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Female labour participation rates in Norway – trends and cycles

Abstract:
Norwegian female labour participation rates have increased steadily since the beginning of the seventies. This paper address several issues concerning female labour participation series for the period 1972-1997. The main purpose is to identify factors that explain the trend-like increase during the last 25 years and a possible cyclical component that is due to labour market conditions. The resulting relations for women in the age-groups 25-39 years and 40-59 years include long-run effects from wages, education and a significant cyclical component. The wage elasticity is the same for the two groups by restriction. For the older women (60-66 years) we find a higher wage elasticity. Children have a negative impact on the labour supply for female 25-39 years. We get no significant effects from the extension of the parental leave and day-care coverage.

Keywords: Female labour participation rates, discouraged worker, lifetime effects, time series.

JEL classification: C22, C32, J22

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1 Introduction

During the recent upturn in the Norwegian economy, a significant increase in the labour force has taken place. This expansion is due both to growth in the working-age population and a rise in the labour force participation rates, particularly for women. Higher participation rates during an upturn can be explained by an opposite "discouraged worker" effect. But, as shown in figure 1, the increase in the female participation rates is also a result of a long-lasting trend. In recent years, labour participation rates for Norwegian women have reached a fairly high level and are among the highest in OECD (see figure 5).

One may expect to find a reverse relationship between female participation rates and fertility rates. This is also the case in Norway until the mid-eighties (see figure 2). But from then on, it seems as this reverse relation has been weakened, or even broken. It may also seem as a puzzle that Norwegian fertility rates are in the upper range in the OECD area, as are female participation rates. During the last decade, however, important reforms concerning parental leave and coverage rate for pre-school children in day care, have been carried through. These reforms have made it more attractive for women to combine motherhood and labour market participation.

Another marked change that has taken place, is the increased educational level among Norwegian women (see figure 3), which is likely to be both a result of more women planning for a working-carreer and increased capacity within the education system, but also a factor that influence on the probabilty for them to continue to work through different stages of life.

Our main focus in this paper is to identify factors that may explain the rise in Norwegian women's labour participation rates during 1972-97. We ask to what extent factors such as higher educational level and reduced fertility may explain the trend-like increase in female participation rates, and to what extent female participation rates are influenced by business cycle fluctuations? We also test whether the reforms passed through during the eighties may explain a part of the increase.

Our approach differs from most of the traditional labour supply litterature, in the way that we base our empirical analyses on time series of aggregated labour participation rates for different age-groups. Our results concerning wage elasticities do however not differ from results obtained in micro-studies. By our approach, we lose the linkage between the husband

and wife's decisions, we cannot handle the complexity of the taxsystem and heterogeneity, and we may get a problem with simultanous decisions. Time series analyses do, however, allow us to account for the effects of labour market conditions in macro on the labour particpation rates. This feed-back effects within the labour market may be important for the size of the economic fluctuations, as an increased participation rate during upturns and a converse reaction during down-turns may reduce the fluctuations. The size of this discouraged/encouraged worker effect is quite essential in evaluating any policies aiming at affecting the unemployment rate. We also capture the effect from other factors that has changed over time when studying aggregated participation rates, such as the extensions in the parental leave program and increased day-care coverage.

The modelling of participation rates using aggregate time series is common for large-scale macroeconometric models such as the model of the London Business School (LBS), Her Majesty's Treasury (HMT), Bank of Finland (BOF5), Bank of Denmark (MONA) and Statistics Denmark (ADAM) (Turner et al., 1989, Christensen and Knudsen, 1992, Willman et al., 1998). All these models have included a discouraged worker effect. The above mentioned models do, however, rely on different levels of disaggregation of the working population and differ with respect to how they capture the rise in the female participation rates across time. None of the models disaggregate according to age, and only the two British models disaggregate according to gender. MONA, ADAM and the LBS-model include a time trend to catch increased female participation, while the HMT-model has replaced the time trend with a set of other variables, among them the ratio of non-manufacturing to total jobs.

Aggregated participation rates for different Norwegian population groups have been analysed by Lindquist et al. (1990), Bowitz (1992) and Zakariassen (1994). In these studies, the female population, 25-66 years, is divided into two groups according to marital status - married or non-married. This classification involves several problems, first of all a mixture of life-cycle effects and cohort effects as each of the two units covers quite many age-groups. A related issue is the substantial changes within the group of non-married female during the last 25 years with regard to the composition on women that never have been married, lonely mothers, mothers that are cohabitant with the father, divorced women and widows.

In the present study, we do not divide according to marital status, but disaggregate according to three age-groups; 25-39 years, 40-59 years and 60-

66 years. Separating the group 25-39 years, makes it more easy to study the effect on female labour participation from the number of smaller children in combination with the extension of the parental leave program and increased day-care coverage. In focusing on different age groups, we may also test for differences over the life-cycle with regard to wage elasticities and the effect from increased educational level.

Quantified models for labour participation rates are often used in connection with large-scale macroeconometric models in analysing the effect of different economic policies and in making economic forecasts. In order to avoid the participation rates to deviate from their logical interval between zero and one during simulations, we assume a logistic function which ensures the rates to stay within this range. The resulting elasticities go towards zero as the participation rates approach their upper limit. This specification of the participation model differs from the Danish, UK and Finnish models mentioned above.

2 An econometric model for participation rates

According to the static labour supply model[1], the individual participation decision is derived by maximizing utility from consumption of goods and leisure, given the budget constraint and the total amount of time disposable for income earning activities and leisure. Participation will occur if the disposal real wage per hour exceeds the individual's reservation wage, r_0, which is the lowest per hour earnings at which an agent will supply labour (equation (1)). The agent is indifferent between participation or not if equality in the equation, while participation will not occur if the resevation wage exceeds the real disposal wage. The reservation wage is a function of the agent's preference structure and the real value of its non-labour income.

$$\frac{w\left(1-t\right)}{p} > r_0 = r\left(T, y_0/p\right) \tag{1}$$

y_o is non-labour income, and $w(1-t)/p$ the real disposal wage rate, where w is wage per hour, t is the taxrate and p is the price level. T is total amount of time. Non-labour income may consist of (a part of) the husband's

[1]See Killingsworth (1983) or Blundell and MaCurdy (1998) for a thorough explanation of the theory of labour supply.

income, benefits (child benefits, lonely parents benefits, social security, disablement benefits) and return on capital. The preference structure may be described by a utility function in which consumption, leisure, number of children, educational level, husband's employment status, own health etc. may be arguments.

Increased non-labour income raises the reservation wage, and as a consequence, some individuals will withdraw from labour participation, while an increased hourly pay has the opposite effect. If both male and female wages raise, the effect on particularly women's participation rate is uncertain, as we get opposite effects via the non-labour income and own wage.

The probability for an agent to participate in the labour market, equals the probability for the real disposal wage per hour to exceed the individual reservation wage. In equation (2) we assume that this probability can be represented by a cumulative probabilty function from the normal distribution.

$$P\left(H>0\right)=P\left(w\cdot\left(1-t\right)/p>r_{0}\right)=\varphi\left(x'\alpha^{*}\right) \tag{2}$$

The vector x' includes variables of importance to the decision, i.e. real disposal wages, non-labour income, and variables which enter the utility functcion. a^{*} is a set of individual parametres.

We define the labour participation rate for a given population (YP) as the ratio of the population that are employed or are searching for a job, and assume that this rate can be described as the average of the individual participation probabilities. We assume a logistic function, $F(\cdot)$, as an approximation to the cumulative density function. This function ensures that the probability stays within the range $<0,1>$.

$$YP=\varphi\left(X'\alpha\right)\approx F\left(x'\alpha\right)=\frac{e^{X'\alpha}}{1+e^{X'\alpha}} \tag{3}$$

The parameter vector α in equation (3) is a function of the individual parameters α^{*} and the distribution of the elements in X' on the population. X' includes aggregates of variables important to the individual probabilities. If the distribution of these characteristics across the population alters significantly, the parameter α may be affected.

We arrive at a relation that is linear in the parameters, by a simple transformation of equation (3).

$$lyp_{it}=ln\left(\frac{YP_{it}}{1-YP_{it}}\right)=X'_{it}\alpha+v_{it} \tag{4}$$

The subscripts i and t refer to the i'th demographic group (i=25 (25-39 years), 40 (40-59 years), 60 (60-66 years)) in period t. v_{it} is a white noise error term representing the discrepancy between the unknown data generating process and our model, and error of measurments in YP_{it}.

If equation (4) is a representation of the long run path of female labour participation rates, we may still have movements around this path due to sluggishnesses in the system and certain factors that may have only short term effects. An error correction model has been used during estimation in order to catch both short- and long term effects. Δ is used to denote differentiated variables ($\Delta lyp_t = lyp_t - lyp_{t-1}$), while u_{it} is a white noise error term.

$$\Delta lyp_{it} = \beta_{i0} + \sum_{j=0}^{J} \Delta X'_{i,t-j}\beta_{ij} + \sum_{j=1}^{J} \lambda_{ij}\Delta lyp_{i,t-j} + \delta_i \left(lyp_{i,t-1} - X'_{i,t-1}\alpha_i \right) + u_{it} \tag{5}$$

Long run elasticities in our labour supply model are time dependent and decrease as the labour participation rate increases. The elasticities are independent of the level on the explanatory variable if this is included on logarithmic form (see equations 6 and 7).

$$El_{X_{ik}} YP_{it} = \frac{\partial YP_i}{\partial X_{ik}} \frac{X_{ik}}{YP_i} = -(1 - YP_{it}) \frac{\alpha_{ik}}{\delta_i}, \quad if \quad \ln(X_{ikt}) \in X'_{it} \tag{6}$$

$$El_{X_{ik}} YP_{it} = -(1 - YP_{it}) \frac{\alpha_{ik}}{\delta_i} X_{ikt}, \quad if \quad X_{ikt} \in X'_{it} \tag{7}$$

2.1 Life cycle- and cohort effects, education and fertility

The choice between material consumption and leisure does truly change as crossing through different stages of life, both due to changing preferences and changes in factors governing the choice; as family size, the household's economic situation, own labour market experience and health. Consequently, if the composition of the female population on different age-groups changes over time, the aggregate participation rate may change. Figure 1 clearly shows the differences across the life-cycle. This call for a seperate analysis of women in different age groups, and in this study we operate with three different groups; (I) 25-39 years, (II) 40-59 years, and (III) 60-66 years. The

first period represents the part of life in which most women give birth, have the responsibility of small children and is establishing a career. In preliminary analysis the second group was seperated into two groups; 40-49 years and 50-59 years. The ratio of women who have small children falls rapidly when passing 40 years, and for housewifes this may be the time to resume their working career. When passing 50 years however, most women who want to, are established in the labour market, but an increasing ratio are leaving work because of disability. Unfortunately, the attempt to estimate separate labour supply functions for the two groups, did not lead to acceptable results. So, in this paper they are treated as one group. During the last seven years before the retirement age, an increasing ratio of the population leaves the working force due to inability and early retirement. Presumably, for people between 60 and 67 years old, the value of the inability benefit may be seen as a potential non-labour income.

Most striking in figure 1, is the upward going trend independent of age, with the exception of the oldest, a result of a constant entry of new cohorts of women with a different attitude towards own labour market participation than those of prior generations. This change in attitudes is also reflected by the increased educational level among Norwegian women through the seventies, eighties and nineties (figure 3). The cohorts represented in our sample do also differ with regard to fertility.

Women's increased labour market participation, increased educational level and reduced fertility are part of the same development and may mutually have influenced each other. The extension of the parental leave and increased day-care coverage makes part of the same picture. In an intertemporal context, educational choices depend on some sort of expected discounted gain from attaining different types of education. If young women see themselves as working most of their life, they may be more eager to attain longer studies. Their plans will probably be influenced by the possibilities for combining motherhood and a job, and by the actual female participation rates.

This leave us with a potential simultanity problem. However, most people take their decisions concerning education and family size during a rather short period in life, and for most these decisions are irreversible, while the choice on whether or not to supply labour may be taken in every single period. Specially for women aged 40 or older, this is the situation. For the younger ones, quite a large part have reached their planned educational level at the age of 25, while they have not yet obtained their final family size.

The simultanity problem from the combination of participation rates and

fertility, may be of less importance. First of all, the negative relationship between them is absent in part of our period. Further, it may be the case that educational level has a greater impact on fertility than has participation rates. After having attained planned educational level, the preference structure may be altered and decisions on labour market participation and planned family size may be revisited. The attained level of education may influence the real wage offers, but also the reservation wage as education may generate a wish for employing the attained skill and may affect the disutilty of labour by altering the job characteristics. Higher educational level among women may be one reason for the increased first birth age, which probably have resulted in fewer children per woman (Kravdal, 1994). .

From the beginning of our period of interest and until the mid eighties fertility fell in Norway, while in the same period, female participation rates increased (see figure 2). One may expect the reservation wage to depend positively on the number of small children in the familiy as having small children is a time consuming activity (Becker, 1965), which may increase the valuation of leisure. During the age 25-39 years, the number of small children per women may be important for the labour supply. By this measure we concentrate on the effect from having small children, and not children per se, on labour market participation. As market based alternatives to care within families arise, the effect from children on women's labour supply may be reduced. Increased coverage rate of day-care is consequently introduced in the relation and may be one factor explaining the continued increase in Norwegian women's labour market participation in later years together with a minor increase in fertility (see figure 2).

Another factor explaining this picture, is the parental leave program, which has been extended several times during the last decade and probably makes it more easy to combine career and motherhood. In 1977 the benefit period was prolonged from 12 to 18 weeks, while the benefits were raised in 1978 to cover 100 per cent of former income. In 1987 the period was prolonged to 20 weeks, and from then on the entitlement periode was prolonged step by step until it reached 42 weeks with full pay (or 52 weeks with 80 per cent compensation) in 1993. After the end of the paid leave, parents are also entitled to a period of unpaid leave, and they obtain full job security during both kind of leaves. Many people find that their qualifications detoriate with interruptions in working careers. Both the numbers and types of job- and wage offers one may receive, and own reservation wage may be influenced and lessen the probability for returning. Full job security counteract this negative

effect childbirths may have on female participation rates. In addition, the generous parental leave may be an incentive to keep up working in between childbirths, as paid parental leave is conditioned on prior work participation. Rönsen and Sundström (1996) find that the right to paid maternity leave with job security speeds up the return of young mothers to work in Norway and Sweden.

2.2 Cyclical components

So far we have concentrated on factors that may help explaining the long run upward going trend in female labour participation rates. But we may also detect cyclical movements in the participation rates which may be due to a discouraged worker effect (Eaton and Quandt, 1983, Turner et al., 1989). Figure 4 suggest a relation between Norwegian female participation rates and the uneployment level, specially from the mid eighties. Figure 5 and 6 suggest similar effects for other countries, as Sweden, Denmark, and US. From search theory we know that people who want a job will, among other things, reflect on the opportunity to succeed before they start, or continue, to search. The probability of success often depends negatively on the unemployment rate. Women that have been homewifes for a while, may postpone their return to working life in periods of high unemployment due to this effect, but may by the same argument be an important reserve to the labour force during upturns. Unemployment may also affect different segments of the labour force and typically workers with low seniority and part-time work, to which group a lot of female workers belong, may be hit more often than others. In addition, older women may be expelled from the labour force by way of early retirement and disability pensions during dowturns. Bowitz (1997) find evidence for a positive relation between the unemployment level and entries into disability pensions in Norway.

2.3 Data

We use annual data for the period 1972-97. The labour participation rate (YP_i) is defined as the ratio of a given population who is in the labour force, either by being employed or unemployed[2] according to the Labour Force

[2]Unemployed persons are persons who were not employed in the survey week, but who had been seeking work during the preciding four weeks, and were available for work within the next two weeks.

Sample Surveys (Statistics Norway, 1998) which started in 1972. Employed persons are persons who performed work for pay or profit at least one hour in the survey week, or who were temporarily absent. The total number of women that participate is taken from national accounts[3], while the age distribution is taken from the Labour Force Sample Surveys. The situation on the labour market is proxied by the unemployment rate (U) in macro according to Labour Force Sample Surveys.

The labour force participation is defined relative to the total population, inclusive those classified as unfit for paid employment. DR_i is the rate of a population that receives disability benefit and as shown in figure 7, this rate has increased a lot up to the beginning of the nineties, specially for the oldest group. At a given point of time, the rate is given from the past, as disability has to be permanently in order to be classified as unfit for paid employment. Recievers of disability benefit may, however, have some earnings from paid employment without losing the benefit. There is also a rather numberous group that receive only partial compensation for disability and thus may want to work part-time. In our estimations, disability rates enter the equations in order to pick up the effect on the participation rates.

The educational variable (ED_i) is defined as the ratio of the female population within age group i, that has finished higher education (13 years or more) relative to the ratio that has finished the nine-year (compulsory primary and secondary) school as their highest education. The ratios are smoothed in order to catch the trend in the educational level, as the original series seemed to contain noise probably due to the survey design. Information on attained educational level is taken from the survey.

As real disposal wage (WF) we apply the average hourly pay for all women, adjusted for the average tax rate and deflated by the consumer price index. We also try to include males' annual earnings (real disposal) (WAM) due to it's effect as part of non-labour income. Attempts have also been done to replace WAM by males' hourly earnings, or the couple of WF and WAM by relative female-male hourly pay. The disability benefit (DB) is measured as the annual benefit for a person whith an average number of points, and who receives full benefit.

$CH03$ is defined as the number of children up to 3 years[4] old per women between 25 and 40 years old. $DC03$ is defined as the number of day-care

[3]Which in turn is based on the Labour Force Sample Survey.

[4]Attempts with children up to six years old made little difference in the equation.

spaces per children younger than 3 years old. Defining the coverage rate according to different age groups did not lead to qualitative different conclusions. The parental leave index, ML_t, is defined as the duration of the benefit period[5] (number of weeks/52) with full compensation[6].

3 Results

For the three female groups, separate labour participation rate equations have been derived by single equation estimation techniques. Subsequently, we test whether elasticities with regard to wages and educational level are the same for all three groups. If equal elasticities are not rejected, we ask if there is any gain from imposing these restrictions during estimation in a multi-equation framework[7].

3.1 Single equation results

Equation (5) serves as a starting point for all three groups, but with somewhat different specification of the vector X'. Ordinary least squares or instrumental variable methods have been used, and succesively variables with insignificant estimates, or wrong sign, on their coefficients have been removed according to the general-to-specific estimation strategy advocated by Davidson et al. (1978). The final version of the model is choosen according to a set of model selection criteria; significance, relevance and constancy of the parameters, satisfactory outcomes on mis-specification and recursive tests, and a relative good fit compared to alternative specifications of the model.

3.1.1 25-39 years

The preferred equation for women of the age-group 25-39 years is given in equation (8). Lower-case letters imply logarithmitc transformations of the

[5] We also included the leave that have to be taken before expected birth (from 1991 on), and the four weeks reserved for the father (from 1993 on), in the duration period. During estimations alternative definitions, with the index based solely on the period after the child is born, or the period exlusive of the weeks reserved for the father, were investigated, but their inclusion did not alter the results.

[6] In Norway one may expand the period by choosing 80 per cent compensation.

[7] The empirical analysis has been carried out using PcGive 9.1 (Hendry and Doornik, 1996) and PcFiml 9.1 (Doornik and Hendry, 1996).

involved variables, i.e. ln(U)=u, etc.

$$\begin{aligned}\Delta lyp25_t &= \underset{(1.09)}{-1.25} - \underset{(.18)}{0.84}\, lyp25_{t-1} - \underset{(.04)}{0.16}\, u_t + \underset{(.25)}{0.44}\, wf_t \\ &\quad - \underset{(.14)}{0.47}\, ch03_{t-3} + \underset{(.13)}{0.49}\, ed25_{t-2} - \underset{(.04)}{0.12}\, i95_t \end{aligned} \tag{8}$$

$Method : OLS, N = 25(1973 - 1997), R^2 = 0.74, \sigma = .0356, RSS = .0228,$

$DW = 2.30, ARCH_1 : F(1,16) = 0.37\,[.55]\,, AR_{1-2} : F(2,16) = 0.84\,[.45]\,,$

$HETERO : F(11,6) = 0.30\,[.96]\,, NORM : \chi^2(2) = 1.22\,[.54]\,,$

$RESET : F(1,17) = 0.08\,[.78]$

Standard errors are provided in parentheses and significance probabilities in brackets. The equation passes all diagnostic tests for functional form misspecification[8] and it seems to track the movements in $\Delta lyp25_t$ reasonable well according to figure 8. The relation is extended by a dummy ($i95$) which equals one in 1995, zero else, and contributes to improve both the fit and the constancy according to recursive Chow tests (figure 9). Long-run elasticities are shown in table 2, and we notice that the elasticity with respect to educational level and number of smaller children are significant at a 5% level, while the other elasticities are almost significant.

According to the model, there is a positive effect from wages and the attained level of education, while there is a negative effect from the unemployment rate and the number of smaller children per women. The result supports the assumption of a cyclical component in the labour supply, in addition to the more traditional factors suggested by micro-based theories. No short-run dynamics are included due to insignificant parameters.

Unlagged values of the unemployment rate and female wages are included and we consequently have a simultanity problem which may lead to biased estimates on the parameters. The exogeneity of wf_t and u_t in our preferred equation has been tested by use of the Wu-Hausman statistic (Hausman,

[8] AR_{1-2} is the Lagrange Multiplier test for residual serial correlation, see Harvey (1990). $ARCH_1$ is a test for heteroscedasticity, see Engle (1982). $NORM$ is a test for the normality of the residuals, see Doornik and Hansen (1994). Next follows White's test for heteroscedasticity, see White (1980) and the $RESET$-test for functional form misspecification, see Ramsey (1969).

1978). The statistic, based on the Lagrange Multiplier, is computed as 0.89 with an associated significance probabilty of 0.43 in a F(2, 16)-distribution. The exogeneity assumption is thereby not rejected. The equation has, however, also been estimated with intruments[9] for wf_t and u_t with only minor changes in the estimated parameters.

3.1.2 Effects from policy variables

In the general version of the model, policy variables as the parental leave and day-care coverage were included in the vector X'. Neither of them become significant and in addition, the estimated parameters indicated a negative effect from an extension of the parental leave or increased day-care coverage on female labour supply. Furthermore, the effect of these variabels have been tested for explicitly in relation to the preferred model presented in equation (8).

Two different ways of including the policy variables have been investigated. In the participation rate for younger women the variables may have a direct effect by its own, but may also influence the elasticity with regard to the number of smaller children as proposed in equation (9).

$$\alpha_{ch,t} = \alpha_o + \alpha_1 ML_t + \alpha_2 DC_t \tag{9}$$

$\alpha_{ch,t}$ is the coefficient in front of the children variable ($ch03_t$), and supposed to be negative. According to equation (9) this negative effect may be reduced with extended parental leave or increased day-care coverage if α_1 and/or α_2 are positive. The significane of $\alpha_1$and α_2 are tested through the parameters on the compound variables $ch03_t \cdot ML_t$ and $ch03_t \cdot DC_t$.

The results from testing the effect of the policy variables are given in table 1. Results from tests of their direct effect and from an eventual effect on the elaticity with respect to children, are reported. The figures in the table are significance probabilities from a F-test of a zero-restriction with regard to the listed variables and we conclude that we find no significant effect from the parental leave program or day-care coverage on female labour participation rates. The variables have also been included with only short-run effects (Δml_{t-j}, Δdc_{t-j}) or with short-run effects in combination with long-run effects (ml_{t-j}, dc_{t-j}), without altering the conclusions.

[9] $\Delta wf_{t-1}, wam_{t-1}, u_{t-1}, \Delta u_{t-2}, q_{t-2}, \Delta q_{t-1}$ served as additional instruments for wf_t and u_t. Q is gross domestic product.

Table 1: Tests on policy variables. p -values.

Variable(s)[1)]	ml_{t-1}	ml_{t-2}	dc_{t-1}	dc_{t-2}	ml_{t-1}, dc_{t-1}	ml_{t-2}, dc_{t-2}
p**-value**	.341	.212	.179	.064	.195	.168
Variable(s)	$ch03ML_{t-2}$		$ch03DC_{t-2}$.		$ch03ML_{t-2}$, $ch03DC_{t-2}$	
p**-value**	.160		.360		.369	

1) $ml_t = \ln(ML_t)$, $dc_t = \ln(DC_t)$

Microbased studies on Norwegian data find a small, but positive effect from the extended parental leave on the probability of getting a second or third child (Rönsen, 1998), and from increased day-care coverage on the probabilty of getting a third one (Kravdal, 1996). These findings suggest that one result of the policy may have been to reduce the negative effect that increased female educational level and/or labour participation may have had on fertility.

3.1.3 40-59 years

Equation (10) is our prefered equation for the age-group 40-59 years.

$$\begin{aligned}\Delta lyp40_t &= \underset{(1.02)}{-\,0.29} \underset{(.09)}{-\,0.32}\, lyp40_{t-1} \underset{(.01)}{-\,0.07}\, U_{t-1} \underset{(.23)}{+\,0.27}\, wf_{t-1} \\ &\quad \underset{(.07)}{+\,.22}\, ed40_{t-1} \underset{(.01)}{-\,0.04}\, \Delta U_t \underset{(.42)}{-\,1.00}\, \Delta wam_{t-1} \underset{(.35)}{-\,1.02}\, \Delta dr45_t\end{aligned} \tag{10}$$

$Method : OLS, N = 25(1973 - 1997), R^2 = 0.83, \sigma = .0330, RSS = .0185,$

$DW = 2.26, ARCH_1 : F(1,15) = 0.30\,[.59]\,, AR_{1-2} : F(2,15) = 2.56\,[.11]\,,$

$HETERO : F(14,2) = 0.41\,[.88]\,, NORM : \chi^2(2) = 2.26\,[.32]\,,$

$RESET : F(1,16) = 2.61\,[.13]$

The model performs well according to the reported statistics and misspecification tests and the tracking performance as shown in figure 10. The recursive graphics in figure 11 indicate that the parameters are relatively

constant over the estimation periode, but with increased uncertainty after 1990. The exogeneity of ΔU_t and $\Delta dr45_t$ is not rejected according to a Wu-Hausman test. The Lagrange Multiplier statistic is computed as 1.26 with a significance probability of 0.31 in a F(2,15)-distribution.

The elasticity with regard to unemployment are significant and the elasticity with regard to educational level is almost significant, while the wage elasticity is clearly insignificant (see table 2). We have choosen to keep the wage elasticity in the relation, both because we expect, based on theorethical considerations, that there is a wage effect, but also in order to test whether we may improve the significance by imposing restrictions across our three participation rate models. The discouraged worker effect is stronger than for the younger ones, which may be reasoned both by the effect the labour market situation may have on women who wants to reenter the labour market, but also the effect from older women being squeezed out during down-turns in the economy. The results support the view that a higher educational level has a positive impact on female labour supply. In the short run, there is also a negative effect from changes in male annual earnings, which we assume to be a part of the potential non-labour income. The disability rate has no long run effects, but changes in it has a negative effect on the participation rate in the short run.

3.1.4 60-66 years

Two variables are included in the long-run solution for the oldest group; the real disposal wage and the disability rate. Both elasticities are significant, and the relation passes our misspecification tests. The wage elasticity is rather high (see table 2), which may reflect that utility from leisure is relatively high for this group. Neither the educational level nor the unemployment rate enter the relation due to clearly insignificant coefficients. The disability rate may, however, pick up some of the effect that otherwise would have been caught up by the unemployment rate. According to our relation, the disability benefit only has effects in the short run, not in the long run.

$$\begin{aligned}\Delta lyp60_t &= \underset{(1.39)}{-6.43} - \underset{(.17)}{0.85}\, lyp40_{t-1} + \underset{(.28)}{1.26}\, wf_{t-1} - \underset{(.11)}{0.43}\, dr60_{t-1} \\ &\quad - \underset{(.52)}{1.42}\, \Delta wf_{t-1} - \underset{(.46)}{1.35}\, \Delta db_t \end{aligned} \tag{11}$$

$Method : OLS, N = 25(1973 - 1997), R^2 = 0.76, \sigma = .0361, RSS = .0248,$

$DW = 1.56, ARCH_1 : F(1,17) = 1.01\,[.33]\,, AR_{1-2} : F(2,17) = 0.99\,[.39]\,,$

$HETERO : F(10,8) = 0.26\,[.97]\,, NORM : \chi^2(2) = 1.45\,[.48]\,,$

$RESET : F(1,18) = 0.41\,[.53]$

Actual and fitted values are shown in figure 12. Again we detect increased instability after 1990 according to the recursive graphics in figure 13, and the 1-step Chow test reject the hypothesis of constancy in 1991. The relation, however, passes the break-point Chow test.

3.2 Cross-restrictions across the groups

Table 2 shows the elasticities for all three groups of women, and we notice that the oldest group differ most from the others with a rather high wage elasticity. The wage elasticities for the two other groups are both insignificant at a 5% level, but rather close to each other. Their educationsl elasticities are also quite similar. In estimating female labour participation rates, prior works on Norwegian data have reported a rather strong multicollinarity between hourly wages and educational level. As a consequence, most attempts to obtain significant effects from both wages and educational level fail. In our study, this problem has been more serious for the age group 40-59 years than for the younger one. One way to solve this problem is to fix one or more coefficients during estimations in order to obtain more significant estimates on the remainder. This may be done by implementing restrictions across our three relations. In the continuing of this paper, we investigate this strategy further.

Our first step is to test whether cross-equation restrictions are accepted by data. If the restrictions are not rejected, our next step is to estimate the relations subject to the restrictions in order to use the information in our data in a more efficient way. One objective is to get sharper estimates on the elasticities, and reduce the standard error of the equations. Another objective is to investigate differences in behaviour between the groups, as we

Table 2: Single equation results. Long-run elasticities. 1997.

	25-39 years	**40-59 years**	**60-66 years**
Elasticities w.r.t.			
WF	0.078 (.042)	0.143 (.140)	0.847* (.337)
U	-0.028*(.010)	-0.156* (.059)	
ED_i	0.087*(.040)	0.115 (.061)	
$CH03$	-0.084 (.042)		
DR_i			-0.292* (.121)
$\boldsymbol{\sigma}$	0.356	0.330	0.361
Participation rate (97)	0.85	0.83	0.43

*: Significant at a 5% level. Standard errors are provdided in parantheses and are derived according to Bårdsen (1989).

Table 3: Cross-restrictioncs on elasticities.

Model	**Restriction(s)**	**Wald-test**[1)]
I	$\alpha_{25,ED}/\delta_{25} = \alpha_{40,ED}/\delta_{40}$	$\chi^2(1) = 0.26\,[.609]$
II	$\alpha_{25,WF}/\delta_{25} = \alpha_{40,WF}/\delta_{40}$	$\chi^2(1) = 0.20\,[.655]$
III	$\alpha_{25,WF}/\delta_{25} = \alpha_{40,WF}/\delta_{40}$ *and* $\alpha_{25,ED}/\delta_{25} = \alpha_{40,ED}/\delta_{40}$	$\chi^2(2) = 3.97\,[.138]$
IV	$\alpha_{40,WF}/\delta_{40} = \alpha_{60,WF}/\delta_{60}$	$\chi^2(1) = 0.93\,[.334]$
V	$\alpha_{25,WF}/\delta_{25} = \alpha_{60,WF}/\delta_{60}$	$\chi^2(1) = 6.37\,[.012]$
VI	$\alpha_{25,WF}/\delta_{25} = \alpha_{40,WF}/\delta_{40} = \alpha_{60,WF}/\delta_{60ik}$	$\chi^2(2) = 6.80\,[.033]$

1) Significance probabilities are provided in brackets.

ask whether the wage elasticity is independent of age when conditioned on other factors important to labour market participation and which may differ across the life-cycle. We also ask whether the effect of increased educational level is the same for all groups regardless of differing ages and different basis of educational level.

We test whether the elasticitites are equal after having controlled for differences in the participation rates, i.e. we test restrictions of the type $\alpha_{ik}/\delta_i = \alpha_{jk}/\delta_j, j \neq i$.

As shown in table 3, we may restrict the elasticities regarding both wages and educational level to be equal for the two youngest groups, or the wage

Table 4: Constrained long-run elasticities. Women 25-39 years. 1997.

	Model 0	**Model I**	**Model II**	**Model III**
Elast. w.r.t.				
WF	.08 (.04)	.07 (.04)	.09*(.04)	.15*(.06)
U	-.03*(.01)	-.03*(.01)	-.03*(.01)	-.04*(.01)
ED_{25}	.09*(.04)	.09*(.04)	.09*(.04)	.08*(.04)
$CH03$	-.08 (.04)	-.08 (.04)	-.08 (.04)	-.06 (.04)
$\boldsymbol{\sigma}$	.0356	.0356	.0356	.0370

*: Significant at a 5% level. Standard errors are provdided in parantheses.

Table 5: Constrained long-run elasticities. Women 40-59 years. 1997.

.	**Model 0**	**Model I**	**Model II**	**Model III**	**Model IV**
Elast. w.r.t					
WF	.14 (.14)	.19 (.10)	.10 (.08)	.17 (.10)	.25 (.14)
U	-.16*(.06)	-.15*(.05)	-.17*(.06)	-.12*(.05)	-.15*(.05)
ED_{40}	.12 (.06)	.10 (.05)	.13 (.07)	.10 (.05)	.09 (.05)
$\boldsymbol{\sigma}$	.0330	.0323	.0322	.0325	.0320

*: Significant at a 5% level. Standard errors are provdided in parantheses.

elacticities for the age-groups 40-59 years and 60-66 years. We do not get any support for equal wage elactisities across all three groups.

The equations have been reestimated using constrained full information maximum likelihood estimation subject to the four set of valid restrictions; model I-IV in table 3. Model 0 relates to the single equation models. The estimated elasticities are given in tables 4-6.

For the 40-59 years old women, the most to gain in accuracy according to the standard error of equation, σ, is by restricting the wage elasticity to equal that of the oldest ones. The resulting elasticity is however heavily influenced by the latter, which one may hesitate to accept as the oldest group is the definitely smallest one with regard to the number of female it includes.

According to the estimated standard errors of the equations, there is nothing to gain for the models for the youngest and oldest from imposing cross-restrictions. If both wage- and education level elasticities are restricted, the accuracy of the model for female 25-39 years decreases according to σ

Table 6: Constrained long-run elasticities. Women 60-66 years. 1997.

	Model 0	**Model IV**
Elast. w.r.t.		
WF	.84*(.34)	.82*(.33)
DR_{60}	-.29*(.12)	-.28*(.12)
$\boldsymbol{\sigma}$	.0361	.0362

*: Significant at a 5% level. Standard errors are provdided in parantheses.

(Model III). In Model II, with only the wage elasticities for the age-groups 25-39 and 40-59 set equal, we obtain a significant wage elasticity for the youngest group with no loss in accuracy for this group and a gain in accuracy for the older ones. The elasticities with regard to children for female 25-39 years, and education for female 40-59 years, are almost significant with significance probabilities of 0.06 and 0.07 respectively. Model II may thus be evaluated as superior to Model 0 where no restrictions are imposed.

4 Conclusions

As opposed to previous results on female labour participation rates in Norway and most international studies using aggregated time-series, our relations include long-run effects from both wages, education and the number of children, in addition to a significant cyclical component represented by the unemployment rate. It seems as the disaggregation according to different age groups have been more successful then the prior disaggregation according to marital status, even if not all elasticities are significant at a 5 per cent level. With one exception, they are all significant at a 10 per cent level. There is also something to gain by imposing restrictions on the wage elasticity across age after having controlled for other factors that may be more life-cycle specific.

We never obtain significant wage effects on the participation rate for women between 40 and 60 years, which may be due to multicollinarity in the data. The estimated effects are, however, positive and lie within the range 0.10 to 0.25. The highest estimate is found in a specification where the elasticity is heavily influenced by that of the oldest ones, which obtain a wage elasticity of 0.85 when estimated without restrictions. For the youngest group we may conclude on a wage elasticity between 0.07 and 0.09 in 1997.

There are some difficulties in comparing our results with those in other studies, as we disaggregate according to age and not marital status, male earnings are not included due to insignificant parameters, and our elasticities are dependent on the participation rates. A summary of microbased studies on female labour supply in Killingsworth and Heckman (1986), OECD (1995) and Blundell and MaCurdy (1998), however suggest an own wage elasticity on married women's labour supply (in hours) of about 0.5-0.6, when controlled for male earnings. A microbased study on Norwegian 1986-data (Aaberge et al., 1998), finds a net effect on married women's participation rates of 0.25 if both male and female wages increase. With the 1986-participation rate our model II gives wage elasticities of 0.14 for both 25-39 years and 40-59 years females. Previous macrobased Norwegian studies find a zero net effect on married women's participation rates as female and male wages has a opposite, but equal effect. The wage elasticity for unmarried women differs between 0.07 and 0.18 in the same studies (Lindquist et al., 1990, Bowitz, 1992 and Zakariassen, 1994).

For the two age-groups, 25-39 years and 40-59 years, we obtain significant effects from labour market conditions on female labour participation rates. The effect is strongest for the oldest of these two groups[10], with an elasticity between -0.12 and -0.17, while the youngest obtain an elasticity of -0.03. The increased labour participation rate among Norwegian women during the last upturn may accordingly be seen as a result of an opposite discouraged worker effect, and not only as part of a more general trend. In this context it is worth noting that Norway, being almost on top in the OECD with regard to female participation rates, also has been more successful in keeping a low rate of unemployment compared to other European countries. According to our findings, a high rate of unemployment may be reactiv in order to increase female labour participation rates.

Our results also give reasonable results with regard to the effect from increased educational level and from the number of smaller children. We do not get any effects from the extension of the parental leave and increased day-care coverage. These negative conclusions may be due to aggregation problems but may also indicate that these reforms are more a result of the entrance of huge groups of females into the labour market. We should neither ignore that these reforms may work more slowely, by giving a signal to

[10]Not yet published results for male participation rates, indicate a similar effect with an elasticity of -0.06 for the age-group 25-59 years, and -0.18 for the age-group 60-66 years.

younger women that it is possible to be a working mother and consequently, increasing the potential gain from getting more education. And female participation rates increase with education. Yet another explanation may be that the policy reforms considered in this paper do not affect female labour participation, but instead act to reduce a possible negative effect on fertility from an increased educational level among women. In any case, confronted with an ageing population, society both wants women to have children and to participate in the labour market. A successful policy should be directed at making this combination possible.

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Figurer

Figure 1. Female labour participation rates. 1972-97

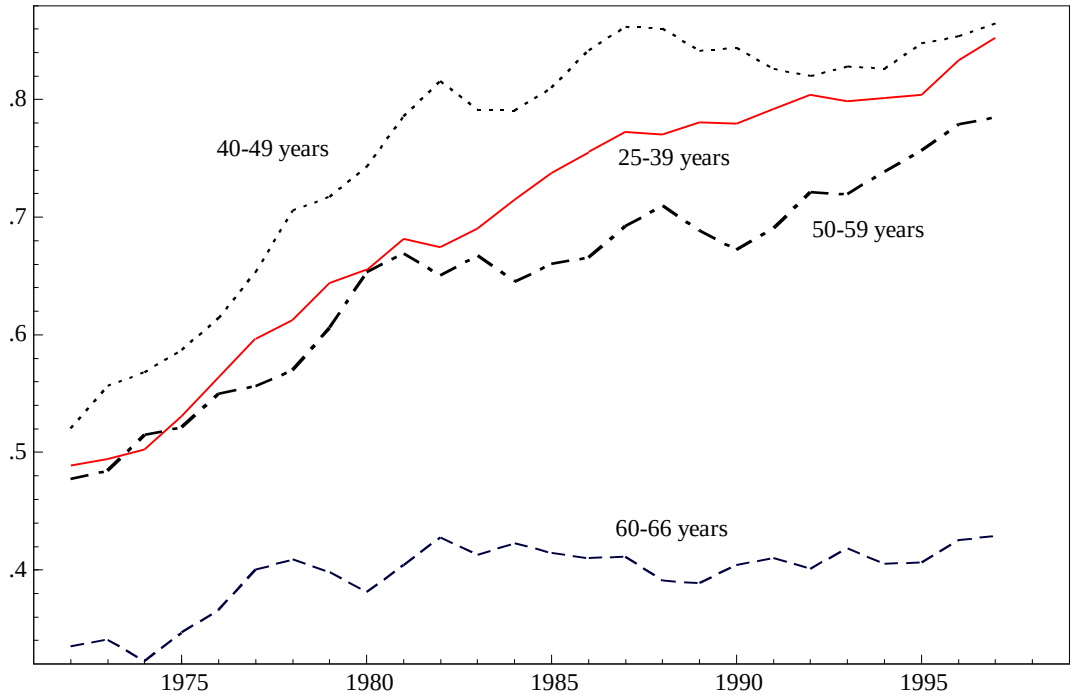

Figure 2. Labour participation rate 25-39 years (YP25), number of children 0-3 years per women (CH03) and day-care coverage (DC)

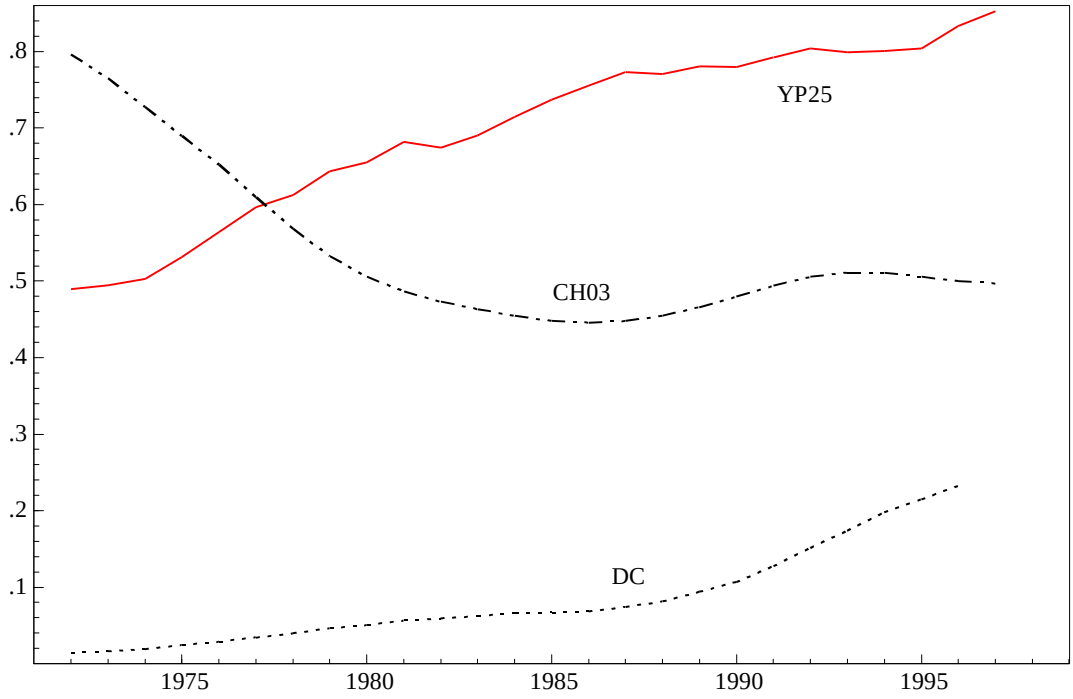

Figure 3. Educational level. The ratio with 13 years or more education relative to the ratio with nine-years school.

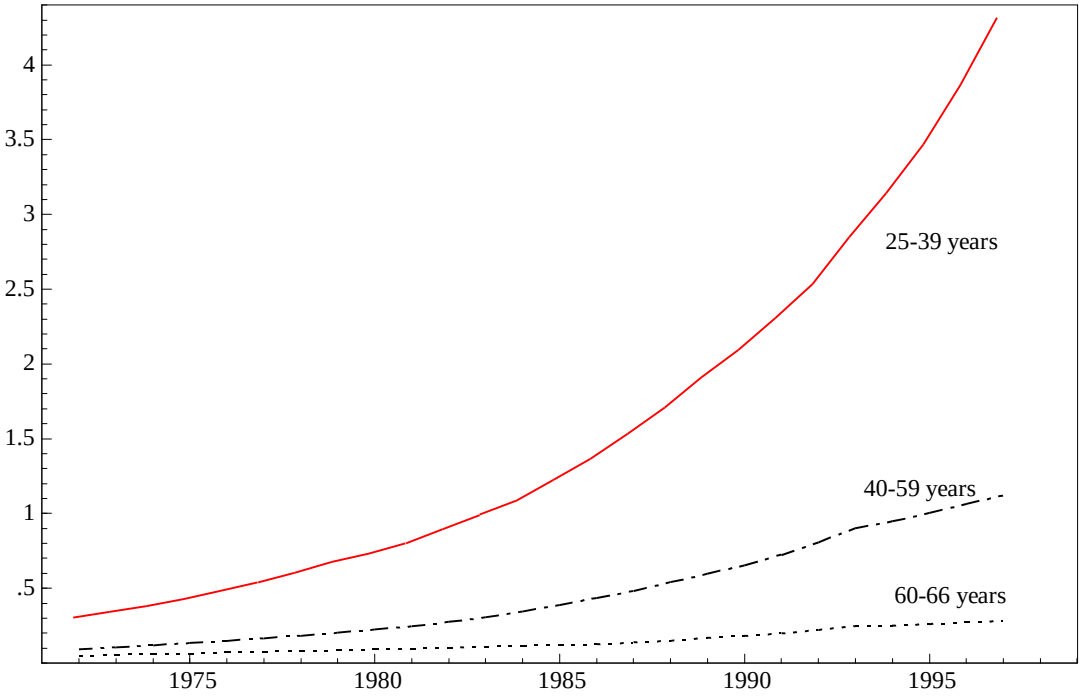

Figure 4. Labour participation rate 25-39 years (YP25) and 40-59 years (YP40), and uneployment rate (U) (adjusted scale).

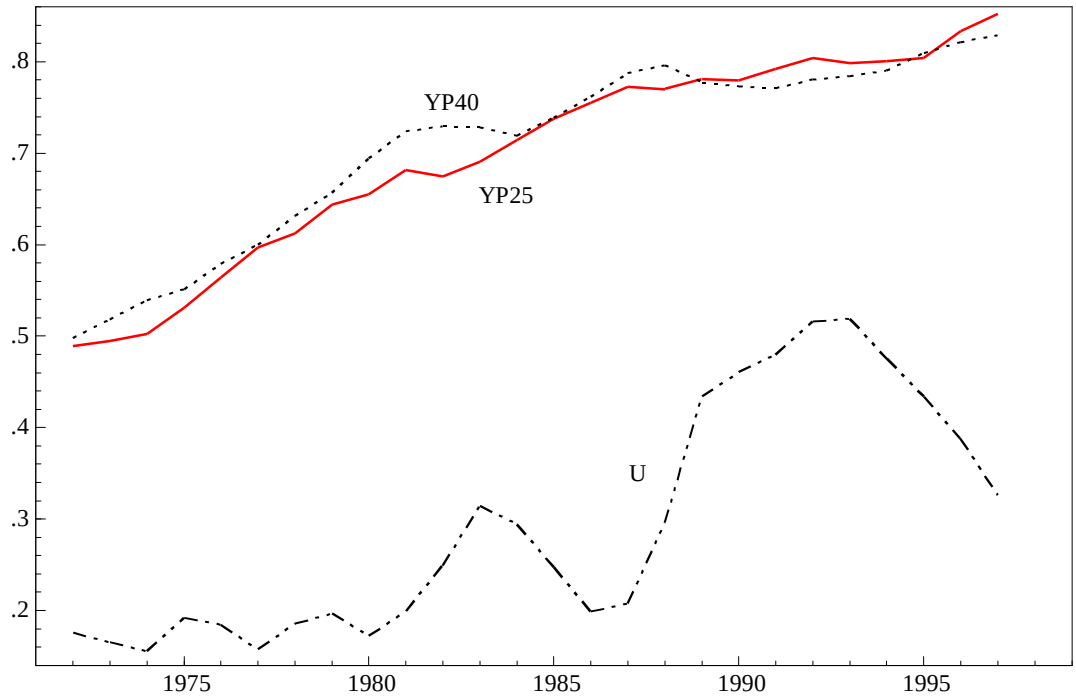

Figure 5. Female labour participation rates, 15 (16)-64 years. Source: OECD Employment outlook 1993, 1994, 1998

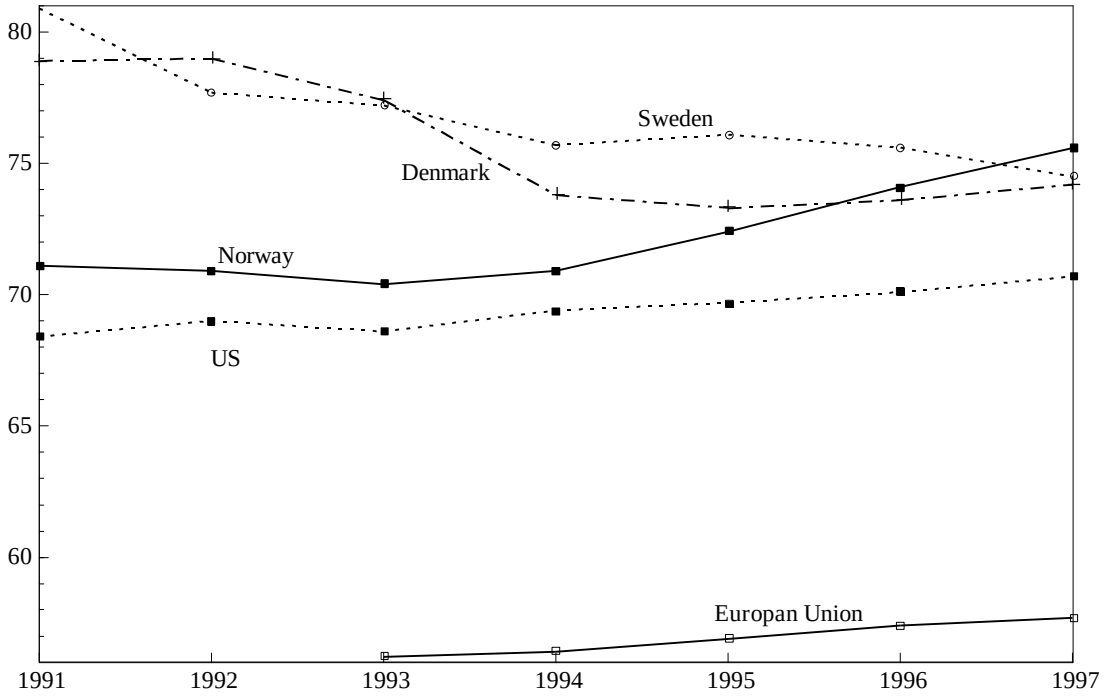

Figure 6. Standarized unemployment rates. Source: OECD: Employment Outlook 1998

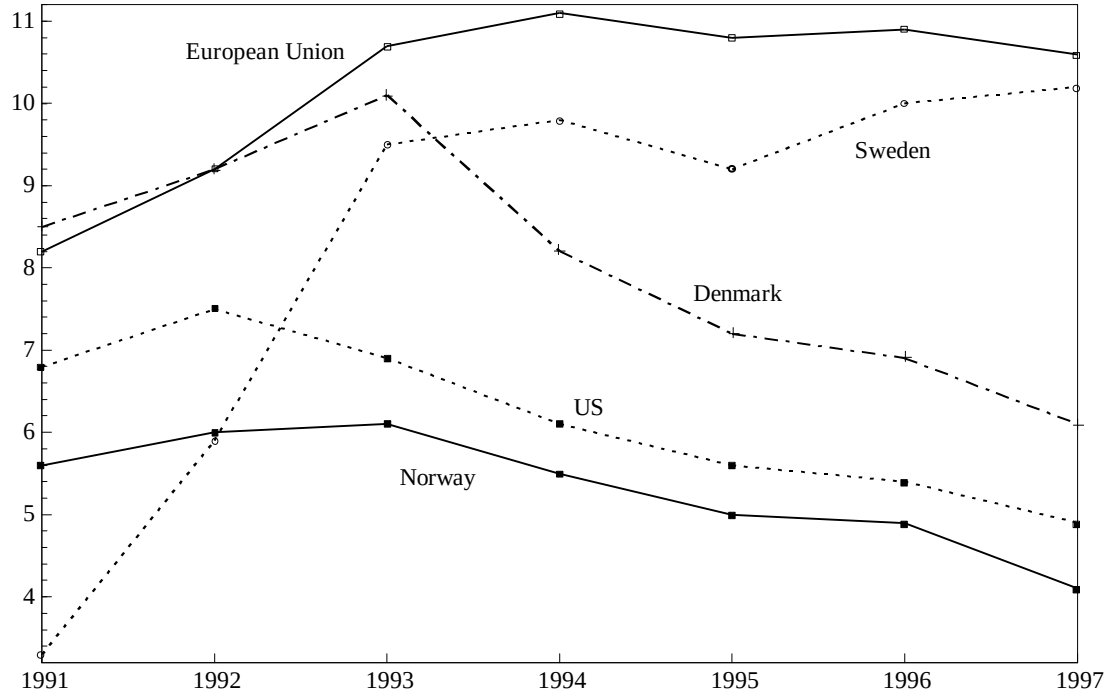

Figure 7. Labour participation rate 40-59 years (YP40) and 60-66 years (YP60), and disability rate 40-59 years (DR40) and 60-66 years (DR60)

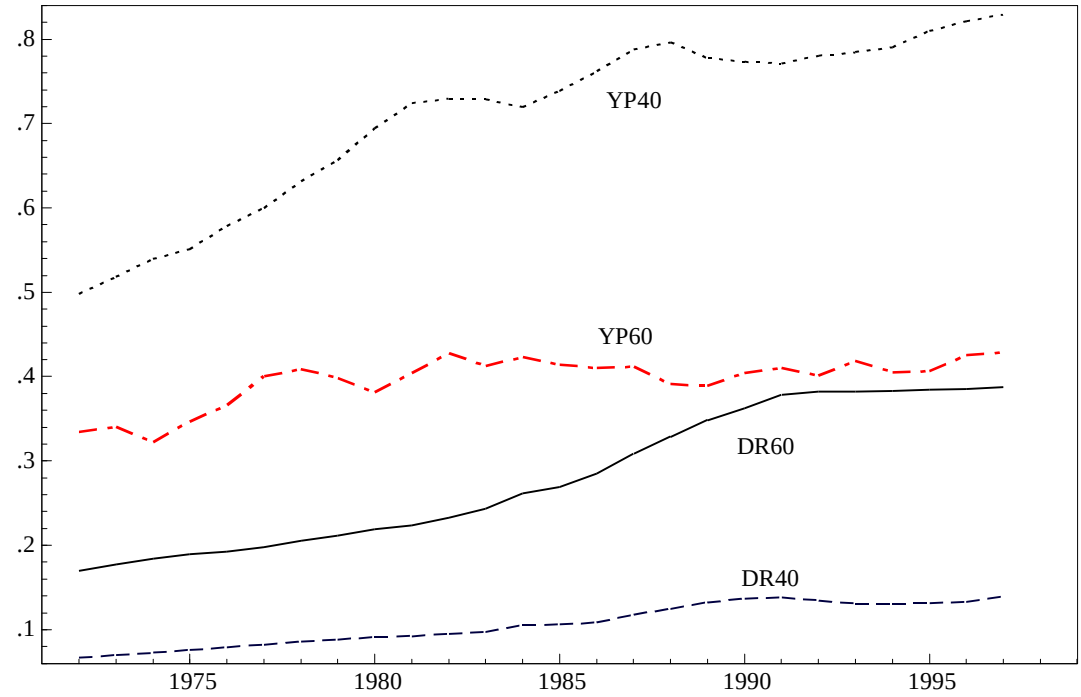

Figure 8. Female 25-39 years. Actual and fitted values of Δyp25

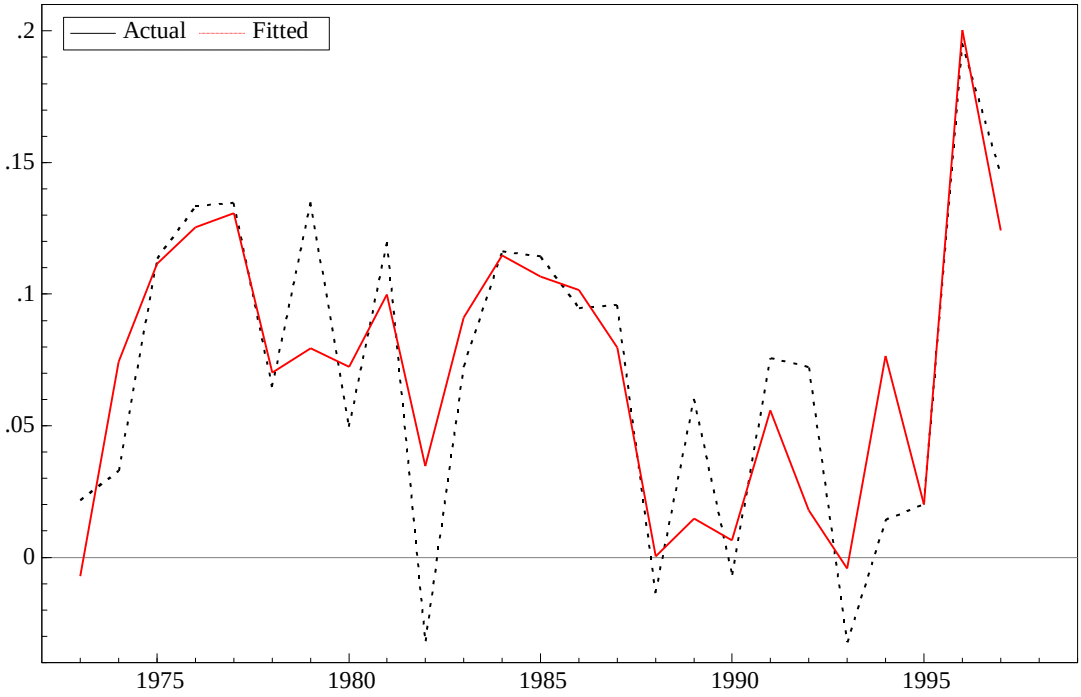

Figure 9. Female 25-39 years. Recursive graphics

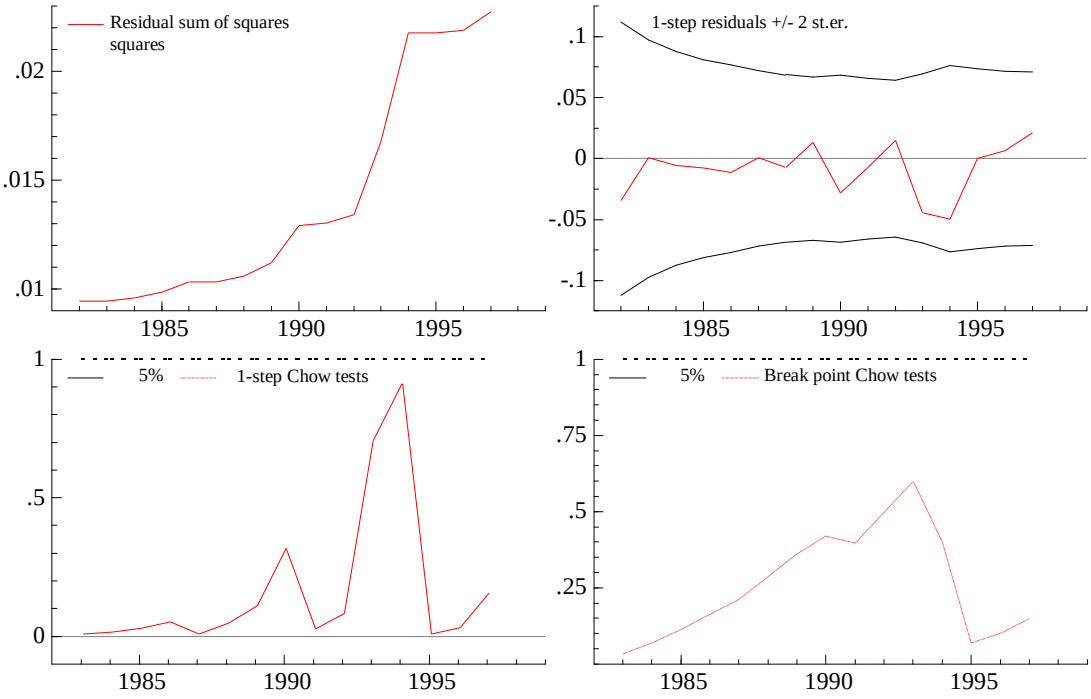

Figure 10. Female 40-59 years. Actual and fitted values of Δyp40

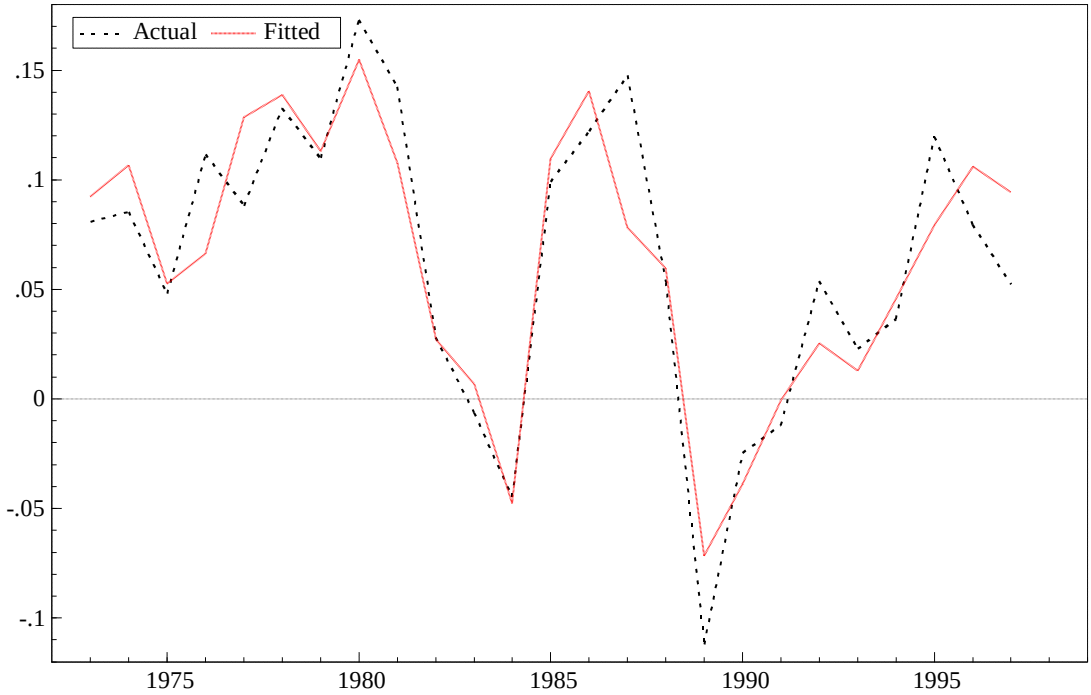

Figure 11. Female 40-59 years. Recursive graphics

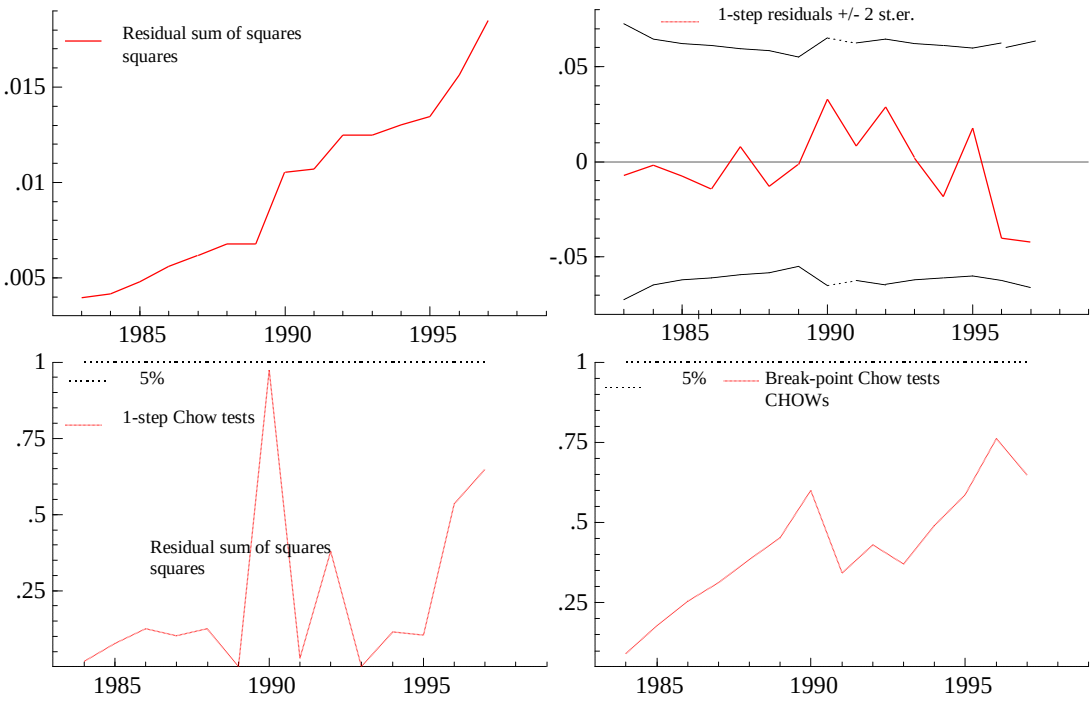

Figure 12. Female 60-66 years. Actual and fitted values of Δyp60

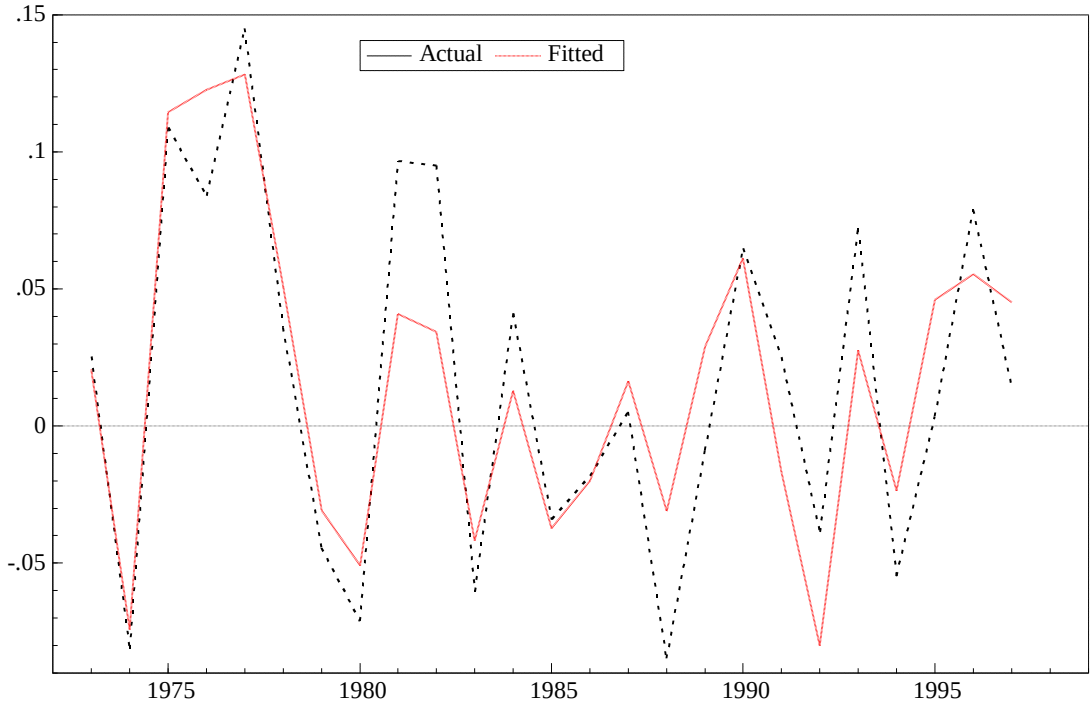

Figure 13. Female 60-66 years. Recursive graphics