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## Labour supply and wages of married and cohabiting women in the Federal Republic of Germany and the Netherlands: A decomposition analysis

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**Diskussionspapiere**  
**Discussion Papers**

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by

J.D. Vlasblom<sup>\*</sup>, P.P. de Gijsel<sup>\*\*</sup> and J.J. Siegers<sup>\*\*\*</sup>

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# **Deutsches Institut für Wirtschaftsforschung**

Discussion Paper No. 132

## **Labour supply and wages of married and cohabiting women in the Federal Republic of Germany and the Netherlands: A decomposition analysis**

by

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## 1. Introduction

In recent years there has been an increasing interest in comparing labour market behaviour in the Federal Republic of Germany and the Netherlands. To illustrate the existing differences between the Netherlands and the FRG, in Table 1 some information on female labour force participation rates and activity rates for married females is given. As can be seen from the first column in the table, in both countries the employment rates were rising although the rise in the Netherlands was more pronounced than in the FRG. As an indication of labour supply of married and cohabiting women in the next column of the table the activity rates for married females are given.<sup>1</sup> In the third column the part-time employment rates are given. As can be seen from these numbers, the low participation rate in the Netherlands is partly due to the low employment rates of married females. The rise in the activity rate in the Netherlands seems to be caused by a large increase in the part-time employment rates during the last ten years. The conclusion from the table is that there has been a substantial increase in the employment rate in the Netherlands, while at the same time the increase in the employment rate in the FRG was less pronounced. The increase in the Dutch employment rate is due to an increase in the female employment rate; especially the part-time employment rate has risen. At the same time the volume of labour (measured in hours) increased less than the employment rates, i.e., the available labour was divided over more individuals.

This paper is about to what extent the differences in employment over time and between the two countries can be attributed to differences in wages and other socio-economic characteristics, and to what extent they can be attributed to differences in evaluation of these characteristics by both the individuals and the market. In this paper a static model is estimated for both countries explaining labour supply and net market wage rates simultaneously. The results of these estimates will be used to conduct some decomposition analyses, both within countries over time and between countries. This kind of decomposition analysis is used before by, a.o., Siegers (1985), Groot and Pott-Buter (1993), and Henkens, Meijer and Siegers (1993).

Although the necessity of using intertemporal analyses is clear from an economic point of view, almost all studies until mid eighties use static models. More recently, in a large number of countries longitudinal data-bases are available; at the same time econometric techniques to use these data-bases for estimating intertemporal and dynamic models as good as possible are developed. Therefore, empirical research now shifts towards dynamic and intertemporal analyses. However, although in this paper comparisons are made over time, the model used is a static model estimated using cross-section data. The same analysis using explicitly the panel structure of the data will be left for future research.

The paper is structured as follows. In section 2 some institutional differences between the FRG and the Netherlands are discussed. In section 3 the economic model is presented. Section 4 contains the econometric specifications. The principle of the decomposition technique used is explained in section 5. In section 6 a description of the data used is presented. In

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<sup>1</sup>Eurostat does not give the numbers for cohabiting women.

section 7 the empirical results are given. Section 8 contains a summary and some conclusions.

Table 1. Employment rates in the Netherlands and the FRG

Year	Netherlands			FRG		
	Employment rates	Activity rate (married women)	Part-time rates	Employment rates	Activity rate (married women)	Part-time rates
1984	28.7	a)	a)	36.8	41.9	28.2
1985	29.9	31.7	51.0	37.1	41.9	29.1
1986	30.3	31.1	49.8	37.6	42.3	29.2
1987	35.2	37.6	56.0	37.7	41.8	29.0
1988	36.1	38.1	56.1	38.4	42.4	30.0
1989	36.8	38.7	58.4	38.9	42.9	30.4
1990	38.5	40.3	57.7	42.1	46.6	33.6
1991	39.9	41.6	58.6	42.3	46.4	34.0
1992						

a) Not reported in Eurostat Labour Force Survey.

Source: All numbers are from: Labour Force Survey, Eurostat, various issues and tables:

Employment rates: Table 1, Principal characteristics of activity of the population,

Activity rates: Table 4, Activity rates by marital status and broad age groups

Part-time rates: Table 34, Persons in employment by professional status and full-time/part-time breakdown

Definitions used by Eurostat in these tables:

Labour force: all individuals in employment or registered unemployed

Activity rate: labour force as percentage of the population of working age(14 years and above) living in private households

Employment rate: individuals in employment as a percentage of the population of working age

Part-time rate: individuals in part-time employment as a percentage of all individuals in employment

Part-time: working hours  $\leq$  35 hours per week

## 2. Institutional differences between the FRG and the Netherlands

Although in the remainder of this paper institutional differences are not explicitly taken into account, it should be noted that differences in labour supply between the two countries may very well result from differences in institutions like the tax and social premium system, child care facilities, participation in education, etc.

In the FRG spouses are taxed jointly: for the amount of taxes to be paid the distribution of this income between the spouses does not matter. The gross labour income of both partners is added and the total amount of taxes is computed on the basis of this total household income. The contributions to the social security system, however, are a (fixed) percentage of own labour income. In the Netherlands both partners are taxed separately: the amount of taxes due is dependent on own labour income only. The payments to social security are, as in the FRG, dependent on own labour income only.

In principle, the tax system in the FRG induces higher tax rates on the second earner than on the first earner, because the system is progressive. Vermeulen *et al.* (1995) show that when comparing effective tax and social premiums rates<sup>2</sup> on second earners in the two countries it shows up that in the FRG the effective tax and social premiums rates in the FRG are higher than in the Netherlands at average hours, but about equal for women that work only ten hours per week.

There are some details of both systems that should be noted here:

- In the FRG there exists a tax deduction that is dependent on own labour income; for the amount of this deduction, the distribution of income over the partners does matter.
- In the FRG there exist several regulations with respect to the payment of social premiums. People in relatively small jobs are not insured, which implies that they do not pay contributions. Those working in somewhat 'larger' jobs are insured, but do not pay contributions, because their employers pay their contributions.
- In the Dutch tax system it is possible for a partner to transfer his or her personal tax allowance (which is in principle a personal deduction) to the other partner when he or she does not have an income. This holds for married as well as for cohabiting partners.

The regulations in both countries with respect to maternity leave do not differ too much; the regulations with respect to the parental leave, however, show important differences. In the FRG since 1986 there exists the so called *Erziehungsgeld*, which is a benefit that allows one of the parents to stop working temporarily in order to care for a new-born baby. The benefit is DM 600 per month, during the first six months; in the period

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<sup>2</sup>In this study the effective tax and social premiums rate is defined as the difference between the amounts of taxes and social premiums that have to be paid by the household in the situation the woman works a given amount of hours and in the situation the woman does not work for pay, respectively, expressed as a fraction of the gross income of the woman when she participates.



thereafter (four months in 1986, gradually increased to eighteen months in 1992), this amount is means tested, but at most DM 600 per month. When receiving this benefit, it is not allowed to work for pay more than eighteen hours per week. Additional to this benefit, employees have the possibility to take a leave from their job during the period of the *Erziehungsgeld*. At the end of this leave, their employer has to offer them the same or a comparable job. In the Netherlands the regulations with respect to parental leave are introduced in 1991. From then on there exists the legal right for both parents to take an unpaid leave for a period of six months. The leave is partial because the employee that is taking the leave is not allowed to reduce working hours below twenty hours per week. The leave can be taken until the child reaches the age of four years. In some collective labour agreements these regulations are extended. These extensions concern the length of the leave, the minimum number of hours worked during the leave, and the introduction of a paid leave.

### 3. The labour supply model

Usually, in labour supply models only two goods are considered: leisure and aggregate consumption. Define  $\bar{h}$  as the maximum amount of time a consumer can work. Then leisure can be defined as  $l = \bar{h} - h$ , the complement of time worked. The price of this consumption good is equal to the opportunity costs of leisure, i.e., the amount of money foregone by not working, which is equal to the net market wage rate. By aggregating the consumption of goods and using one aggregate consumption index, labour supply can be analyzed in a two-good context with aggregate consumption and leisure as the goods available to the consumer. The problem can then be expressed as the maximization of the following utility function subject to an income budget restriction:

$$\max_{(l,q)} u(l,q) \quad (1)$$

subject to:

$$Y(y,l,w) = pq \quad (2)$$

with:

- $u$  - utility
- $l$  - the amount of leisure
- $Y(.)$  - the 'budget function', giving total income as a function of the net market wage rate, labour supply and other household income
- $y$  - other household income
- $w$  - net market wage rate
- $q$  - the amount of the aggregate consumption good
- $p$  - the price of the aggregate consumption good

An individual's "other household income" consists of her non-labour income and, if she is part of a household, it also includes labour and non-labour income of other household members. Both non-labour income and the net market wage rate are, for the moment, assumed to be independent from the labour supply decision. By assumption no negative amounts can be bought. Neither time worked nor non-market time can be negative or larger than the total time available (e.g., 24 hours per day).

Here, as is usual in most literature on labour supply, the income budget constraint is assumed to be linear in net market wage rates and other household income:

$$y + \bar{h}w = pq + lw \quad (3)$$

with:

- $\bar{h}$  - total time available.

When the utility function is assumed to be (locally) quasi-concave, i.e., when preferences (and, therefore, the iso-utility curves) are assumed to be

convex, solving the above formulated utility maximization problem results in a unique solution for leisure. The Lagrangean is:

$$L(l, q, \lambda) = u(l, q) + \lambda(y + hw - lw - pq) \quad (4)$$

The first-order conditions for this problem are:

$$\begin{aligned} \frac{\partial L}{\partial l} &= \frac{\partial u(l, q)}{\partial l} - \lambda w = 0 \\ \frac{\partial L}{\partial q} &= \frac{\partial u(l, q)}{\partial q} - \lambda p = 0 \\ \frac{\partial L}{\partial \lambda} &= y + hw - lw - pq = 0 \end{aligned} \quad (5)$$

For the solution of this problem to be a maximum, the second order conditions have to be fulfilled. These conditions can be checked using the bordered Hessian of the problem<sup>3</sup>: when all the principal minors of this matrix are positive, the solution fulfils the second order conditions (see, e.g., Varian, 1984). As follows directly from (5), an interior solution exists if at  $h = 0$  the slope of the budget line is larger than the slope of the iso-utility curve. This corresponds to the notion of the reservation wage, i.e., the minimum wage rate at which a person is willing to work, which is equal to the slope of the iso-utility curve at point  $h = 0$ . An individual works for pay if the utility of working is higher than the utility of not working.

If an interior solution exists, i.e., if an individual works for pay, the point of tangency of the budget curve with the highest possible iso-utility curve determines the amount of leisure consumed, i.e., the amount of leisure is determined by solving the first-order conditions. The first conclusion that can be drawn from the first-order conditions is that in an interior optimum the following relationship holds:

$$\frac{\partial u(l, q)}{\partial q} / \frac{\partial u(l, q)}{\partial l} = \frac{w}{p} \quad (6)$$

i.e., in the optimum the ratio of the marginal utilities of consumption and leisure is equal to the price ratio of leisure and consumption. This implies that the optimum corresponds to the point of tangency of the highest possible utility curve and the budget restriction, i.e., to the point where the shadow price of time is equal to the net market wage rate.

The first-order conditions can be solved for, leading to expressions for leisure, consumption and the Lagrange multiplier  $\lambda$  as functions of the exogenous prices and other household income. The solution for leisure and

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<sup>3</sup>The bordered Hessian of the problem is the matrix  $\begin{bmatrix} D_{xx}^2 L & D_x g \\ D_x g' & 0 \end{bmatrix}$ , where  $L$  is the Lagrangean,  $g$  is the restriction and  $D_x$  indicates derivatives with respect to  $x$ .

consumption are the Marshallian demand functions. The labour supply results from the demand for leisure by taking the complement to the total time available:

$$h(w,p,y) = \bar{h} - l(w,p,y) \quad (7)$$

Both leisure and consumption are assumed to be normal goods, i.e., if income rises, the quantity demanded will rise.

This economic model contains two important assumptions that are quite common in the empirical literature. The first assumption is that individuals are not restricted in any way in finding a job that has the desired characteristics, which includes that there is no difference between actual and desired labour supply. When this would not be the case, equation (6) would no longer hold, and the model should be extended to incorporate restricted choice.

The second assumption concerns the interdependence of choices of individuals within the household. The model as presented above does not take into account that many individuals live in a household. Labour supply decisions of one partner may have effects on labour supply of the other partner. In the existing empirical literature most models of female labour supply are so-called male-chauvinist models (Killingsworth, 1981, p. 22). In these models the male decides on his labour supply without taking into account the labour supply decision of his partner. The wife decides on her labour supply given the labour supply of her husband. Thus, she takes her partner's labour supply and, so, her partner's labour income as given. Labour income of the partner, therefore, is part of the other household income in the income budget restriction and is assumed to be exogenous with respect to female labour supply. In this paper both the assumption of unrestricted choice as well as the male chauvinist structure will be maintained.

#### *The problem of non-convexities of the income budget restriction*

In the model presented, the income budget constraint is taken to be a linear function of working hours. In practice this will not be true and the constraint will be a non-linear and probably quite complex function. Because the nature of the budget constraint can have quite large effects on the labour supply, the economic model should be extended to incorporate the exact nature of the income budget restriction. This has been done for cross-section models of labour supply a.o. by Hausman (1980). The problem of non-linear budget restrictions is ignored in this paper and left for further research. A direct result of this is that a choice has to be made on the linearization of the budget restriction. In this paper the mean net market wage rate is used to solve for the first-order conditions mentioned before.

Recent work of De Bartolome (1995) showed that in constructed experiments a non-trivial part of his sample used the mean tax rate as if it were the marginal tax rate. In his experiments this part is larger when the computation of the marginal tax rate is complex. De Bartolome expects using his experimental results, that in labour supply decisions also a large share of the individuals will not be able to compute their marginal tax rate and will

use the mean rate instead. Therefore, the use of a mean net market wage rate instead of the marginal rate may not give unreasonable results. .

### *Factors influencing labour supply*

Using the model presented above, implies that the factors influencing labour supply are the factors influencing the shadow price of time and/or the net market wage rate.

The shadow price of time is assumed to be influenced by the number of hours an individual works: the more she works, the higher the shadow price of time will be, i.e., the higher the financial compensation she wants to receive for an additional hour of labour. Also other household income has a positive effect on the shadow price of time, due to the fact that leisure time will become more market-goods-intensive as other household income increases. Other factors that will affect the price of time concern "constraints which arise from previous economic choices or chance events" (Heckman, 1974, p. 681). We expect the shadow price of time to be higher when there are children in the household, the effect being stronger the younger the children are. Because cohabiting women seem to be more economically independent than married women (Henkens et al., 1993) we expect that the shadow price of time of cohabiting women is lower than the shadow price of time of married women. The shadow price of time will also be positively influenced by experience in homework; in the empirical specification, this experience will be proxied by age.

The net market wage rate is assumed to be explained by human capital variables: schooling and age (with age as a proxy for experience), both having a positive, but possibly curvi-linear effect on the net market wage rate. To account for market influences the local unemployment rate will be included in the model; the higher the local unemployment rate, the lower the net market wage rate is expected to be.

Although the structure of the model is such that the net market wage rate reflects market opportunities and the shadow price of time reflects preferences, we have to realize that both the net market wage rate and the shadow price of time are, at least partly, determined by, e.g., institutional constraints that are not captured by the model. The extent to which the shadow price of time depends on the presence of children within the household depends e.g. at least partly on the availability of child-care facilities. The net market wage rate as used in this model is the mean net wage rate which is not only influenced by human capital but also by the tax and social premium system. When a decomposition of changes over time or differences between countries in labour supply is made, all changes and differences in net market wage rates are, by construction of the model, attributed to human capital variables or the evaluation of these in the market. This might not be a problem when the tax and social premium system does not change over time or when the systems in the two countries are comparable, but it might be a problem when the system changes or when the differences between the two countries are large. When comparing the Dutch and the German tax and social premium system, it can be seen that the differences are large: in the Netherlands individuals are taxed separately, in the FRG the household is taxed, i.e., in the Netherlands the mean and marginal tax rate

of women is independent of the income of the partner, in the FRG it is not: the higher the income of the partner, the higher the mean and marginal tax rates. When comparing the tax and social premium systems in both countries over time, it can be seen that both countries have had substantial tax reforms between 1985 and 1992, resulting in changes in the mean and marginal wages also for individuals without changes in human capital or gross wage rates. Therefore, the results of the decomposition analyses in this paper should be interpreted with some care.

#### 4. Econometric specification of the model

Following Heckman (1974) the following empirical specification is chosen. The shadow price of time, as given by the left-hand-side of equation (6), is assumed to be linear. Both the net market wage rate and the shadow price of time are assumed to be log-linear:

$$\ln(w) = \beta_0 + \beta_1 X + \varepsilon_w \quad (8)$$

$$\ln(S) = \gamma_0 + \gamma_1 h + \gamma_2 Z + \varepsilon_s \quad (9)$$

with:

- w: net market wage rate
- S: shadow price of time
- h: hours worked
- X, Z: vectors of explanatory variables.

The error terms  $\varepsilon_w$  and  $\varepsilon_s$  are assumed to be generated by a bivariate normal distribution with variances  $\sigma_w$  and  $\sigma_s$  and correlation  $\rho$ .

An individual works for pay if at  $h=0$  his net market wage rate is larger than the shadow price of time. This leads to the following expression for labour market participation:

$$Pr(h > 0) = Pr \left[ \frac{(\varepsilon_w - \varepsilon_s)}{\gamma_1} > \frac{(\gamma_0 - \beta_0 + \gamma_2 Z - \beta_1 X)}{\gamma_1} \right] \quad (10)$$

Given participation, the amount of labour supplied can be computed by equating the net market wage rate and the shadow price of time (i.e., equations (8) and (9)). This leads to the following equation for hours, conditional on participation:

$$h = \frac{(\beta_0 + \beta_1 X - \gamma_0 - \gamma_2 Z)}{\gamma_1} + \frac{(\varepsilon_w - \varepsilon_s)}{\gamma_1} \quad (11)$$

The model consisting of equations (8) and (11) can be estimated using a maximum likelihood procedure. The likelihood function is specified as follows (see also Heckman, 1974):

$$L(\beta_0, \beta_1, \gamma_0, \gamma_1, \gamma_2) = \prod_{i \in I_n} Pr(\ln(w_i) < \ln(s_{i0})) \prod_{i \in I_p} n(h_i, \ln(w_i)) \quad (12)$$

with:

- $s_0$ : shadow price at zero hours
- $I_n, I_p$ : set of non-participants and participants, respectively
- $n(h_i, \ln(w_i))$ : bivariate distribution function of hours and wages.

Having estimated the model, the expected number of hours can be computed as well as the expected net market wage rates and the expected shadow prices of time. These expectations can be computed unconditional and conditional on working and non-working, respectively. The expressions for the expectations are:

Unconditional hours:

$$E(h) = (1 - \Phi(u)) (\beta_0 - \gamma_0 + \beta_1 X - \gamma_2 Z + \sigma \frac{\phi(u)}{(1 - \Phi(u))}) / \gamma_1 \quad (13)$$

Hours conditional on working:

$$E(h|h>0) = (\beta_0 - \gamma_0 + \beta_1 X - \gamma_2 Z + \sigma \frac{\phi(u)}{(1 - \Phi(u))}) / \gamma_1 \quad (14)$$

Unconditional net market wage rate:

$$E(w) = \exp(\beta_0 + \beta_1 X + 0.5\sigma_w^2) \quad (15)$$

Unconditional shadow price of time:

$$E(s) = \exp(\gamma_0 + \gamma_1 h + \gamma_2 Z + 0.5\sigma_s^2) \quad (16)$$

with:

$$\sigma = \sqrt{\sigma_w^2 + \sigma_s^2 - 2\rho\sigma_w\sigma_s}$$

$$u = \frac{(\gamma_0 - \beta_0 + \gamma_2 Z - \beta_1 X)}{\sigma}$$

$\phi(\cdot)$ ,  $\Phi(\cdot)$  the probability density function and the cumulative probability density function of the standard normal distribution, respectively.

The model explains labour supply and net market wage rates simultaneously. Participation and hours are determined by the market opportunities, as reflected by the net market wage rate, and the preferences, as reflected by the shadow price of time. The net market wage rate is determined by characteristics of the individual and the evaluation of these characteristics in the market as represented by the parameters in equation (8). The woman's shadow price of time is determined by her characteristics and her own evaluation of these characteristics as represented by the parameters in equation (9). Labour supply is influenced by these two: given a net market wage rate, a rise in the shadow price of time results in a decline of the participation probability, and a rise in the net market wage rate given the shadow price of time results in an increase in the participation probability. The effects on the expected conditional and unconditional hours are in the same direction.



## 5. Decomposition analysis

Given the estimates of the parameters of the model for each respondent expected labour supply (both participation and hours), the expected net market wage rate and the expected shadow price of time can be computed. Given the structure of the model, all expectations are determined by two parts: unconditional hours are determined by the participation probability and conditional hours. The participation probability and conditional hours are determined by the confrontation of the net market wage rate and the shadow price of time. The net market wage rate and the shadow price of time are determined by the characteristics and the estimated parameters (i.e., the evaluation of these characteristics).

Given this structure the differences in labour supply and net market wage rates between two countries can be decomposed into a part that can be attributed to a difference in the first and a difference in the second factor. The difference in unconditional hours can be written as follows:

$$E(h_1) - E(h_2) = P(h_1 > 0)E(h_1 | h_1 > 0) - P(h_2 > 0)E(h_1 | h_1 > 0) + P(h_2 > 0)E(h_1 | h_1 > 0) - P(h_2 > 0)E(h_2 | h_2 > 0) \quad (17)$$

The first two terms in the right-hand-side of this expression correspond to the part of the difference that can be attributed to the difference in the participation probability, the last two terms correspond to the part that can be attributed to the difference in the conditional number of hours.

Both participation rate and conditional hours are a function of the net market wage rate and the shadow price of time. Therefore, following the same decomposition technique, the difference in participation and hours can be written as:

$$P(h_1 > 0) - P(h_2 > 0) = p(w_1, s_1) - p(w_2, s_1) + p(w_2, s_1) - p(w_2, s_2) \quad (18)$$

$$E(h_1 | h_1 > 0) - E(h_2 | h_2 > 0) = h(w_1, s_1) - h(w_2, s_1) + h(w_2, s_1) - h(w_2, s_2) \quad (19)$$

with:

$h(\dots), p(\dots)$ : the functions describing hours and participation.

In these two equations the first two terms give the part of the difference that can be attributed to a difference in the net market wage rate, the last two terms give the difference that can be attributed to a difference in the shadow price of time. Notice that for this decomposition both a shadow price and a net market wage rate should be known. Therefore, it is not possible to do the decomposition for all individuals separately, but only for a given representative individual. In this paper this representative individual is taken as the individual with all characteristics set at their sample averages.

Finally, both the shadow price of time and the net market wage rate are functions of estimated parameters and the characteristics, which allow a

decomposition of the difference into a part that can be attributed to a difference in estimated parameters and a part that can be attributed to a difference in characteristics:

$$w_1 - w_2 = w(X_1, \beta_1) - w(X_1, \beta_2) + w(X_1, \beta_2) - w(X_2, \beta_2) \quad (21)$$

with:

$s(\dots), w(\dots)$ : the functions describing the shadow price of time and the net market wage rate, respectively.

Although this kind of decompositions can be informative on whether differences in estimated parameters or differences in characteristics of the population contributed to differences in the dependent variable, there are some remarks to be made.

- The decomposition analysis is not a causal analysis: it is not correct to claim that differences in characteristics or in parameters caused differences in the dependent variable.
- The decomposition is not unique: equation (17) can also be written as:

$$E(h_1) - E(h_2) = P(h_1 > 0)E(h_1 | h_1 > 0) - P(h_1 > 0)E(h_2 | h_2 > 0) + P(h_1 > 0)E(h_2 | h_2 > 0) - P(h_2 > 0)E(h_2 | h_2 > 0) \quad (22)$$

- Now the first part corresponds to the difference in unconditional hours that can be attributed to a difference in unconditional hours, and the second part to a difference in the participation probabilities. This decomposition will, in general, lead to a decomposition that is different from the one obtained from equation (17).
- All estimations needed for the decomposition are point estimates. Due to the fact that the estimated parameters are stochastic, one should in fact calculate confidence bands for the point estimates and check whether the conclusions from the decomposition are robust with respect to the exact values of the parameters.
- The decompositions as formulated above assume that the model does not leave an unexplained part. However, when there is such an unexplained part, the existing difference in the dependent variable between two samples can be due to this unexplained part. This unexplained part (the epsilons in the empirical estimation equation) is a mixture of everything not captured by the model. Therefore, when differences in this unexplained part result in differences in the dependent variable, the decomposition will not yield satisfactory results.
- Due to the structure of the model used in this paper all decompositions have been done for the representative individual, as noted above. However, as the predictions from the model for the representative individual are not equal to the average prediction for the total sample (due to the nonlinear structure of the model), the decomposition of the differences in labour supply need not necessarily hold for the total sample.

The decompositions will be presented in section 7, both for changes in labour supply over time within each of both countries, as well as for the differences between the two countries. The procedure that will be followed

in this paper is to compute the expectations for an 'average' women from both samples (i.e., all characteristics set at their sample averages).

## 6. Data and sample selection

In this section the data sets used in this study will be discussed. Also some attention will be paid to the differences between these data sets and to possible effects of these differences with respect to the interpretation of the results of the empirical analyses.

### *Data on the Netherlands*

The data on the Netherlands that are used in this study are from the Labour Supply Panel of the Organisatie voor Strategisch Arbeidsmarktonderzoek (OSA, Organisation for Strategic Labour Market Research). This data base is constructed to study labour market behaviour. The first wave of the OSA panel data base consists of about 2000 households which have been interviewed in 1985. The households have been sampled randomly. In every sampled households all persons aged 16 years and older but not when they are older than 60 (except those in full time education and military service) have been interviewed. An exception is the case in which there is at least one person who matches the selection criteria while the main breadwinner does not (e.g., when he is older than 60). In this case this main breadwinner is interviewed also (Allaart c.s., 1987, appendices, p. 1). When individuals refused to cooperate when asked for an interview or were not at home when they were visited, a replacement address has been sampled. The total number of realized interviews is 4020.

For the next wave of the panel in 1986 all individuals included in the 1985 sample were asked to cooperate (even when their age is over 60 years). When one or more members of the household refused to cooperate the other members were interviewed; when the head of the household refused, the other members were interviewed and also a new household was sampled. When a household or members of it moved during the year, one tried to find the new address. In all cases where the household did not respond, a new household was sampled randomly, using the same procedure as for the first wave. Different questionnaires were used for 'old' and 'new' individuals. Individual in old households who did not meet the selection criteria in 1985 but did so in 1986 (e.g., because they were in education in 1985) were interviewed in 1986, using the questionnaire for new respondents. The total number of individuals interviewed in 1986 is 4115 (Allaart c.s., 1987, bijlagen, p. 3).

For the 1988 wave the procedures were slightly changed: Instead of sampling a new household when an old household has to be replaced, the households refusing cooperation in 1985 were asked to re-enter the sample. Only when there was no "old" household available, a new one was sampled. In this wave the questionnaire for the old and the new households are the same.

Earlier analyses show that there is a problem with the procedure to sample 'replacement households' for non-responding households: panel attrition proved to be non-random while new households are sampled randomly. The resulting sample is therefore not fully representative: women are over-sampled, age category 20-24 is undersampled while age category 30-39 is oversampled. Also, due to the household replacement procedure, the age category 60-65 is undersampled. Only people being in the sample when they are younger than 60 can "grow in" in this category. As soon as they drop out, they will be replaced by younger people. The three large cities

(Rotterdam, Amsterdam, Den Haag) are undersampled as are self-employed. Unemployed are undersampled but long-term unemployed are oversampled (Allaart c.s., 1991).

For both the 1990 and the 1992 wave of the OSA-panel the sampling procedures were again slightly changed, the main changes being the change in the age range: from 1990 on all individuals aged 16 to 64 were interviewed; those of 65 and older are only interviewed when there is at least one individual in the household aged under 64. This change resulted in the fact that in the first three waves the age category 60-64 was underrepresented, while in 1990 and 1992 this is no longer the case.

With respect to the sampling of new households to replace households that dropped out from the panel, there was also a slight change: in 1988 households that cooperated in 1985 but did not do so in 1986 were asked again to cooperate. This procedure was no longer used in 1990 and 1992. An other difference was the fact that due to select panel attrition the 1988 panel was not representative for the Dutch population. To correct for this, from 1990 on the new households were sampled non-randomly to make sure the sample remains an a-select sample of the Dutch potential labour force population.

To give some idea of the panel attrition in the OSA-panel: in 1985 4020 individuals were interviewed, in 1992 4536 individuals; 1072 of them were interviewed both in 1985 and in 1992. For a more complete description of the panel attrition and the representativity of the data see Allaart *et al.*, 1991 and 1993.

#### *Data on the FRG*

The data that are used on the FRG are from the "Sozio-ökonomische Panel (SOEP)". The information on this data is taken from the Benutzerhandbuch SOEP (DIW, 1992). This data base is a panel data base, starting in 1984 (Welle A). One of the primary goals of the data base is to get representative micro-panel data on individuals, households and families. Special attention is paid to changes in family and household composition, labour force participation, labour mobility, income profiles and housing condition and regional mobility. Together with this information there is information on education, health, spending of time, satisfaction and opinions.

The data are collected on a household basis. The first sample contained 5921 households in which all persons of 16 years and older have been interviewed. The sample of 5921 households is split up in two sub-samples. The first sub-sample contains 4528 households which have been sampled randomly. The second sub-sample contains 1393 non-German households (immigrants or guest-workers). This second sample is not sampled randomly but contains 397 Turkish, 294 Yugoslavian, 306 Italian, 196 Greek and 200 Spanish households. Households of other nationalities are present in the first sample. Although it is possible that the nationality of the household changes, the household stays in the sample in which they started. In combining both samples to one large sample there arise, therefore, some difficulties because of the non-random selection of the second sample.

From the second wave on all persons from the first wave have been interviewed together with persons who moved in old households as well as persons

who were in a new household together with a person already interviewed in the first wave. Individuals refusing to be interviewed again are dropped from the sample and will not return in it<sup>4</sup>. Persons who move abroad are also dropped. No new households are sampled to replace those that are lost due to attrition.

To illustrate the panel attrition in the German data: in 1985 11090 individuals were interviewed, in 1992 there 9305 interviews were taken. Of the individuals interviewed in 1992 6598 were also in the 1985 wave. Compared to the Dutch data the panel attrition is considerably lower in the German data.

#### *Selection criteria used in this study*

The sample used for both the Netherlands and the FRG are selected from the data in comparable ways. The first criterium is age: all individuals younger than 16 and older than 65 are removed. Because of the differences in behaviour of self-employed and employees, self-employed women and those women with self-employed partners have been dropped. Notice that if this second selection is applied in every wave separately, there may be some endogenous sample selection, due to fact that the decision for people to start for their own may be dependent on earlier labour supply decisions.

After selecting on the basis of age and employment status the sample is selected on nationality. In the German sample all non-Germans are excluded for two reasons:

1. they are oversampled and sampled in a different way than the Germans;
  2. not all information used in the analyses is known for the non-Germans.
- The first problem, the different sampling procedures, can perhaps be solved by weighting the observations, although this may be quite difficult. The second problem can not be solved because information is not available<sup>5</sup>. In the Dutch sample there has been no selection on nationality because there is no information on nationality in the data base.

People in full-time education are dropped both from the Dutch and the German sample. Because this study concerns married and cohabiting women, as a last selection all single women are dropped.

After the samples have been selected, the consistency of answers has been tested: Women about whom we have incomplete information on hours and/or income variables have been dropped. Also, women with missing information that can not be imputed have been dropped from the sample.

After applying the selection criteria the resulting number of individuals in the sample are as given in the tables in appendix A and B for the Netherlands and the FRG, respectively. When comparing the panel attrition for the resulting samples, the differences in panel attrition for the total samples proves to translate to the samples that will be used in this paper. For the

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<sup>4</sup>This is a result of German legislation: it is not allowed to follow persons who refuse cooperation and ask them again to cooperate.

<sup>5</sup>E.g. the information on schooling outside Germany.

Dutch data there are 1052 individuals in 1985 and 1025 individuals in 1992, of them 221 were also present in the 1985 cross-section. In the German data in 1985 1603 individuals are present, in 1992 this number is 1319; of those 752 were present in 1985.

#### *Variables used in this study*

Now the variables used in this study will be presented and their construction will be explained.

*Hours:* The average normal working hours per week, including overtime.

*Participation rate:* An individual is defined to be participating in the labour market if he reports positive working hours, non-participating otherwise.

*Hourly wage rate:* The net monthly labour income divided by the product of the normal weekly working hours and the number of weeks worked per month. Given vacation, holidays, etc, there are on average 43 working weeks per year, which results in 3.6 weeks per month for both countries. (See, e.g., Bundesministerium für Wirtschaft, 1993, page 17).

*Other household income:* The sum of the two most important sources of other income of the household: net labour income of the partner and the child benefits.

*Age:* Age at the moment of interview.

*Effective schooling years:* In the Dutch as well as in the German questionnaire there is information on the educational level of the respondents. This information is recoded into information on effective schooling years, i.e., the minimum number of effective schooling years needed to attain the indicated level. The information in the Dutch questionnaire is based on the so called 'Standaard Onderwijs Indeling'. The effective schooling years are assigned as follows: Lower education six years of schooling, extended lower education nine years, secondary education twelve years, and higher education fifteen years. A university degree corresponds to seventeen years. The information in the German questionnaire is somewhat less detailed compared to the Dutch questionnaire. The coding used for the German data is as follows: Hauptschulabschluss and Realschulabschluss correspond to ten years of schooling. Fachoberschule, Lehre, Abitur, Berufsfachschule and Fachschule is set to twelve and a half years. Schule Gesundheitswesen and Beamtenausbildung is set to sixteen and a half years. Fachhochschule and a university degree is set to seventeen years.

*Marital status:* Equals one if cohabiting, zero if married.

*Unemployment rate:* local unemployment rate. For the Netherlands: the local unemployment rate in each of the 28 RBA-regions in which the respective respondents live (Source: Statistics Netherlands, Enquête Beroepsbevolking). For the FRG: the local unemployment rate in each of the

Bundesländer in which the respective respondents live (Source: Bundesanstalt für Arbeit, 'Amtliche Nachrichten der Bundesanstalt für Arbeit, Arbeitsstatistik- Jahreszahlen 1993', Übersicht 19).

*Sample descriptives for both countries*

In Appendix A some descriptive statistics of the Dutch data and in Appendix B those of the German data are presented. Because there has been inflation in both the Netherlands and the FRG it is not valid to compare incomes between years and countries without taking the inflation and exchange rates into account. Therefore, in the decomposition analysis incomes have been deflated using the consumer price indexes as presented in table 2. To compare incomes between countries the nominal exchange rate have been used.

Table 2. Consumer price indices and exchange rates, the Netherlands and the FRG, 1984-1992

	The Netherlands CPI <sup>a)</sup>	The FRG CPI <sup>a)</sup>	Exchange rate (Fl/DM) <sup>b)</sup>
1984	97.8	97.8	1.128
1985	100.0	100.0	1.128
1986	100.2	99.9	1.129
1987	99.8	100.1	1.127
1988	100.6	101.4	1.125
1989	101.7	104.2	1.128
1990	104.2	107.0	1.127
1991	108.4	110.7	1.126
1992	112.5	115.1	1.125

<sup>a)</sup> Source: Eurostat, Consumer price index, 1992, (1985=100).

<sup>b)</sup> Source: Centraal Planbureau, Macro Economische Verkenning 1995, Den Haag, 1994, page 182 ; computed using exchange rates to US Dollar.



Appendix A shows that in the Netherlands working women have less children than non-working women, are higher educated and younger. It can also be seen that the participation rate of partners of working women is higher than the participation rate of partners of non-working women, which can possibly be explained by an age effect. Other household income is lower for working women than for non-working women.

Not only the educational level of working women is higher than the average, but also their partners education is slightly higher than the sample average. Educational levels of partners are usually positively correlated. The same, of course, holds for age.

When looking whether there are any trends over time, it can be seen that in the total population most of the characteristics stay relatively stable from 1985 to 1988; the changes from 1988 to 1992 are larger. Labour market participation was going up from 35% to 47% which is a large rise given the short period. The number of hours worked in the total sample is only going up slightly. The number of women that have young children at home age is slightly going up till 1988 but is falling from 1988 to 1992. The educational level of men and women increased from 1985 to 1988 but decreased from 1988 to 1992. When comparing these trends to those in the working sub-sample, it can be seen that the number of women with young children was increasing in the working sub-sample at a faster rate than in the total sample, but also decreased from 1988 to 1992. The educational level of the partners follow the trend in the total sample. Age, however, increased in the working sub-sample from 1985 to 1992, but in this period it is not rising in the total sample. This may indicate a changing behaviour in the population: more women with young children and more older women enter (or stay in) the labour market. At the same time, the number of hours worked declines in the working sub-sample. This is consistent with the Eurostat information given in section 1: an increasing part of the working population is in a part-time job.<sup>6</sup> The changes in, e.g., age and the presence of children can, at least partly, be explained by the fact that the sample includes only few people aged 60 and older in the first three waves, but considerably more in 1992. This results in a rise in age of the average individual. The non-random selection of new households in 1990 and 1992 can perhaps explain observed changes in education.

The last thing worth noting is the fact that although the nominal hourly wage rate is increasing, the change in real hourly wage rates is in fact slightly negative:  $17.0/1.125 = 15.1$  which is below the level of 1985.<sup>7</sup> This, however, does not apply for other household income: both in the total sample and in the working sub-sample, other household income increases, both in nominal and in real terms: the nominal increase in the total sample is about 17%, the real increase is about 4%. For the working sub-sample the

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<sup>6</sup>It should be noted that the definition of participation used here is: the percentage of the total sample in a paid job. This does match the Eurostat definition of employment rate (see table 1), except for the differences in the population used.

<sup>7</sup>The value of the hourly wage rate and the CPI can be found in Appendix A and Table 2, respectively.

nominal increase is 30%, the real increase is 15%. The rise in other household income could be explained by the increase in the labour income of the partner. The decline in real hourly wage rates can perhaps be explained by the fact that compared to the earlier waves educational level is lower, implying a lower market wage rate.

In Appendix B the same characteristics are presented for the German sample. Although the analyses will only cover the years 1985 and 1992, the statistics are given for the full period available, i.e., the years 1984 to 1992. The comparison of total and working sample gives the same conclusions as for the Dutch data with respect to children, education, age and characteristics of the partner: i.e., women in paid work have on average less children compared to the total sample, are, on average, higher educated and are younger; this also holds for the partner.

Compared to the Dutch population, the German population is more stable over time in characteristics: over the nine year period there are in most variables only small changes. Nevertheless, employment rate has risen from 41% to 49%. The number of hours worked has risen both for the total as for the working sub-sample by about the same amount. The rise in other household income and the rise in hourly wage rate are far above the inflation rate: inflation from 1985 to 1992 is about 15% and the rise in other household income and hourly wage rates is over 30%. There is only a small change in presence of younger children. However, the percentage of women with older children present in the household falls from 28% to 19%. This drop is also found by, e.g., Bertschek, Lechner and Ulloa (1991). Educational level and age do not change at all.

When comparing the Dutch and the German data, the following differences are clear. As already noticed in the introduction, German women have higher labour supply, both in participation and in hours worked. However, the net hourly wage rate is lower in the FRG. This however, may be a misleading conclusion because in both countries there is a tax system with increasing marginal tax rates, implying that net marginal wage rates decline when hours of work rise, even at constant gross wage rates. As German women work more hours their net wages tend to be lower. Also the fact that the German tax system taxes total household income instead of own labour income, will result in lower net wages for women.

An other difference between the Dutch and the German sample is that the number of women with children present in the household in the German sample is lower than in the Dutch sample, but this can perhaps be explained from the fact that women in the German sample are on average five years older than women in the Dutch sample. This is presumably a result of the difference in the original samples. The German respondents are higher educated than the Dutch, although the years are computed from information on educational level and the exact number of years is sensitive with respect to the number of years that is assigned to the different levels.

## 7. Empirical results

### *The Netherlands*

In this section the empirical results are presented. As explained in section 3 they concern two different topics: the estimation of the labour supply model and the question whether the estimated relationships between income and socio-economic variables change over time.

To begin with, the labour supply model presented in section 4 is estimated to explain weekly working hours. In table 3 the results are presented for both the Netherlands and the FRG, both for 1985 and 1992. The results are in line with the expectations mentioned in section 3.

First describing the estimates for the shadow price of time: The shadow price of time increases with the number of hours worked. This implies that there is a positive effect of the wage rate on hours worked. (This effect is given by the inverse of the parameter on hours.) The higher a woman's other household income the higher the shadow price of time. Also the presence of children has a positive effect on the shadow price of time, and this effect is stronger the younger the children are. Presence of children in the oldest age category has a significant effect on the shadow price of time in 1985, but no longer in 1992. Cohabiting women tend to have a lower shadow price of time than married women, although this effect is not significant in 1985. The shadow price of time is positively affected by age.

The market opportunities of the individual are represented by the net market wage rate. The net market wage rate reaches its peak at slightly different ages for different educational levels. In 1992 for women with only lower education the net market wage rate reaches its peak at an age of 40 years, for those having a university degree at an age of 39 years. This peak has shifted compared to 1985: the peaks were at age 40 and 43, respectively. The peak in the age-earnings profile shifted to the right for lower educated workers, but it shifted to the left for higher educated workers. Education proves to have a positive effect on the net market wage rate for all individuals.

When comparing the results of the two years, it seems that the shifts in the coefficients are quite large, both for the shadow price of time and for the net market wage rate equation.

Table 3. Estimation results of the labour supply model explaining market wage rates and weekly working hours, the Netherlands and the FRG, 1985 and 1992. <sup>a)</sup>

	The Netherlands		The FRG	
	1985	1992	1985	1992
<b>Shadow price of time (log)</b>				
Constant	1.4629 ** (0.1795)	1.8807 ** (0.1648)	0.9167 ** (0.2674)	0.9169 ** (0.3192)
Hours/10	0.1589 ** (0.0250)	0.1519 ** (0.0270)	0.2025 ** (0.0352)	0.2371 ** (0.0438)
Other household income/1000 (in Dfl, DM per month)	0.1118 ** (0.0212)	0.0148 * (0.0074)	0.0729 ** (0.0170)	0.0559 ** (0.0157)
Age/10	0.1988 ** (0.0346)	0.1710 ** (0.0351)	0.2486 ** (0.0516)	0.2877 ** (0.0571)
<b>Presence of children</b>				
0- 5	0.5767 ** (0.0952)	0.3535 ** (0.0677)	0.6528 ** (0.1255)	0.8295 ** (0.1649)
6-11	0.1938 ** (0.0463)	0.1116 ** (0.0321)	0.2942 ** (0.0635)	0.3258 ** (0.0737)
12-17	0.1674 ** (0.0442)	0.0336 (0.0294)	0.1453 ** (0.0434)	0.1221 ** (0.0521)
Marital status (1:cohabiting)	-0.0801 (0.0562)	-0.1272 * (0.0533)	-0.0347 (0.0685)	-0.1056 (0.0660)
<b>Market wage rate (log)</b>				
Constant	2.0090 ** (0.3661)	1.7887 ** (0.2750)	2.2593 ** (0.5803)	2.4609 ** (0.4787)
Age/10	0.5449 ** (0.1155)	0.3515 ** (0.1040)	0.4382 ** (0.1123)	0.2915 ** (0.1052)
Age squared/100	-0.0785 ** (0.0134)	-0.0428 ** (0.0132)	-0.0643 ** (0.0101)	-0.0590 ** (0.0100)
Effective schooling years/10	-1.0955 ** (0.4113)	0.1789 (0.2591)	-1.5382 * (0.6853)	-1.1916 * (0.5872)
Effective schooling years squared/100	0.5157 ** (0.1370)	0.1201 (0.1090)	0.6893 ** (0.2134)	0.3932 * (0.1972)
Age*Effective schooling years/100	0.0829 (0.0480)	-0.0119 (0.0436)	0.0603 (0.0593)	0.1768 ** (0.0495)
Unemployment rate/10	0.0003 (0.0200)	-0.0778 (0.0534)	-0.0932 * (0.0440)	-0.0197 (0.0565)
$\sigma_s$	0.4732 ** (0.0485)	0.4514 ** (0.0371)	0.7012 ** (0.0839)	0.7319 ** (0.0977)
$\sigma_m$	0.3000 ** (0.0110)	0.3451 ** (0.0113)	0.3639 ** (0.0102)	0.3289 ** (0.0101)
	0.6186 ** (0.0766)	0.7247 ** (0.0757)	0.5751 ** (0.0873)	0.5913 ** (0.0819)
Number of observations	1052	1025	1603	1319
Log likelihood	-1219.4	-1514.3	-2491.1	-2138.4

a) Standard errors in brackets. \*: significant at 5%, \*\* significant at 1%.

From the previous results it can be concluded that there are changes both in characteristics of the population (as can be read from the sample descriptives ) and in the evaluation of these characteristics (as can be read from the estimated parameters). It will be investigated to what extent the observed change in labour supply from 1985 to 1992 (a rise from 9.4 to 11.1 hours on average, and a rise in participation from 35% to 47%) can be explained by changes in characteristics and by changes in the evaluation of these characteristics, respectively. To answer this question a decomposition analysis has been carried out.

The results of the decomposition analyses are presented in table 4. As can be seen from panel A of this table, the difference in labour supply between both years is mainly attributable to a change in participation probability: computing the unconditional expectations of hours holding the conditional labour supply fixed gives a larger change than keeping the participation at a fixed level and changing the number of hours. Then decomposing the change in participation probability into a part attributable to changes in market wage rates and changes in the shadow price of time as is done in panel B, shows that as far as there were any changes in market wage rates, they did hardly contribute to a change in participation, and if so, the effect was negative. Therefore, the increase in labour supply is attributable to the change in the shadow price of time which resulted in both an increase in conditional hours and in the participation probability. Panel C shows that the increase in the conditional hours of work can also be attributed to a change in the shadow price of time. Panel D shows that there were almost no changes in market wage rates between 1985 and 1992. Finally, decomposing the shadow price of time as is done in panel E, leads to the conclusion that the change in characteristics induced a slight increase in the shadow price of time, and the change in the evaluation of these characteristics resulted in a larger decrease. Therefore, the overall conclusion is that the change in labour supply over this seven year period was mainly determined by a decrease of the shadow price of time, which resulted in a increase in participation probability.

This conclusion is in accordance with earlier work by Hartog et al. (1985), Groot et al. (1993) and Henkens et al. (1993), who all studied changing labour supply in the Netherlands over time, and reached the same conclusion using other data and other time periods.

Table 4. Results of the decomposition analysis of labour supply, the Netherlands <sup>a)</sup>

A. Unconditional hours			
	Conditional hours	Participation probability	
		1985	1992
	1985	5.7	8.1
	1992	6.0	8.5
B. Participation probability			
	Market wage rate	Shadow price of time	
		1985	1992
	1985	0.36	0.56
	1992	0.32	0.51
C. Conditional hours			
	Market wage rate	Shadow price of time	
		1985	1992
	1985	15.8	19.9
	1992	15.3	16.6
D. Unconditional market wage rates			
	Evaluation	Characteristics	
		1985	1992
	1985	14.8	15.4
	1992	13.0	14.4
E. Unconditional shadow price of time			
	Evaluation	Characteristics	
		1985	1992
	1985	19.8	19.8
	1992	16.6	16.9

<sup>a)</sup> Computations using results from table 3; expectations evaluated at sample means. All prices in Dutch Guilders at the 1985 price level.

## *Federal Republic of Germany*

In this section the results of the labour supply model and the decomposition analyses are presented for the FRG. The results of the labour supply model are presented in table 3. As was the case for the Netherlands, the results for the FRG are in accordance to the expectations.

The shadow price of time is increasing with hours worked, implying a positive effect of the wage rate on labour supply. The shadow price of time is higher the higher other household income. The presence of children also increases the shadow price of time, the effect being larger the younger the children are. In the FRG cohabiting women tend to have a lower shadow price of time, although this effect is not significant. Older women tend to have a higher shadow price of time.

According to the estimates for 1992, the net market wage rate reaches its peak at 40 years of age for those having lower education and at 51 for individuals having a university degree. These values are quite large when compared to the values for 1985 which are 39 and 42 years of age, respectively. The estimated effect of schooling is positive for all individuals. The unemployment rate seems to have a negative effect on the net market wage rate and, so, on labour supply, although this effect is not significant in 1992.

When using the estimation results for the FRG to conduct the decomposition analyses, the results are as given in table 5. As already noticed before, the changes in labour supply in the FRG are relatively small from 1985 to 1992. However, when estimating the expectations for an average individual, they seem to be quite high. This may indicate the need to use a more elaborate model.

From panel A in table 5 it can be seen that the shift in unconditional hours is completely determined by a change in participation probability, and not by a change in conditional hours. Panels B and C show that the changes in participation probability and conditional hours are caused on the one hand by the effect of a change in the net market wage rate, which resulted in an increase in labour supply, and on the other hand by a change in the shadow price which resulted in a slight decrease of labour supply. The total effect of these two changes resulted in an increase in the participation probability and almost no change in the conditional hours of work. Finally, panels D and E of table 5 show that the increase in the net market wage rate can be attributed to a change in the evaluation of the characteristics, while the increase in the shadow price of time can be attributed about equally to a change in characteristics of the population and to a change in evaluation of these characteristics. Therefore, the conclusion is that the changes in estimated labour supply, both in participation and in hours, are caused on the one hand by a rise in the net market wage rate, induced by a changing evaluation of human capital, and on the other hand, partly offsetting the effect of the rise in the net market wage rate, an increase in the shadow price of time caused by both a change in the characteristics of the population and by the evaluation of characteristics by the population.

Table 5. Results of the decomposition analysis of labour supply, the FRG <sup>a)</sup>

A. Unconditional hours			
	Conditional hours	Participation probability	
		1985	1992
1985	10.2	10.2	12.3
1992	10.2	10.2	12.2
B. Participation probability			
	Market wage rate	Shadow price of time	
		1985	1992
1985	0.47	0.47	0.44
1992	0.60	0.60	0.56
C. Conditional hours			
	Market wage rate	Shadow price of time	
		1985	1992
1985	21.8	21.8	18.9
1992	25.6	25.6	21.7
D. Unconditional market wage rates			
	Evaluation	Characteristics	
		1985	1992
1985	10.5	10.5	10.7
1992	12.4	12.4	14.4
E. Unconditional shadow price of time			
	Evaluation	Characteristics	
		1985	1992
1985	16.2	16.2	17.1
1992	17.9	17.9	21.7

<sup>a)</sup> Computations using results from table 3; expectations evaluated at sample means. Prices are in German Marks, price level 1985.



*A decomposition analysis of the differences in labour supply between the Netherlands and the FRG*

Like the decomposition analysis of the changes over time in the preceding sections it is also possible to carry out a decomposition analyses with respect to the differences in labour supply between two countries. The decomposition tables that were presented for the Netherlands and the FRG over time can be computed for a comparison of both countries within one year. To compare income in both countries the nominal exchange rate is used to compare German Marks and Dutch Guilders. In tables 6 and 7 the results of the decomposition analysis of the differences in labour supply between both countries are presented for 1985 and 1992, respectively.

The difference in 1985 between both countries in unconditional hours can be explained about equally by a difference in participation probability and by a difference in conditional hours. This can be seen from panel A of table 6: changing the participation probability from the Dutch to the German level while holding conditional hours at the Dutch level induces an increase in unconditional hours of  $7.4 - 5.7 = 1.7$  and changing conditional hours from the Dutch to the German level while keeping the participation rate at the Dutch level induces a rise of  $7.8 - 5.7 = 2.1$  hours. When further decomposing the differences in participation probability and conditional hours it can be read from panels B and C of table 6 that the lower participation and conditional hours in the Netherlands can be attributed to the fact that the shadow price of time in the FRG is lower than in the Netherlands. This effect is partly offset by the higher market wage rates in the Netherlands which result in a slightly higher labour supply (both in participation and in hours), but the effect of the difference in the shadow price of time proves to be dominant. Therefore, it can be concluded that although the net market wage rate is lower in the FRG, the shadow price of time in the FRG is lower to such a degree that German women work more than Dutch women. When decomposing the differences in the net market wage rate and the shadow price of time between both countries, it can be seen that given the evaluation of the characteristics, German characteristics result in higher wage rates than Dutch characteristics, but this effect is dominated by the fact that given the characteristics the evaluation of characteristics in the FRG is such that German wage rates are lower than Dutch wage rates. The same holds for the decomposition of the differences in the shadow price of time. The overall conclusion is that the large difference in labour supply between both countries in 1985 is the result of a large difference in the evaluation of characteristics between the two countries and to a much lesser extent of differences in these characteristics.

Doing the same decomposition for 1992, the results are as presented in table 7. The difference in 1992 between both countries in unconditional hours can be explained by about one quarter by a difference in participation probability and by three quarters by a difference in conditional hours. This can be seen from panel A of table 7: changing the participation probability from the Dutch to the German level while holding conditional hours at the Dutch level induces a rise in unconditional hours of  $9.3 - 8.5 = 0.8$  and changing conditional hours from the Dutch to the German level keeping the participation at the Dutch level induces a rise of  $11.1 - 8.5 = 2.6$  hours. It can be read from panels B and C of table 7 that the lower participation and conditional hours in the Netherlands should be attributed to a difference in the

shadow prices of time. The difference between both countries in conditional hours can only for a very small part be attributed to a difference in the net market wage rates between both countries, as panel C shows.

When decomposing the differences in the net market wage rate and the shadow price of time between both countries, it can be seen that there is no difference in the net market wage rate, while the shadow price of time in the FRG is higher than in the Netherlands. When decomposing the zero difference in the net market wage rate, it can be seen that German characteristics lead to slightly higher net wage rates, while the German evaluation of the characteristics lead to lower wage rates. These two effects cancel out. The difference in the shadow prices of time can be attributed to a difference in the evaluation of characteristics, with German characteristics resulting in higher shadow prices of time, which is partly offset by a difference in the evaluation of the characteristics, as can be seen in panel E of table 7.

At this point the effect of the estimated variances of both the net market wage rate and the shadow prices should be noticed: in the FRG the shadow price of time is higher, which should correspond to lower hours and participation given a market wage rate: However: in the FRG both hours and participation are higher. This is an effect of the larger variance of the shadow price of time in the FRG: the difference between the net market wage rate and the shadow price of time is larger for the FRG, but due to the larger standard error of this difference, the estimated participation probability is higher.

The overall conclusion is that the differences in labour supply between both countries in 1992 is the result of a difference in the characteristics between the two countries and to a much lesser extent a result of a difference in the evaluation of these characteristics. However, the difference in the variance-covariance structure between both countries is also a cause for differences in estimated labour supply.

Table 6. Results of the decomposition analysis of labour supply, the Netherlands versus the FRG, 1985 <sup>a)</sup>

A. Unconditional hours

	Conditional hours	Participation probability	
		NL	FRG
NL	5.7	5.7	7.4
FRG	7.8	7.8	10.2

B. Participation probability

	Market wage rate	Shadow price of time	
		NL	FRG
NL	0.36	0.36	0.64
FRG	0.16	0.16	0.47

C. Conditional hours

	Market wage rate	Shadow price of time	
		NL	FRG
NL	15.8	15.8	26.4
FRG	12.4	12.4	21.8

D. Unconditional market wage rates

	Evaluation	Characteristics	
		NL	FRG
NL	14.8	14.8	15.8
FRG	10.8	10.8	11.8

E. Unconditional shadow price of time

	Evaluation	Characteristics	
		NL	FRG
NL	20.0	20.0	24.6
FRG	14.3	14.3	18.2

<sup>a)</sup> Computations using results from table 3; expectations evaluated at sample means. Prices in Dutch Guilders, price level 1985.

Table 7. Results of the decomposition analysis of labour supply, the Netherlands versus the FRG, 1992 <sup>a)</sup>

A. Unconditional hours			
	Conditional hours	Participation probability	
		NL	FRG
NL	8.5	8.5	9.3
FRG	11.1	11.1	12.2
B. Participation probability			
	Market wage rate	Shadow price of time	
		NL	FRG
NL	0.51	0.51	0.57
FRG	0.52	0.52	0.56
C. Conditional hours			
	Market wage rate	Shadow price of time	
		NL	FRG
NL	16.6	16.6	19.5
FRG	16.7	16.7	21.7
D. Unconditional market wage rates			
	Evaluation	Characteristics	
		NL	FRG
NL	16.2	16.2	16.7
FRG	15.7	15.7	16.2
E. Unconditional shadow price of time			
	Evaluation	Characteristics	
		NL	FRG
NL	19.0	19.0	25.8
FRG	18.1	18.1	24.4

<sup>a)</sup> Computations using results from table 3; expectations evaluated at sample means. Prices in Dutch Guilders, price level 1992.

## 8. Summary and conclusions

In this paper a static model is estimated for both the Netherlands and the FRG explaining market wage rates and labour supply of married and cohabiting women simultaneously. The results of these estimates are used to conduct some decomposition analyses, both within each country over time and between both countries. This kind of decomposition analysis has been used before by, a.o., Siegers (1985), Groot and Pott-Buter (1993), and Henkens, Meijer and Siegers (1993).

The model used is a model introduced by Heckman (1974). This model explains labour supply and hours simultaneously. Participation and hours are determined by market opportunities, as reflected by the net market wage rate, and the own evaluation of time, as reflected by the shadow price of time. The net market wage rate is determined by characteristics of the individual and the evaluation of these characteristics in the market. The woman's shadow price of time is determined by her characteristics and her own evaluation of these characteristics. Labour supply is influenced by both the net market wage rate and the shadow price of time.

The estimations of this model presented in this paper for both the Netherlands and the FRG are in accordance with expectations. The higher a woman's other household income the higher the shadow price of time. Also the presence of children has a positive effect on the shadow price of time, and this effect is stronger the younger the children are. Cohabiting women tend to have a lower shadow price of time than married women. The shadow price of time increases with the number of hours worked.

The net market wage rate reaches its peak at different ages for different educational levels, resulting in an age-range over which the net market wage rate rises with age, followed by a range over which it declines with age. Education proves to have a positive effect on the net market wage rate.

The decomposition analyses for changes in the labour supply in the Netherlands from 1985 to 1992 leads to the conclusion that this change was mainly determined by a change in the shadow price of time, which resulted in an increase in participation probability. This conclusion is in accordance with earlier work by Hartog et al. (1985), Groot et al. (1993) and Henkens et al. (1993), who all studied changing labour supply in the Netherlands over time, and reached the same conclusion using other data and other time periods.

The same decomposition analyses for the FRG leads to the conclusion that the changes in labour supply are caused on the one hand by an increase in the net market wage rate, induced by a changing evaluation of human capital, and at the other hand, partly offsetting the effect of the rise in the net market wage rate, an increase in the shadow price of time caused by both a change in the characteristics of the women and by their evaluation of these characteristics.

The decomposition analyses of the differences in labour supply between both countries showed that the large difference in labour supply between both countries in 1985 is the result of a large difference in the evaluation of

characteristics between the two countries, and to a much lesser extent of differences in these characteristics.

The difference in labour supply between both countries in 1992, which is smaller than in 1985, is the result of a difference in the characteristics between the two countries and to a much lesser extent the result of a difference in the evaluation of these characteristics. However, the difference between both countries in the estimated variance-covariance structure of the simultaneous model is also a cause for differences in estimated labour supply.

As there are substantial differences between the two countries in the tax and social premium system and, therefore, in the determination of the net wage rate, this is a reason to replicate the analyses using a model that explicitly includes the tax and social premium system, e.g., following Hausman (1980).

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Appendix A, Descriptives of the Dutch data

Descriptives for the OSA data, 1985, 1986, 1988, 1992 respectively.<sup>a)</sup>

	All women		Working women only		
	Mean	St. dev.	Mean	St. dev.	
Age	36.45	10.37	33.47	9.72	
	35.58	9.61	33.44	9.02	
	36.39	9.30	34.38	8.77	
	39.15	9.74	36.46	8.94	
Age partner	38.95	10.55	36.02	10.08	
	38.01	9.72	35.86	9.36	
	38.75	9.41	36.57	8.84	
	41.46	9.87	38.74	9.21	
Effective schooling years	11.01	2.58	11.67	2.54	
	11.59	2.29	12.22	2.36	
	11.58	2.42	12.14	2.39	
	10.97	2.64	11.67	2.60	
Effective schooling years partner	12.00	2.74	12.17	2.68	
	12.66	2.34	12.95	2.34	
	12.66	2.42	12.84	2.38	
	11.52	2.88	11.88	2.75	
Presence of children	aged 0 - 5	0.30	0.46	0.13	0.34
		0.31	0.46	0.21	0.40
		0.33	0.47	0.22	0.41
		0.23	0.42	0.16	0.37
	aged 6 - 11	0.27	0.44	0.17	0.38
		0.28	0.45	0.17	0.38
		0.31	0.46	0.23	0.42
		0.27	0.45	0.25	0.43
	aged 12 - 17	0.26	0.44	0.21	0.41
		0.28	0.45	0.22	0.41
		0.27	0.45	0.22	0.41
		0.30	0.46	0.30	0.46
Net hourly wage rate (Dutch guilders)			15.30	7.07	
			15.18	5.84	
			15.59	5.40	
			17.01	6.05	
Hours	9.43	14.93	26.60	13.13	
	10.59	15.29	26.40	12.84	
	10.75	14.94	24.97	12.79	
	11.12	14.37	23.79	11.83	

Participation rate	0.35	0.48		
	0.40	0.49		
	0.43	0.50		
	0.47	0.50		
Participation rate partner	0.87	0.34	0.91	0.28
	0.91	0.29	0.94	0.23
	0.89	0.32	0.94	0.24
	0.90	0.30	0.95	0.23
Other household income (/1000) (Dutch guilders per month)	2.96	1.16	2.57	0.99
	2.97	1.09	2.79	1.09
	2.99	1.15	2.81	1.15
	3.45	1.72	3.33	1.63
Number of observations				
	1985			
	1986	1052	373	
	1988	897	360	
	1992	927	399	
	1025	479		

a) Source: OSA, 1985, 1986, 1988, 1992

## Appendix B, Descriptives of the German data

Descriptives for the SOEP data, 1984, 1985, 1986, 1987, 1988, 1989, 1990, 1991, 1992, respectively.<sup>a)</sup>

	All women		Working women only		
	Mean	St. dev.	Mean	St. dev.	
Age	41.23	11.65	37.97	10.35	
	41.40	11.43	38.41	10.33	
	40.93	11.27	38.26	10.42	
	41.14	11.39	38.31	10.31	
	41.45	11.37	39.12	10.33	
	41.18	11.62	38.29	10.56	
	41.19	11.59	38.42	10.38	
	40.92	11.55	38.60	10.40	
	41.06	11.43	38.86	10.39	
Age partner	43.80	11.41	40.84	10.72	
	43.91	11.29	41.19	10.69	
	43.47	11.16	41.05	10.80	
	43.72	11.28	41.19	10.84	
	44.12	11.21	42.09	10.66	
	43.78	11.56	41.24	11.10	
	43.72	11.58	41.14	10.92	
	43.49	11.59	41.52	10.82	
	43.66	11.47	41.79	10.88	
Effective schooling years	12.17	2.06	12.56	2.18	
	12.22	2.10	12.52	2.22	
	12.35	2.12	12.62	2.20	
	12.30	2.09	12.55	2.16	
	12.34	2.07	12.66	2.11	
	12.36	2.05	12.60	2.10	
	12.43	2.08	12.65	2.09	
	12.52	2.10	12.71	2.06	
	12.50	2.08	12.70	2.06	
Effective schooling years partner	13.48	2.24	13.44	2.17	
	13.56	2.23	13.47	2.17	
	13.64	2.25	13.55	2.17	
	13.62	2.26	13.52	2.20	
	13.65	2.27	13.67	2.19	
	13.62	2.26	13.58	2.20	
	13.59	2.26	13.53	2.18	
	13.63	2.25	13.54	2.16	
	13.63	2.26	13.60	2.21	
Presence of children	aged 0 - 5	0.19	0.40	0.13	0.33
		0.19	0.39	0.12	0.33
		0.20	0.40	0.12	0.33
		0.20	0.40	0.12	0.33
		0.20	0.40	0.12	0.32
		0.21	0.41	0.12	0.32
		0.21	0.41	0.12	0.33
		0.23	0.42	0.12	0.33
		0.21	0.41	0.11	0.31
	aged 6 - 11	0.19	0.40	0.16	0.37
		0.21	0.40	0.16	0.37
		0.21	0.41	0.15	0.36
		0.20	0.40	0.16	0.37
		0.22	0.41	0.17	0.37
		0.21	0.41	0.16	0.37
		0.20	0.40	0.19	0.39
		0.20	0.40	0.18	0.38
		0.21	0.41	0.18	0.38

aged 12 - 17	0.27	0.45	0.25	0.43
	0.28	0.45	0.27	0.45
	0.25	0.43	0.21	0.41
	0.23	0.42	0.20	0.40
	0.21	0.41	0.19	0.40
	0.19	0.39	0.19	0.39
	0.18	0.39	0.18	0.38
	0.19	0.39	0.19	0.39
	0.19	0.39	0.19	0.40
	Net hourly wage rate (German Marks)			10.61
			10.82	5.72
			11.32	6.40
			11.66	6.92
			12.08	5.81
			12.53	7.52
			13.66	7.70
			13.73	5.92
			14.23	5.89
Hours		12.66	17.00	30.85
	13.19	17.14	30.92	11.84
	13.97	17.59	31.57	11.97
	14.01	17.31	31.06	11.59
	13.59	17.13	30.43	12.02
	14.38	17.42	31.08	11.68
	15.05	17.52	30.90	11.83
	15.48	17.38	30.35	11.85
	15.43	17.56	31.35	11.28
	Participation rate	0.41	0.49	
0.43		0.49		
0.44		0.50		
0.45		0.50		
0.45		0.50		
0.46		0.50		
0.49		0.50		
0.51		0.50		
0.49	0.50			
Participation rate partner	0.84	0.37	0.88	0.33
	0.83	0.38	-0.88	0.33
	0.84	0.37	0.89	0.32
	0.85	0.36	0.89	0.32
	0.85	0.36	0.90	0.30
	0.84	0.36	0.88	0.33
	0.85	0.36	0.89	0.31
	0.86	0.35	0.90	0.30
	0.85	0.36	0.88	0.32
Other household income (/1000) (German Marks per month)	2.15	1.25	2.09	1.07
	2.20	1.35	2.11	1.10
	2.30	1.40	2.18	1.15
	2.38	1.43	2.24	1.18
	2.45	1.45	2.41	1.19
	2.50	1.51	2.37	1.25
	2.64	1.58	2.55	1.27
	2.81	1.64	2.72	1.37
	2.92	1.73	2.82	1.47
Number of observations				
	1984	1677	688	
	1985	1603	684	
	1986	1568	694	
	1987	1545	697	
	1988	1438	642	
	1989	1426	660	
	1990	1374	669	
	1991	1345	686	
	1992	1319	649	

a) Source: SOEP, 1984-1992