^{N} \ln l_{it}(\xi_t | \widetilde{H}_{it}, \ln w_{it}) \qquad (3\text{-}15)$$

with

$\xi_t = (\pi_{1t}, \pi_{2t}, \sigma_{1t}^2, \sigma_{2t}^2, \sigma_{12t})'$ and $\xi = (\xi_1, ..., \xi_t, ..., \xi_T)'$

The log of the individual likelihood contributions ln$l_{it}$ are summed up over individuals and time periods. Estimates of the reduced-form parameter vectors $\xi_t = (\pi_{1t}, \pi_{2t}, \sigma_{1t}^2, \sigma_{2t}^2, \sigma_{12t})'$ could be obtained by separate maximisation of the marginal log-likelihood functions $\ln L_t(\xi_t)$ .

When unbalanced panel data is considered, the problem appears that for some individuals the likelihood contributions $l_{it}$ (t = 1,..,T) could not be calculated for every panel wave due to missing data. At this stage it does not seem to be a real problem, because maximisation of $\ln L_t(\xi_t)$ could simply be based on the set of available cases $N_t = \{ i \in \{1,...,N\} \mid d_{it} = 1 \}$ of wave t. This corresponds to set ln$l_{it}$ to zero for those individuals with missing information in wave t ( $i \notin \{N_t\}$ ). More formally the problem could be written as:

$$\max_{\xi_t} \; \ln L_t(\xi_t | \widetilde{H}_t, \ln w_t) = \sum_{i=1}^{N} \ln l_{it}(\xi_t | \widetilde{H}_{it}, \ln w_{it}) \;= \sum_{i \in N_t} \ln l_{it}(\xi_t | \widetilde{H}_{it}, \ln w_{it}) \qquad (3\text{-}16)$$

if $\ln l_{it} = 0$ for $i \notin \{N_t\}$

subject to:

$$\frac{\partial \ln L_t(\hat{\xi}_t^{N_t})}{\partial \xi_t} = \frac{\partial \left[ \sum_{i \in N_t} \ln l_{it}\left(\hat{\xi}_t^{N_t}\right) \right]}{\partial \xi_t} = 0 \quad \text{for all } t = 1,...,T$$

With $\hat{\xi}_t^{N_t}$ we denote the estimated reduced-form parameter vector which maximises the marginal log-likelihood function ln$L_t$ , based on the sample $N_t$. The second step of Chamberlain's QML-approach (1984) consists of a Minimum-Distance procedure. Besides the identification restrictions for obtaining the structural parameters and other parameter restrictions, the intertemporal correlation, which had been assumed away in the first step, is taken into account by an appropriate weighting matrix. Usually this weighting matrix $\Omega$ is an estimate of the inverse of the reduced-form parameter covariance matrix and could be estimated based on the M-estimator approach of Huber (1967) as follows:

$$\hat{\Omega} = \hat{I}^{-1} \hat{\Delta} \hat{I}^{-1} \qquad (3\text{-}17)$$

with

$$\hat{I}(\hat{\xi}^*) = diag \left\{ -\frac{\partial^2 \ln L_t(\hat{\xi}_t^*)}{\partial \xi_t \partial \xi_t'} \right\}$$

where $\hat{I}(\hat{\xi}^*)$ is a block-diagonal matrix containing the information matrices, estimated at the maximum of the marginal log-likelihood function ln$L_t$ (Hujer/Schnabel, 1994, Schnabel, 1994). The weighting matrix $\hat{\Delta}$ consists of the sum of outer products of the likelihood scores for the total sample N:

$$\hat{\Delta} = \sum_{i=1}^{N} \Psi_i \Psi_i' \tag{3-18}$$

with

$\psi_i = (\psi_{11}', \ldots, \psi_{it}', \ldots, \psi_{iT}')'$

The individual score for period t, denoted $\psi_{it}$, contains the first derivatives of the individual log-likelihood function ln$l_{it}$ of the reduced-form parameters $\hat{\xi}_t^*$, estimated for the total sample N :

$$\psi_{it} = \frac{\partial \ln l_{it}(\xi_t^*)}{\partial \xi_t} \tag{3-19}$$

Obviously, in the case of unbalanced panel data the individual score could not be calculated for the time periods where the individual data is missing. For the same reason, parameter estimates $\hat{\xi}_t^*$, based on the total sample N are not available. Therefore an additional assumption has to be introduced.

The simplest and most convincing assumption is to set the score for the individuals with missing-data $\psi_{i \notin N_t}$ equal to the mean individual score $\overline{\psi}_t$ of the sample $N_t$ at the parameter vector $\hat{\xi}_t^{N_t}$, estimated at the first step.

$$\psi_{i \notin N_t} = \overline{\psi}_t(\hat{\xi}_t^{N_t}) = 0 \qquad \text{for t = (1,...,T)} \tag{3-20}$$

with $\overline{\psi}_t = \frac{1}{n_t} \sum_{i \in N_t} \psi_{it}\left(\hat{\xi}_t^{N_t}\right)$ $\qquad n_t = \sum_{i \in N_t} d_{it}$

Setting $\psi_{i \notin N_t}$ to zero corresponds to the assumption $\ln l_{it} = 0$ for $i \notin \{N_t\}$ in the first estimation step. Thus, the parameter vector $\hat{\xi}_t^{N_t}$ maximizing ln$L_{it}$ based on a sample $N_t$ is also the maximizing parameter vector $\hat{\xi}_t^*$ (= $\hat{\xi}_t^{N_t}$ ) for a sample N, where by assumption the likelihood contributions of the individuals with missing data are set to zero.

A possible critique could be the argument that the individual score vector is usually non-zero and therefore the missing $\psi_{i \notin N_t}$ should better be replaced by the value of a similar individual. But this implies a rather blurred assumption concerning data imputation for the individuals with missing data, so that the estimated parameter vector at the first stage, based on the complete cases, could not longer be optimal $\hat{\xi}_t^* \neq \hat{\xi}_t^{N_t}$ . Another possibility is to leave out the unbalanced cases when the outer product of scores is computed, but this means that additional information is ignored.

Following the above approach, the corresponding information matrix $\hat{I}(\hat{\xi}^{N_t})$ could easily be obtained from the cross-section estimation of the first step, where $\hat{\xi}_t^*$ is set equal to $\hat{\xi}_t^{N_t}$ .

# 4. Data Description

This comparative study is primarily based on data of the US Panel Study of Income Dynamics (PSID) and the German Socio Economic Panel (SEP), which both provide detailed information on the economic and socio-demographic situation of individuals and households. A description of these panel studies could be found in Hanefeld (1987) for the SEP and in Hill (1992) for the PSID. At present 10 waves of the SEP from 1984 to 1993 are available, whereas the PSID family-individual file covers the years from 1968 to 1988. The database of our study consists of four waves from 1984 to 1987. The same time period for both countries is chosen to control for possible cohort effects and the impact of international business cycle fluctuations on the parameter estimates. We could not extend our database beyond 1987, because in the PSID information on income variables is ascertained retrospective. Therefore the recent PSID wave 1988 could only be exploited to get the 1987 income data.

In order to determine the effects of regional and sectoral variables on labour supply, we merged additional data from other sources. For the regional unemployment rate of the US-sample we used the unemployment rate of the county of residence, which is already included in the PSID. Missing values were replaced by the state unemployment rate from the Handbook of Labor Statistics (HLS) (US Department of Labor, 1989). For the German sample the regional unemployment rate is provided by the Federal Institute for Research in Urban and Regional Policy (BfLR). Industry-specific unemployment rates have been taken from official statistics of the Federal Bureau of Labour (Bundesanstalt für Arbeit, 1989) and the US Department of Labour (1989), where we could distinguish between 34 different industries for the German sample and 11 for the US-sample. Data of industry-specific economic indicators, disaggregated on a level of 31 industries for both countries, are obtained from the OECD International Sectoral Database (ISD).

A description of the variables chosen for the econometric estimation is supplied in the appendix (Table A1.). As measure of labour supply we used weekly hours to guarantee comparability between the data sets, taking into account that the SEP questionnaire does not provide a reliable measure of annual hours.

For our analysis, we chose the unmarried female heads of household, who are younger than 61 years and not self-employed. The selection process is described in the appendix (Tables A2. and A3.). The term 'unmarried' covers different family statuses and therefore the sample compromises single, divorced, separated and widowed females. Although this wide interpretation could be criticised (cf. Riedmüller/Glatzer), we assume similar behaviour of the unmarried females, reflecting their central economic position as head of the household.

A look at the means and standard deviations of the selected variables in the appendix (Table A4., A4.A., A5. and A5.A.) shows, that the widowed females are considerably older than the other subgroups. Their average age is about 50 years, whereas the average age of the other groups (single, divorced, separated) range between 30 and 43 years. Moreover the widows are characterized by lower labour force participation (USA: 48-61% (73-78%) widows (total sample); FRG: 38-45% (64-71%) widows (total sample)) and higher other income (USA: 690-850 $ (360-440 $) widows (total sample); FRG: 1400-1650 DM (700-870 DM) widows (total sample)).[2]

These descriptive results suggest the hypothesis that the behaviour of the widowed women, due to their higher age and better economic backround, differ from the other unmarried females. Thus, we

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[2] A more detailed descriptive and explorative analysis of the sample heterogeneity is presented in Hujer/Hassel (1995).

test this hypothesis by carrying out our econometric analyses for a complete sample and a sample without widows.

Another important question concerns the unbalancedness of the data. As shown in the last section, the identification of the intertemporal correlation requires individuals with available data for more than one panel wave. Table 4.1 shows the response frequency in the different data sets. For nearly one quarter of the population only one observation is available. Conversely, almost 75% of the sample to identify the intertemporal correlation and the parameters of the correlated random effects regressors seems to be sufficient. As a further result of Table 4.1., estimation based on a balanced sub-sample is not recommended, because two third of the observations would get lost, inducing a dramatical loss of efficiency.

**Table 4.1.**
**Frequency of response**

| | SEP | | | | PSID | | | |
|---|---|---|---|---|---|---|---|---|
| | complete sample | | sample without widows | | complete sample | | sample without widows | |
| frequency of re-sponse | abs. | rel. (%) | abs. | rel. (%) | abs. | rel. (%) | abs. | rel. (%) |
| 1 | 192 | 27,1 | 151 | 25,9 | 190 | 24,8 | 175 | 25,7 |
| 2 | 139 | 19,6 | 119 | 20,4 | 131 | 17,1 | 110 | 16,2 |
| 3 | 127 | 17,9 | 104 | 17,9 | 153 | 19,9 | 138 | 20,3 |
| 4 | 251 | 35,4 | 208 | 35,7 | 239 | 38,2 | 258 | 37,9 |
| total | 709 | 100 | 582 | 100 | 767 | 100 | 681 | 100 |

In addition, the importance of unbalancedness could be assessed with measures of unbalancedness as proposed by Ahrens/Pincus (1981) and Baltagi/Chang (1993). In the next table the results of the following measures are shown.

$$\gamma(N) = \frac{m}{\bar{n}\sum_{i=1}^{m}\frac{1}{n_i}} \qquad (4\text{-}1)$$

$$\nu(N) = \frac{1}{m\sum_{i=1}^{m}\left(\frac{n_i}{N}\right)^2} \qquad (4\text{-}2)$$

with $\bar{n} = \frac{1}{m}\sum_{i=1}^{m} n_i$ and $N = \sum_{i=1}^{m} n_i$

$m$ = number of observed individuals
$N$ = total number of observations
$n_i$ = number of individual observations
$\bar{n}$ = average number of individual observations

**Table 4.2.**
**Measures of Unbalancedness**

| | SEP | | PSID | |
|---|---|---|---|---|
| | complete sample | sample without widows | complete sample | sample without widows |
| $\gamma(N)$ | 0,739 | 0,744 | 0,744 | 0,740 |
| $\nu(N)$ | 0,822 | 0,826 | 0,834 | 0,832 |
| $\bar{n}$ | 2,616 | 2,634 | 2,716 | 2,703 |

The measures $\gamma(N)$ and $\nu(N)$ take the value one, if the data set is balanced and zero if it is completely unbalanced. Together with $\bar{n}$ they reinforce the impression that the data sets are rather unbalanced, but not too severe to spoil the analysis. The direct comparison between the US and the German samples shows that the differences in unbalancedness are not significant.

# 5. Empirical Results

In this section we present the estimation results of the econometric model, developed in the preceding section. The estimation is performed for a complete sample of unmarried women and a sample excluding the widows. The results for the complete sample are displayed in Table 5.1. and 5.2., the results for the sample without widows could be found in the appendix, Table A6. and A7. The choice of the explanatory variables is oriented at the analysis of married female labour supply by Hujer/Grammig/Schnabel (1994) Hujer/Grammig (1994) and Grammig (1994) to provide a basis of comparison between married and unmarried women.

The structural log-wage equation is specified by taking human capital theory into account, using the individual variables education (EDUMI), experience (EXP) and experience squared (EXP2). In addition, as mentioned in section 2, variables indicating the impact of inter-industrial wage differentials are included. The variables capital stock per employee (KTVDPC) and sectoral unemployment rate (SUNEMP) provide together with the experience variables the necessary overidentifying restrictions. Moreover, the profit per employee (OPET), the index of the sectoral gross product (IGD80), the difference between productivity growth and growth of total payroll per employee (PRDIET) and the regional unemployment rate (RUNEMP) are used as explanatory variables.

In the specification of the hours equation the variables AGE and EDUMI are included to represent individual preferences. The influence of children on labour supply is considered by the number of children of different age groups: 0-6 (K6), 7-10 (K10) and 11-15 (K15). It should be noted, that the presence of children could have two effects on the labour supply of unmarried women. Supposing that she is the main earner of the household, the necessity of financial support could counteract the negative effect of child care necessity on labour supply. We assume that the child care effect is dominant for young children, whereas the presence of older children could have an insignificant or positive effect on labour supply. Furthermore, to control for the effect of other income on labour supply, the variables HRINC and HRINC2 are included in the hours equation, which contains the non-labour income of unmarried women, as for example transfers, alimony payments or pensions.

According to the above theoretical considerations, sectoral and regional demand-side indicators are included as explanatory variables. The regional unemployment rate (RUNEMP) should control for the effects of the regional labour market situation on labour supply. The sectoral variables IGD80 and OPET represent the industry's market and rentability situation, which could affect the labour market as maintained by the Neokeynesian theory. The variable PRDIET is considered as a test of the effect of a difference between wage growth and productivity growth on the employment possibilities. The variable ITKT measures the sectoral intensity of investment. Its effect on labour supply could indicate whether the investments are rather job-creating or job-destroying.

Examination of the estimated log-wage equation shows that the parameters of the education and experience variable are quite similar for the USA and the FRG. The positive relation between education/experience and wages assumed by the human capital theory could be confirmed by the data. This result also corresponds to the results for married women as shown in Hujer/Grammig (1994) and Grammig (1994). Concerning the impact of the sectoral variables some estimated parameters differ considerably between USA and FRG. For example, the variable capital per employee (KTVDPC) has a significant negative impact on the US wages. This could be interpreted as an indicator for negative wage differentials in capital-intensive industries due to easier monitoring feasibility (Wagner, 1991). In contrast to this result, a positive, but insignificant, relation between KTVDPC and the log-wage for the FRG is found. Another important difference concerns the influence of the regional unemployment rate (RUNEMP), which has a negative impact on US and FRG wages, but is only significant for the US data. For the sectoral unemployment rate (SUNEMP) a high significant negative impact on the log-wage is found for both data sets. Therefore, the hypothesis of wage-compensations induced by industry-specific high unemployment risk could not be accepted but it seems that sectoral unemployment is taken into account in the wage structure and the wage bargaining process, perhaps to prevent more dismissal in shrinking industries. The high significant negative relation between SUNEMP and the log-wage could also be confirmed for married women.

## Table 5.1.
## Tobit-III-Model
### Minimum Distance Estimation Unbalanced with Correlated Random Effects (Mundlak specification) SOEP (Complete sample)

| | **Hours equation** | | **Wage equation** | |
|---|---|---|---|---|
| | Parameter | t-value | Parameter | t-value |
| ln w | 0.36547 | 4.55743 | - | - |
| **Year effects** | | | | |
| 1984 | -0.42706 | -6.15395 | 1.83568 | 11.66881 |
| 1985 | -0.43516 | -6.28863 | 1.86243 | 11.81221 |
| 1986 | -0.45045 | -6.55610 | 1.90637 | 11.73748 |
| 1987 | -0.46291 | -6.69383 | 1.92772 | 11.57265 |
| **Individual variables** | | | | |
| AGE | -0.04983 | -4.12510 | - | - |
| EDUMI | -0.16664 | -3.27234 | 0.68412 | 13.79744 |
| EXP | - | - | 0.39333 | 8.47170 |
| EXP2 | - | - | -0.61501 | -5.97964 |
| K6 | -0.07244 | -3.86481 | - | - |
| K10 | -0.04248 | -2.84529 | - | - |
| K15 | -0.03207 | -2.45178 | - | - |
| HRINC | -0.17484 | -10.43383 | - | - |
| HRINC2 | 0.04927 | 8.32386 | - | - |
| **Sectoral and regional variables** | | | | |
| RUNEMP | -0.01224 | -0.50080 | -0.06830 | -1.58224 |
| OPET | -0.08477 | -1.71964 | 0.11471 | 1.76755 |
| PRDIET | 0.15702 | 0.89542 | - | - |
| PRDIET84 | - | - | -0.25725 | -0.25969 |
| PRDIET85 | - | - | 0.23534 | 0.56406 |
| PRDIET86 | - | - | -0.29559 | -0.83306 |
| PRDIET87 | - | - | -0.71385 | -1.90893 |
| IGD80 | 0.13869 | 1.65609 | -0.27313 | -2.04948 |
| ITKT | -0.11250 | -0.23629 | - | - |
| SUNEMP | - | - | -0.13427 | -4.54882 |
| KTVDPC | - | - | 0.01740 | 1.22688 |
| **Corr. random effects** | | | | |
| HRINCMT | -0.03888 | -3.96725 | - | - |
| **Variances** | | | | |
| 1984 | 0.13294 | 23.81538 | 0.32406 | 20.78413 |
| 1985 | 0.13184 | 23.69226 | 0.33829 | 14.73043 |
| 1986 | 0.13507 | 23.76216 | 0.38114 | 15.73236 |
| 1987 | 0.13314 | 23.19240 | 0.34814 | 18.74002 |
| | | | | |
| RHO84 | -0.16471 | -2.96956 | - | - |
| RHO85 | -0.26450 | -4.99071 | - | - |
| RHO86 | -0.33094 | -5.12222 | - | - |
| RHO87 | -0.27839 | -3.65455 | - | - |

## Table 5.2.
## Tobit-III-Model
### Minimum Distance Estimation Unbalanced with Correlated Random Effects (Mundlak specification)
### PSID (Complete sample)

| | Hours equation | | Wage equation | |
|---|---|---|---|---|
| | Parameter | t-value | Parameter | t-value |
| ln w | 0.15547 | 4.60451 | - | - |
| **Year effects** | | | | |
| 1984 | 0.13757 | 1.15264 | 0.47255 | 1.91047 |
| 1985 | 0.12046 | 1.03082 | 0.51259 | 2.02247 |
| 1986 | 0.09381 | 0.79008 | 0.40920 | 1.58968 |
| 1987 | 0.14511 | 1.21202 | 0.37807 | 1.46068 |
| **Individual variables** | | | | |
| AGE | -0.01466 | -2.70628 | - | - |
| EDUMI | 0.00018 | 0.00314 | 1.27508 | 14.62973 |
| EXP | - | - | 0.32670 | 7.35157 |
| EXP2 | - | - | -0.64716 | -5.95362 |
| K6 | -0.04102 | -4.68108 | - | - |
| K10 | -0.01524 | -1.37169 | - | - |
| K15 | -0.01238 | -1.17267 | - | - |
| HRINC | -0.22469 | -8.75792 | - | - |
| HRINC2 | 0.05377 | 4.25008 | - | - |
| **Sectoral and regional variables** | | | | |
| RUNEMP | 0.01034 | 0.57160 | -0.21147 | -4.21375 |
| OPET | -0.02559 | -0.65755 | 1.01556 | 4.83594 |
| PRDIET | 0.19602 | 2.41471 | - | - |
| PRDIET84 | - | - | 0.48561 | 1.18117 |
| PRDIET85 | - | - | -2.12556 | -6.15768 |
| PRDIET86 | - | - | -1.37389 | -1.60348 |
| PRDIET87 | - | - | 2.04025 | 1.58076 |
| IGD80 | -0.15707 | -2.11589 | 0.25752 | 1.56830 |
| ITKT84 | 0.59994 | 2.31483 | - | - |
| ITKT85 | 0.94871 | 3.25600 | - | - |
| ITKT86 | 1.48912 | 4.42045 | - | - |
| ITKT87 | 0.79299 | 2.12051 | - | - |
| SUNEMP | - | - | -0.81988 | -8.22203 |
| KTVDPC | - | - | -0.09826 | -4.41310 |
| **Corr. random effects** | | | | |
| HRINCMT | 0.01963 | 1.17166 | - | - |
| **Variances** | | | | |
| 1984 | 0.12511 | 23.49166 | 0.39006 | 25.47862 |
| 1985 | 0.13119 | 22.32754 | 0.38513 | 26.50121 |
| 1986 | 0.12541 | 24.25826 | 0.39576 | 34.33465 |
| 1987 | 0.14172 | 25.30357 | 0.40089 | 33.53383 |
| RHO84 | -0.03963 | -0.54881 | - | - |
| RHO85 | -0.15149 | -1.96736 | - | - |
| RHO86 | 0.06714 | 1.09007 | - | - |
| RHO87 | -0.20699 | -2.92322 | - | - |

In the hours equation, the wage parameter $\gamma$ is of special interest. As mentioned before, $-\gamma$ could be interpreted as the intertemporal elasticity or the $\lambda$ -constant wage elasticity of leisure. The corresponding labour supply elasticity could be obtained by the following relation:

$$\frac{\partial H_{it}}{\partial w_{it}^{*}} \cdot \frac{w_{it}^{*}}{H_{it}} = \gamma \cdot \frac{(\overline{L} - H_{it})}{H_{it}} \qquad (5\text{-}1)$$

In table 5.3. the estimates of the labour supply elasticity for the complete sample and the sample without widows are compared to the results of an almost similar model for married women estimated by Grammig (1994).

**Table 5.3.**

**Comparison of the labour supply elasticity at 40 hours between unmarried and married women**

| | Unmarried women | | Married women[3] |
|---|---|---|---|
| | Complete Sample | Sample without widows | |
| FRG | 1.169504 | 0.836032 | 0.713696 |
| USA | 0.497504 | 0.4032 | 0.829664 |

A comparison between the complete sample and the sample without widows shows that the estimated labour supply elasticity decreases in the USA by 18,9% and in the FRG by 28,5% when the widows are excluded. Therefore, the different labour supply behaviour of the widowed women could not be explained by pure age- or other income-effects as suggested by our descriptive analysis. Considering in addition the results for married women, we found the labour supply elasticities for the sample without widows in the FRG to be very similar to those of the married women. For unmarried women in the USA the labour supply elasticity is in general almost 50% higher than for married women. Comparing these results to the results for prime-age males in the survey of Pencavel (1986), who reports intertemporal labour supply elasticities from US- and UK-studies varying between -0,07 and 0,45, we conclude that in the USA unmarried women seem to behave more like men, when wage changes are occuring. In contrast, in the FRG unmarried women tend to behave quite similar to married women. These differences between the two countries are confirmed by a direct comparison of the estimates, showing that the labour supply elasticities for unmarried women in the USA are more than 50% smaller than the estimates for the FRG. Possible explanations for

[3] Parameters for married women are from : Grammig, J.(1994): Ökonometrische Arbeitsangebotsmodelle für Paneldaten - Alternative Ansätze in einer vergleichenden empirischen Studie für die USA und die Bundesrepublik Deutschland. Unpublished Dissertation, Frankfurt, pp.140/141.

these obvious differences could be unobserved factors like different work opportunities, different attitudes towards work or other institutional conditions, like for example the alimony payment regulation which is easier to avoid in the USA (Coverman, Kemp, 1987).

For the effects of the individual variables similar results are obtained in both countries, except the education variable which is significantly negative for the FRG data and insignificantly positive for the USA. A comparison of the effects of the children indicators shows that for the FRG all children variables indicate a significantly negative impact on labour supply, whereas for the USA data only the little children (K6) have a significantly negative influence on labour supply. This conflicts with the empirical results for married women, where all children variables exert a significantly negative influence on labour supply (Hujer/Grammig (1994), Grammig (1994) ). An explanation could be the increasing importance of financial support when children are growing, which partly offset the child care effect. It is clear that unmarried women are more exposed to this problem because of their economic status as the main-earner of the family.

Inclusion of the variable other income (HRINC) could be interpreted as a test of the life-cycle hypothesis (Jakubson, 1988, Hujer/Schnabel, 1991). According to the life-cycle theory, changes in other income should only exert an influence on labour supply via the individual-specific component $\lambda_{it}$. Thus, the parameter of the variable HRINC in our estimated model is expected to be not significantly different from zero. In contrast, our estimation results in Table 5.1. and 5.2. show, that for both countries the parameter of HRINC has a significantly negative effect on labour supply. Comparable studies on labour supply of married women also found significant negative, but smaller parameters of the other income variable (Hujer/Grammig/Schnabel, 1994, Grammig, 1994). Therefore we conclude, that the validity of the life-cycle hypothesis for unmarried women is questionable.

Turning to the impact of the sectoral variables on labour supply, we observe that for the FRG only the variables profit per employee (OPET) and index of sectoral gross product (IGD80) are significant. For the USA, the variables PRDIET, ITKT and IGD80 are significant. The unexpected negative impact of IGD80 on labour supply, which persists also for other specifications and contradicts the hypothesis of the Neo-Keynesian theory, could be explained by the sector affiliation of the unmarried women. As shown in tables A8.-A10. in the appendix nearly 70 % in the USA and 60 % in the FRG of the unmarried females are working in service sectors including governmental and social services, for which the usual Neo-Keynesian considerations could fail to hold. The results for married women presented by Grammig (1994) are very similar, except the positive significant effect of IGD80 in the US hours-equation. In general, as pointed out by the above cited studies of married female labour supply, the sectoral variables seems to have a higher impact on the participation decision. This relation is concealed by the Tobit-model, where participation and hours are estimated together. Therefore, to bring out the effects of sectoral variables on labour supply, a double-hurdle three equation model as proposed in Hujer/Grammig (1994) should be estimated.

In order to assess the quality of our estimated model, we perform specification tests for the results of the first and the second step of our estimation. The tests on misspecification, non-normality and heteroskedasticity for the reduced-form estimation of the first step are proposed by Lechner (1993), who argues that application of the usual specification tests, developed for cross-section estimation, would not be appropriate for panel-data estimation, due to the correlation between different periods. A detailed description of the test procedures for the Tobit-model could be found in Grammig (1994). In addition, a panel version of Mc Kelvey-Zaviona's Pseudo $R^2$ is computed for the reduced-form hours and wage equations. The specification of our structural model, obtained from the Minimum-Distance estimation step, is tested with an ordinary $\chi^2$ -test.

The tables A10. to A17. in the appendix display the results of the specification tests for the reduced-form estimation at the first step. Considering the hours equation, the RESET-Tests on misspecification are indicating serious specification problems for both countries, except the hours equation for the sample without widows of the FRG, where only RESET23 and RESET234 reject our specification. The RESET23 test, which could be regarded as a test of non-normality, indicates that the assumption of normality is in general invalid for the hours equations of all samples of unmarried women in both data sets.

The log-wage equation is misspecified for the complete sample and the sample without widows of the FRG. For the USA the RESET tests indicate a rather well-specified log-wage equation for both samples. Only for the log-wage equations of the US-samples, non-normality does not seem to be a very serious problem. The results of the Mc Kelvey-Zaviona's Pseudo $R^2$ in table A18. confirm the misspecification of the log-wage equations for the FRG. For the other equations, especially the FRG-hours equation, the goodness of fit is not as bad as expected from the RESET-test results.

Heteroskedasticity could not be rejected for the variables EDUMI, HRINC, SUNEMP and PRDIET in the hours equations of the FRG-samples, whereas in the hours equations of the US-samples heteroskedasticity appears through the variables EDUMI, EXP2, HRINC and the young children variables K6 and K10. The log-wage equations of the FRG displays heteroskedasticity for SUNEMP, KTVDPC and IGD80. For the US-samples the null hypothesis of homoskedasticity is accepted for all variables of the log-wage equation.

The specification tests for the overidentifying and time-constant restrictions of the Minimum-Distance step are provided in table A19. and A20. of the appendix. We are starting from the basic model without restrictions, where the distance is zero. The overidentifying restrictions (Model A) are accepted in all samples, whereas time-constancy of all slope-parameters is rejected (Model B). In general, time-constancy of the individual variables is accepted (Model C). Only in the complete sample of the FRG time-constancy of the wage parameter is not very well accepted. Time-constancy of the sectoral and regional variables is accepted with exception of PRDIET in the wage equations of the FRG and the USA (Model I) and ITKT in the hours equation of the USA (Model G).

As main conclusion of these test results, a respecification of the model, especially the wage-equation for the FRG is recommended. This implies that the wages of unmarried women in the USA and the FRG are determined by different models, leading to a restricted direct comparability between the two countries. Furthermore, we expect that some of the specification problems of the hours equation could be overcome by a three-equation model, where the participation decision is separately modeled from the equation of supplied hours.

## 6. Conclusion

The present paper analyses the labour supply of unmarried women in a life-cycle framework. Althought the sample consists of a rather heterogenous population, the hypothesis that the status of being an unmarried head of household leads to similar behaviour, could in general be accepted. A result, which is also confirmed by the detailed cluster and discriminant analysis of Hujer/Hassel (1995).

As the estimated labour supply elasticities show, the unmarried women in the USA tend to behave rather like men. They react more inflexible to wage changes. Whereas the unmarried women in the FRG resemble in their behaviour the married women.

The unsatisfactory test results are regarded as the main problem. One strategy to overcome this problem could be the estimation of a double-hurdle model following Hujer/Grammig (1994) and Zabel (1993), where the participation decision is explicitly modeled in an additional equation. As another possibility an ordered-probit model could be estimated, where a distinction is made between non-participation, part-time and full-time work. The impact of the sectoral variables surely is stronger on the participation decision than on supplied hours, as shown for married women in Grammig (1994). However, the general misspecification of the log-wage equation for the FRG will still remain, which recommends a different specification, and therefore be leading to a restricted comparability between the two countries.

## 7. Literature

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# 8. Appendix

**Table A1.**
**Description of Variables**

| Individual Variables: | USA (Data Source in Brackets) | FRG (Data Source in Brackets) |
|---|---|---|
| HOURMI | Average weekly hours on main job. (PSID) | Average weekly hours on main job. (SEP) |
| $\tilde{H}$ | $\ln\left(\frac{168}{168 - HOURMI}\right)$ (PSID) | $\ln\left(\frac{168}{168 - HOURMI}\right)$ (SEP) |
| WAGE | Average hourly gross wage. Deflated by consumer price index of current year. (PSID) | Average hourly gross wage. Deflated by consumer price index of current year. (SEP) |
| EDUMI | Years of schooling , academic training and vocational training/apprenticeship programs divided by 10. (PSID) | Years of schooling, academic training and vocational training divided by 10. (SEP) |
| AGE | Age in years divided by 10. (PSID) | Age in years divided by 10. (SEP) |
| EXP | Potential labor force experience divided by 10: (AGE−SCHOOL−0.6). (PSID) | Potential labor force experience divided by 10: (AGE−SCHOOL−0.6). (SEP) |
| EXP2 | EXP squared. (PSID) | EXP squared. (SEP) |
| HRINC | Other income per month: Family income minus taxes and individual's earned income in 1000 $. Deflated by consumer price index of corresponding year. (PSID) | Other income per month: Household net income minus individual's salary on main job in 1000 DM. Deflated by consumer price index of corresponding year. (SEP) |
| HRINC2 | HRINC squared | HRINC squared |
| K6 | Children in family unit up to age 6. (PSID) | Children in family unit up to age 6. (SEP) |
| K10 | Children in family unit age 7 to 10. (PSID) | Children in family unit age 7 to 10. (SEP) |
| K15 | Children in family unit age 11 to 15. (PSID) | Children in family unit age 11 to 15. (SEP) |
| HRINCMT | Mean of individual other income $\frac{1}{T_i}\sum_{t=1}^{T_i} HRINC(t)$ | Mean of individual other income $\frac{1}{T_i}\sum_{t=1}^{T_i} HRINC(t)$ |

Table A1., continued

| Sectoral and Regional Variables | USA (Data Source in Brackets) | FRG (Data Source in Brackets) |
|---|---|---|
| *RUNEMP* | Unemployment rate in the household's county of residence. (ISR/HLS) | Unemployment rate in the household's region of residence. (BfLR) |
| *SUNEMP* | Unemployment rate in individual's industry. (HLS) | Unemployment rate in individual's industry. (FBL) |
| *ITKT* | Intensity of gross investment in individual's industry. Computed as gross investment to capital stock in year. (OECD/ISD) | Intensity of gross investment in individual's industry. Computed as gross investment to capital stock. (OECD/ISD) |
| *PRDIET* | Productivity gap in individual's industry: Difference of productivity growth and growth of total payroll per employee in individual's industry. (OECD/ISD) | Productivity gap in individual's industry: Difference of productivity growth and growth of total payroll per employee in individual's industry. (OECD/ISD) |
| *IDGD80* | Index of gross product of individual's industry (basis 1980) divided by 100. (OECD/ISD) | Index of gross product of individual's industry (basis 1980) divided by 100. (OECD/ISD) |
| *OPET* | Operating surplus in $ per employee in individual's industry divided by 100000. (OECD/ISD) | Operating surplus in DM per employee in individual's industry divided by 100000. (OECD/ISD) |
| *KTVDPC* | Capital stock (Basis 1980) per employee in individual`s industry divided by 100000. (OECD / ISD) | Capital stock (Basis 1980) per employee in individual`s industry divided by 100000. (OECD / ISD) |

## Table A2.
## Sample-Selection Socio economic Panel

| | Wave | | | |
|---|---|---|---|---|
| **criteria of selection** | **1984** | **1985** | **1986** | **1987** |
| unmarried (single), german | 1884 | 1741 | 1684 | 1650 |
| + Head of household | 1077 | 981 | 953 | 966 |
| + age under 61 | 540 | 504 | 519 | 521 |
| + not self-employed | 517 | 486 | 497 | 492 |
| + no missing values for labour supply and income variables | 498 | 473 | 479 | 472 |
| + selection of outliers | 481 | 452 | 464 | 458 |
| total sample size | 481 | 452 | 464 | 458 |
| **Status of labour force participation** | | | | |
| employed | 311 | 308 | 328 | 329 |
| not employed | 170 | 144 | 136 | 129 |
| **Family status** | | | | |
| single | 205 | 205 | 219 | 222 |
| divorced | 144 | 133 | 143 | 135 |
| separated | 36 | 30 | 33 | 28 |
| widowed | 96 | 84 | 69 | 73 |

## Table A3.
## Sample-Selection Panel Study of Income Dynamics

| | Wave | | | |
|---|---|---|---|---|
| **criteria of selection** | **1984** | **1985** | **1986** | **1987** |
| unmarried, white, head of house-hold | 801 | 878 | 909 | 934 |
| + age under 61 | 519 | 574 | 585 | 592 |
| + not self-employed | 498 | 542 | 552 | 559 |
| + no missing values for labour supply, income and education variables | 491 | 535 | 548 | 549 |
| + selection of outliers | 482 | 524 | 538 | 539 |
| total sample size | 482 | 524 | 538 | 539 |
| **Status of labour force participation** | | | | |
| employed | 364 | 407 | 415 | 394 |
| not employed | 118 | 117 | 123 | 145 |
| **Family status** | | | | |
| single | 194 | 209 | 217 | 214 |
| divorced | 181 | 196 | 203 | 197 |
| separated | 55 | 61 | 52 | 62 |
| widowed | 52 | 58 | 66 | 66 |

Table A4.A.
Descriptives of variables, unmarried women, USA
wave 1984-1987

| | Total sample | | Employed | | Not employed | |
|---|---|---|---|---|---|---|
| Variable | Mean | Std.dev. | Mean | Std.dev. | Mean | Std.dev. |
| PAMI84 | 0,76 | 0,43 | 1,00 | 0,00 | 0,00 | 0,00 |
| PAMI85 | 0,78 | 0,42 | 1,00 | 0,00 | 0,00 | 0,00 |
| PAMI86 | 0,77 | 0,42 | 1,00 | 0,00 | 0,00 | 0,00 |
| PAMI87 | 0,73 | 0,44 | 1,00 | 0,00 | 0,00 | 0,00 |
| AGE84 | 35,93 | 11,89 | 35,10 | 11,24 | 38,49 | 13,45 |
| AGE85 | 36,01 | 12,05 | 35,37 | 11,51 | 38,25 | 13,57 |
| AGE86 | 36,29 | 11,98 | 35,13 | 11,15 | 40,21 | 13,78 |
| AGE87 | 36,49 | 12,17 | 36,24 | 11,26 | 38,83 | 14,23 |
| HOURMI84 | 30,10 | 18,89 | 39,86 | 9,10 | 0,00 | 0,00 |
| HOURMI85 | 31,39 | 18,56 | 40,41 | 8,85 | 0,00 | 0,00 |
| HOURMI86 | 30,96 | 18,61 | 40,14 | 8,93 | 0,00 | 0,00 |
| HOURMI87 | 29,44 | 19,66 | 40,27 | 9,59 | 0,00 | 0,00 |
| WAGE84 | 6,42 | 5,29 | 8,26 | 4,51 | 0,00 | 0,00 |
| WAGE85 | 6,21 | 5,04 | 8,00 | 4,29 | 0,00 | 0,00 |
| WAGE86 | 6,44 | 5,14 | 8,35 | 4,28 | 0,00 | 0,00 |
| WAGE87 | 6,37 | 5,47 | 8,71 | 4,52 | 0,00 | 0,00 |
| HRINC84 | 0,37 | 0,52 | 0,24 | 0,43 | 0,77 | 0,58 |
| HRINC85 | 0,36 | 0,51 | 0,25 | 0,43 | 0,76 | 0,59 |

Table A4.A. continued

| | Total sample | | Employed | | Not employed | |
|---|---|---|---|---|---|---|
| Variable | Mean | Std.dev. | Mean | Std.dev. | Mean | Std.dev. |
| HRINC86 | 0,36 | 0,51 | 0,25 | 0,42 | 0,76 | 0,58 |
| HRINC87 | 0,44 | 0,58 | 0,29 | 0,50 | 0,83 | 0,62 |
| EDUMI84 | 12,45 | 1,92 | 12,82 | 1,63 | 11,30 | 2,28 |
| EDUMI85 | 12,44 | 1,94 | 12,69 | 1,74 | 11,59 | 2,33 |
| EDUMI86 | 12,45 | 1,94 | 12,79 | 1,69 | 11,30 | 2,29 |
| EDUMI87 | 12,43 | 1,96 | 12,80 | 1,64 | 11,42 | 2,39 |
| EXP84 | 17,49 | 12,31 | 16,28 | 11,55 | 21,20 | 13,82 |
| EXP85 | 17,58 | 12,46 | 16,68 | 11,82 | 20,68 | 14,07 |
| EXP86 | 17,85 | 12,33 | 16,34 | 11,44 | 22,93 | 13,85 |
| EXP87 | 18,51 | 12,50 | 17,44 | 11,50 | 21,41 | 14,53 |
| K684 | 0,21 | 0,55 | 0,13 | 0,40 | 0,43 | 0,81 |
| K685 | 0,19 | 0,52 | 0,11 | 0,37 | 0,44 | 0,81 |
| K686 | 0,20 | 0,53 | 0,16 | 0,47 | 0,33 | 0,69 |
| K687 | 0,18 | 0,79 | 0,12 | 0,38 | 0,35 | 0,67 |
| K1084 | 0,14 | 0,41 | 0,11 | 0,35 | 0,24 | 0,53 |
| K1085 | 0,13 | 0,38 | 0,11 | 0,34 | 0,22 | 0,48 |
| K1086 | 0,14 | 0,41 | 0,11 | 0,37 | 0,22 | 0,50 |
| K1087 | 0,15 | 0,42 | 0,12 | 0,36 | 0,22 | 0,55 |

Table A4.A. continued

| | Total sample | | Employed | | Not employed | |
|---|---|---|---|---|---|---|
| Variable | Mean | Std.dev. | Mean | Std.dev. | Mean | Std.dev. |
| K1584 | 0,15 | 0,45 | 0,12 | 0,39 | 0,25 | 0,60 |
| K1585 | 0,17 | 0,49 | 0,15 | 0,46 | 0,26 | 0,59 |
| K1586 | 0,17 | 0,49 | 0,15 | 0,46 | 0,24 | 0,59 |
| K1587 | 0,17 | 0,49 | 0,16 | 0,48 | 0,21 | 0,53 |
| NK84 | 0,50 | 0,91 | 0,37 | 0,76 | 0,92 | 1,17 |
| NK85 | 0,49 | 0,89 | 0,37 | 0,76 | 0,92 | 1,13 |
| NK86 | 0,51 | 0,88 | 0,43 | 0,81 | 0,80 | 1,03 |
| NK87 | 0,50 | 0,87 | 0,40 | 0,77 | 0,78 | 1,03 |
| LPARTN84 | 0,07 | 0,25 | 0,07 | 0,25 | 0,08 | 0,27 |
| LPARTN85 | 0,09 | 0,28 | 0,07 | 0,26 | 0,15 | 0,35 |
| LPARTN86 | 0,08 | 0,27 | 0,08 | 0,27 | 0,09 | 0,29 |
| LPARTN87 | 0,08 | 0,28 | 0,07 | 0,25 | 0,12 | 0,33 |
| MLED84 | 0,40 | 0,49 | 0,45 | 0,50 | 0,25 | 0,43 |
| MLED85 | 0,40 | 0,49 | 0,44 | 0,50 | 0,24 | 0,43 |
| MLED86 | 0,40 | 0,49 | 0,45 | 0,50 | 0,25 | 0,44 |
| MLED87 | 0,40 | 0,49 | 0,42 | 0,49 | 0,32 | 0,47 |
| MGES84 | 0,38 | 0,48 | 0,38 | 0,49 | 0,36 | 0,48 |
| MGES85 | 0,37 | 0,48 | 0,39 | 0,49 | 0,33 | 0,47 |

Table A4.A. continued

| | Total sample | | Employed | | Not employed | |
|---|---|---|---|---|---|---|
| Variable | Mean | Std.dev. | Mean | Std.dev. | Mean | Std.dev. |
| MGES86 | 0,38 | 0,49 | 0,38 | 0,49 | 0,37 | 0,49 |
| MGES87 | 0,37 | 0,48 | 0,38 | 0,48 | 0,34 | 0,47 |
| MVERG84 | 0,11 | 0,32 | 0,10 | 0,30 | 0,17 | 0,38 |
| MVERG85 | 0,12 | 0,32 | 0,09 | 0,28 | 0,21 | 0,41 |
| MVERG86 | 0,10 | 0,30 | 0,08 | 0,27 | 0,15 | 0,35 |
| MVERG87 | 0,12 | 0,32 | 0,10 | 0,30 | 0,16 | 0,37 |
| MVERW84 | 0,11 | 0,31 | 0,07 | 0,25 | 0,23 | 0,42 |
| MVERW85 | 0,11 | 0,31 | 0,08 | 0,27 | 0,21 | 0,41 |
| MVERW86 | 0,12 | 0,33 | 0,09 | 0,29 | 0,23 | 0,42 |
| MVERW87 | 0,12 | 0,33 | 0,10 | 0,30 | 0,18 | 0,38 |
| RUNEMP84 | 7,30 | 3,07 | 7,03 | 2,82 | 8,14 | 3,63 |
| RUNEMP85 | 6,69 | 2,31 | 6,59 | 2,30 | 7,07 | 2,32 |
| RUNEMP86 | 6,40 | 2,39 | 6,29 | 2,31 | 6,78 | 2,62 |
| RUNEMP87 | 5,42 | 1,98 | 5,30 | 1,99 | 5,75 | 1,93 |
| SUNEMP84 | 6,90 | 1,53 | 6,76 | 1,57 | 7,32 | 1,31 |
| SUNEMP85 | 6,65 | 1,45 | 6,43 | 1,47 | 6,97 | 1,28 |
| SUNEMP86 | 6,42 | 1,48 | 6,30 | 1,51 | 6,80 | 1,30 |
| SUNEMP87 | 5,65 | 1,36 | 5,55 | 1,38 | 5,91 | 1,26 |

Table A4.B.:: Descriptives of variables by family status, unmarried women, USA wave 1984-1987

*refers to employed

| | single | | divorced | | seperated | | widowed | |
|---|---|---|---|---|---|---|---|---|
| | Mean | Std.d. | Mean | Std.d. | Mean | Std.d. | Mean | Std.d. |
| PAMI84 | 0,85 | 0,36 | 0,77 | 0,42 | 0,64 | 0,49 | 0,48 | 0,50 |
| PAMI85 | 0,87 | 0,34 | 0,80 | 0,40 | 0,59 | 0,50 | 0,57 | 0,50 |
| PAMI86 | 0,86 | 0,35 | 0,77 | 0,42 | 0,65 | 0,48 | 0,58 | 0,50 |
| PAMI87 | 0,78 | 0,41 | 0,75 | 0,43 | 0,63 | 0,49 | 0,61 | 0,49 |
| AGE84 | 29,10 | 8,28 | 39,40 | 10,83 | 34,71 | 11,32 | 50,60 | 9,12 |
| AGE85 | 28,78 | 8,25 | 39,27 | 10,76 | 36,26 | 11,79 | 50,81 | 9,45 |
| AGE86 | 29,21 | 8,44 | 39,27 | 10,65 | 35,13 | 10,27 | 51,33 | 9,39 |
| AGE87 | 29,71 | 8,69 | 40,05 | 10,57 | 35,92 | 11,68 | 52,05 | 8,93 |
| HOURMI84* | 40,55 | 9,46 | 40,77 | 8,04 | 35,94 | 7,57 | 35,76 | 11,92 |
| HOURMI85* | 40,72 | 8,77 | 41,11 | 8,44 | 38,50 | 10,00 | 37,45 | 9,45 |
| HOURMI86* | 40,90 | 9,88 | 39,91 | 7,73 | 39,06 | 10,43 | 38,29 | 6,94 |
| HOURMI87* | 40,23 | 9,37 | 41,39 | 8,89 | 39,77 | 12,43 | 36,82 | 9,31 |
| WAGE84* | 8,77 | 4,27 | 8,42 | 5,04 | 6,42 | 3,35 | 6,61 | 3,32 |
| WAGE85* | 8,43 | 4,17 | 7,88 | 4,43 | 7,36 | 4,46 | 6,92 | 3,88 |
| WAGE86* | 8,67 | 4,18 | 8,29 | 4,44 | 7,37 | 4,09 | 7,92 | 4,20 |
| WAGE87* | 9,31 | 4,48 | 8,38 | 4,21 | 8,00 | 5,50 | 8,14 | 4,63 |
| HRINC84 | 0,22 | 0,47 | 0,38 | 0,47 | 0,42 | 0,41 | 0,85 | 0,66 |
| HRINC85 | 0,22 | 0,43 | 0,37 | 0,49 | 0,47 | 0,50 | 0,75 | 0,67 |
| HRINC86 | 0,23 | 0,42 | 0,37 | 0,48 | 0,46 | 0,50 | 0,72 | 0,65 |
| HRINC87 | 0,31 | 0,51 | 0,44 | 0,56 | 0,60 | 0,70 | 0,69 | 0,61 |
| EDUMI84 | 13,09 | 1,87 | 12,35 | 1,74 | 11,69 | 1,59 | 11,15 | 2,09 |
| EDUMI85 | 13,03 | 1,73 | 12,39 | 1,77 | 11,77 | 1,99 | 11,17 | 2,32 |
| EDUMI86 | 13,04 | 1,77 | 12,25 | 1,79 | 12,13 | 2,04 | 11,39 | 2,27 |
| EDUMI87 | 13,05 | 1,71 | 12,27 | 1,82 | 11,84 | 2,07 | 11,44 | 2,37 |
| EXP84 | 10,02 | 8,21 | 21,05 | 10,99 | 17,04 | 11,57 | 33,44 | 9,48 |
| EXP85 | 9,74 | 8,04 | 20,88 | 10,93 | 18,54 | 12,16 | 33,64 | 9,90 |
| EXP86 | 10,18 | 8,18 | 21,03 | 10,57 | 17,00 | 10,48 | 33,94 | 10,19 |
| EXP87 | 10,66 | 8,40 | 21,78 | 10,55 | 18,10 | 11,91 | 34,61 | 9,74 |

Table A4.B. continued

| | single | | divorced | | seperated | | widowed | |
|---|---|---|---|---|---|---|---|---|
| Variable | Mean | Std.d. | Mean | Std.d. | Mean | Std.d. | Mean | Std.d. |
| K684 | 0,13 | 0,48 | 0,22 | 0,51 | 0,58 | 0,85 | 0,04 | 0,19 |
| K685 | 0,08 | 0,34 | 0,22 | 0,49 | 0,56 | 0,96 | 0,07 | 0,26 |
| K686 | 0,10 | 0,33 | 0,28 | 0,61 | 0,54 | 0,87 | 0,05 | 0,27 |
| K687 | 0,10 | 0,37 | 0,22 | 0,54 | 0,50 | 0,70 | 0,05 | 0,21 |
| K1084 | 0,03 | 0,16 | 0,21 | 0,47 | 0,36 | 0,65 | 0,10 | 0,36 |
| K1085 | 0,03 | 0,17 | 0,19 | 0,43 | 0,31 | 0,56 | 0,10 | 0,36 |
| K1086 | 0,04 | 0,21 | 0,20 | 0,49 | 0,33 | 0,51 | 0,14 | 0,46 |
| K1087 | 0,05 | 0,29 | 0,20 | 0,44 | 0,32 | 0,62 | 0,14 | 0,43 |
| K1584 | 0,04 | 0,28 | 0,24 | 0,50 | 0,29 | 0,69 | 0,13 | 0,40 |
| K1585 | 0,02 | 0,23 | 0,30 | 0,61 | 0,34 | 0,66 | 0,12 | 0,38 |
| K1586 | 0,03 | 0,23 | 0,30 | 0,62 | 0,29 | 0,54 | 0,15 | 0,50 |
| K1587 | 0,03 | 0,24 | 0,34 | 0,64 | 0,16 | 0,41 | 0,17 | 0,51 |
| NK84 | 0,20 | 0,63 | 0,67 | 0,91 | 1,24 | 1,28 | 0,27 | 0,72 |
| NK85 | 0,13 | 0,48 | 0,71 | 0,93 | 1,21 | 1,25 | 0,29 | 0,73 |
| NK86 | 0,16 | 0,49 | 0,78 | 0,99 | 1,15 | 1,09 | 0,33 | 0,77 |
| NK87 | 0,17 | 0,53 | 0,76 | 0,95 | 0,98 | 1,09 | 0,35 | 0,77 |
| LPARTN84 | 0,05 | 0,22 | 0,10 | 0,30 | 0,07 | 0,26 | 0,02 | 0,14 |
| LPARTN85 | 0,12 | 0,33 | 0,09 | 0,28 | 0,03 | 0,18 | 0,02 | 0,13 |
| LPARTN86 | 0,13 | 0,34 | 0,06 | 0,25 | 0,04 | 0,19 | 0,00 | 0,00 |
| LPARTN87 | 0,13 | 0,34 | 0,07 | 0,25 | 0,05 | 0,22 | 0,02 | 0,12 |
| RUNEMP84 | 6,73 | 2,79 | 7,59 | 2,95 | 7,94 | 3,82 | 7,76 | 3,33 |
| RUNEMP85 | 6,37 | 2,14 | 7,04 | 2,26 | 6,43 | 2,05 | 6,96 | 3,06 |
| RUNEMP86 | 5,99 | 2,23 | 6,64 | 2,21 | 6,64 | 2,67 | 6,84 | 3,02 |
| RUNEMP87 | 5,06 | 1,85 | 5,60 | 1,97 | 5,56 | 1,70 | 5,92 | 2,48 |
| SUNEMP84 | 6,77 | 1,43 | 6,89 | 1,50 | 7,22 | 1,96 | 7,02 | 1,43 |
| SUNEMP85 | 6,37 | 1,45 | 6,53 | 1,28 | 6,82 | 1,83 | 6,96 | 1,43 |
| SUNEMP86 | 6,26 | 1,34 | 6,53 | 1,67 | 6,48 | 1,56 | 6,53 | 1,14 |
| SUNEMP87 | 5,48 | 1,44 | 5,75 | 1,23 | 5,76 | 1,68 | 5,80 | 1,03 |

Table A5.A.
Descriptives of variables, unmarried women, FRG
wave 1984-1987

| | Total sample | | Employed | | Not employed | |
|---|---|---|---|---|---|---|
| Variable | Mean | Std.dev. | Mean | Std.dev. | Mean | Std.dev. |
| PAMI84 | 0,647 | 0,479 | 1,000 | 0,000 | 0,000 | 0,000 |
| PAMI85 | 0,681 | 0,466 | 1,000 | 0,000 | 0,000 | 0,000 |
| PAMI86 | 0,707 | 0,456 | 1,000 | 0,000 | 0,000 | 0,000 |
| PAMI87 | 0,718 | 0,450 | 1,000 | 0,000 | 0,000 | 0,000 |
| AGE84 | 39,289 | 12,727 | 38,048 | 11,495 | 41,559 | 14,480 |
| AGE85 | 38,885 | 12,651 | 37,351 | 11,761 | 42,167 | 13,851 |
| AGE86 | 37,804 | 12,424 | 36,445 | 11,901 | 41,081 | 13,076 |
| AGE87 | 38,024 | 12,351 | 37,116 | 11,886 | 40,341 | 13,233 |
| HOURMI84 | 24,911 | 20,120 | 38,527 | 10,026 | 0,000 | 0,000 |
| HOURMI85 | 26,330 | 19,844 | 38,640 | 10,063 | 0,000 | 0,000 |
| HOURMI86 | 27,808 | 19,403 | 39,338 | 8,838 | 0,000 | 0,000 |
| HOURMI87 | 27,194 | 19,003 | 37,857 | 9,911 | 0,000 | 0,000 |
| WAGE84 | 9,770 | 8,671 | 15,111 | 5,955 | 0,000 | 0,000 |
| WAGE85 | 10,392 | 9,769 | 15,251 | 8,116 | 0,000 | 0,000 |
| WAGE86 | 10,584 | 8,756 | 14,972 | 6,531 | 0,000 | 0,000 |
| WAGE87 | 11,210 | 9,224 | 15,605 | 7,054 | 0,000 | 0,000 |
| HRINC84 | 0,698 | 0,806 | 0,418 | 0,709 | 1,211 | 0,718 |
| HRINC85 | 0,726 | 0,833 | 0,487 | 0,759 | 1,236 | 0,753 |

Table A5.A. continued

| | Total sample | | Employed | | Not employed | |
|---|---|---|---|---|---|---|
| Variable | Mean | Std.dev. | Mean | Std.dev. | Mean | Std.dev. |
| HRINC86 | 0,806 | 0,908 | 0,572 | 0,869 | 1,372 | 0,734 |
| HRINC87 | 0,867 | 0,988 | 0,607 | 0,894 | 1,530 | 0,906 |
| EDUMI84 | 11,075 | 2,981 | 11,648 | 3,133 | 10,026 | 2,350 |
| EDUMI85 | 11,010 | 3,034 | 11,617 | 3,198 | 9,712 | 2,139 |
| EDUMI86 | 10,906 | 3,045 | 11,288 | 3,088 | 9,985 | 2,738 |
| EDUMI87 | 10,660 | 3,083 | 11,009 | 3,171 | 9,771 | 2,656 |
| EXP84 | 22,214 | 13,723 | 20,400 | 12,494 | 25,532 | 15,212 |
| EXP85 | 21,875 | 13,618 | 19,734 | 12,576 | 26,455 | 14,641 |
| EXP86 | 20,898 | 13,055 | 19,157 | 12,295 | 25,096 | 13,903 |
| EXP87 | 21,364 | 13,052 | 20,106 | 12,484 | 24,570 | 13,942 |
| K684 | 0,102 | 0,329 | 0,058 | 0,247 | 0,182 | 0,431 |
| K685 | 0,084 | 0,315 | 0,039 | 0,210 | 0,181 | 0,453 |
| K686 | 0,078 | 0,298 | 0,040 | 0,210 | 0,169 | 0,431 |
| K687 | 0,072 | 0,283 | 0,046 | 0,209 | 0,140 | 0,410 |
| K1084 | 0,052 | 0,231 | 0,042 | 0,216 | 0,071 | 0,257 |
| K1085 | 0,082 | 0,312 | 0,055 | 0,256 | 0,139 | 0,403 |
| K1086 | 0,075 | 0,310 | 0,049 | 0,255 | 0,140 | 0,407 |
| K1087 | 0,061 | 0,257 | 0,043 | 0,217 | 0,109 | 0,336 |

Table A5.A. continued

| | Total sample | | Employed | | Not employed | |
|---|---|---|---|---|---|---|
| Variable | Mean | Std.dev. | Mean | Std.dev. | Mean | Std.dev. |
| K1584 | 0,139 | 0,412 | 0,116 | 0,358 | 0,182 | 0,495 |
| K1585 | 0,148 | 0,413 | 0,130 | 0,399 | 0,188 | 0,442 |
| K1586 | 0,138 | 0,419 | 0,122 | 0,395 | 0,176 | 0,470 |
| K1587 | 0,133 | 0,394 | 0,103 | 0,368 | 0,209 | 0,445 |
| NK84 | 0,293 | 0,625 | 0,215 | 0,516 | 0,435 | 0,768 |
| NK85 | 0,314 | 0,668 | 0,224 | 0,558 | 0,507 | 0,828 |
| NK86 | 0,291 | 0,647 | 0,210 | 0,526 | 0,485 | 0,843 |
| NK87 | 0,266 | 0,644 | 0,191 | 0,527 | 0,457 | 0,848 |
| LPARTN84 | 0,067 | 0,249 | 0,084 | 0,277 | 0,035 | 0,185 |
| LPARTN85 | 0,106 | 0,308 | 0,110 | 0,314 | 0,097 | 0,297 |
| LPARTN86 | 0,159 | 0,367 | 0,174 | 0,379 | 0,125 | 0,332 |
| LPARTN87 | 0,183 | 0,387 | 0,204 | 0,403 | 0,132 | 0,340 |
| MLED84 | 0,426 | 0,495 | 0,498 | 0,501 | 0,294 | 0,457 |
| MLED85 | 0,454 | 0,498 | 0,536 | 0,500 | 0,278 | 0,449 |
| MLED86 | 0,472 | 0,500 | 0,555 | 0,498 | 0,272 | 0,447 |
| MLED87 | 0,485 | 0,500 | 0,553 | 0,498 | 0,310 | 0,464 |
| MGES84 | 0,299 | 0,458 | 0,312 | 0,464 | 0,276 | 0,449 |
| MGES85 | 0,294 | 0,456 | 0,299 | 0,458 | 0,285 | 0,453 |

Table A5.A. continued

| | Total sample | | Employed | | Not employed | |
|---|---|---|---|---|---|---|
| Variable | Mean | Std.dev. | Mean | Std.dev. | Mean | Std.dev. |
| MGES86 | 0,308 | 0,462 | 0,299 | 0,458 | 0,331 | 0,472 |
| MGES87 | 0,295 | 0,456 | 0,277 | 0,448 | 0,341 | 0,476 |
| MVERG84 | 0,075 | 0,263 | 0,071 | 0,257 | 0,082 | 0,276 |
| MVERG85 | 0,066 | 0,249 | 0,062 | 0,241 | 0,076 | 0,267 |
| MVERG86 | 0,071 | 0,257 | 0,061 | 0,240 | 0,096 | 0,295 |
| MVERG87 | 0,061 | 0,240 | 0,070 | 0,255 | 0,039 | 0,194 |
| MVERW84 | 0,200 | 0,400 | 0,119 | 0,324 | 0,347 | 0,477 |
| MVERW85 | 0,186 | 0,389 | 0,104 | 0,306 | 0,361 | 0,482 |
| MVERW86 | 0,149 | 0,356 | 0,085 | 0,280 | 0,301 | 0,461 |
| MVERW87 | 0,159 | 0,366 | 0,100 | 0,301 | 0,310 | 0,464 |
| RUNEMP84 | 10,133 | 2,945 | 9,849 | 3,005 | 10,654 | 2,766 |
| RUNEMP85 | 10,450 | 3,256 | 10,179 | 3,274 | 11,030 | 3,151 |
| RUNEMP86 | 10,397 | 3,253 | 10,227 | 3,332 | 10,804 | 3,027 |
| RUNEMP87 | 10,327 | 3,268 | 10,144 | 3,267 | 10,793 | 3,237 |
| SUNEMP84 | 7,996 | 4,181 | 7,329 | 3,203 | 9,217 | 5,341 |
| SUNEMP85 | 7,507 | 3,894 | 6,934 | 3,159 | 8,734 | 4,917 |
| SUNEMP86 | 7,076 | 3,705 | 6,548 | 2,785 | 8,349 | 5,097 |
| SUNEMP87 | 7,076 | 3,633 | 6,716 | 3,069 | 7,995 | 4,671 |

Table A5.B.: Descriptives of variables by family status, unmarried women, FRG wave 1984-1987

| | single | | divorced | | seperated | | widowed | |
|---|---|---|---|---|---|---|---|---|
| Variable | Mean | Std.d. | Mean | Std.d. | Mean | Std.d. | Mean | Std.d. |
| PAMI84 | 0,756 | 0,430 | 0,674 | 0,471 | 0,611 | 0,494 | 0,385 | 0,489 |
| PAMI85 | 0,805 | 0,397 | 0,692 | 0,464 | 0,633 | 0,490 | 0,381 | 0,489 |
| PAMI86 | 0,831 | 0,376 | 0,685 | 0,466 | 0,606 | 0,496 | 0,406 | 0,495 |
| PAMI87 | 0,820 | 0,385 | 0,674 | 0,470 | 0,821 | 0,390 | 0,452 | 0,501 |
| AGE84 | 31,185 | 10,401 | 42,222 | 9,856 | 36,750 | 10,699 | 53,146 | 6,824 |
| AGE85 | 30,995 | 10,427 | 42,677 | 9,823 | 37,533 | 10,136 | 52,619 | 6,686 |
| AGE86 | 30,384 | 10,386 | 42,678 | 9,809 | 37,576 | 9,371 | 51,362 | 7,006 |
| AGE87 | 30,270 | 9,974 | 43,807 | 9,366 | 39,750 | 11,047 | 50,247 | 7,293 |
| HOURMI84* | 40,587 | 9,193 | 37,371 | 10,651 | 35,409 | 10,046 | 34,784 | 10,020 |
| HOURMI85* | 39,891 | 9,182 | 38,315 | 9,155 | 35,263 | 9,398 | 35,125 | 15,203 |
| HOURMI86* | 40,549 | 7,467 | 39,163 | 9,656 | 36,350 | 9,326 | 34,214 | 11,497 |
| HOURMI87* | 39,132 | 8,620 | 38,308 | 8,749 | 32,478 | 12,365 | 33,333 | 14,641 |
| WAGE84* | 14,992 | 5,658 | 15,793 | 6,010 | 13,903 | 5,662 | 14,535 | 7,133 |
| WAGE85* | 14,988 | 7,316 | 14,833 | 5,710 | 13,980 | 6,991 | 18,563 | 15,225 |
| WAGE86* | 14,159 | 6,485 | 15,980 | 6,049 | 15,597 | 6,131 | 16,287 | 8,158 |
| WAGE87* | 15,175 | 6,707 | 16,689 | 6,475 | 16,129 | 10,040 | 14,628 | 7,921 |
| HRINC84 | 0,350 | 0,557 | 0,750 | 0,761 | 0,566 | 0,522 | 1,416 | 0,923 |
| HRINC85 | 0,440 | 0,676 | 0,753 | 0,799 | 0,683 | 0,765 | 1,397 | 0,876 |
| HRINC86 | 0,614 | 0,862 | 0,796 | 0,857 | 0,602 | 0,664 | 1,538 | 0,897 |
| HRINC87 | 0,664 | 0,936 | 0,855 | 0,888 | 0,486 | 0,509 | 1,654 | 1,066 |
| EDUMI84 | 12,163 | 2,991 | 10,632 | 2,738 | 10,069 | 2,775 | 9,792 | 2,581 |
| EDUMI85 | 12,100 | 2,950 | 10,372 | 2,702 | 9,900 | 3,430 | 9,756 | 2,696 |
| EDUMI86 | 11,906 | 2,921 | 10,297 | 2,590 | 9,045 | 3,649 | 9,884 | 2,959 |
| EDUMI87 | 11,730 | 2,970 | 9,981 | 2,616 | 8,464 | 3,434 | 9,507 | 2,915 |
| EXP84 | 13,022 | 10,831 | 25,590 | 10,354 | 20,681 | 11,084 | 37,354 | 7,801 |
| EXP85 | 12,895 | 10,818 | 26,305 | 10,220 | 21,633 | 10,486 | 36,863 | 7,585 |
| EXP86 | 12,477 | 10,226 | 26,381 | 10,030 | 22,530 | 9,811 | 35,478 | 7,832 |
| EXP87 | 12,541 | 9,844 | 27,826 | 9,425 | 25,286 | 11,470 | 34,740 | 7,962 |

* refers to employed

Table A5.B. continued

| | single | | divorced | | seperated | | widowed | |
|---|---|---|---|---|---|---|---|---|
| Variable | Mean | Std.d. | Mean | Std.d. | Mean | Std.d. | Mean | Std.d. |
| K684 | 0,054 | 0,226 | 0,153 | 0,415 | 0,333 | 0,535 | 0,042 | 0,201 |
| K685 | 0,044 | 0,205 | 0,105 | 0,375 | 0,433 | 0,626 | 0,024 | 0,153 |
| K686 | 0,046 | 0,209 | 0,112 | 0,377 | 0,303 | 0,529 | 0,000 | 0,000 |
| K687 | 0,045 | 0,208 | 0,096 | 0,343 | 0,321 | 0,548 | 0,014 | 0,117 |
| K1084 | 0,005 | 0,070 | 0,090 | 0,311 | 0,250 | 0,439 | 0,021 | 0,144 |
| K1085 | 0,010 | 0,099 | 0,158 | 0,424 | 0,367 | 0,615 | 0,036 | 0,187 |
| K1086 | 0,009 | 0,095 | 0,147 | 0,427 | 0,242 | 0,561 | 0,058 | 0,235 |
| K1087 | 0,018 | 0,133 | 0,126 | 0,375 | 0,071 | 0,262 | 0,068 | 0,254 |
| K1584 | 0,020 | 0,139 | 0,250 | 0,535 | 0,250 | 0,500 | 0,188 | 0,488 |
| K1585 | 0,020 | 0,139 | 0,263 | 0,491 | 0,333 | 0,606 | 0,214 | 0,539 |
| K1586 | 0,014 | 0,117 | 0,238 | 0,489 | 0,364 | 0,603 | 0,217 | 0,615 |
| K1587 | 0,023 | 0,149 | 0,252 | 0,500 | 0,393 | 0,685 | 0,151 | 0,430 |
| NK84 | 0,078 | 0,269 | 0,493 | 0,784 | 0,833 | 0,845 | 0,250 | 0,598 |
| NK85 | 0,073 | 0,261 | 0,526 | 0,784 | 1,133 | 1,137 | 0,274 | 0,608 |
| NK86 | 0,068 | 0,253 | 0,497 | 0,838 | 0,909 | 0,843 | 0,275 | 0,639 |
| NK87 | 0,086 | 0,280 | 0,474 | 0,862 | 0,786 | 1,031 | 0,233 | 0,566 |
| LPARTN84 | 0,073 | 0,261 | 0,076 | 0,267 | 0,000 | 0,000 | 0,063 | 0,243 |
| LPARTN85 | 0,117 | 0,322 | 0,105 | 0,308 | 0,067 | 0,254 | 0,095 | 0,295 |
| LPARTN86 | 0,215 | 0,411 | 0,140 | 0,348 | 0,030 | 0,174 | 0,087 | 0,284 |
| LPARTN87 | 0,261 | 0,440 | 0,148 | 0,357 | 0,000 | 0,000 | 0,082 | 0,277 |
| RUNEMP84 | 9,827 | 2,913 | 10,241 | 2,981 | 10,53 | 2,606 | 10,477 | 3,054 |
| RUNEMP85 | 10,270 | 3,315 | 10,469 | 3,182 | 10,81 | 2,671 | 10,727 | 3,435 |
| RUNEMP86 | 10,254 | 3,410 | 10,389 | 3,116 | 10,31 | 2,833 | 10,904 | 3,225 |
| RUNEMP87 | 10,112 | 3,310 | 10,456 | 3,232 | 10,03 | 2,802 | 10,853 | 3,361 |
| SUNEMP84 | 7,529 | 3,595 | 7,940 | 4,353 | 9,252 | 5,731 | 8,609 | 4,303 |
| SUNEMP85 | 6,990 | 3,310 | 7,731 | 3,805 | 7,553 | 4,887 | 8,400 | 4,749 |
| SUNEMP86 | 6,534 | 3,093 | 7,086 | 3,298 | 8,749 | 6,081 | 7,976 | 4,421 |
| SUNEMP87 | 6,678 | 2,860 | 6,938 | 3,266 | 7,357 | 2,492 | 8,436 | 5,839 |

**Table A6.**
**Tobit-III-Model**
**Minimum Distance Estimation Unbalanced with**
**Correlated Random Effects (Mundlak specification)**

**PSID (Sample without widows)**

| | Hours equation | | Wage equation | |
|---|---|---|---|---|
| | Parameter | t-value | Parameter | t-value |
| ln w | 0.12600 | 3.69844 | - | - |
| **Year effects** | | | | |
| 1984 | 0.10494 | 0.88263 | 0.38835 | 1.48935 |
| 1985 | 0.09903 | 0.85055 | 0.42519 | 1.59146 |
| 1986 | 0.08191 | 0.68623 | 0.32446 | 1.19727 |
| 1987 | 0.14011 | 1.17242 | 0.28639 | 1.05456 |
| **Individual variables** | | | | |
| AGE | -0.01117 | -1.87112 | - | - |
| EDUMI | 0.03072 | 0.53797 | 1.29553 | 14.21368 |
| EXP | - | - | 0.32413 | 6.79641 |
| EXP2 | - | - | -0.63422 | -5.15355 |
| K6 | -0.04360 | -4.88881 | - | - |
| K10 | -0.01253 | -1.08938 | - | - |
| K15 | -0.01180 | -1.09367 | - | - |
| HRINC | -0.23804 | -8.81048 | - | - |
| HRINC2 | 0.06122 | 4.35355 | - | - |
| **Sectoral and regional variables** | | | | |
| RUNEMP | 0.01915 | 1.05545 | -0.21659 | -4.05525 |
| OPET | -0.03154 | -0.82622 | 0.96204 | 4.34248 |
| PRDIET | 0.17375 | 2.17585 | - | - |
| PRDIET84 | - | - | 0.40789 | 0.96969 |
| PRDIET85 | - | - | -2.11357 | -6.02525 |
| PRDIET86 | - | - | -2.06411 | -2.31309 |
| PRDIET87 | - | - | 2.31833 | 1.83978 |
| IGD80 | -0.11714 | -1.65903 | 0.30098 | 1.75597 |
| ITKT84 | 0.48281 | 1.90956 | - | - |
| ITKT85 | 0.65257 | 2.26559 | - | - |
| ITKT86 | 1.01733 | 3.09600 | - | - |
| ITKT87 | 0.18565 | 0.49341 | - | - |
| SUNEMP | - | - | -0.78578 | -7.54676 |
| KTVDPC | - | - | -0.09581 | -4.10168 |
| **Corr. random effects** | | | | |
| HRINCMT | 0.02976 | 1.65214 | - | - |
| **Variances** | | | | |
| 1984 | 0.11796 | 21.38147 | 0.38033 | 24.48440 |
| 1985 | 0.12457 | 20.54596 | 0.38846 | 25.47763 |
| 1986 | 0.12258 | 23.03107 | 0.39357 | 32.25038 |
| 1987 | 0.14186 | 23.84130 | 0.39323 | 31.27607 |
| RHO84 | -0.04470 | -0.61720 | - | - |
| RHO85 | -0.17433 | -2.19166 | - | - |
| RHO86 | 0.07023 | 1.08215 | - | - |
| RHO87 | -0.22064 | -3.04145 | - | - |

**Table A7.**
**Tobit-III-Model**
**Minimum Distance Estimation Unbalanced with Correlated Random Effects (Mundlak specification)**

**SOEP (Sample without widows)**

| | **Hours equation** | | **Wage equation** | |
|---|---|---|---|---|
| | Parameter | t-value | Parameter | t-value |
| ln w | 0.26126 | 3.35195 | - | - |
| **Year effects** | | | | |
| 1984 | -0.16739 | -2.62811 | 1.89072 | 11.56977 |
| 1985 | -0.16749 | -2.59604 | 1.90274 | 11.77119 |
| 1986 | -0.18318 | -2.83065 | 1.96395 | 11.70020 |
| 1987 | -0.18796 | -2.85622 | 1.96509 | 11.50997 |
| **Individual variables** | | | | |
| AGE | -0.03092 | -2.46247 | - | - |
| EDUMI | -0.10959 | -2.47035 | 0.64649 | 12.19750 |
| EXP | - | - | 0.35640 | 7.25723 |
| EXP2 | - | - | -0.52866 | -4.79192 |
| K6 | -0.06869 | -3.78120 | - | - |
| K10 | -0.04344 | -3.02948 | - | - |
| K15 | -0.02809 | -2.10557 | - | - |
| HRINC | -0.20886 | -11.85736 | - | - |
| HRINC2 | 0.06477 | 9.51195 | - | - |
| **Sectoral and regional variables** | | | | |
| RUNEMP | -0.01137 | -0.53457 | -0.08477 | -1.92647 |
| OPET | -0.04659 | -1.12747 | 0.09872 | 1.50314 |
| PRDIET | -0.01132 | -0.07391 | - | - |
| PRDIET84 | - | - | -0.03222 | -0.02846 |
| PRDIET85 | - | - | 0.92891 | 1.87513 |
| PRDIET86 | - | - | -0.22200 | -0.60592 |
| PRDIET87 | - | - | -0.75716 | -1.73944 |
| IGD80 | 0.02764 | 0.38538 | -0.24833 | -1.86704 |
| ITKT | -0.39050 | -0.95964 | - | - |
| SUNEMP | - | - | -0.13437 | -3.47064 |
| KTVDPC | - | - | 0.02864 | 1.83364 |
| **Corr. random effects** | | | | |
| HRINCMT | -0.02088 | -2.14174 | - | - |
| **Variances** | | | | |
| 1984 | 0.12468 | 21.76669 | 0.30759 | 20.03805 |
| 1985 | 1.87513 | 23.02037 | 0.35152 | 14.07972 |
| 1986 | 0.12772 | 22.08740 | 0.38109 | 15.46429 |
| 1987 | 0.12112 | 22.68116 | 0.33322 | 17.73820 |
| RHO84 | -0.15633 | -2.73113 | - | - |
| RHO85 | -0.25970 | -4.39734 | - | - |
| RHO86 | -0.36758 | -5.64281 | - | - |
| RHO87 | -0.21034 | -2.55323 | - | - |

**Chart A.8.**
**Sector affiliation of unmarried women**
**Complete sample SOEP 1984 (in%)**

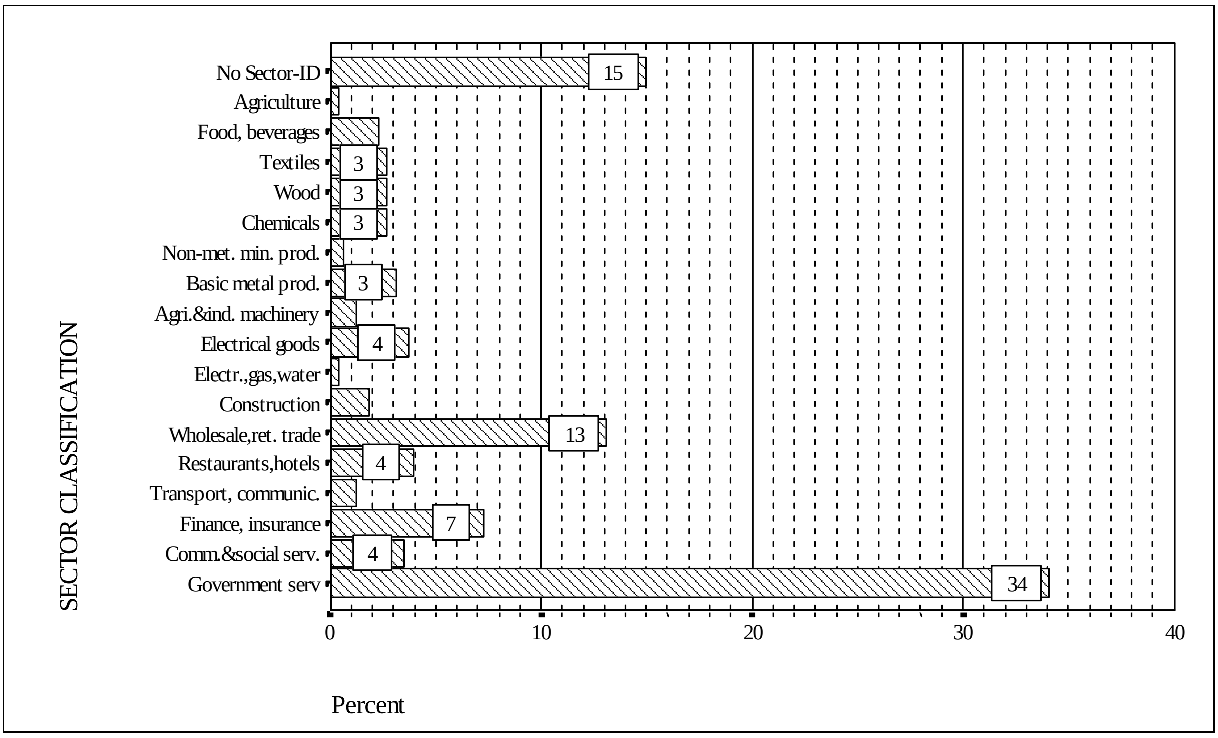


**Chart A.9.**
**Sector affiliation of unmarried women**
**Complete sample PSID 1984 (in%)**

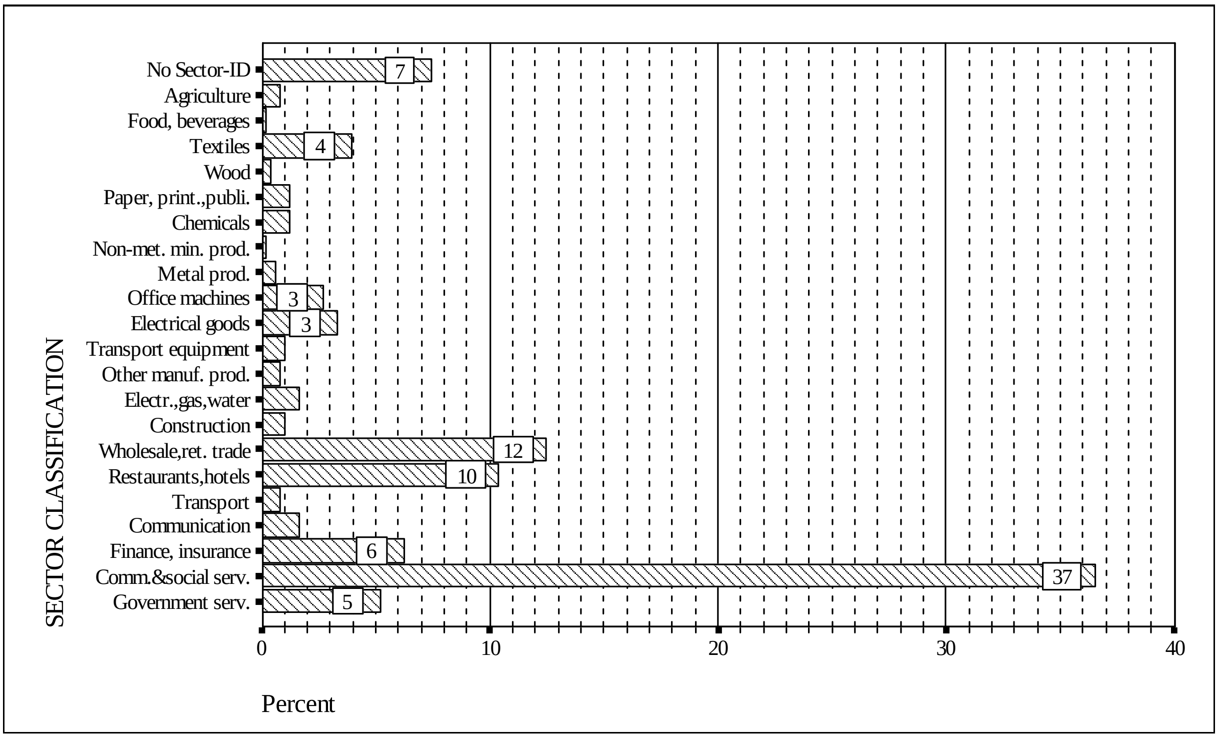

**Table A10.: Misspecification Tests for the Hours equation (complete sample)**

| | PSID | | | SOEP | | |
|---|---|---|---|---|---|---|
| | $\chi^2$ | d.f. | $p_{crit}$ (%) | $\chi^2$ | d.f. | $p_{crit}$ (%) |
| RESET2 | 23.41 | 4 | 0.01 | 17.05 | 4 | 0.19 |
| RESET3 | 30.29 | 4 | 0.00 | 14.93 | 4 | 0.49 |
| RESET4 | 33.06 | 4 | 0.00 | 17.47 | 4 | 0.16 |
| RESET23 | 33.19 | 8 | 0.01 | 26.60 | 8 | 0.08 |
| RESET234 | 37.06 | 12 | 0.02 | 53.59 | 12 | 0.00 |

**Table A11.: Misspecification Tests for the Wage equation (complete sample)**

| | PSID | | | SOEP | | |
|---|---|---|---|---|---|---|
| | $\chi^2$ | d.f. | $p_{crit}$ (%) | $\chi^2$ | d.f. | $p_{crit}$ (%) |
| RESET2 | 7.06 | 4 | 13.28 | 14.07 | 4 | 0.71 |
| RESET3 | 6.24 | 4 | 18.18 | 13.65 | 4 | 0.85 |
| RESET4 | 5.56 | 4 | 23.46 | 13.20 | 4 | 1.03 |
| RESET23 | 17.51 | 8 | 2.52 | 22.85 | 8 | 0.36 |
| RESET234 | 21.71 | 12 | 4.09 | 28.79 | 12 | 0.42 |

**Table A12.: Tests for Heteroskedasticity in the Hours equation (complete sample)**

| | PSID | | | SOEP | | |
|---|---|---|---|---|---|---|
| Variable | $\chi^2$ | d.f. | $p_{crit}$ (%) | $\chi^2$ | d.f. | $p_{crit}$ (%) |
| AGE | 11.22 | 4 | 2.42 | 1.04 | 4 | 90.37 |
| EDUMI | 15.53 | 4 | 0.37 | 9.07 | 4 | 5.93 |
| RUNEMP | 11.00 | 4 | 2.65 | 5.93 | 4 | 20.43 |
| OPET | 1.53 | 4 | 82.15 | 2.28 | 4 | 68.36 |
| PRDIET | 6.95 | 4 | 13.86 | 15.29 | 4 | 0.41 |
| IGD80 | 3.64 | 4 | 45.71 | 5.91 | 4 | 20.57 |
| EXP2 | 19.25 | 4 | 0.07 | 1.95 | 4 | 74.57 |
| SUNEMP | 12.31 | 4 | 1.52 | 14.13 | 4 | 0.69 |
| KTVDPC | 1.55 | 4 | 81.80 | 6.24 | 4 | 18.16 |
| K6 | 14.34 | 4 | 0.62 | 9.43 | 4 | 5.11 |
| K10 | 7.02 | 4 | 0.19 | 1.24 | 4 | 87.18 |
| K15 | 3.65 | 4 | 45.48 | 5.71 | 4 | 22.20 |
| HRINC | 116.28 | 4 | 0.00 | 149.39 | 4 | 0.00 |
| ITKT | 9.09 | 4 | 5.88 | 7.84 | 4 | 9.74 |

**Table A13.: Tests for Heteroskedasticity in the Wage equation (complete sample)**

| | PSID | | | SOEP | | |
|---|---|---|---|---|---|---|
| Variable | $\chi^2$ | d.f. | $p_{crit}$ (%) | $\chi^2$ | d.f. | $p_{crit}$ (%) |
| EDUMI | 3.64 | 4 | 45.64 | 12.38 | 4 | 1.47 |
| RUNEMP | 0.69 | 4 | 95.27 | 7.09 | 4 | 13.13 |
| OPET | 1.90 | 4 | 75.47 | 4.21 | 4 | 37.88 |
| PRDIET | 4.90 | 4 | 29.71 | 9.01 | 4 | 6.09 |
| IGD80 | 3.10 | 4 | 54.17 | 13.51 | 4 | 0.90 |
| EXP | 3.11 | 4 | 53.90 | 7.85 | 4 | 9.72 |
| EXP2 | 2.29 | 4 | 68.24 | 6.24 | 4 | 18.20 |
| SUNEMP | 1.76 | 4 | 77.97 | 12.44 | 4 | 1.44 |
| KTVDRC | 2.53 | 4 | 63.84 | 14.98 | 4 | 0.47 |

**Table A14.: Misspecification Tests for the Hours equation (sample without widows)**

| | PSID | | | SOEP | | |
|---|---|---|---|---|---|---|
| | $\chi^2$ | d.f. | $p_{crit}$ (%) | $\chi^2$ | d.f. | $p_{crit}$ (%) |
| RESET2 | 30.41 | 4 | 0.00 | 8.52 | 4 | 7.43 |
| RESET3 | 33.33 | 4 | 0.00 | 8.90 | 4 | 6.35 |
| RESET4 | 34.60 | 4 | 0.00 | 11.31 | 4 | 2.33 |
| RESET23 | 34.94 | 8 | 0.00 | 22.21 | 8 | 0.45 |
| RESET234 | 40.58 | 12 | 0.01 | 44.79 | 12 | 0.00 |

**Table A15.:Misspecification Tests for the Wage equation (sample without widows)**

| | PSID | | | SOEP | | |
|---|---|---|---|---|---|---|
| | $\chi^2$ | d.f. | $p_{crit}$ (%) | $\chi^2$ | d.f. | $p_{crit}$ (%) |
| RESET2 | 6.26 | 4 | 18.09 | 16.99 | 4 | 0.19 |
| RESET3 | 5.99 | 4 | 20.01 | 16.41 | 4 | 0.25 |
| RESET4 | 5.81 | 4 | 21.37 | 15.78 | 4 | 0.33 |
| RESET23 | 12.79 | 8 | 11.94 | 24.24 | 8 | 0.21 |
| RESET234 | 19.51 | 12 | 7.69 | 28.22 | 12 | 0.51 |

**Table A16.: Tests for Heteroskedasticity in the Hours equation (sample without widows)**

| | PSID | | | SOEP | | |
|---|---|---|---|---|---|---|
| Variable | $\chi^2$ | d.f. | $p_{crit}$ (%) | $\chi^2$ | d.f. | $p_{crit}$ (%) |
| AGE | 6.32 | 4 | 17.62 | 5.72 | 4 | 22.13 |
| EDUMI | 17.34 | 4 | 0.17 | 13.65 | 4 | 0.85 |
| RUNEMP | 13.04 | 4 | 1.11 | 7.76 | 4 | 10.07 |
| OPET | 0.89 | 4 | 92.54 | 4.82 | 4 | 30.67 |
| PRDIET | 6.30 | 4 | 17.77 | 14.10 | 4 | 0.70 |
| IGD80 | 4.6 | 4 | 32.62 | 4.09 | 4 | 39.46 |
| EXP2 | 11.33 | 4 | 2.31 | 1.80 | 4 | 77.17 |
| SUNEMP | 8.37 | 4 | 7.90 | 13.42 | 4 | 0.95 |
| KTVDPC | 1.99 | 4 | 73.70 | 4.91 | 4 | 29.68 |
| K6 | 17.03 | 4 | 0.19 | 8.75 | 4 | 6.78 |
| K10 | 17.30 | 4 | 0.17 | 2.34 | 4 | 67.36 |
| K15 | 4.35 | 4 | 36.02 | 3.39 | 4 | 49.44 |
| HRINC | 96.27 | 4 | 0.00 | 153.85 | 4 | 0.00 |
| ITKT | 10.95 | 4 | 2.71 | 12.56 | 4 | 1.37 |

**Table A17.: Tests for Heteroskedasticity in the Wage equation (sample without widows)**

| | PSID | | | SOEP | | |
|---|---|---|---|---|---|---|
| Variable | $\chi^2$ | d.f. | $p_{crit}$ (%) | $\chi^2$ | d.f. | $p_{crit}$ (%) |
| EDUMI | 5.66 | 4 | 22.63 | 10.91 | 4 | 2.76 |
| RUNEMP | 0.59 | 4 | 96.40 | 8.28 | 4 | 8.20 |
| OPET | 2.94 | 4 | 56.76 | 2.15 | 4 | 70.88 |
| PRDIET | 7.16 | 4 | 12.77 | 10.09 | 4 | 3.90 |
| IGD80 | 3.81 | 4 | 43.30 | 10.79 | 4 | 2.90 |
| EXP | 4.254 | 4 | 37.28 | 11.87 | 4 | 1.84 |
| EXP2 | 4.69 | 4 | 32.04 | 9.87 | 4 | 4.27 |
| SUNEMP | 2.51 | 4 | 64.22 | 13.44 | 4 | 0.93 |
| KTVDRC | 2.38 | 4 | 66.63 | 13.47 | 4 | 0.92 |

**Table A18.**
**Mc Kelvey-Zaviona Pseudo R² (in %)**

| | USA | | FRG | |
|---|---|---|---|---|
| Equation | Complete Sample | Sample Without Widows | Complete Sample | Sample Without Widows |
| $\tilde{H}_{it}^{*}$ | 36,82 | 34,33 | 44,24 | 41,45 |
| $\ln w_{it}^{*}$ | 42,35 | 42,30 | 27,99 | 27,69 |

$$R_{MZ}^{2}\left(\tilde{H}_{it}^{*}\right)=\frac{\sum_{t=1}^{T}\sum_{i=1}^{N_t}\left(\hat{\tilde{H}}_{it}^{*}-\bar{\hat{\tilde{H}}}_{t}^{*}\right)^{2}}{\sum_{t=1}^{T}\sum_{i=1}^{N_t}\left(\hat{\tilde{H}}_{it}^{*}-\bar{\hat{\tilde{H}}}_{t}^{*}\right)^{2}+\sum_{t=1}^{T}N_t\cdot\hat{\sigma}_{e_{1t}}}\cdot 100$$

with $\bar{\hat{\tilde{H}}}_{t}^{*}=\frac{1}{N_t}\sum_{i=1}^{N_t}\hat{\tilde{H}}_{it}^{*}$

$$R_{MZ}^{2}\left(\ln w_{it}^{*}\right)=\frac{\sum_{t=1}^{T}\sum_{i=1}^{N_t}\left(\ln\hat{w}_{it}^{*}-\ln\bar{\hat{w}}_{t}^{*}\right)^{2}}{\sum_{t=1}^{T}\sum_{i=1}^{N_t}\left(\ln\hat{w}_{it}^{*}-\ln\bar{\hat{w}}_{t}^{*}\right)^{2}+\sum_{t=1}^{T}N_t\cdot\hat{\sigma}_{e_{2t}}}\cdot 100$$

with $\ln\bar{\hat{w}}_{t}^{*}=\frac{1}{N_t}\sum_{i=1}^{N_t}\ln\hat{w}_{it}^{*}$

**Table A19.**
**Specification Tests for the Minimum-Distance Estimation**

| | | SOEP | | | | PSID | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | complete sample | | without widows | | complete sample | | without widows | |
| model | d.f. | $\chi^2$ | p crit (%) | $\chi^2$ | p crit (%) | $\chi^2$ | p crit (%) | $\chi^2$ | p crit (%) |
| A | 8 | 10,37 | 23,90 | 4,99 | 75,80 | 5,49 | 70,30 | 10,18 | 25,10 |
| B-A | 69 | 112,72 | 0,08 | 92,45 | 3,13 | 112,35 | 0,08 | 110,83 | 0,10 |
| C-A | 33 | 53,23 | 1,40 | 37,76 | 26,10 | 36,85 | 30,00 | 29,04 | 66,40 |
| D-C | 9 | 14,37 | 11,00 | 12,68 | 17,80 | 17,05 | 4,80 | 17,51 | 4,10 |
| E-C | 18 | 21,05 | 27,70 | 24,46 | 14,00 | 35,51 | 0,80 | 29,50 | 4,20 |
| F-D | 3 | 2,36 | 50,13 | 2,62 | 45,41 | 9,37 | 2,47 | 9,07 | 2,84 |
| G-D | 6 | 10,10 | 12,10 | 10,48 | 10,60 | 18,09 | 0,60 | 13,13 | 4,10 |
| H-G | 9 | 9,79 | 36,70 | 13,36 | 14,70 | 8,36 | 49,86 | 6,92 | 64,57 |
| I-H | 3 | 17,97 | 0,04 | 15,04 | 0,12 | 24,07 | 0,00 | 22,82 | 0,00 |
| J-H | 3 | 12,79 | 0,50 | 4,89 | 18,00 | 3,76 | 28,90 | 3,04 | 38,50 |
| K-J | 3 | 5,43 | 14,30 | 3,22 | 35,90 | 5,44 | 14,20 | 5,26 | 15,30 |
| L-K | 3 | 2,03 | 56,54 | 0,31 | 95,81 | 0,50 | 91,80 | 1,68 | 64,25 |

**Table A20.**
**List of estimated Minimum-Distance Specifications**

| Model | Specification |
|---|---|
| A | overidentifying restrictions |
| B | A + all slope–parameters time-constant |
| C | A + individual variables and $\gamma$ time-constant |
| D | C + RUNEMP and SUNEMP time-constant |
| E | C + IGD80, OPET, KTVDPC and ITKT time-constant |
| F | D + KTVDPC |
| G | D + ITKT and KTVDPC time-constant |
| H | G + IGD80 in hours and wage equation, OPET in wage equation time-constant<br>for the PSID: ITKT time-variable |
| I | H + PRDIET in wage equation time-constant |
| J | H + PRDIET in hours equation time-constant |
| K | J + OPET in hours equation time-constant |
| L | K + HRINCMT time-constant |

## 9. Formulation of the empirical labour supply function

Period-Utility-Function:

$$U_{it} = K_{it}(C_{it}) + a_{it} L_{it}^{\alpha}$$

Derivative of 1. order of the Lagrange-function by $L_{it}$ :

$$\alpha \cdot a_{it} L_{it}^{(\alpha-1)} = \lambda_{it} \cdot w_{it}^{*}$$ (natural logarithm.)

$$(\alpha-1)\ln L_{it} = \ln \lambda_{it} + \ln w_{it}^{*} - \ln \alpha - \ln a_{it}$$

$$\ln L_{it} = \frac{1}{(\alpha-1)}\left(\ln \lambda_{it} + \ln w_{it}^{*} - \ln \alpha - \ln a_{it}\right)$$

Substitute: $\gamma = -\frac{1}{(\alpha-1)}$

=> $$-\ln L_{it} = \gamma \ln w_{it}^{*} + \gamma \ln \lambda_{it} - \gamma \ln \alpha - \gamma \ln a_{it}$$

Substitute: $-\ln L_{it} = H_{it}^{*} - \ln \overline{L}$

=> $$H_{it}^{*} = \ln \overline{L} + \gamma \ln w_{it}^{*} + \gamma \ln \lambda_{it} - \gamma \ln \alpha - \gamma \ln a_{it}$$

Substitute: $\ln a_{it} = a_i + x_{it}'\delta + \upsilon_{it}$

=> $$H_{it}^{*} = \ln \overline{L} - \gamma \ln \alpha + \gamma \ln \lambda_{it} - \gamma a_i - \gamma x_{it}'\delta + \gamma \ln w_{it}^{*} - \gamma \upsilon_{it}$$

of $\ln \lambda_{it} = b_t + \ln \lambda_{it-1} + \varepsilon_{it}$ with $b_t = \ln\left(\frac{1+\rho}{1+r_t}\right) - \ln\left[E_{t-1}\left(\exp(\varepsilon_{it})\right)\right]$

repeated substitution implies:

$$\ln \lambda_{it} = \overline{b}_t + \ln \lambda_{i0} + \sum_{j=1}^{t} \varepsilon_{ij}$$ with $\overline{b}_t = \sum_{j=0}^{t} b_j$

Substitution into the empirical labour supply function:

=> $$H_{it}^{*} = \ln \overline{L} - \gamma \ln \alpha + \gamma \overline{b}_t + \gamma(\ln \lambda_{i0} - a_i) - \gamma x_{it}'\delta + \gamma \ln w_{it}^{*} + \gamma\left(\sum_{j=1}^{t} \varepsilon_{ij} - \upsilon_{it}\right)$$